# IRP SURVEY

- AES Indiana invites the public and stakeholders to provide feedback on the IRP process.
- Your responses will help AES Indiana ensure the 2022 IRP reflects a meaningful, objective look at our shared energy future.
- Input from this survey will be reviewed by members of the IRP team in advance of the final IRP report filing on or before Dec. 1, 2022, and to improve future IRPs.
- Your participation in this survey is confidential and completely voluntary.
- Responses will be collected until Nov. 13, 2022.
- The survey link will be shared in the chat.

# Final Q&A and Next Steps

# Public Advisory Meeting

| Public Advisory Meeting #1 | Public Advisory Meeting #2 | Public Advisory Meeting #3 | Public Advisory Meeting #4 | Public Advisory Meeting #5 |
|---|---|---|---|---|
| **Jan. 24, 2022** | **April 12, 2022** | **June 27, 2022** | **Sept. 19, 2022** | **Oct. 31, 2022** |

→ All meetings were made available for attendance via Teams.

→ A Technical Meeting was held the week preceding each Public Advisory Meeting for stakeholders with nondisclosure agreements. Tech Meeting topics focused on those anticipated at the proceeding Public Advisory Meeting.

→ Meeting materials can be accessed at ***www.aesindiana.com/integrated-resource-plan***.

→ ***IRP Report will be filed with the IURC December 1, 2022***

# Thank You



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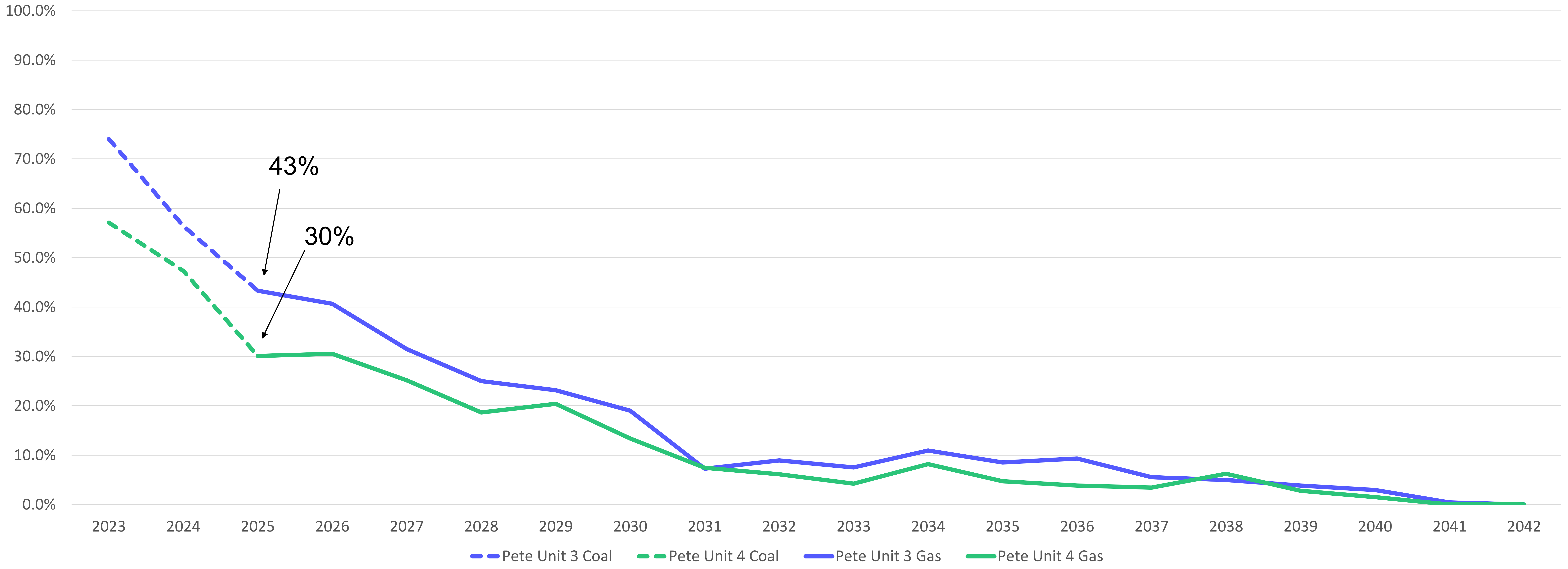
# Appendix

# Petersburg Capacity Factors Pre vs Post Gas Conversion

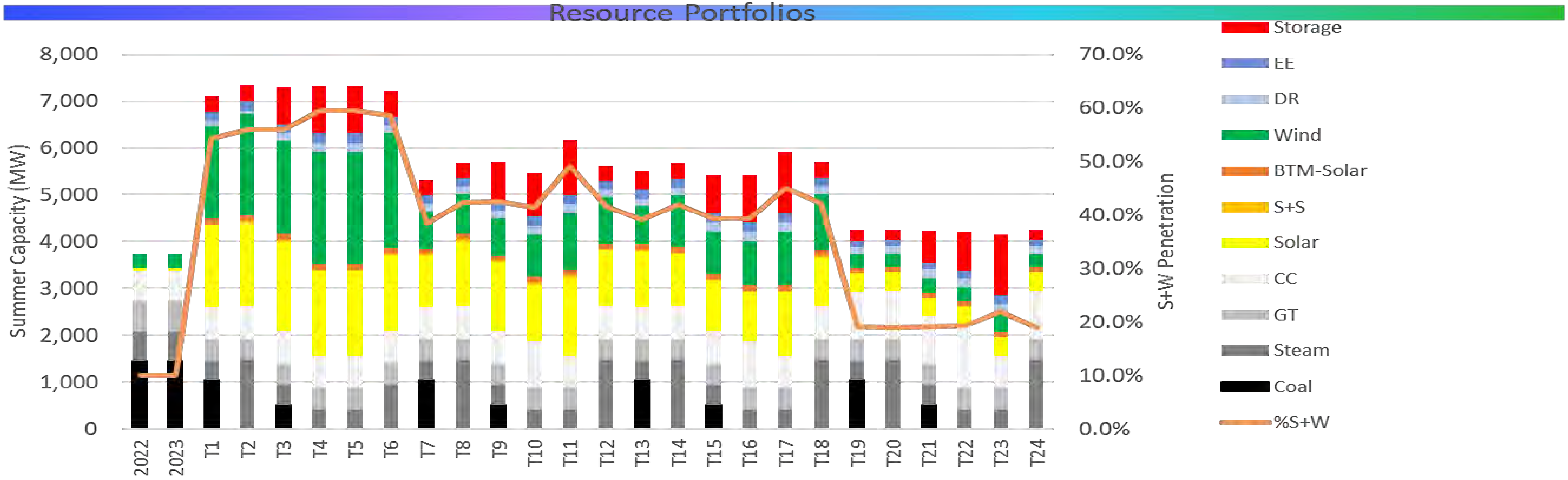
Converting Petersburg to natural gas results in significant drop in capacity factor that continues over the planning period.



# Quanta Analysis - Appendix 1

# All Portfolios

# Portfolios (T1-T24)




| | Aggressive Environmental | | | | | | Current Trends | | | | | | Decarbonization | | | | | | No Environmental | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz |
| **Disp %** | **43** | **42** | **42** | **38** | **38** | **39** | **58** | **55** | **54** | **55** | **48** | **55** | **57** | **55** | **57** | **57** | **52** | **55** | **78** | **78** | **78** | **77** | **73** | **78** |
| **S&W %** | 54 | 56 | 56 | 59 | 59 | 59 | 38 | 42 | 43 | 41 | 49 | 42 | 39 | 42 | 39 | 39 | 45 | 42 | 19 | 19 | 19 | 19 | 22 | 19 |



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# Portfolio Resources

| | Aggressive Environmental | | | | | | Current Trends | | | | | | Decarbonization | | | | | | No Environmental | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz |
| **Y2031 - All Resources** | **T1** | **T2** | **T3** | **T4** | **T5** | **T6** | **T7** | **T8** | **T9** | **T10** | **T11** | **T12** | **T13** | **T14** | **T15** | **T16** | **T17** | **T18** | **T19** | **T20** | **T21** | **T22** | **T23** | **T24** |
| Solar | 1,755 | 1,780 | 1,905 | 1,805 | 1,805 | 1,630 | 1,105 | 1,380 | 1,480 | 1,180 | 1,655 | 1,205 | 1,205 | 1,130 | 1,080 | 1,030 | 1,355 | 1,055 | 405 | 405 | 405 | 405 | 405 | 405 |
| BTM-Solar | 124 | 124 | 124 | 124 | 124 | 124 | 110 | 110 | 110 | 110 | 110 | 110 | 124 | 124 | 124 | 124 | 124 | 124 | 102 | 102 | 102 | 102 | 102 | 102 |
| Wind | 1,950 | 2,150 | 2,000 | 2,400 | 2,400 | 2,450 | 800 | 850 | 800 | 900 | 1,200 | 1,000 | 800 | 1,100 | 900 | 950 | 1,150 | 1,200 | 300 | 300 | 300 | 300 | 400 | 300 |
| S+S | 25 | 50 | 50 | 25 | 25 | 25 | 25 | 60 | 35 | 69 | 69 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 0 | 0 | 0 | 0 | 0 | 0 |
| Storage | 333 | 345 | 785 | 1,013 | 1,013 | 553 | 333 | 313 | 840 | 920 | 1,180 | 313 | 393 | 333 | 813 | 1,013 | 1,293 | 333 | 240 | 240 | 680 | 820 | 1,280 | 240 |
| Steam | 420 | 1,472 | 420 | 420 | 420 | 946 | 420 | 1,472 | 420 | 420 | 420 | 1,472 | 420 | 1,472 | 420 | 420 | 420 | 1,472 | 420 | 1,472 | 420 | 420 | 420 | 1,472 |
| GT | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 | 464 |
| CC | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 680 | 1,005 | 680 | 680 | 680 | 680 | 680 | 1,005 | 680 | 680 | 1,005 | 1,005 | 1,005 | 1,330 | 680 | 1,005 |
| Coal | 1,040 | 0 | 520 | 0 | 0 | 0 | 1,040 | 0 | 520 | 0 | 0 | 0 | 1,040 | 0 | 520 | 0 | 0 | 0 | 1,040 | 0 | 520 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| EE | 195 | 195 | 195 | 195 | 195 | 195 | 195 | 194 | 194 | 194 | 195 | 195 | 195 | 195 | 195 | 195 | 195 | 194 | 118 | 118 | 136 | 165 | 194 | 119 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| DR | 121 | 73 | 154 | 198 | 198 | 154 | 154 | 154 | 154 | 198 | 198 | 154 | 154 | 154 | 198 | 198 | 198 | 154 | 154 | 154 | 198 | 198 | 198 | 154 |
| **ICAP (MW) - Total** | **7,106** | **7,333** | **7,296** | **7,322** | **7,322** | **7,220** | **5,325** | **5,676** | **5,696** | **5,460** | **6,170** | **5,617** | **5,499** | **5,676** | **5,417** | **5,422** | **5,902** | **5,700** | **4,247** | **4,259** | **4,229** | **4,203** | **4,142** | **4,260** |
| **Conventional (MW)** | 2,604 | 2,616 | 2,084 | 1,564 | 1,564 | 2,090 | 2,604 | 2,616 | 2,084 | 1,889 | 1,564 | 2,616 | 2,604 | 2,616 | 2,084 | 1,889 | 1,564 | 2,616 | 2,929 | 2,941 | 2,409 | 2,214 | 1,564 | 2,941 |
| **Intermittent (MW)** | 3,854 | 4,104 | 4,079 | 4,354 | 4,354 | 4,229 | 2,040 | 2,390 | 2,415 | 2,240 | 3,015 | 2,340 | 2,154 | 2,379 | 2,129 | 2,129 | 2,654 | 2,404 | 807 | 807 | 807 | 807 | 907 | 807 |
| **Storage (MW)** | 333 | 345 | 785 | 1,013 | 1,013 | 553 | 333 | 313 | 840 | 920 | 1,180 | 313 | 393 | 333 | 813 | 1,013 | 1,293 | 333 | 240 | 240 | 680 | 820 | 1,280 | 240 |
| % Renewable Penetration | 70% | 76% | 74% | 81% | 81% | 80% | 35% | 40% | 41% | 39% | 52% | 41% | 36% | 42% | 37% | 37% | 46% | 43% | 13% | 13% | 13% | 13% | 15% | 13% |
| % Intermittent | 54% | 56% | 56% | 59% | 59% | 59% | 38% | 42% | 43% | 41% | 49% | 42% | 39% | 42% | 39% | 39% | 45% | 42% | 19% | 19% | 19% | 19% | 22% | 19% |



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# Scorecard – Portfolio Scores

| | | | Aggressive Environmental | | | | | | Current Trends | | | | | | Decarbonization | | | | | | No Environmental | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz |
| | **Year 2031** | | **T1** | **T2** | **T3** | **T4** | **T5** | **T6** | **T7** | **T8** | **T9** | **T10** | **T11** | **T12** | **T13** | **T14** | **T15** | **T16** | **T17** | **T18** | **T19** | **T20** | **T21** | **T22** | **T23** | **T24** |
| 1 | Energy Adequacy | Loss of Load Hours (LOLH) - normal system, 50/50 forecast | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| | | Expected Energy not Served (GWh) - normal system 50/50 fcst | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | max MW Short (MW) - normal system 50/50 forecast | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | max MW Short - loss of 50% of tieline capacity, 50/50 fcst | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1/2 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| | | max MW Short (islanded, 50/50 forecast) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | max MW Short (normal system, 90/10 forecast) | 1/2 | 1/2 | 0 | 0 | 0 | 0 | 1/2 | 1/2 | 0 | 0 | 0 | 1/2 | 1/2 | 1/2 | 0 | 1/2 | 0 | 1/2 | 1/2 | 1/2 | 0 | 0 | 0 | 1/2 |
| 2 | Operational Flexibility and Frequency Support | Inertia MVA-s | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1 | 1 | 1/2 | 1 | 1/2 | 1 |
| | | Inertial Gap FFR MW (% CAP) | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| | | Primary Gap PFR MW (% CAP) | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 3 | Short Circuit Strength | Inverter MWs passing ESCR limits (%) - Connected System | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Inverter MWs passing ESCR limits (%) - Islanded System | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1/2 | 0 | 1 | 1 | 1 | 1/2 | 1/2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Required Additional Synch Condensers MVA (when Connected) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Required Additional Synch Condensers MVA (when Islanded) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1/2 | 1/2 | 0 | 1 | 1 | 1 | 1/2 | 1/2 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4 | Power Quality | Compliance with Flicker limits when Connected (GE Flicker Curve or IEC Flicker Meter) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Compliance with Flicker limits when Islanded | 1 | 1 | 1 | 1/2 | 1/2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Required Synchronous Condensers MVA to mitigate Flicker | 1 | 1 | 1 | 1/2 | 1/2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | Blackstart | Qualitative Assessment of Ability to Blackstart the system | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | Dynamic VAR Support | Dynamic VAR to load Center Capability (% of Peak Load) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | Dispatchability and Automatic Generation Control | Dispatchable (%CAP) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Unavoidable VER Penetration % | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Increased Freq Regulation Requirements (% Peak Load) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | 1-min Ramp Capability (MW) | 1/2 | 1/2 | 1 | 1 | 1 | 1 | 1/2 | 1/2 | 1 | 1 | 1 | 1/2 | 1/2 | 1/2 | 1 | 1 | 1 | 1/2 | 1/2 | 1/2 | 1 | 1 | 1 | 1/2 |
| | | 10-min Ramp Capability (MW) | 0 | 0 | 0 | 1/2 | 1/2 | 0 | 0 | 0 | 1/2 | 1/2 | 1/2 | 0 | 0 | 0 | 1/2 | 1/2 | 1 | 0 | 0 | 0 | 1/2 | 1/2 | 1 | 0 |
| 8 | Predictability and Firmness | Ramping Capability to Mitigate Forecast Errors (+Excess/-Deficit) (%VER MW) | 1/2 | 1/2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | Location | Average Number of Evacuation Paths | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| | | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 | T14 | T15 | T16 | T17 | T18 | T19 | T20 | T21 | T22 | T23 | T24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Energy Adequacy | 0.92 | 0.92 | 0.83 | 0.50 | 0.50 | 0.83 | 0.92 | 0.92 | 0.67 | 0.58 | 0.50 | 0.92 | 0.92 | 0.92 | 0.67 | 0.92 | 0.50 | 0.92 | 0.92 | 0.92 | 0.83 | 0.67 | 0.50 | 0.92 |
| 2 | Dispatchability and Automatic Generation Control | 0.70 | 0.70 | 0.80 | 0.90 | 0.90 | 0.80 | 0.70 | 0.70 | 0.90 | 0.90 | 0.90 | 0.70 | 0.70 | 0.70 | 0.90 | 0.90 | 1.00 | 0.70 | 0.70 | 0.70 | 0.90 | 0.90 | 1.00 | 0.70 |
| 3 | Operational Flexibility and Frequency Support | 0.33 | 0.33 | 0.67 | 0.67 | 0.67 | 0.33 | 0.33 | 0.33 | 0.67 | 0.67 | 0.67 | 0.33 | 0.33 | 0.33 | 0.67 | 0.67 | 0.67 | 0.33 | 0.50 | 0.50 | 0.67 | 0.83 | 0.67 | 0.50 |
| 4 | Predictability and Firmness | 0.50 | 0.50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 5 | Short Circuit Strength | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 1.00 | 1.00 | 0.63 | 0.75 | 0.50 | 1.00 | 1.00 | 1.00 | 0.75 | 0.75 | 0.50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 6 | Dynamic VAR Support | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 7 | Location | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 8 | Power Quality | 1.00 | 1.00 | 1.00 | 0.67 | 0.67 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 9 | Blackstart | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| | Cumulative Score (out of possible 9 | 6.95 | 6.95 | 7.80 | 7.23 | 7.23 | 7.47 | 7.95 | 7.95 | 7.86 | 7.90 | 7.57 | 7.95 | 7.95 | 7.95 | 7.98 | 8.23 | 7.67 | 7.95 | 8.12 | 8.12 | 8.40 | 8.40 | 8.17 | 8.12 |

# Mitigations

| | Aggressive Environmental | | | | | | Current Trends | | | | | | Decarbonization | | | | | | No Environmental | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz | Quo | Refuel | 1 Retire | 2 Retire | Clean | Optimiz |
| | **T1** | **T2** | **T3** | **T4** | **T5** | **T6** | **T7** | **T8** | **T9** | **T10** | **T11** | **T12** | **T13** | **T14** | **T15** | **T16** | **T17** | **T18** | **T19** | **T20** | **T21** | **T22** | **T23** | **T24** |
| Equip Stand-alone ESS with GFM inverters (MW) | **124** | **93** | **178** | **123** | **123** | **164** | **129** | **99** | **183** | **49** | **128** | **98** | **129** | **98** | **183** | **49** | **128** | **98** | **53** | **23** | **107** | **221** | **133** | **23** |
| Additional Synchronous Condensers (MVA) | **1250** | **1500** | **1900** | **2700** | **2700** | **2050** | **0** | **0** | **350** | **300** | **1500** | **0** | **0** | **0** | **100** | **200** | **1100** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| Additional Power Mitigations (MW) | **323** | **322** | **178** | **123** | **123** | **164** | **298** | **326** | **183** | **49** | **128** | **325** | **239** | **310** | **183** | **49** | **128** | **310** | **370** | **378** | **107** | **221** | **133** | **378** |
| Increased Freq Regulation | 90 | 97 | 97 | 105 | 105 | 101 | 39 | 48 | 49 | 45 | 66 | 47 | 42 | 48 | 41 | 41 | 56 | 49 | 9 | 9 | 9 | 9 | 11 | 9 |
| Address Inertial Response Gaps | 124 | 93 | 178 | 123 | 123 | 164 | 129 | 99 | 183 | 49 | 128 | 98 | 129 | 98 | 183 | 49 | 128 | 98 | 53 | 23 | 107 | 221 | 133 | 23 |
| Address Primary Response Gaps | 323 | 322 | 0 | 0 | 0 | 117 | 298 | 326 | 0 | 0 | 0 | 325 | 239 | 310 | 0 | 0 | 0 | 310 | 370 | 378 | 0 | 0 | 0 | 378 |
| Firm up Intermittent Renewable Forecast | 94 | 138 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# IRP Acronyms

*Note: A glossary of acronyms with definitions is available at https://www.aesindiana.com/integrated-resource-plan.*

# IRP Acronyms

- ACEE: The American Council for an Energy-Efficient Economy
- AMI: Advanced Metering Infrastructure
- AD: Ad Valorem
- AD/CVD: Antidumping and Countervailing Duties
- ADMS: Advanced Distribution Management System
- BESS: Battery Energy Storage System
- BNEF: Bloomberg New Energy Finance
- BTA: Build-Transfer Agreement
- BTU: British Thermal Unit
- C&I: Commercial and Industrial
- CAA: Clean Air Act
- CAGR: Compound Annual Growth Rate
- CCGT: Combined Cycle Gas Turbines
- CCP: Coal Combustion Products
- CCS: Carbon Dioxide Capture and Storage
- CDD: Cooling Degree Day
- CIS: Customer Integrated System
- COD: Commercial Operation Date
- CONE: Cost of New Entry
- CP: Coincident Peak
- CPCN: Certificate of Public Convenience and Necessity
- CT: Combustion Turbine
- CVD: Countervailing Duties
- CVR: Conservation Voltage Reduction
- DER: Distributed Energy Resource
- DERA: Distributed Energy Resource Aggregation
- DERMS: Distributed Energy Resource Management System
- DG: Distributed Generation
- DGPV: Distributed Generation Photovoltaic System
- DLC: Direct Load Control
- DOC: U.S. Department of Commerce
- DOE: U.S. Department of Energy
- DR: Demand Response
- DRR: Demand Response Resource
- DSM: Demand-Side Management
- DMS: Distribution Management System
- DSP: Distribution System Planning
- EE: Energy Efficiency
- EFORd: Equivalent Forced Outage Rate Demand
- EIA: Energy Information Administration
- ELCC: Effective Load Carrying Capability
- EM&V: Evaluation Measurement and Verification
- ESCR: Effective Short Circuit Ratio
- ESPT: Energy Storage Planning Tool
- EV: Electric Vehicle
- FLOC: Functional Location
- FTE: Full-Time Employee
- GDP: Gross Domestic Product
- GFL: Grid-Following System
- GFM: Grid-Forming System
- GIS: Geographic Information System
- GT: Gas Turbine
- HDD: Heating Degree Day
- HVAC: Heating, Ventilation, and Air Conditioning
- IAC: Indiana Administrative Code
- IBR: Inverter-Based Resource
- IC: Indiana Code
- ICE: Intercontinental Exchange
- ICAP: Installed Capacity



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# IRP Acronyms

- IEEE: Institute of Electrical and Electronics Engineers
- IRA: Inflation Reduction Act
- IRP: Integrated Resource Plan
- ICE: Internal Combustion Engine
- IQW: Income Qualified Weatherization
- ITC: Investment Tax Credit
- IURC: Indiana Regulatory Commission
- kW: Kilowatt
- kWh: Kilowatt-Hour
- Li-ion: Lithium-ion
- MATS: Mercury and Air Toxics Standards
- MaxGen: Maximum Generation
- MDMS: Meter Data Management System
- MISO: Midcontinent Independent System Operator
- MMGAL: One Million Gallons
- MMTons: One Million Metric Tons
- MPS: Market Potential Study
- MS: Millisecond
- MVA: Mega Volt Ampere
- MW: Megawatt
- Nat Gas: Natural Gas
- NDA: Nondisclosure Agreement
- NOX: Nitrogen Oxides
- NPV: Net Present Value
- NREL: National Renewable Energy Laboratory
- NTG: Net to Gross
- OMS: Outage Management System
- PLL: Phase-Locked Loop
- PPA: Power Purchase Agreement
- PRA: Planning Resource Auction
- PSSE: Power System Simulator for Engineering
- PTC: Renewable Electricity Production Tax Credit
- PRMR: Planning Reserve Margin Requirement
- PV: Photovoltaic
- PVRR: Present Value Revenue Requirement
- PY: Planning Year
- RA: Resource Adequacy
- RAN: Resource Availability and Need
- RAP: Realistic Achievable Potential
- RCx: Retrocommissioning
- REC: Renewable Energy Credit
- REP: Renewable Energy Production
- RFP: Request for Proposals
- RIIA: MISO's Renewable Integration Impact Assessment
- RPS: Renewable Portfolio Standard
- SCADA: Supervisory Control and Data Acquisition
- RTO: Regional Transmission Organization
- SAC: MISO's Seasonal Accredited Capacity
- SAE: Small Area Estimation
- SCR: Selective Catalytic Reduction System
- SEM: Strategic Energy Management
- SO2: Sulfur Dioxide
- SMR: Small Modular Reactors
- ST: Steam Turbine
- SUFG: State Utility Forecasting Group
- T&D: Transmission and Distribution
- TOU: Time-of-Use
- TRM: Technical Resource Manual
- UCT: Utility Cost Test
- UCAP: Unforced Capacity
- VAR: Volt-Amp Reactive
- VPN: Virtual Private Network
- WTP: Willingness to Participate
- XEFORd: Equivalent Forced Outage Rate Demand excluding causes of outages that are outside management control



aes Indiana

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# 2022 Integrated Resource Plan

(IRP)

## Volume III

December 1, 2022

aes Indiana

# 2022 IRP

# Attachment 5-1

(Test Year July 2016 through June 2017 Hourly Loads - MW)

Provided electronically

# 2022 IRP

# Attachment 5-2

(AES Indiana's 2022 Energy and Demand Forecast Report)

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# 2022 Long-Term Energy and Demand Forecast Report

## AES Indiana

*Submitted to:*

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Indianapolis, Indiana

*Submitted by:*

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November 2022

# Contents

# 1 Overview

The 2022 IRP forecast provides sector and system energy and demand forecasts through 2042. The forecast is derived using a bottom-up approach where customer sector sales forecast for residential, commercial, and industrial sectors are translated that into long-term baseline energy and system demand requirements excluding future energy efficiency (EE) program impacts; for planning purposes, future EE savings are treated as a supply resource. The baseline forecast is adjusted for expected impact of behind-the-meter (BTM) solar market penetration and electric vehicle charging loads.

AES Indiana serves over 510,000 customers in the city of Indianapolis and surrounding area (primarily Marion County). In 2021, residential sales accounted for 40% of sales, commercial 39%, and industrial 21%. Figure 1 shows 2021 class-level sales distribution.

**Figure 1: 2021 Class Sales (MWh) Distribution**

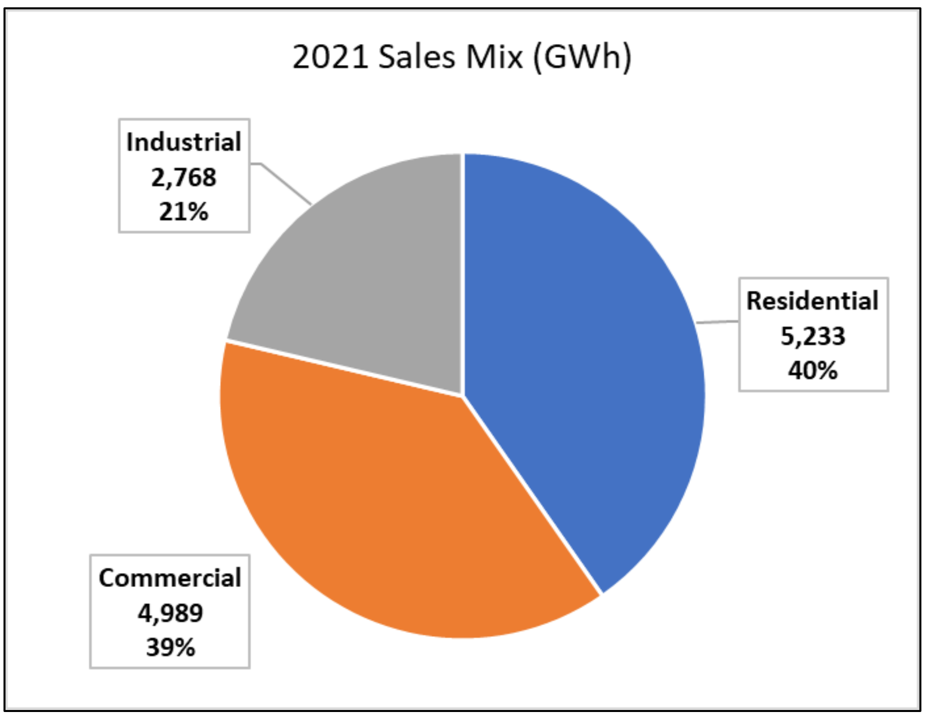
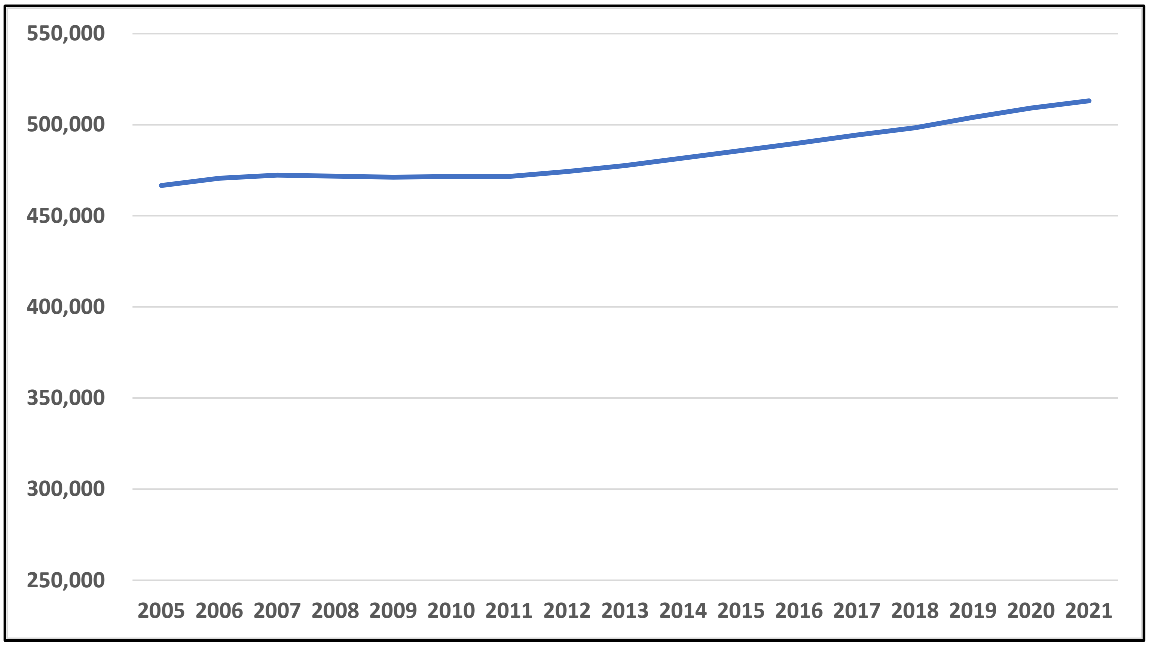



Figure 2 shows total number of customers since 2005.

**Figure 2: AES Indiana Customers**




Between 2005 and 2011 there was little customer growth. This all changed starting in 2011 with consistent customer growth averaging 0.8% per year. Residential customers are 88% of total customers and have been increasing 0.9% per year. Commercial customers have been averaging 0.6% annual growth while the number of industrial customers has declined from 224 customers in 2010 to 185 customers in 2021. AES Indiana is expected to see strong customer growth over the forecast horizon driven by a strong economy combined with relatively affordable housing. Indianapolis is the third most populous city in the Midwest after Chicago and Columbus. There are over 2 million people in the Indianapolis MSA with population is expected to increase by 26 percent over the next 30 years.

Despite relatively strong customer growth, the weather normalized system energy and peak demand has been declining. Largely as a result of strong energy efficiency gains, customer average use has been declining slightly faster than customer growth. Figure 3 and Figure 4 show the annual system energy and peak demand, actual and weather normalized from 2011 to 2021.

**Figure 3: System Energy (MWh)**

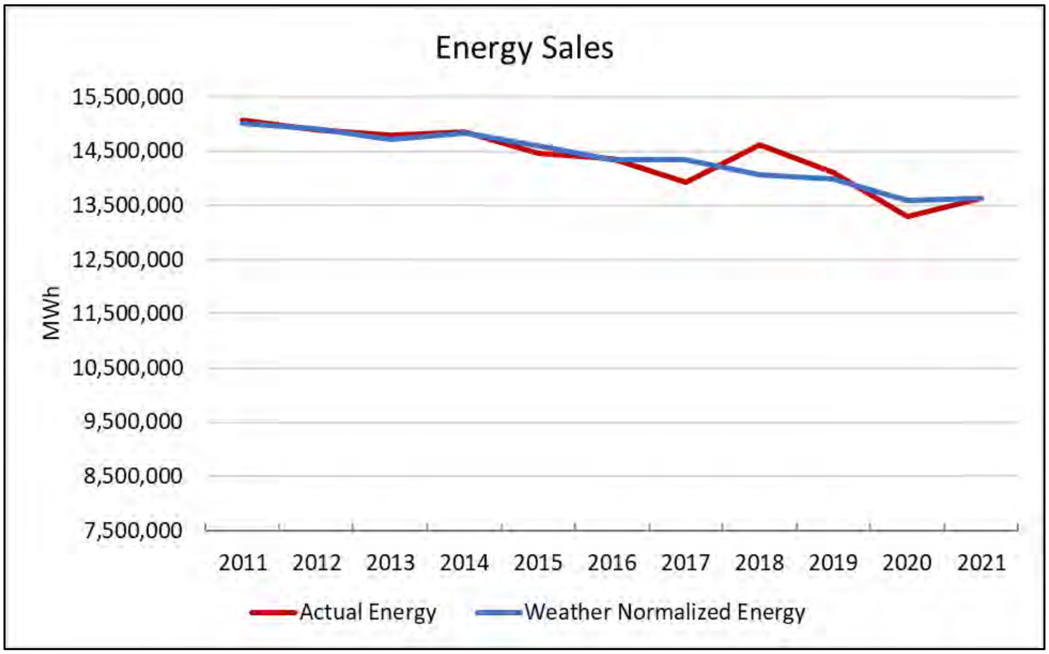
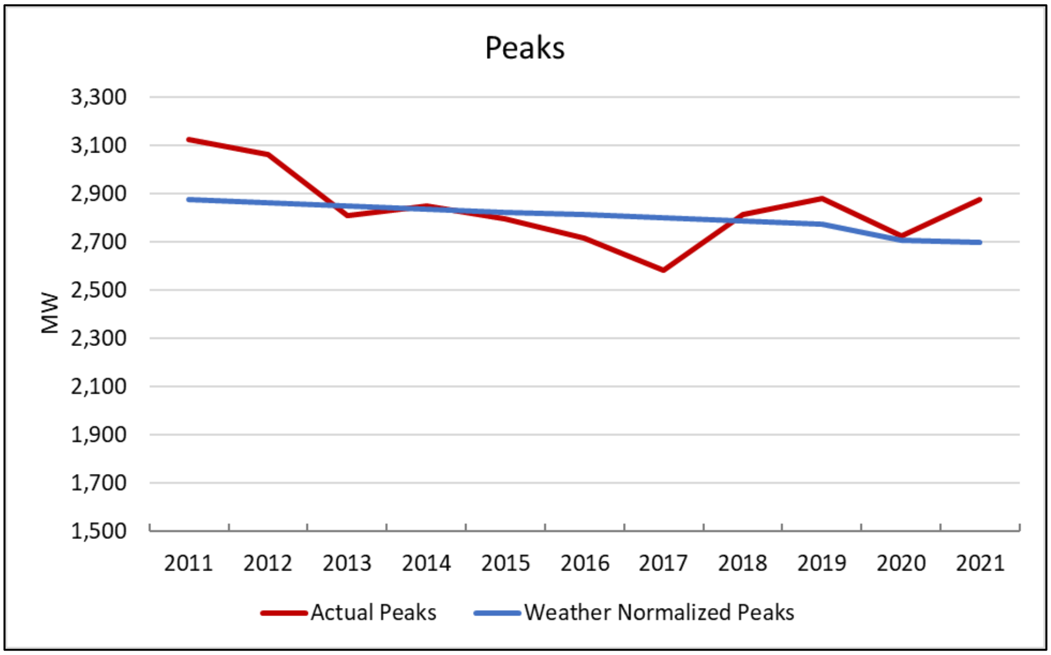



**Figure 4: System Demand (MW)**




Weather normalized system energy requirements in 2021 were 13,640 GWh compared with system energy requirements of 15,017 GWh in 2011. Energy requirements have, on average, declined 1.0% annually over this period. Normalized peak demand has fallen from roughly 2,900 MW in 2011 to 2,700 MW in 2021.

Part of the recent decline can be attributed to COVID-19 as *stay-at-home* orders in early 2020 had a significant impact on customer electricity use. The residential sector saw a significant increase in electricity sales, while commercial and industrial sales experienced a sharp decline. While residential sales gains partially offset C&I sales losses, given the relatively large commercial customer base, the net impact was a drop in sales and energy requirements. Excluding 2020 and 2021, energy requirements have averaged 0.9% annual decline.

The primary factor contributing to the decline in customer use is significant improvements in end-use energy efficiency. Efficiency improvements have largely been driven by federal end-use efficiency standards, AES Indiana EE programs, and market-driven efficiency gains as customer's replace old appliances and business equipment with new appliances and equipment that generally cost less for improved efficiency. With expected EE savings, system energy requirements will continue to decline through the forecast period.

For the purpose of resource planning, future EE program savings are excluded from the demand forecast and treated as a potential resource. Excluding EE, annual energy requirements average 0.5% and system peak demand 0.7% annual growth. The baseline forecast also excludes BTM solar projections and electric vehicles. Separate solar and EV forecasts technologies have been developed by GDS Associates and Brightline Group. Table 1-1 shows the annual baseline energy and demand forecast.

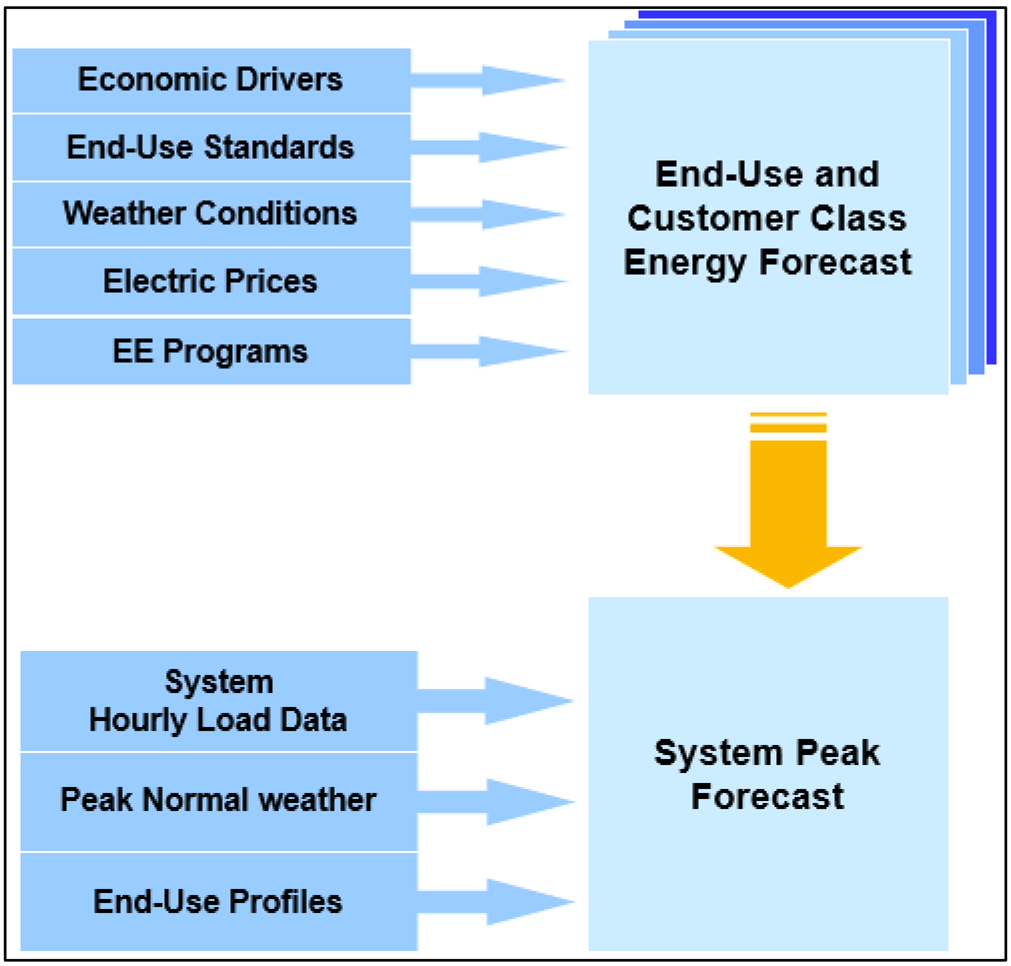
## Table 1-1: Energy and Demand Forecast

| Year | Energy (MWh) | Change | Peak (MW) | Change |
|---|---|---|---|---|
| 2022 | 13,986,185 | | 2,829 | |
| 2023 | 14,024,823 | 0.3% | 2,852 | 0.8% |
| 2024 | 14,133,336 | 0.8% | 2,873 | 0.7% |
| 2025 | 14,162,987 | 0.2% | 2,878 | 0.2% |
| 2026 | 14,182,532 | 0.1% | 2,885 | 0.2% |
| 2027 | 14,262,645 | 0.6% | 2,905 | 0.7% |
| 2028 | 14,373,450 | 0.8% | 2,930 | 0.9% |
| 2029 | 14,446,266 | 0.5% | 2,950 | 0.7% |
| 2030 | 14,496,004 | 0.3% | 2,969 | 0.6% |
| 2031 | 14,555,951 | 0.4% | 2,988 | 0.6% |
| 2032 | 14,619,528 | 0.4% | 3,009 | 0.7% |
| 2033 | 14,690,601 | 0.5% | 3,031 | 0.7% |
| 2034 | 14,775,368 | 0.6% | 3,055 | 0.8% |
| 2035 | 14,863,828 | 0.6% | 3,080 | 0.8% |
| 2036 | 14,957,410 | 0.6% | 3,105 | 0.8% |
| 2037 | 15,054,463 | 0.6% | 3,132 | 0.9% |
| 2038 | 15,153,931 | 0.7% | 3,158 | 0.8% |
| 2039 | 15,256,457 | 0.7% | 3,186 | 0.9% |
| 2040 | 15,352,201 | 0.6% | 3,214 | 0.9% |
| 2041 | 15,457,655 | 0.7% | 3,244 | 0.9% |
| 2042 | 15,567,503 | 0.7% | 3,275 | 1.0% |
| **2022-42** | | **0.5%** | | **0.7%** |

# 2 Forecast Approach

The system baseline energy and demand are derived using a bottom-up modeling framework. The process begins by estimating residential, commercial, and industrial rate class sales models and from these models isolating long-term cooling, heating, and base load energy requirements. End-use energy projections then drive system baseline energy requirements and peak demand. Figure 5 shows the general framework and model inputs.

**Figure 5: Bottom-Up Modeling Framework**



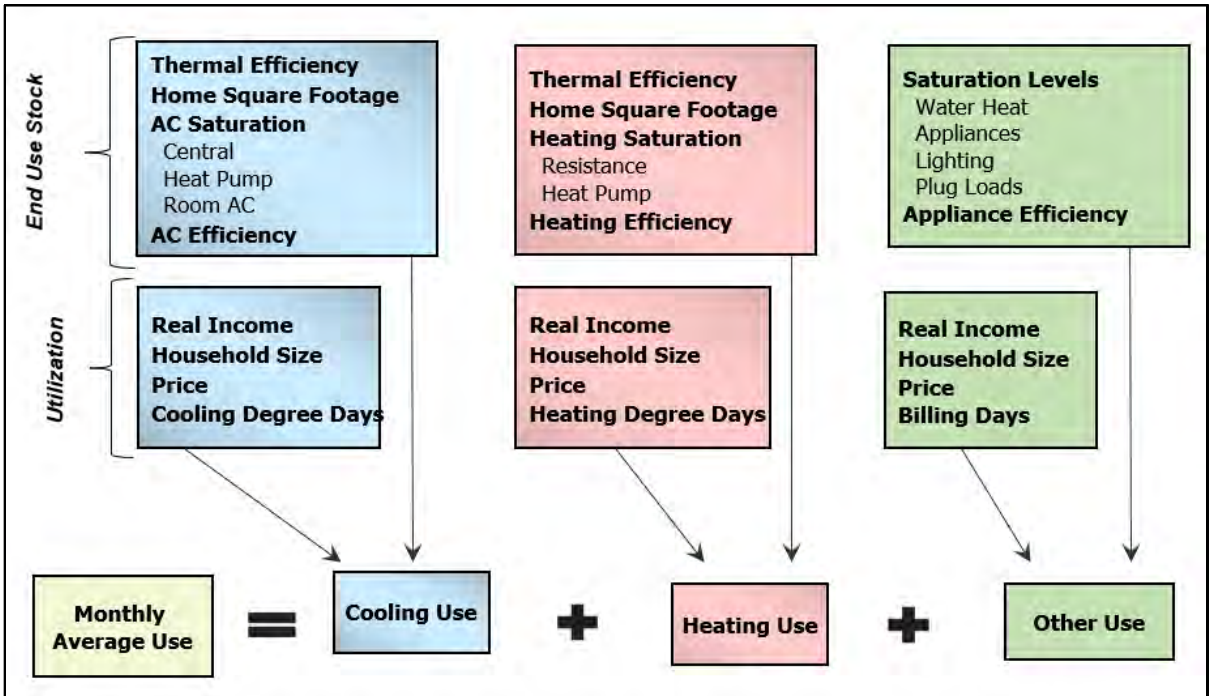

Monthly models are estimated at the rate schedule level and then aggregated to customer class. Table 2-1 shows the modeled rate-classes and associated customer class. By estimating models at the rate class model, we can use the same models for projecting near-term revenues for budget and financial planning as well as long-term resource needs.

**Table 2-1: 2021 Customers and Sales**

| Sector | Rate Schedule | Definition | Customers | MWh |
|---|---|---|---|---|
| Residential | RS | General Service | 252,980 | 2,394,397 |
| Residential | RH | Electric Heat | 165,547 | 2,396,800 |
| Residential | RC | Electric Water Heat | 35,274 | 433,725 |
| Commercial | SS | General Service | 50,761 | 1,242,488 |
| Commercial | SH | GS All Electric | 3,798 | 496,808 |
| Commercial | SE | GS Electric Heat | 24 | 15,117 |
| Commercial | CB | GS Water Heat (Controlled) | 87 | 386 |
| Commercial | UW | GS Water Heat (Uncontrolled) | 83 | 1,136 |
| Commercial | APL | GS Security Lighting | | 28,648 |
| Commercial | SL | Secondary Service | 4,339 | 3,212,691 |
| Industrial | PL | Primary Service | 127 | 1,094,322 |
| Industrial | HL1 | High Load Factor 1 | 26 | 1,208,292 |
| Industrial | HL2 | High Load Factor 2 | 5 | 183,516 |
| Industrial | HL3 | High Load Factor 3 | 2 | 254,577 |
| Industrial | APL | IND Security Light | | 4,415 |
| Other | ST | Street Lighting | | 53,280 |
| Total | | | 513,052 | 13,020,598 |

Residential and commercial models are estimated using a Statistically Adjusted End-Use (SAE) model specification. This entails estimating monthly average use (residential) or sales models (commercial) that are defined as a function of monthly heating, cooling, and non-weather sensitive (base use) load requirements. Figure 6 show the residential SAE model.

**Figure 6: Residential Forecast Model Framework**

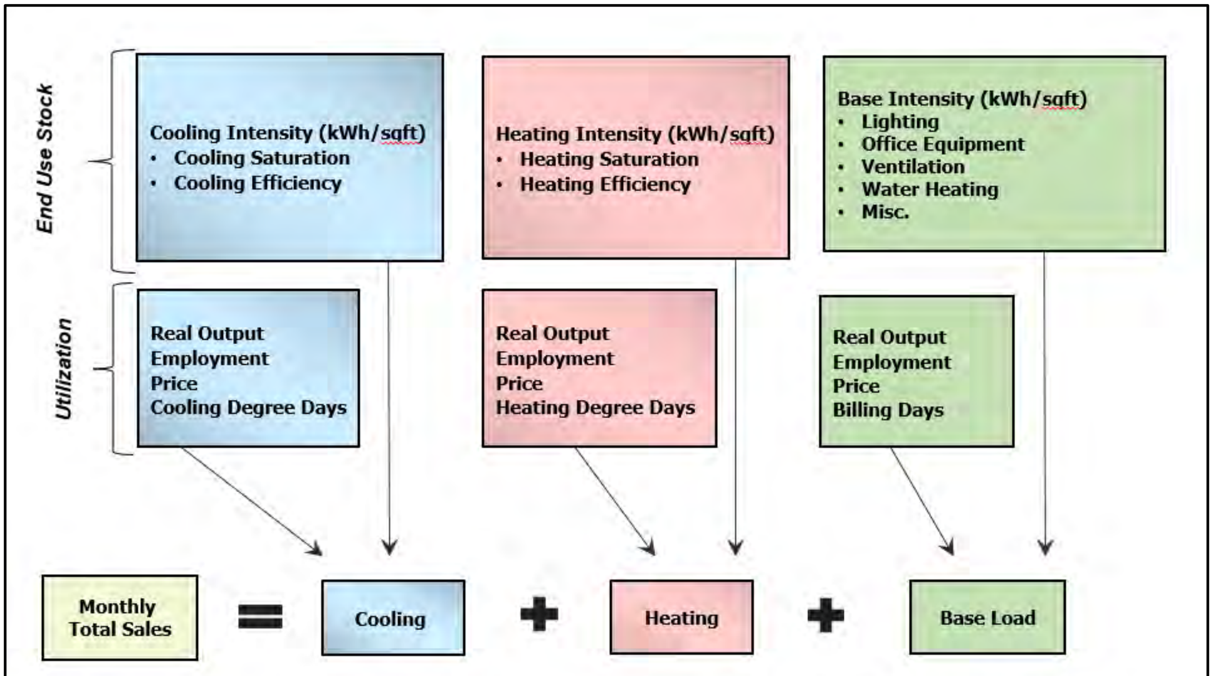



$$AvgUse_m = a + b_c \times XCool_m + b_h \times XHeat_m + b_o \times XOther_m + b_e \times EE_m$$

Cooling (XCool), Heating (XHeat), and Base Use (XOther) are constructed by combining end-use stock variables (that include end-use saturation and efficiency) with monthly utilization variable (that includes cooling and heating degree-days, household size, household income, and price). The interaction of the annual end-use stock variable with monthly utilization variable gives initial estimates of monthly heating, cooling, and baseloads. Monthly models are estimated using linear regression; the estimation process results in a set of model coefficients $b_c$, $b_h$, and $b_0$ that effectively *adjust* the end-use energy requirements to actual customer usage. Historical EE savings are also included to capture EE program savings not captured in the end-use intensity trends; the cumulative historical EE is held constant in the model with future EE treated as resource. The estimated models are used to forecast average use and sales based on projected economic activity, HDD and CDD trend projections, and end-use saturation and efficiency trends. A detail description of the model is included in Appendix B.

A similar model structure is used for forecasting commercial rate class sales as depicted in Figure 7.

**Figure 7: Commercial SAE Model**

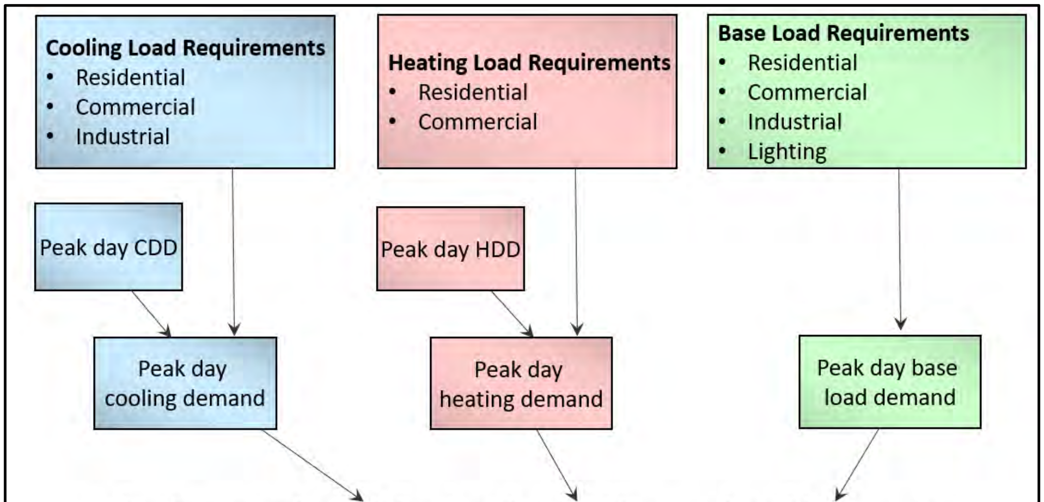



$$MWh_m = \quad a + b_c \times XCool_m + b_h \times XHeat_m + b_o \times XOther_m + b_e \times EE_m$$

Commercial models are estimated using monthly sales rather than average use. End-use intensities are on a kWh per square foot basis and reflect both saturation (space impacted by the end-use) and end-use stock efficiency. The annual end-use indices are combined with monthly utilization variables that capture weather conditions (degree-days), economic activity and growth, and price. A cumulative EE variable is included to account for EE program savings that are not captured in the SAE XCool, XHeat, and XOther variables.

**Energy and Peak**. From a supply planning perspective, the most critical planning inputs are total system energy requirements and system peak demand. Heating, cooling, and base load energy requirements derived from the class sales models are used to drive system energy and peak demand. The energy forecast is calculated by applying a line loss forecast to the aggregated sales forecast. The peak forecast is based on a monthly peak regression model that relates maximum demand to peak-day cooling (PkCool) and heating (PkHeat), and base energy requirements estimated at time of peak (PkBase). Figure 8 shows the peak model framework.

**Figure 8: Peak Model Framework**




$$Peak_m = a + b_c \times PkCool_m + b_h \times PkHeat_m + b_b \times PkBase_m + e_m$$

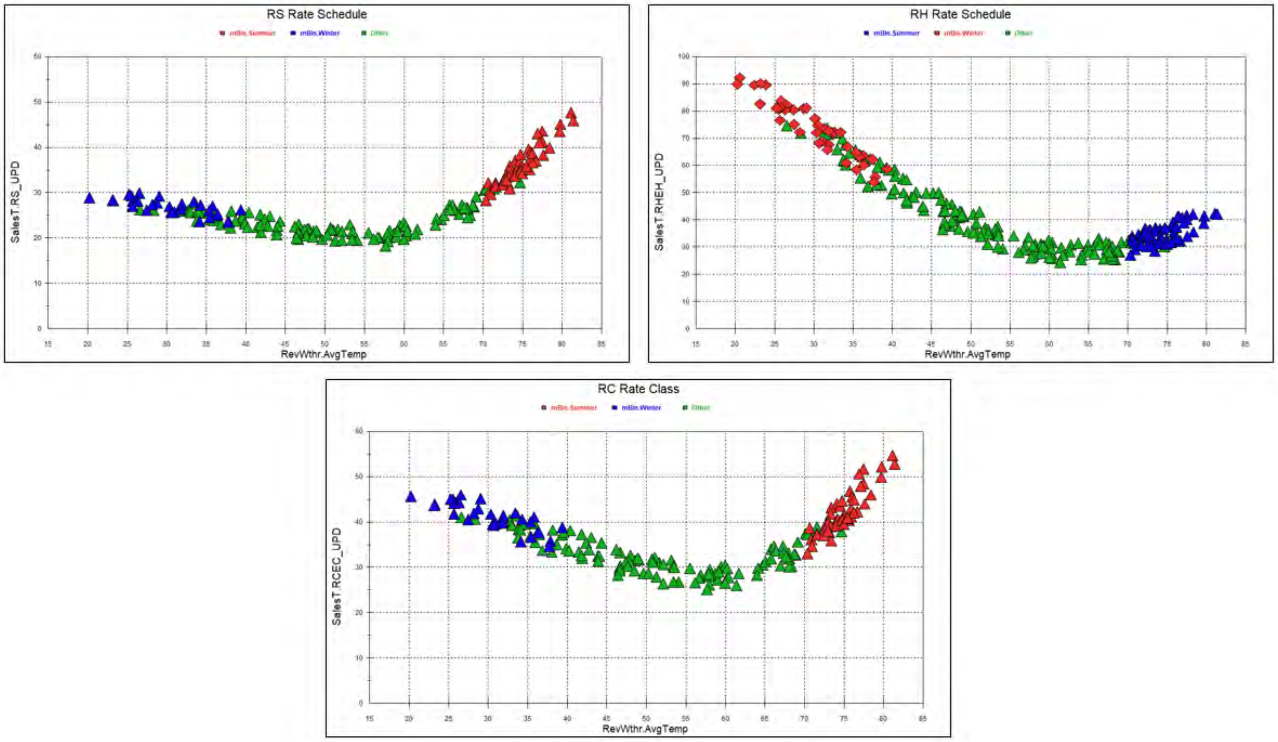
PkCool and PkHeat are derived by combining cooling and heating requirements with peak-day weather conditions. In this structure, the impact of peak-day temperatures on load will increase or decrease over time with changes in cooling and heating load requirements. Base loads at the time of peak are estimated by multiplying end-use energy estimates with end-use peak-day fractions estimated from Itron's library of end-use load profiles.

The coefficients ($b_c$, $b_h$, $b_b$) are estimated using linear regression. The advantage of this approach when compared with a more traditional load factor model is that we can capture factors that may contribute to differences between energy and demand growth. For example, cooling requirements may be increasing faster than heating requirements and as a result the summer peak could potentially increase faster than overall sales and winter peak demand. While lighting sales are declining as a result of the new lighting standards, we can capture the fact that this will impact winter peaks more than summer peaks. As shown in the model section, the model explains historical sales variation well with a high adjusted R-Squared and statistically significant model coefficient.

## 2.1 Residential Models

**Average Use.** Residential average use is modeled for three rate schedules. Non-electric heat customers (RS), electric heat customers (RH) and electric water heat customers (RC). Each rate schedule has a very different load curve and sensitivity to heating and cooling conditions as result of differences in end-use mix. Figure 9 shows the sales/weather relationship for these classes.

**Figure 9: Residential Weather Response Curves**



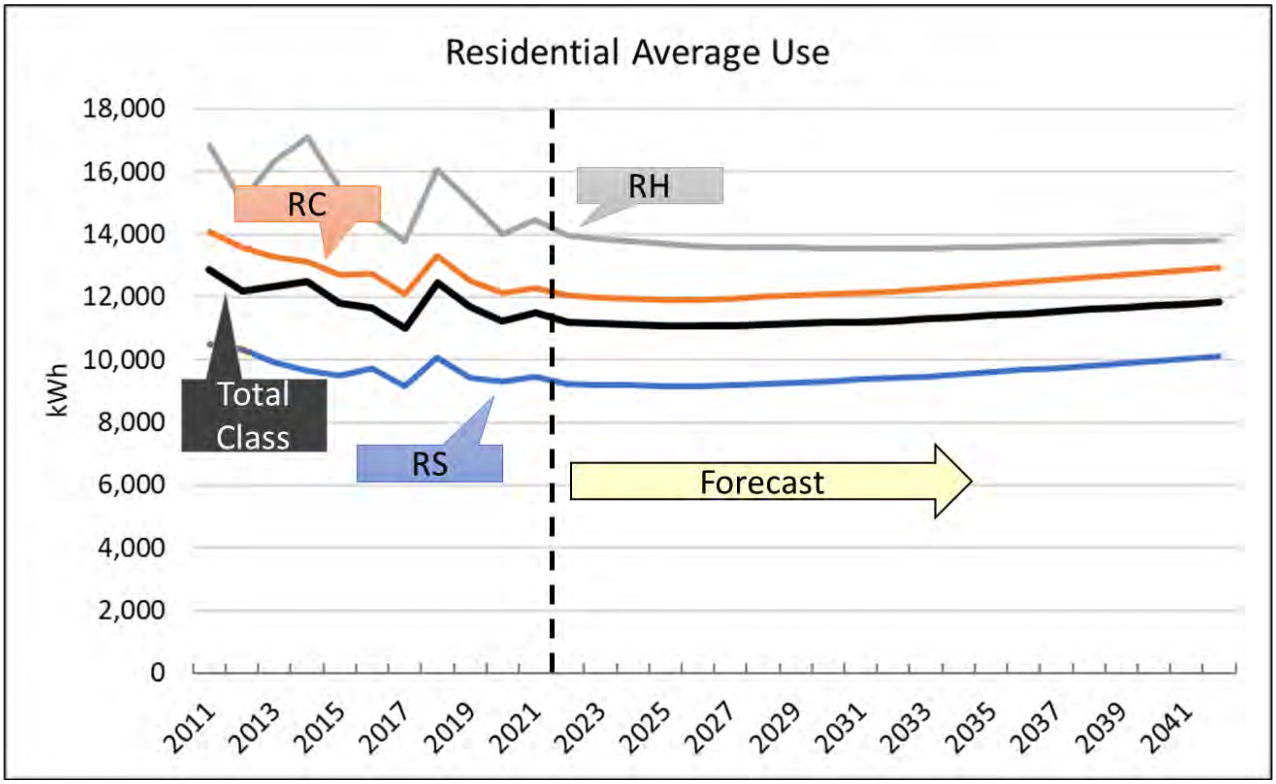

Each slide shows the relationship between average monthly temperature on the X axis and average class monthly use on a per billing-day basis. The curves are distinct with the RH rate schedule having a significantly steeper heating-side slope than either the RS or RC rate schedules. The base use for RC customers is higher reflecting the high electric water heating saturation.

As discussed earlier, the residential average use model relates customer average monthly use to a customer's heating requirements (XHeat), cooling requirements (XCool), other use (XOther), and historical EE program savings:

- $ResAvgUse_m = (B_1 \times XHeat_m) + (B_2 \times XCool_m) + (B_3 \times XOther_m) + (B_4 \times EE_m) + e_m$

The model coefficients ($B_1$, $B_2$, $B_3$, $B_4$) are estimated using a linear regression model. Monthly average use data is derived from historical monthly billed sales and customer data from January 2011 to December 2021. Model statistics are included in Appendix A. Figure 10 shows historical and forecasted average use, excluding future EE.

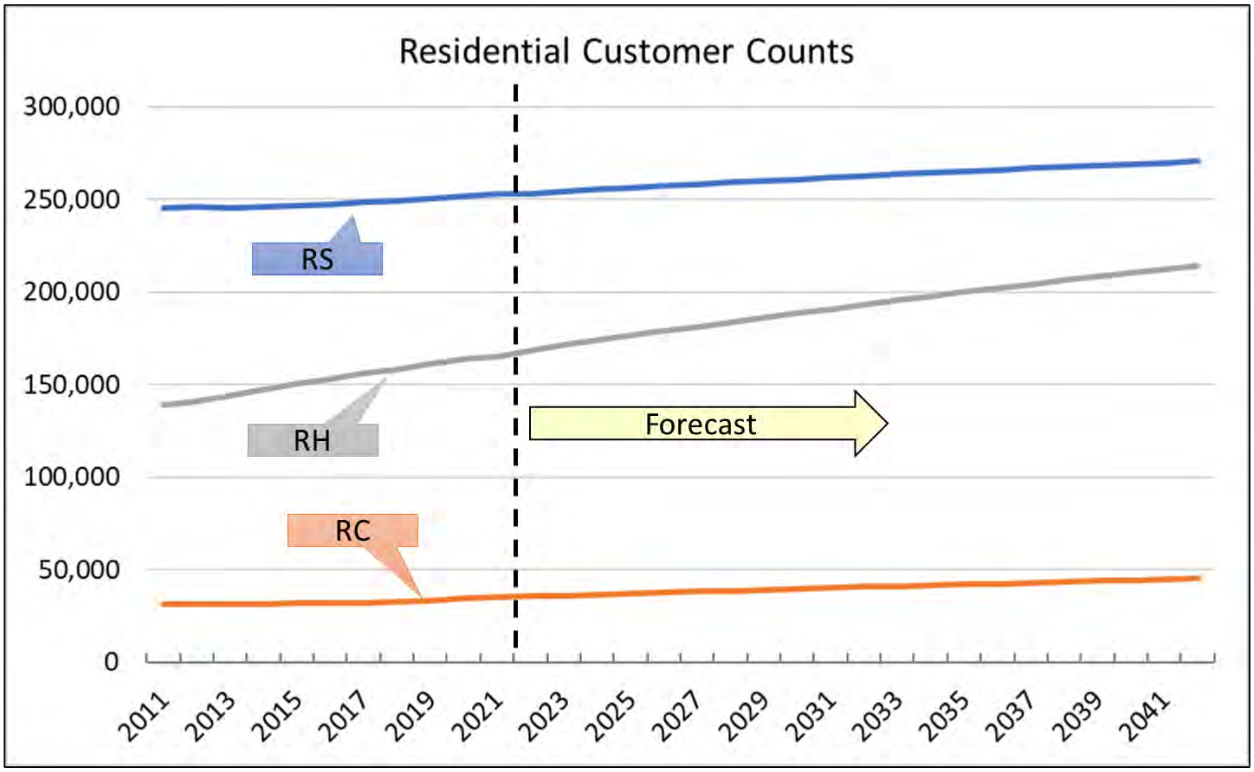
**Figure 10: Residential Average Use**




As depicted in Figure 10, average use has been declining since 2011. Average use flattens out, and even increases, over the forecast period as increases in economic growth counters improving end-use efficiency and future EE program saving are not included in the forecast. Total rate class average use increases partly due to the increasing share of customers with electric heat.

**Customer Forecast**. The customer forecast is based on the population forecast for Marion County. The correlation between Marion County population and number of AES Indiana residential customers is over ninety percent. While all residential customer classes are forecasted to increase, the RH and RC classes are increasing at a significantly faster rate than the RS class. RH and RC customers are forecasted to increase 1.2% annually over the forecast period, RS customers are forecasted to increase 0.3% annually. Figure 11 shows the residential customer forecast.

**Figure 11: Residential Customers**




The residential sales forecast is generated as the product of the average use and customer forecasts. Total residential sales are calculated by adding across the rate schedule forecasts. Table 2-2 shows the forecasted residential customer, sales, and average use before future EE, photovoltaic and electric vehicle adjustments.

**Table 2-2: Residential Forecast**

| Year | Sales (MWh) | Change | Customers | Change | Average Use (kWh) | Change |
|---|---|---|---|---|---|---|
| 2022 | 5,120,205 | | 415,728 | | 12,316 | |
| 2023 | 5,148,145 | 0.5% | 418,276 | 0.6% | 12,308 | -0.1% |
| 2024 | 5,183,132 | 0.7% | 421,275 | 0.7% | 12,303 | 0.0% |
| 2025 | 5,208,018 | 0.5% | 425,237 | 0.9% | 12,247 | -0.5% |
| 2026 | 5,246,104 | 0.7% | 429,000 | 0.9% | 12,229 | -0.2% |
| 2027 | 5,299,299 | 1.0% | 432,885 | 0.9% | 12,242 | 0.1% |
| 2028 | 5,360,175 | 1.1% | 437,014 | 1.0% | 12,265 | 0.2% |
| 2029 | 5,416,700 | 1.1% | 440,588 | 0.8% | 12,294 | 0.2% |
| 2030 | 5,472,660 | 1.0% | 445,760 | 1.2% | 12,277 | -0.1% |
| 2031 | 5,532,095 | 1.1% | 450,367 | 1.0% | 12,284 | 0.1% |
| 2032 | 5,592,595 | 1.1% | 453,800 | 0.8% | 12,324 | 0.3% |
| 2033 | 5,654,854 | 1.1% | 457,267 | 0.8% | 12,367 | 0.3% |
| 2034 | 5,723,758 | 1.2% | 462,142 | 1.1% | 12,385 | 0.2% |
| 2035 | 5,792,730 | 1.2% | 466,305 | 0.9% | 12,423 | 0.3% |
| 2036 | 5,862,577 | 1.2% | 470,260 | 0.8% | 12,467 | 0.4% |
| 2037 | 5,934,492 | 1.2% | 474,157 | 0.8% | 12,516 | 0.4% |
| 2038 | 6,006,119 | 1.2% | 478,188 | 0.9% | 12,560 | 0.4% |
| 2039 | 6,076,064 | 1.2% | 481,976 | 0.8% | 12,607 | 0.4% |
| 2040 | 6,142,240 | 1.1% | 485,759 | 0.8% | 12,645 | 0.3% |
| 2041 | 6,210,088 | 1.1% | 489,543 | 0.8% | 12,685 | 0.3% |
| 2042 | 6,279,732 | 1.1% | 493,330 | 0.8% | 12,729 | 0.3% |
| **2022-42** | | **1.0%** | | **0.9%** | | **0.2%** |

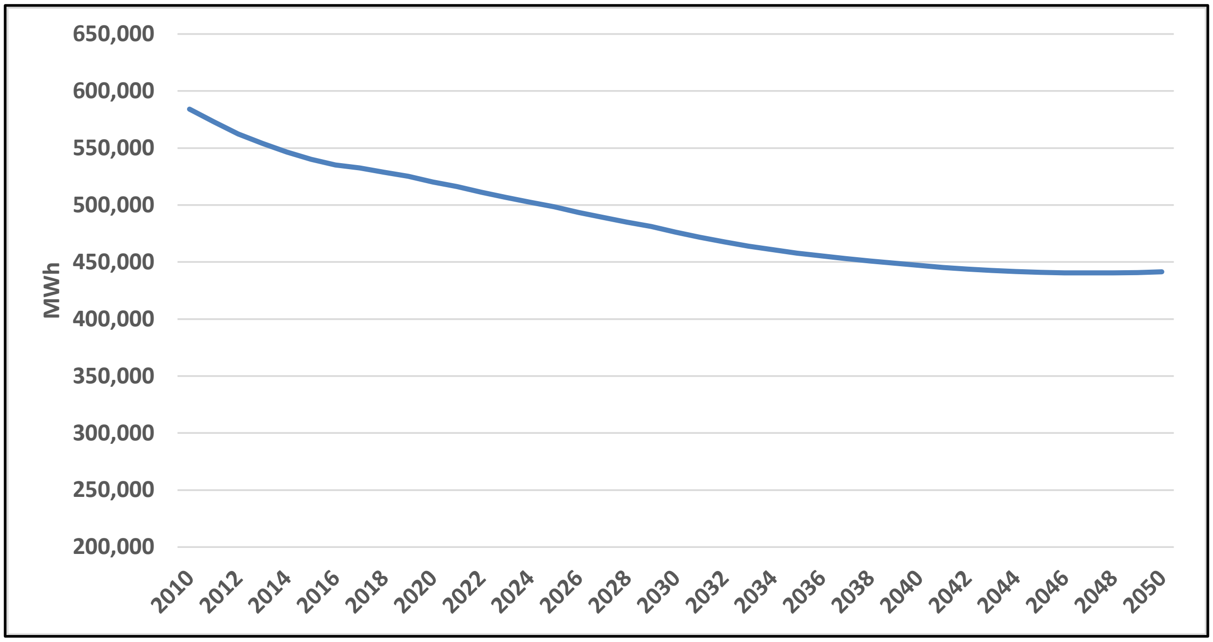
## 2.2 Nonresidential Models

Commercial sales are also estimated using an SAE model structure. The difference is that in the commercial sector the sales forecast is based on a total sales model rather than an average use and customer model. Commercial sales are expressed as a function of heating requirements, cooling requirements, and other commercial use:

- $ComSales_m = B_0 + (B_1 \times XHeat_m) + (B_2 \times XCool_m) + (B_3 \times XOther_m) + (B_4 \times EE_m) + e_m$

The constructed model variables include HDD, CDD, billing days, commercial economic activity variable, price, end-use intensity trends (measured on a kWh per sqft basis), and historical EE savings. To be consistent with rate class sales that are in MWh, the intensity estimates are also scaled to MWh. All but miscellaneous end-use intensities are trending down as end-use efficiency continues to improve. Total intensity is declining through the forecast period as depicted in Figure 12.

**Figure 12: SS Rate Class Total Energy Intensity Trend**




A detailed description of the Commercial SAE model is included in Appendix B.

Separate monthly regression models are estimated for each non-residential rate schedule, all but the high load factor rate schedules (H2 and H3) are modeled using the SAE model specification; the commercial model specification explains sales variation well based on model fit statistics. The high load factor rates are primarily industrial loads and include some of AES Indiana's largest customers.

Commercial sales like residential have been trending down. Since 2011 annual commercial sales have declined on average 0.9%. The COVID-19 pandemic had a significant impact on commercial electric sales, with sales declining by over 7% in 2020. Sales continue to recover in 2021 but have not fully returned to pre-COVID levels. Excluding 2020 and 2021, commercial sales have declined on average 0.4% annually from 2011-2019. Aside from the negative shock from COVID, the primary factors driving commercial sales are expected economic activity, declining end-use intensities, electric prices, and historical EE program savings. Over the next twenty years, employment and output averages 0.6% and 2.1% annual growth, and total end-use intensity declines 0.7% per year. The combination of these factors results in 0.4% annual commercial sales growth through 2042 before EE savings adjustments.

**Economic Driver**. The economic variable is weighted between non-manufacturing employment and non-manufacturing output for the Indianapolis MSA. The variable is more heavily weighted on employment than output as the stronger weighting on employment yields better in-sample and out-of-sample model fit statistics. The two concepts account for different but overlapping aspects of business activity; employment growth captures commercial customer growth and expansion at existing customers' sites and output growth reflects productivity growth and increase in product and service demand. The constructed economic variable for the general service (SS) rate schedule is defined as:

- $SLEconVar_m = (NonManOutput_m^{0.35}) \times (NonManEmployment_m^{0.65})$

The weighting varies for the commercial rate schedules – secondary service (SL), general service electric heat (SH), and general service all electric (SE).

Overall, the constructed model variables explain historical variation well as measured by model Adjusted R-Squared and MAPE. Adjusted R-Squared varies from 0.87 to 0.98 with MAPEs that vary from 5.77% to 1.00%. Model statistics and forecast plots are included in Appendix A.

**Industrial Models**. The high load factor rates (H1, H2, and H3) are primarily industrial customers. The H1 billed sales is based on manufacturing employment, and industrial output. The industrial economic variable is weighted between manufacturing employment and manufacturing output with a stronger weight on output:

- $H1EconVar_m = (ManOutput_m^{0.6}) \times (ManEmployment_m^{0.4})$

The economic weighting is derived by evaluating the model in-sample and out-sample statistics.

The H2 and H3 rate schedules have relatively few customers. H2 currently has 5 customers and H3 has 3 customers. Other than seasonal cooling load variation, H2 and H3 sales have been flat. H2 did see a significant drop in sales with the onset of COVID19 but much of that had recovered by end of 2021. H2 and H3 sales are held constant through the forecast period. Model statistics and forecast plots are included in Appendix A.

Table 2-3 shows the commercial and industrial sales forecast; sales forecast excludes the impact of future EE program activity.

**Table 2-3: Non-Residential Sales Forecast**

| Year | Commercial (MWh) | Change | Industrial (MWh) | Change |
|---|---|---|---|---|
| 2022 | 5,099,965 | | 2,933,049 | |
| 2023 | 5,175,810 | 1.5% | 2,940,658 | 0.3% |
| 2024 | 5,242,675 | 1.3% | 2,942,141 | 0.1% |
| 2025 | 5,256,152 | 0.3% | 2,931,960 | -0.3% |
| 2026 | 5,263,430 | 0.1% | 2,905,114 | -0.9% |
| 2027 | 5,283,036 | 0.4% | 2,907,949 | 0.1% |
| 2028 | 5,313,462 | 0.6% | 2,921,722 | 0.5% |
| 2029 | 5,327,254 | 0.3% | 2,920,310 | 0.0% |
| 2030 | 5,326,090 | 0.0% | 2,912,630 | -0.3% |
| 2031 | 5,327,322 | 0.0% | 2,908,714 | -0.1% |
| 2032 | 5,334,535 | 0.1% | 2,901,176 | -0.3% |
| 2033 | 5,344,582 | 0.2% | 2,896,113 | -0.2% |
| 2034 | 5,358,687 | 0.3% | 2,893,268 | -0.1% |
| 2035 | 5,374,903 | 0.3% | 2,891,749 | -0.1% |
| 2036 | 5,393,600 | 0.3% | 2,891,692 | 0.0% |
| 2037 | 5,413,422 | 0.4% | 2,891,729 | 0.0% |
| 2038 | 5,434,746 | 0.4% | 2,892,841 | 0.0% |
| 2039 | 5,459,080 | 0.4% | 2,895,513 | 0.1% |
| 2040 | 5,481,652 | 0.4% | 2,897,307 | 0.1% |
| 2041 | 5,509,752 | 0.5% | 2,901,085 | 0.1% |
| 2042 | 5,539,743 | 0.5% | 2,905,324 | 0.1% |
| **2022-42** | | **0.4%** | | **0.0%** |

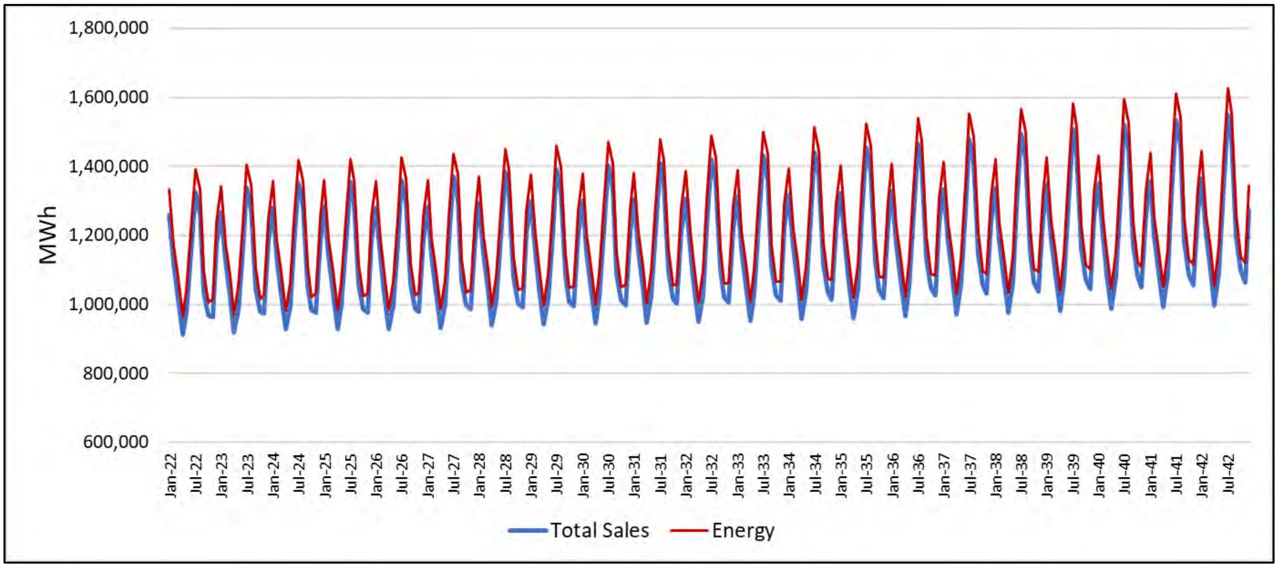
## 2.3 Street and Security Lighting Models

Street lighting sales declined rapidly beginning in 2018, coinciding with the start of a LED conversion program. The program has converted 26,000 lights, or approximately 60% of all fixtures. With the program near completion, street lighting sales should remain flat. Street lighting sales are modeled using a seasonal exponential smoothing model. Security lighting sales are estimated using a trend and monthly binaries model. The monthly binary variables capture the variation in monthly sales across the year with the highest level of lighting in January and lowest level of lighting in July. Lighting models are included in Appendix A.

## 2.4 Energy and Peak Forecast Models

**Energy Forecast**. System energy forecast is derived by summing monthly rate schedule sales forecast and adjusting sales upwards for line losses. The adjustment factor is based on the historical ratio of monthly energy to sales for the last four years. The adjustment factors are calculated for each month. The annual forecast adjustment factor is 1.056. Total baseline sales and energy increase 0.6% annually through the forecast period. Again, the baseline forecast does not include the impact of future EE savings, solar load growth, or electric vehicles. Figure 13 compares monthly energy and sales forecast, excluding future EE program savings.

**Figure 13: Energy and Sales Forecast)**




**Peak Forecast.** The peak model relates monthly system peak demand to peak-day temperatures, heating and cooling load requirements, and base loads at time of peak. Heating, cooling, and base-use energy requirements are derived from the sales forecast models. Cooling (*CoolLoad*) and heating (*HeatLoad*) are interacted with peak-day CDD (*PkCDD*) and HDD (*PkHDD*):

- $PkCool_m = CoolLoad_m \times PkCDD_m$
- $PkHeat_m = HeatLoad_m \times PkHDD_m$

The logic of the interaction is that the impact of peak-producing weather conditions depends on system cooling and heating requirements.

The base-load variable ($PkBase_m$) captures non-weather sensitive loads at the time of the monthly peak. PkBase is calculated by multiplying end-use load estimates with end-use coincident peak factors and then aggregating across end-uses and customer classes. Figure 14 to Figure 16 show the calculated peak model variables.

**Figure 14: Peak Heating Variable**

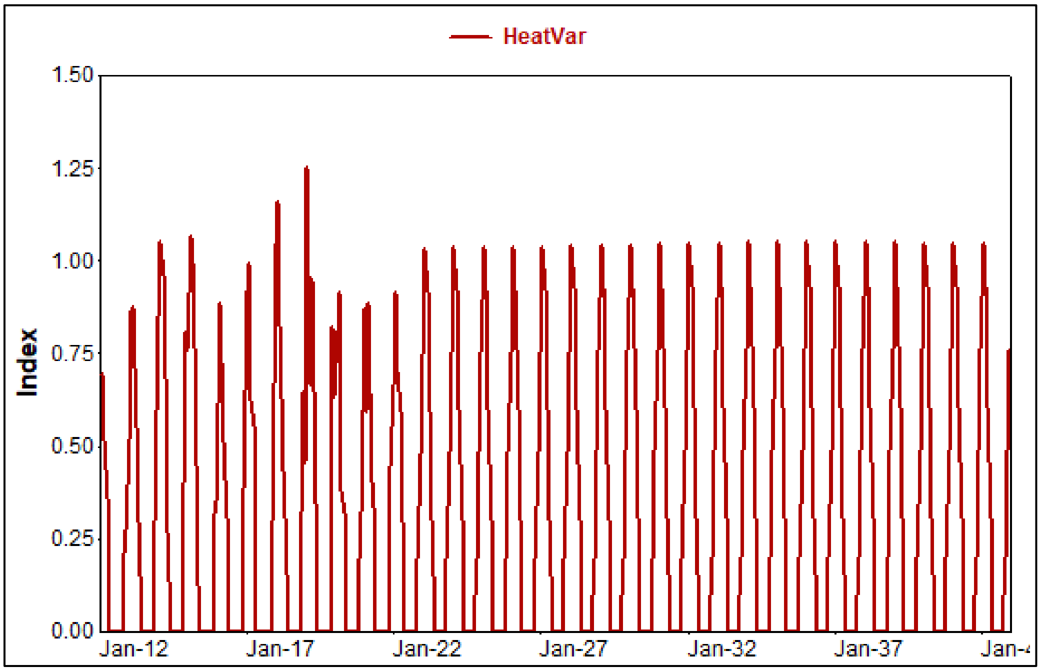



**Figure 15: Peak Cooling Variable**

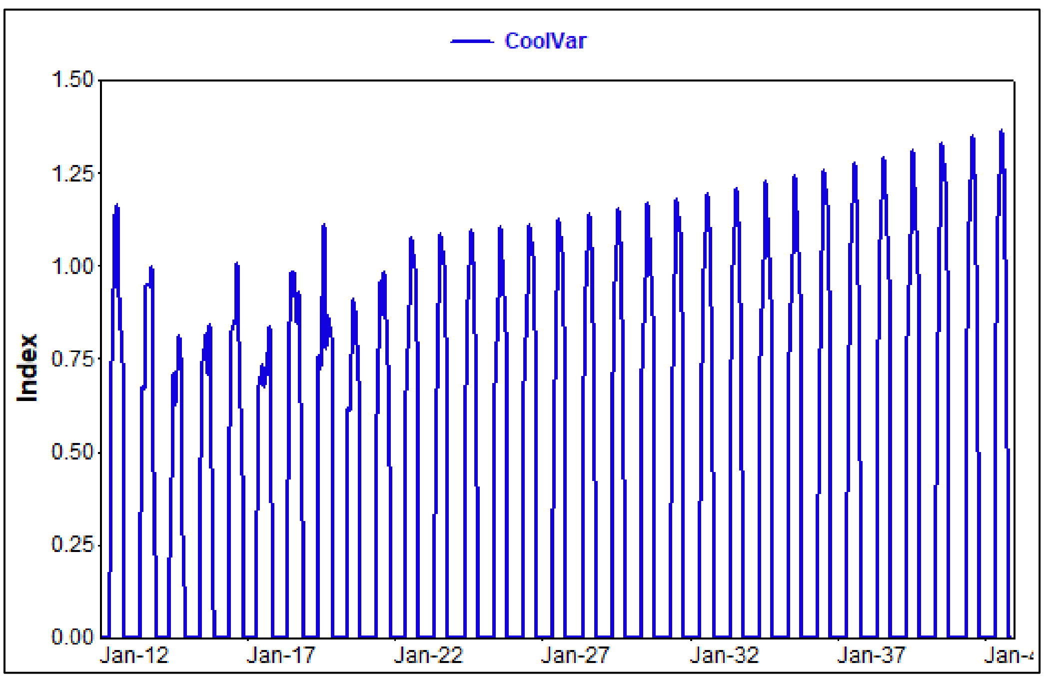
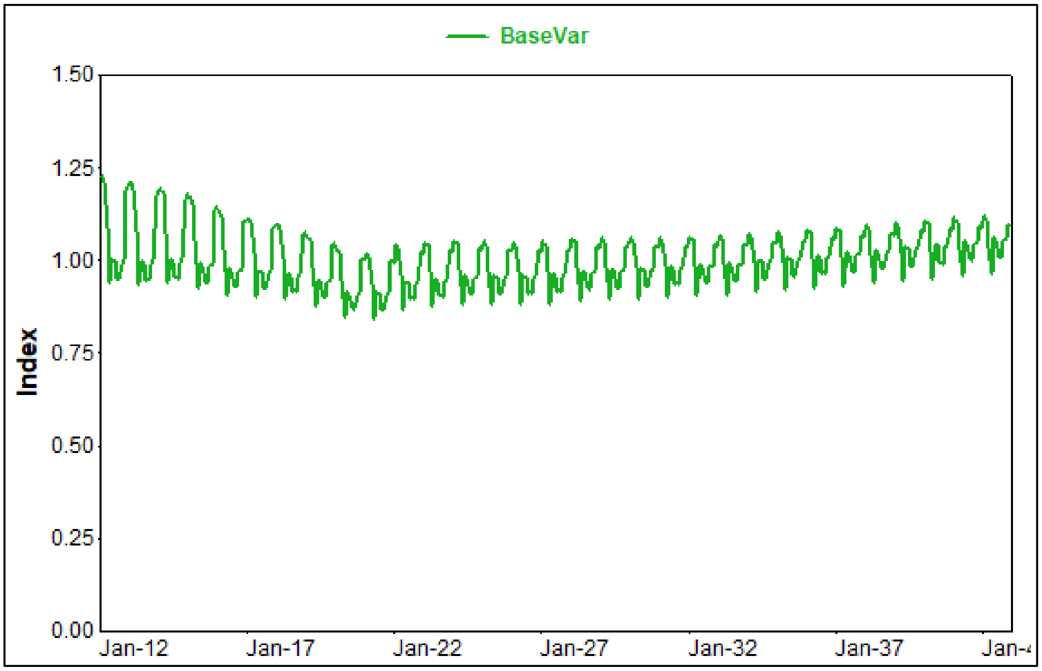


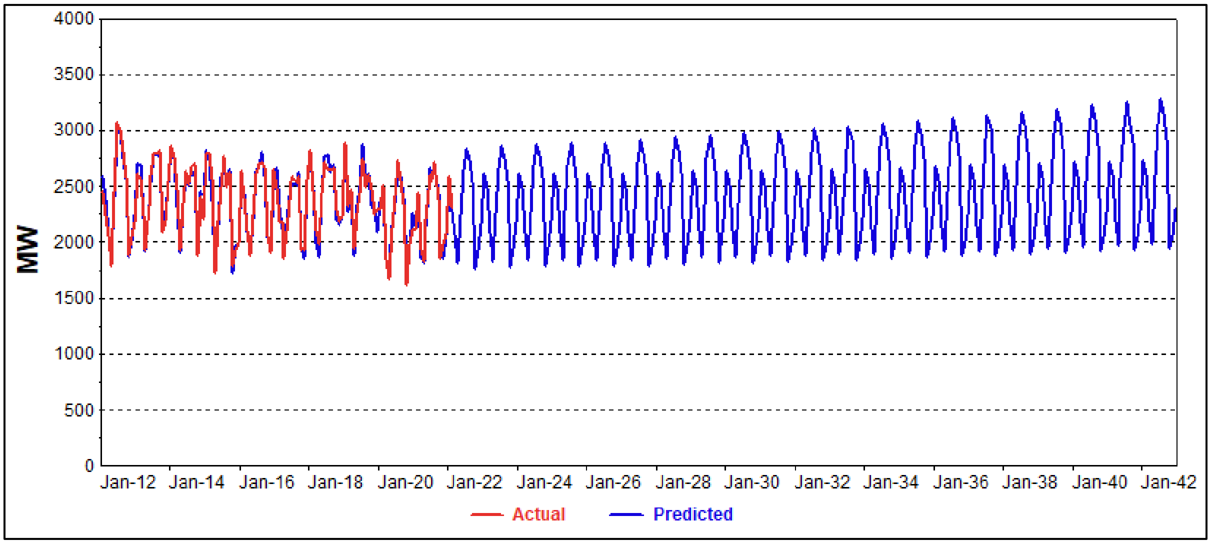
**Figure 16: Peak Base Variable**




The peak model is estimated over the period January 2012 to December 2021. The model explains monthly peak variation well with an adjusted $R^2$ of 0.94 and an in-sample MAPE of 2.45%. The model variables – *PkHeat*, *PKCool*, and *PkBase* are highly statistically significant.

Figure 17 shows actual and predicted model results.

**Figure 17: System Peak Model**




Excluding future EE, solar, and EVs, the baseline peak occurs in the summer and averages 0.7% annual growth; this compares with 0.5% annual energy growth. Model statistics and parameters are included in Appendix A.

# 3 Forecast Assumptions

## 3.1 Weather Data

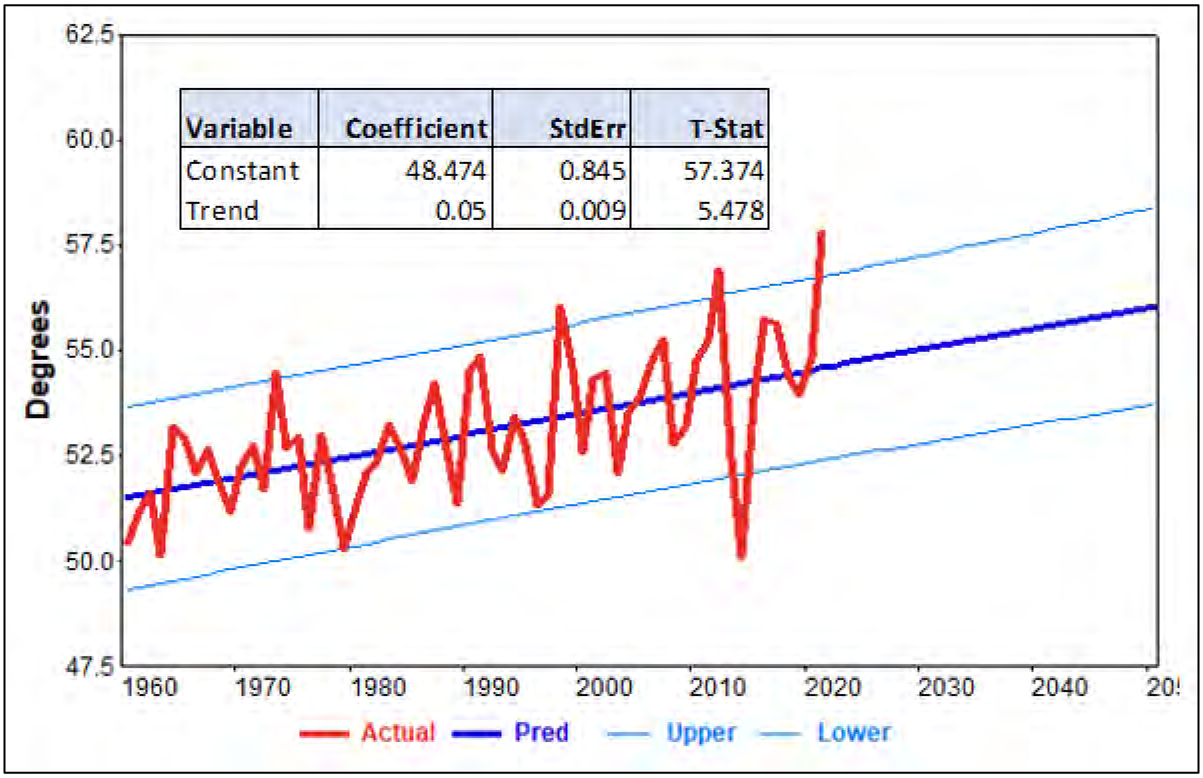
Monthly variation in winter usage is captured with heating-degree days (HDD) while variance in summer usage is modeled using monthly cooling degree days (CDD). HDD and CDD are often referred to as spline variables as they either take on a positive value or are 0. HDD are positive when temperatures are below a specified temperature reference point and are 0 when temperatures are at or above the temperature reference point. CDD are positive when temperatures are above a temperature reference point and are 0 when temperatures are at or below the temperature reference point. The best temperature breakpoints in terms of statistical model fit varies by customer class. Commercial heating and cooling generally start at lower temperature points than residential. Temperature breakpoints are evaluated as part of the model estimation process. For the residential rate classes, the best temperature breakpoints are 60 degrees for HDD and 65 degrees for CDD. In the non-residential classes, HDD with a 55 degree reference point and CDD with a 60 degree reference point improve the overall model fit. Both historical and forecasted monthly degree-days are calculated from Indianapolis International Airport daily temperature data.

**Capturing Increasing Temperatures**. Traditionally, utilities base their long-term forecast on what the industry calls *normal* weather. Normal weather is calculated by averaging historical weather usually over a 20-year or 30-year period. Given the large variation in month-to-month and year over year weather conditions, it seemed reasonable to assume that the best representation of current and forecast weather is an average of the past.

Recent studies that Itron and others have conducted have shown that this is probably not the best assumption; over the last fifty years, average temperatures have been increasing. We have estimated temperature increases of 0.4 degrees (Puget Sound) to 1.5 degrees (Reno) per decade. Given increasing temperatures, normal CDD will underestimate cooling requirements and normal HDD will overestimate heating requirements.

Not surprisingly, average temperatures have also been increasing in Indianapolis at constant rate. Figure 18 shows the long-term Indianapolis temperature trend, and 90% confidence interval.

**Figure 18: Indianapolis Temperature Trend**




Since 1960, average annual temperatures have been increasing 0.05 degrees per year, or 0.5 degrees per decade. The trend coefficient is highly statistically significant indicating a high probability of increasing temperatures. In 1960, the expected temperature was 51.5 degrees and in 2021 the expected annual temperature was 54.6 degrees. The average annual temperature in 2021 is 6 percent higher than 1960. Temperatures on the coldest days are increasing at an even faster rate of 1.1 degrees per decade.

For the baseline forecast, we assume that temperatures will continue to increase at the historical trend rate. Some of the climate models indicate temperatures may increase at even faster rates. Increase in temperature at 0.5 degrees per decade translates into a 0.3% annual increase in the number of CDD and a 0.4% annual decline in the number of HDD.

Figure 19 and Figure 20 show historical and forecasted monthly HDD with a base of 60 degrees and CDD with a base of 65 degrees. Decline in HDD lower long-term heating requirements with increasing CDD result in higher cooling requirements.

**Figure 19: Heating Degree Days (Base 60)**

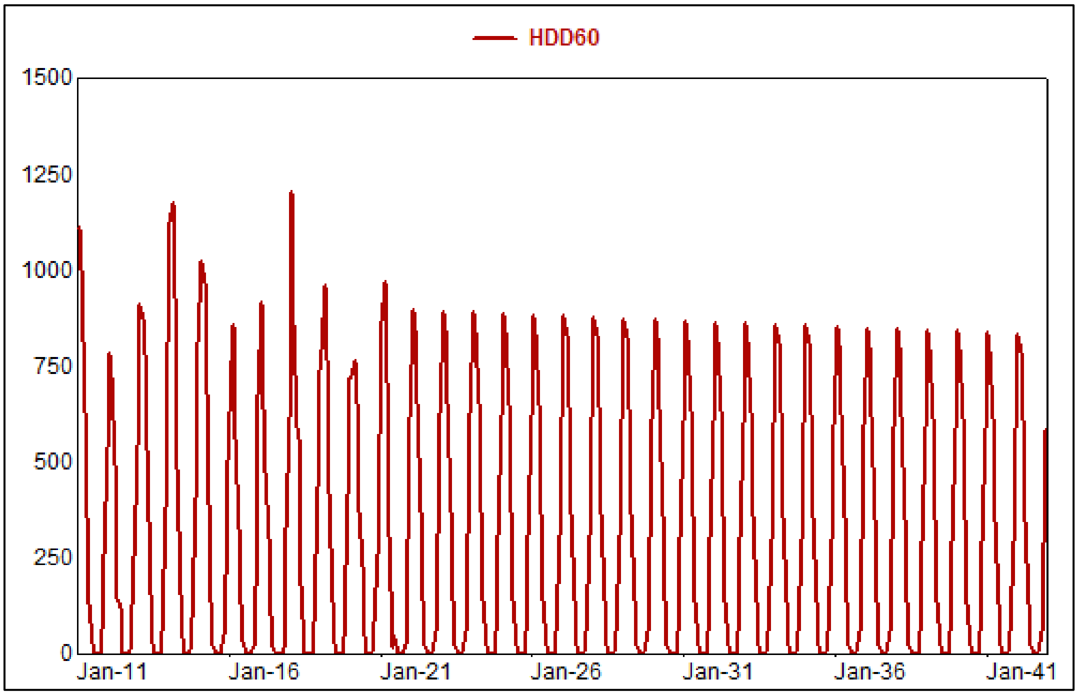
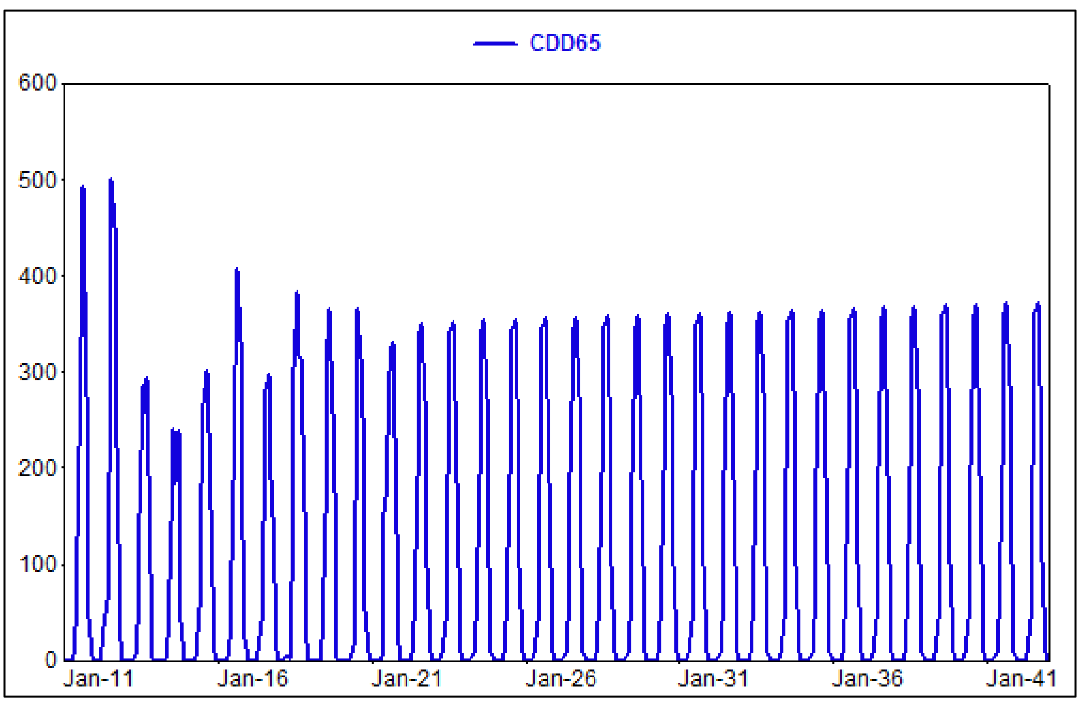


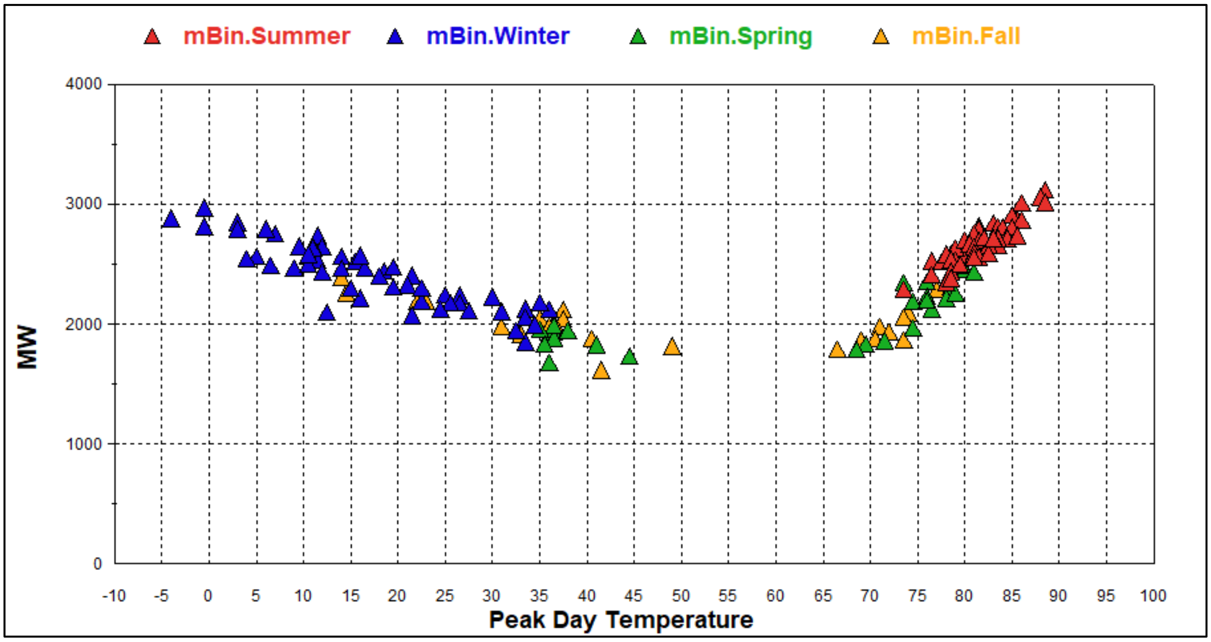

**Figure 20: Cooling Degree Days (Base 65)**



***Peak-Day Weather Variables***

Peak-day CDD and HDD are used in forecasting system peal demand. Peak-day HDD and CDD are derived by finding the HDD and CDD that occurred on the day of the peak. The appropriate breakpoints for defining peak-day HDD and CDD are determined by evaluating the relationship between monthly peak and the peak-day average temperature as shown in Figure 21.

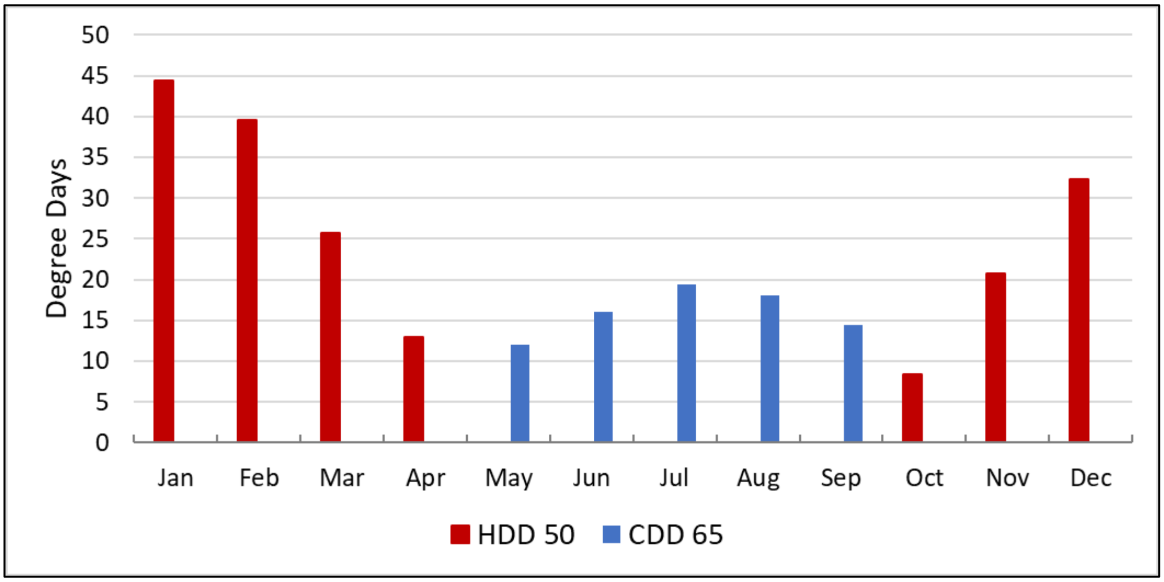
**Figure 21: Monthly Peak Demand /Temperature Relationship**




Peak-day cooling occurs when temperatures are above 65 degrees, and peak-day heating occurs when temperatures are below 50 degrees.

Normal peak-day HDD and CDD are calculated using 20 years of historical weather data (2001 to 2020). Normal peak-day HDD and CDD are based on the hottest and coldest days that occurred in each month over the historical time period. Peak-day weather is not adjusted for increasing average temperature as temperature trend impact is captured in the heating and cooling requirements; trending both peak-day and monthly degree-days would result in "double-counting" the impact of increasing temperatures Figure 22 shows normal peak-day HDD (base 50 degrees) and peak-day CDD (base 65 degrees).

**Figure 22: Normal Peak-Day HDD & CDD**




## 3.2 Economic Data

Economic projections are key forecast drivers. The rate class sales forecasts are based on Moody Analytics historical and projected economic data (September 2021 forecast) for Marion County and the greater Indianapolis Metropolitan Statistical Area (MSA). The primary economic drivers in the residential model are Marion County population projections, real income projections and household size. Commercial sales are driven by Indianapolis MSA non-manufacturing employment and non-manufacturing output. The primary industrial sales model variables are manufacturing employment and manufacturing output. Table 3-1 through Table 3-3 shows the economic forecasts applicable to each customer class.

## Table 3-1: Residential Economic Drivers

| Year | Population (000's) | Change | Household Size | Change | Household Income (Real $) | Change |
|---|---|---|---|---|---|---|
| 2022 | 985 | | 2.4 | | 48,223 | |
| 2023 | 992 | 0.7% | 2.4 | -0.6% | 48,757 | 1.1% |
| 2024 | 998 | 0.6% | 2.4 | -0.6% | 49,664 | 1.9% |
| 2025 | 1,004 | 0.6% | 2.4 | -0.6% | 50,222 | 1.1% |
| 2026 | 1,010 | 0.6% | 2.4 | -0.6% | 50,776 | 1.1% |
| 2027 | 1,017 | 0.6% | 2.3 | -0.5% | 51,500 | 1.4% |
| 2028 | 1,022 | 0.6% | 2.3 | -0.5% | 52,477 | 1.9% |
| 2029 | 1,028 | 0.6% | 2.3 | -0.4% | 53,487 | 1.9% |
| 2030 | 1,034 | 0.6% | 2.3 | -0.4% | 54,448 | 1.8% |
| 2031 | 1,040 | 0.6% | 2.3 | -0.4% | 55,338 | 1.6% |
| 2032 | 1,046 | 0.6% | 2.3 | -0.4% | 56,192 | 1.5% |
| 2033 | 1,052 | 0.5% | 2.3 | -0.4% | 57,033 | 1.5% |
| 2034 | 1,057 | 0.5% | 2.3 | -0.3% | 57,881 | 1.5% |
| 2035 | 1,063 | 0.5% | 2.3 | -0.3% | 58,723 | 1.5% |
| 2036 | 1,068 | 0.5% | 2.3 | -0.4% | 59,552 | 1.4% |
| 2037 | 1,073 | 0.5% | 2.3 | -0.3% | 60,371 | 1.4% |
| 2038 | 1,078 | 0.5% | 2.2 | -0.3% | 61,155 | 1.3% |
| 2039 | 1,083 | 0.5% | 2.2 | -0.3% | 61,901 | 1.2% |
| 2040 | 1,088 | 0.5% | 2.2 | -0.3% | 62,662 | 1.2% |
| 2041 | 1,093 | 0.4% | 2.2 | -0.3% | 63,472 | 1.3% |
| 2042 | 1,098 | 0.4% | 2.2 | -0.3% | 64,304 | 1.3% |
| **2022-42** | | **0.5%** | | **-0.4%** | | **1.4%** |

### Table 3-2: Commercial Economic Drivers

| Year | Non-Manufacturing Employment (thou's) | Change | Non-Manufacturing Output (mil Real $) | Change |
|---|---|---|---|---|
| 2022 | 1,009 | | 260,623 | |
| 2023 | 1,028 | 1.9% | 267,147 | 2.5% |
| 2024 | 1,040 | 1.2% | 276,295 | 3.4% |
| 2025 | 1,047 | 0.6% | 284,085 | 2.8% |
| 2026 | 1,052 | 0.5% | 291,076 | 2.5% |
| 2027 | 1,058 | 0.6% | 297,045 | 2.1% |
| 2028 | 1,065 | 0.6% | 303,805 | 2.3% |
| 2029 | 1,072 | 0.6% | 310,421 | 2.2% |
| 2030 | 1,078 | 0.6% | 316,803 | 2.1% |
| 2031 | 1,084 | 0.5% | 323,088 | 2.0% |
| 2032 | 1,089 | 0.5% | 329,700 | 2.0% |
| 2033 | 1,095 | 0.5% | 336,311 | 2.0% |
| 2034 | 1,100 | 0.5% | 343,007 | 2.0% |
| 2035 | 1,106 | 0.5% | 349,661 | 1.9% |
| 2036 | 1,111 | 0.4% | 356,390 | 1.9% |
| 2037 | 1,115 | 0.4% | 363,025 | 1.9% |
| 2038 | 1,120 | 0.4% | 369,601 | 1.8% |
| 2039 | 1,125 | 0.4% | 376,226 | 1.8% |
| 2040 | 1,130 | 0.5% | 382,974 | 1.8% |
| 2041 | 1,135 | 0.5% | 389,820 | 1.8% |
| 2042 | 1,141 | 0.5% | 396,646 | 1.8% |
| **2022-42** | | **0.6%** | | **2.1%** |

**Table 3-3: Industrial Economic Drivers**

| Year | Manufacturing Employment (thou's) | Change | Manufacturing Output (mil Real $) | Change |
|---|---|---|---|---|
| 2022 | 95.5 | | 100,900 | |
| 2023 | 95.5 | 0.0% | 102,595 | 1.7% |
| 2024 | 94.9 | -0.6% | 105,818 | 3.1% |
| 2025 | 93.9 | -1.0% | 107,392 | 1.5% |
| 2026 | 93.0 | -1.0% | 108,241 | 0.8% |
| 2027 | 92.3 | -0.8% | 109,461 | 1.1% |
| 2028 | 91.7 | -0.7% | 111,492 | 1.9% |
| 2029 | 91.1 | -0.7% | 113,524 | 1.8% |
| 2030 | 90.5 | -0.7% | 115,574 | 1.8% |
| 2031 | 89.9 | -0.6% | 117,832 | 2.0% |
| 2032 | 89.3 | -0.7% | 120,224 | 2.0% |
| 2033 | 88.7 | -0.6% | 122,663 | 2.0% |
| 2034 | 88.2 | -0.6% | 125,154 | 2.0% |
| 2035 | 87.6 | -0.7% | 127,639 | 2.0% |
| 2036 | 87.1 | -0.6% | 130,097 | 1.9% |
| 2037 | 86.5 | -0.7% | 132,410 | 1.8% |
| 2038 | 86.0 | -0.6% | 134,691 | 1.7% |
| 2039 | 85.4 | -0.6% | 137,019 | 1.7% |
| 2040 | 84.9 | -0.6% | 139,411 | 1.7% |
| 2041 | 84.5 | -0.6% | 141,728 | 1.7% |
| 2042 | 84.0 | -0.6% | 143,990 | 1.6% |
| **2022-42** | | **-0.6%** | | **1.8%** |

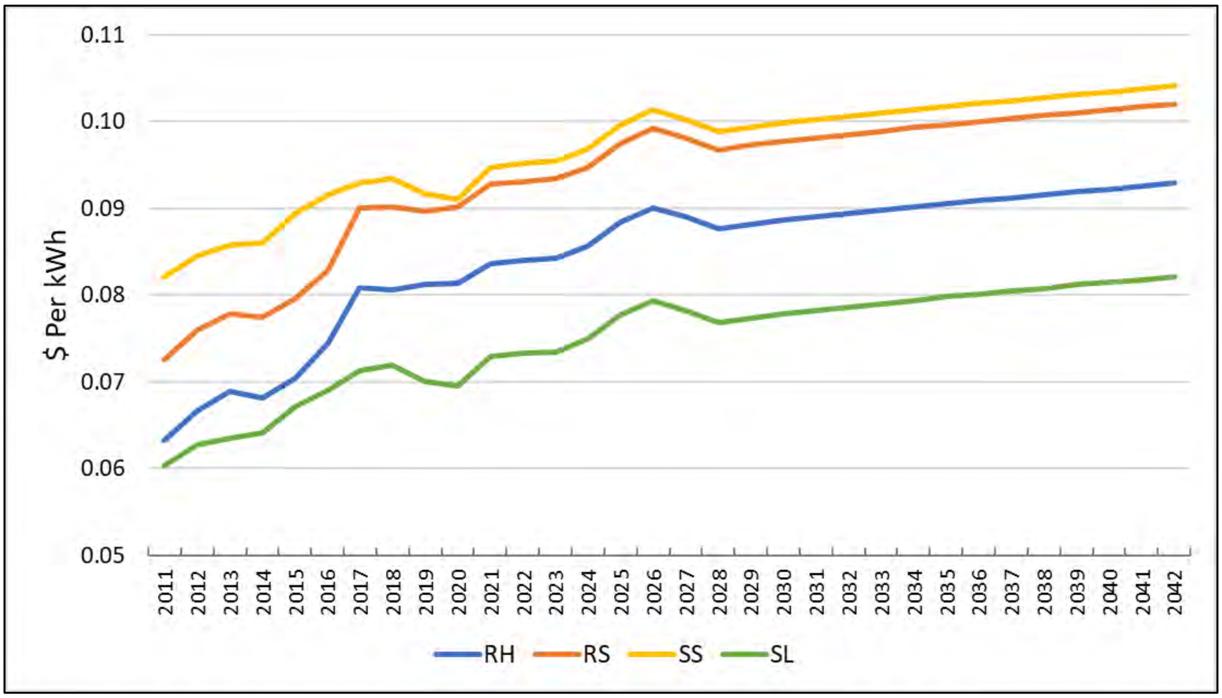
## 3.3 COVID-19 Impact

By the spring of 2020, Indiana, like many others states across the country, issued a “Stay at Home” order in response to the COVID-19 virus. This had the impact of significantly reducing commercial and industrial usage as businesses shutdown and significantly increasing residential usage as work activity shifted from the office to the home. As these restrictions were lifted most businesses re-opened, although even today some portion of the workforce remains working from home. To capture the impact, the residential average use and non-residential rate class models include a COVID impact variable. This variable is constructed using Google Mobility Report data for the residential, workplace and retail place types for Marion County. Google Mobility Report data tracks daily cell phone locations by place type compared to a pre-COVID baseline. The residential place type active increased while the workplace and retail decreased, this data correlates well to the actual changes in electric sales.

## 3.4 Prices

Historical prices (in real dollars) are derived from billed sales and revenue data. Historical prices are calculated as a 12-month moving average of the average rate (revenues divided by sales); prices are expressed in real dollars. Prices impact residential and commercial sales through imposed short-term price elasticities. Short-term price elasticities are small; residential elasticities are set at -0.05 and commercial and industrial price elasticities are set at -0.15. Figure 23 shows price forecasts for the residential RH and RS schedules, the commercial SS and SL schedules. Electric prices are expected to average 0.5% growth over the forecast period.

**Figure 23: Historical and projected real electricity prices (cents per kWh)**



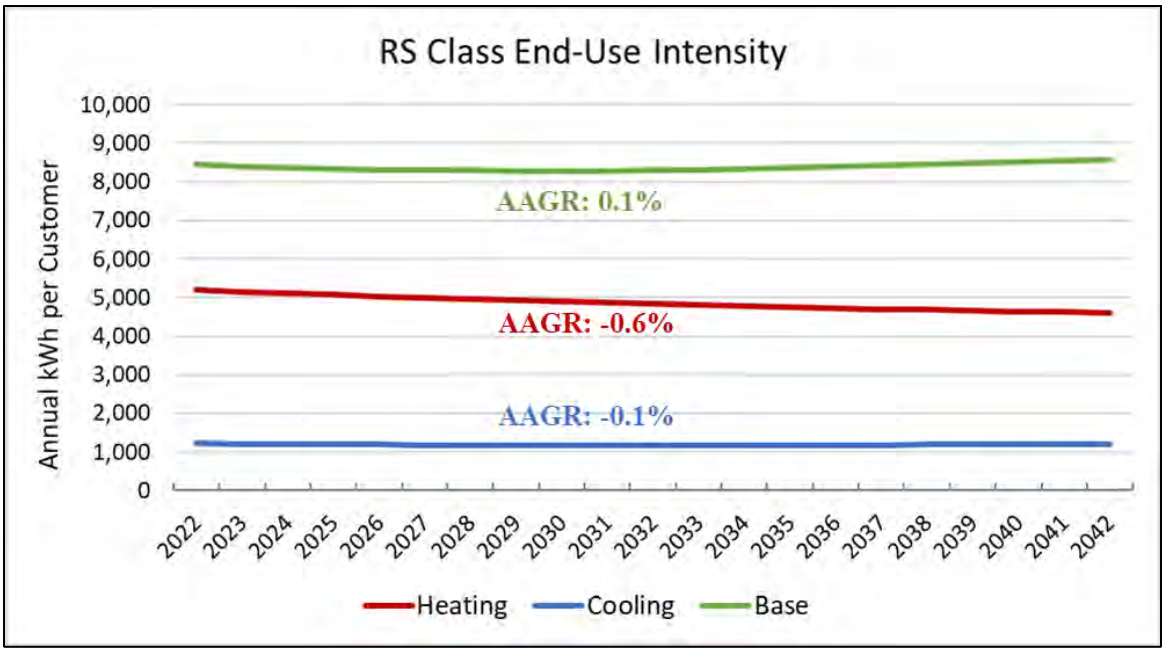

## 3.5 Appliance Saturation and Efficiency Trends

Over the long-term, changes in end-use saturation and stock efficiency impact class sales, system energy, and peak demand. End-use energy intensities, expressed in kWh per household for the residential sector and kWh per square foot for the commercial sectors, are incorporated into the constructed forecast model variables. Energy intensities reflect both change in ownership (saturation) and average stock efficiency. Energy intensities are derived from Energy Information Administration's (EIA) 2021 Annual Energy Outlook for the East

North Central Census Division. The residential sector is further calibrated to AES Indiana's service territory based on information from DSM potential studies. The residential sector incorporates saturation and efficiency trends for twenty end-uses. The commercial sector captures end-use intensity projections for ten end-use classifications across ten building types.

Residential end-use intensities are used in constructing residential XHeat, XCool, and XOther in the residential average use model. Figure 24 shows the resulting aggregated end-use intensity projections.

**Figure 24: Residential End-Use Energy Intensities**

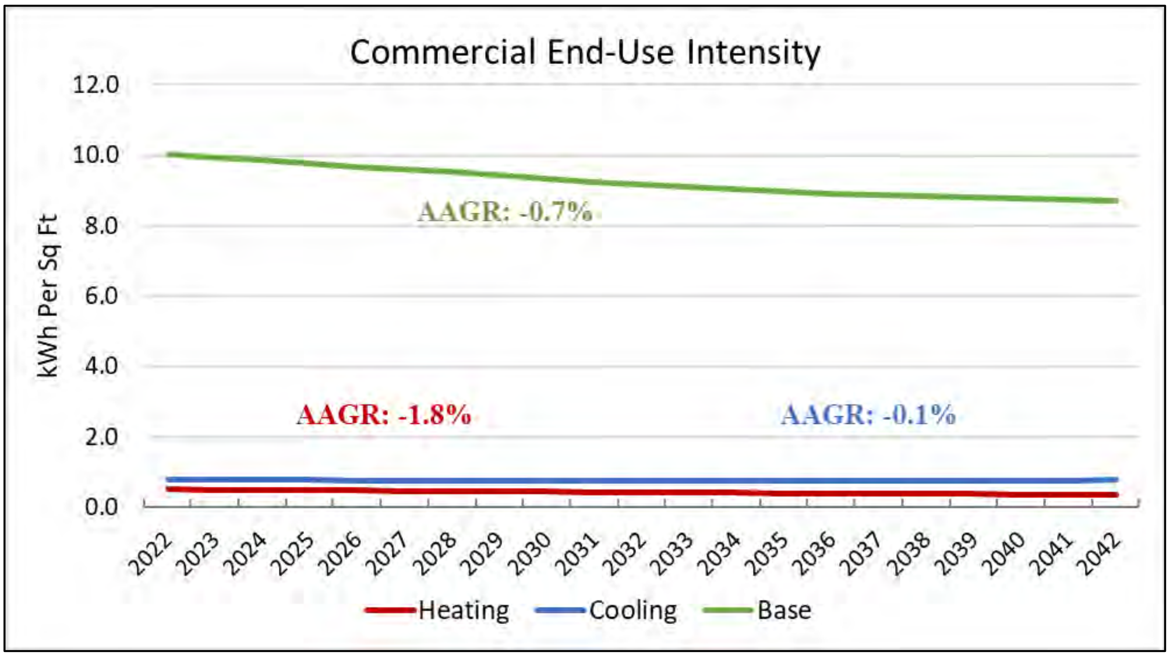



*AAGR=Average Annual Growth Rate

While overall, heating use per household is declining, total AES Indiana heating load is increasing as a result of strong growth in electric heat customers. Cooling intensity declines 0.1% annually through the forecast period as overall air conditioning efficiency improvements and change from less efficient room air conditioning to central air conditioning slightly outweighs overall increase in air conditioning saturation. Again, while cooling intensity is declining overall cooling load is increasing as the number of new customers is increasing faster than cooling use per customer is declining. Total non-weather sensitive end-use intensity (Base) declines in the first 10 years of the forecast before increasing over the last 10 years. Most non-weather sensitive end-uses are declining driven by end-use efficiency improvements. Declines in intensities across most of the end-use categories are partially offset by miscellaneous end-use sales growth.

Commercial end-use intensities are expressed in kWh per sqft. As in the residential sector, there have been significant improvements in end-use efficiency as a result of new codes and standards. Figure 25 shows commercial end-use energy intensity forecasts for the aggregated end-use categories.

**Figure 25: Commercial End-Use Energy Intensity**




Commercial usage is dominated by non-weather sensitive end-uses, which over the forecast period are projected to decline 0.7% annually, driven by improvements in lighting and ventilation efficiency. Cooling intensity declines 0.1% annually through the forecast period, with efficiency improvement only slightly stronger than saturation increases. Heating intensity declines an even stronger 1.8% annual rate though commercial electric heating is relatively small.

## 3.6 Historical EE Program Savings

Over the past ten years AES Indiana has promoted energy efficiency (EE) savings through utility sponsored programs. These programs have had a significant impact on electricity usage across nearly all customer classes. The EE program savings are above and beyond naturally occurring savings, and impact of federal codes and standards.

The residential and commercial models incorporate EE to account for historical program savings. The EE variables help explain historical usage trends. In the forecast period EE is held constant, as incremental EE program savings are treated as a supply-side resource in the IRP modeling framework. The EE variables are based on annual verified EE savings that are converted to a monthly series. In the residential average use models, EE is expressed as savings per customer. Figure 26 and Figure 27 shows the cumulative MWh savings and savings as a percentage of class sales for the residential, commercial, and industrial classes.

**Figure 26: Residential EE Savings**

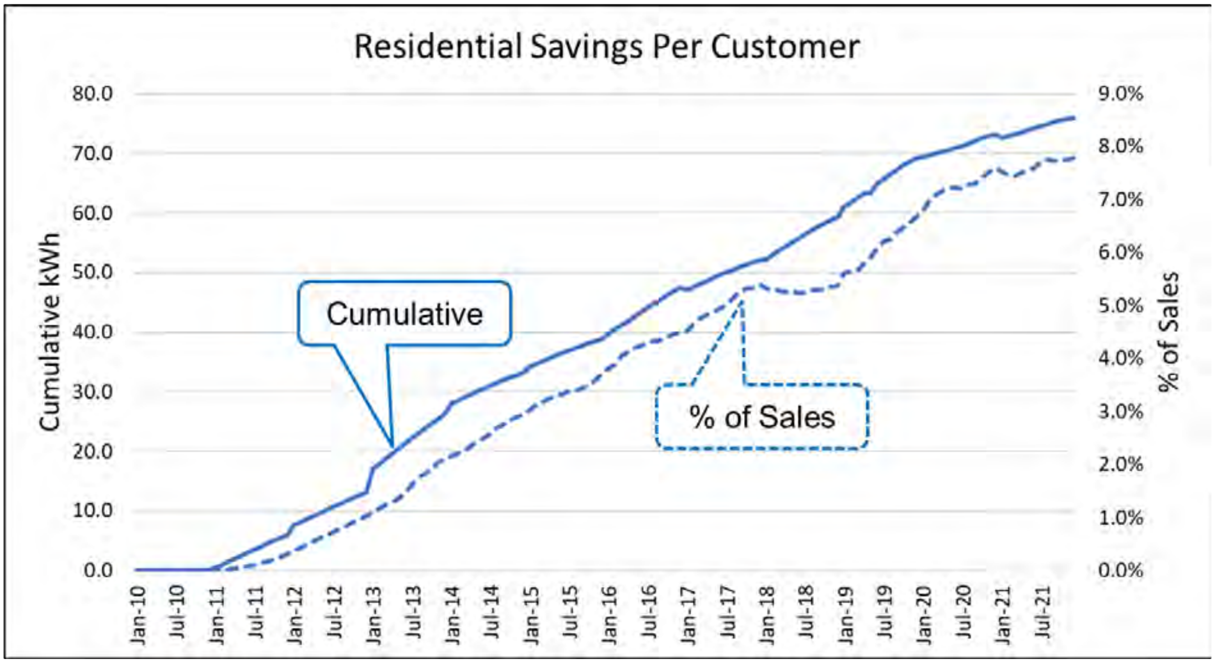
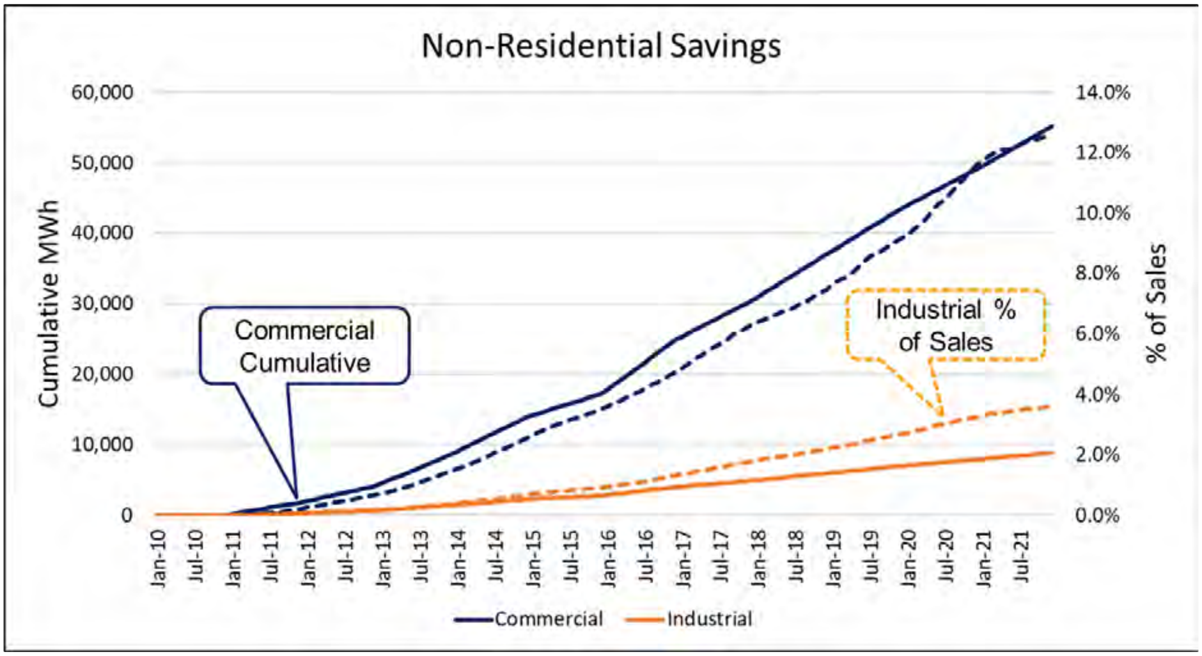


**Figure 27: Non-Residential EE Savings**



# 4 Forecast Sensitivities

High and low forecast scenarios are based on alternative economic scenarios provided by Moody Analytics.

The high case is Moody Analytics Alternative Scenario 1 – Upside – 10th Percentile. In this scenario, there is just a 10% probability that the economy for the Indianapolis MSA could potentially perform better.

The low case is based on Moody Analytics Alternative Scenario 3 – Downside – 90th Percentile scenario.  This is the opposite boundary where there is a 10% or less probability that economy will perform worse.

The economic scenarios are constructed by applying the scenario economic growth rates to the baseline economic variables starting in the first month of the forecast period (2022). Scenarios are further adjusted to ensure the growth rates are less than or equal to the baseline growth rates in the low case and greater than or equal to the baseline growth rates in the high case.

The estimated rate class models are used to generate the high and low sales forecasts. Heating, cooling, and base-load energy requirements derived from the scenarios drive the drive the high and low system peak forecast.  Table 4-1 and Table 4-2 summarize base, high, and low case energy, and peak forecasts.

**Table 4-1: Scenario Forecasts: Energy**

| Year | Baseline (MWh) | change | Low Scenario (MWh) | change | High Scenario (MWh) | change |
|---|---|---|---|---|---|---|
| 2022 | 13,986,185 | | 13,730,461 | | 14,040,156 | |
| 2023 | 14,024,823 | 0.3% | 13,647,974 | -0.6% | 14,105,462 | 0.5% |
| 2024 | 14,133,336 | 0.8% | 13,751,860 | 0.8% | 14,217,033 | 0.8% |
| 2025 | 14,162,987 | 0.2% | 13,779,967 | 0.2% | 14,259,179 | 0.3% |
| 2026 | 14,182,532 | 0.1% | 13,797,417 | 0.1% | 14,289,229 | 0.2% |
| 2027 | 14,262,645 | 0.6% | 13,874,989 | 0.6% | 14,371,347 | 0.6% |
| 2028 | 14,373,450 | 0.8% | 13,982,390 | 0.8% | 14,483,077 | 0.8% |
| 2029 | 14,446,266 | 0.5% | 14,052,471 | 0.5% | 14,557,288 | 0.5% |
| 2030 | 14,496,004 | 0.3% | 14,098,157 | 0.3% | 14,608,424 | 0.4% |
| 2031 | 14,555,951 | 0.4% | 14,154,709 | 0.4% | 14,669,504 | 0.4% |
| 2032 | 14,619,528 | 0.4% | 14,215,016 | 0.4% | 14,733,988 | 0.4% |
| 2033 | 14,690,601 | 0.5% | 14,281,061 | 0.5% | 14,806,326 | 0.5% |
| 2034 | 14,775,368 | 0.6% | 14,362,804 | 0.6% | 14,892,551 | 0.6% |
| 2035 | 14,863,828 | 0.6% | 14,446,481 | 0.6% | 14,984,181 | 0.6% |
| 2036 | 14,957,410 | 0.6% | 14,536,042 | 0.6% | 15,081,119 | 0.6% |
| 2037 | 15,054,463 | 0.6% | 14,628,845 | 0.6% | 15,180,645 | 0.7% |
| 2038 | 15,153,931 | 0.7% | 14,723,851 | 0.6% | 15,283,189 | 0.7% |
| 2039 | 15,256,457 | 0.7% | 14,820,646 | 0.7% | 15,387,479 | 0.7% |
| 2040 | 15,352,201 | 0.6% | 14,909,653 | 0.6% | 15,484,756 | 0.6% |
| 2041 | 15,457,655 | 0.7% | 15,005,944 | 0.6% | 15,592,886 | 0.7% |
| 2042 | 15,567,503 | 0.7% | 15,105,575 | 0.7% | 15,706,773 | 0.7% |
| **2022-42** | | **0.54%** | | **0.48%** | | **0.56%** |

**Table 4-2: Scenario Forecasts: Demand**

| Year | Baseline (MW) | change | Low Scenario (MW) | change | High Scenario (MW) | change |
|---|---|---|---|---|---|---|
| 2022 | 2,829 | | 2,781 | | 2,840 | |
| 2023 | 2,852 | 0.8% | 2,787 | 0.2% | 2,865 | 0.9% |
| 2024 | 2,873 | 0.7% | 2,807 | 0.7% | 2,887 | 0.8% |
| 2025 | 2,878 | 0.2% | 2,812 | 0.2% | 2,895 | 0.3% |
| 2026 | 2,885 | 0.3% | 2,819 | 0.2% | 2,904 | 0.3% |
| 2027 | 2,905 | 0.7% | 2,838 | 0.7% | 2,924 | 0.7% |
| 2028 | 2,930 | 0.9% | 2,862 | 0.9% | 2,949 | 0.9% |
| 2029 | 2,950 | 0.7% | 2,881 | 0.7% | 2,969 | 0.7% |
| 2030 | 2,969 | 0.6% | 2,899 | 0.6% | 2,989 | 0.7% |
| 2031 | 2,988 | 0.6% | 2,918 | 0.6% | 3,008 | 0.7% |
| 2032 | 3,009 | 0.7% | 2,938 | 0.7% | 3,029 | 0.7% |
| 2033 | 3,031 | 0.7% | 2,958 | 0.7% | 3,052 | 0.7% |
| 2034 | 3,055 | 0.8% | 2,982 | 0.8% | 3,076 | 0.8% |
| 2035 | 3,080 | 0.8% | 3,005 | 0.8% | 3,101 | 0.8% |
| 2036 | 3,105 | 0.8% | 3,030 | 0.8% | 3,127 | 0.8% |
| 2037 | 3,132 | 0.9% | 3,056 | 0.8% | 3,155 | 0.9% |
| 2038 | 3,158 | 0.8% | 3,081 | 0.8% | 3,182 | 0.9% |
| 2039 | 3,186 | 0.9% | 3,107 | 0.8% | 3,210 | 0.9% |
| 2040 | 3,214 | 0.9% | 3,134 | 0.9% | 3,238 | 0.9% |
| 2041 | 3,244 | 0.9% | 3,162 | 0.9% | 3,269 | 1.0% |
| 2042 | 3,275 | 0.9% | 3,191 | 0.9% | 3,300 | 1.0% |
| **2022-42** | | **0.73%** | | **0.69%** | | **0.76%** |

# 5 Appendix A: Model Statistics

***RS Average Use Model***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| RS_Vars.XOther | 1.02 | 0.013 | 68.975 | 0.00% |
| RS_Vars.XCool | 1.67 | 0.021 | 61.152 | 0.00% |
| RS_Vars.XHeat | 0.82 | 0.029 | 71.416 | 0.00% |
| mBin.Jan | 23.51 | 4.854 | 3.936 | 0.00% |
| mBin.Mar | -18.49 | 5.547 | -2.39 | 0.11% |
| mBin.Apr | -38.12 | 6.815 | -4.167 | 0.00% |
| mBin.May | -29.29 | 5.906 | -2.919 | 0.00% |
| mBin.Nov | -22.47 | 4.549 | -5.458 | 0.00% |
| mBin.Oct17 | -48.13 | 14.215 | -2.922 | 0.10% |
| mBin.May21 | -210.40 | 14.839 | -6.963 | 0.00% |
| COVID_Shift.Res | 47.44 | 15.004 | 2.145 | 0.20% |
| DSM_10YrML.RS_Constant | -1.39 | 0.145 | -8.788 | 0.00% |
| MA(1) | 0.56 | 0.077 | 6.688 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 18 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 119 |
| R-Squared | 0.993 |
| Adjusted R-Squared | 0.992 |
| AIC | 5.725 |
| BIC | 6.009 |
| Model Sum of Squares | 4,824,488 |
| Sum of Squared Errors | 33,230 |
| Mean Squared Error | 279.24 |
| Std. Error of Regression | 16.71 |
| Mean Abs. Dev. (MAD) | 11.88 |
| Mean Abs. % Err. (MAPE) | 1.43% |
| Durbin-Watson Statistic | 2.11 |

***RS Customer Model***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | -216268.204 | 5835.68 | -37.06 | 0.00% |
| Econ.MarionPop | 390.175 | 6.318 | 61.755 | 0.00% |
| mBin.May19 | 2270.705 | 100.483 | 22.598 | 0.00% |
| mBin.Yr16Plus | 628.115 | 193.735 | 3.242 | 0.15% |
| MA(1) | 1.638 | 0.08 | 20.418 | 0.00% |
| MA(2) | 1.713 | 0.136 | 12.569 | 0.00% |
| MA(3) | 1.642 | 0.145 | 11.356 | 0.00% |
| MA(4) | 1.14 | 0.136 | 8.391 | 0.00% |
| MA(5) | 0.5 | 0.08 | 6.276 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 52 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 123 |
| R-Squared | 0.999 |
| Adjusted R-Squared | 0.999 |
| AIC | 11.32 |
| BIC | 11.51 |
| Model Sum of Squares | 10,101,483,592 |
| Sum of Squared Errors | 9,469,010 |
| Mean Squared Error | 76983.82 |
| Std. Error of Regression | 277.46 |
| Mean Abs. Dev. (MAD) | 219.45 |
| Mean Abs. % Err. (MAPE) | 0.15% |
| Durbin-Watson Statistic | 1.50 |

***RC Average Use Model***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| RC_Vars.XHeat | 1.481 | 0.027 | 54.544 | 0.00% |
| RC_Vars.XCool | 1.53 | 0.026 | 59.588 | 0.00% |
| RC_Vars.XOther | 1.378 | 0.013 | 106.876 | 0.00% |
| mBin.Jan | 25.494 | 5.385 | 4.735 | 0.00% |
| mBin.Apr | -17.013 | 5.987 | -2.841 | 0.53% |
| mBin.May | -26.127 | 6.397 | -4.084 | 0.01% |
| mBin.Jul | 35.548 | 6.547 | 5.43 | 0.00% |
| mBin.Aug | 45.023 | 6.538 | 6.886 | 0.00% |
| mBin.Oct | -18.78 | 6.055 | -3.102 | 0.24% |
| mBin.Nov | -32.466 | 5.831 | -5.568 | 0.00% |
| mBin.Apr12 | -53.372 | 16.497 | -3.235 | 0.16% |
| mBin.Sep20 | 68.584 | 16.068 | 4.268 | 0.00% |
| mBin.May21 | -183.565 | 16.495 | -11.129 | 0.00% |
| COVID_Shift.Res | 33.74 | 11.242 | 3.001 | 0.33% |
| DSM_10YrML.RC_Constant | -1.851 | 0.089 | -20.809 | 0.00% |
| MA(1) | 0.198 | 0.094 | 2.097 | 3.81% |

| Model Statistics | |
|---|---|
| Iterations | 17 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 116 |
| R-Squared | 0.994 |
| Adjusted R-Squared | 0.993 |
| AIC | 5.629 |
| BIC | 5.979 |
| Model Sum of Squares | 4,887,472 |
| Sum of Squared Errors | 28,841 |
| Mean Squared Error | 248.63 |
| Std. Error of Regression | 15.77 |
| Mean Abs. Dev. (MAD) | 11.61 |
| Mean Abs. % Err. (MAPE) | 1.08% |
| Durbin-Watson Statistic | 1.97 |

***RC Customer Model***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | -46381.575 | 7145.536 | -6.491 | 0.00% |
| Econ.MarionPop | 83.166 | 7.397 | 11.244 | 0.00% |
| mBin.Jan | 38.48 | 16.626 | 2.314 | 2.24% |
| mBin.Feb | 43.031 | 18.714 | 2.299 | 2.32% |
| mBin.Mar | 20.133 | 16.077 | 1.252 | 21.29% |
| mBin.Jun | -58.156 | 17.116 | -3.398 | 0.09% |
| mBin.Jul | -62.97 | 22.085 | -2.851 | 0.51% |
| mBin.Aug | -73.076 | 24.185 | -3.022 | 0.31% |
| mBin.Sep | -91.574 | 24.185 | -3.786 | 0.02% |
| mBin.Oct | -93.905 | 22.084 | -4.252 | 0.00% |
| mBin.Nov | -51.28 | 17.115 | -2.996 | 0.33% |
| AR(1) | 0.958 | 0.01 | 98.018 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 30 |
| Adjusted Observations | 131 |
| Deg. of Freedom for Error | 119 |
| R-Squared | 0.998 |
| Adjusted R-Squared | 0.998 |
| AIC | 8.29 |
| BIC | 8.55 |
| Model Sum of Squares | 221,965,102 |
| Sum of Squared Errors | 433,041 |
| Mean Squared Error | 3639 |
| Std. Error of Regression | 60.32 |
| Mean Abs. Dev. (MAD) | 41 |
| Mean Abs. % Err. (MAPE) | 0.12% |
| Durbin-Watson Statistic | 1.62 |

***RH Average Use Model***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| RH_Vars.XOther | 0.913 | 0.016 | 55.629 | 0.00% |
| RH_Vars.XHeat | 1.692 | 0.015 | 113.607 | 0.00% |
| RH_Vars.XCool | 1.179 | 0.029 | 40.424 | 0.00% |
| mBin.Mar | -27.937 | 11.153 | -2.505 | 1.36% |
| mBin.Apr | -43.095 | 10.638 | -4.051 | 0.01% |
| mBin.Nov | -82.197 | 10.612 | -7.745 | 0.00% |
| mBin.Dec | -87.72 | 10.803 | -8.12 | 0.00% |
| COVID_Shift.Res | 35.116 | 25.184 | 1.394 | 16.58% |
| DSM_10YrML.RH_Constant | -1.514 | 0.134 | -11.261 | 0.00% |
| MA(1) | 0.348 | 0.09 | 3.852 | 0.02% |

| Model Statistics | |
|---|---|
| Iterations | 18 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 122 |
| R-Squared | 0.996 |
| Adjusted R-Squared | 0.996 |
| AIC | 6.998 |
| BIC | 7.217 |
| Model Sum of Squares | 32,912,744 |
| Sum of Squared Errors | 124,203 |
| Mean Squared Error | 1018.05 |
| Std. Error of Regression | 31.91 |
| Mean Abs. Dev. (MAD) | 24.68 |
| Mean Abs. % Err. (MAPE) | 2.06% |
| Durbin-Watson Statistic | 1.91 |

***RH Customer Model***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | -216268.204 | 5835.68 | -37.06 | 0.00% |
| Econ.MarionPop | 390.175 | 6.318 | 61.755 | 0.00% |
| mBin.May19 | 2270.705 | 100.483 | 22.598 | 0.00% |
| mBin.Yr16Plus | 628.115 | 193.735 | 3.242 | 0.15% |
| MA(1) | 1.638 | 0.08 | 20.418 | 0.00% |
| MA(2) | 1.713 | 0.136 | 12.569 | 0.00% |
| MA(3) | 1.642 | 0.145 | 11.356 | 0.00% |
| MA(4) | 1.14 | 0.136 | 8.391 | 0.00% |
| MA(5) | 0.5 | 0.08 | 6.276 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 52 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 123 |
| R-Squared | 0.999 |
| Adjusted R-Squared | 0.999 |
| AIC | 11.32 |
| BIC | 11.51 |
| Model Sum of Squares | 10,101,483,592 |
| Sum of Squared Errors | 9,469,010 |
| Mean Squared Error | 76983.82 |
| Std. Error of Regression | 277.46 |
| Mean Abs. Dev. (MAD) | 219.45 |
| Mean Abs. % Err. (MAPE) | 0.15% |
| Durbin-Watson Statistic | 1.50 |

## ***CR Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CR_Custs.Filled | 229.809 | 6.683 | 34.387 | 0.00% |
| mBin.Jan | 832.885 | 178.274 | 4.672 | 0.00% |
| mBin.Jun | 551.794 | 154.127 | 3.58 | 0.06% |
| mBin.Jul | 718.884 | 174.773 | 4.113 | 0.01% |
| mBin.Aug | 534.18 | 153.779 | 3.474 | 0.09% |
| mBin.Dec | 164.899 | 152.833 | 1.079 | 28.42% |
| mBin.Oct | -341.78 | 134.706 | -2.537 | 1.33% |
| mBin.Nov16 | -1316.122 | 357.222 | -3.684 | 0.04% |
| mBin.Jan19 | 1913.357 | 382.736 | 4.999 | 0.00% |
| mBin.Jan21 | 943.731 | 380.847 | 2.478 | 1.56% |
| AR(1) | 0.657 | 0.092 | 7.146 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 12 |
| Adjusted Observations | 83 |
| Deg. of Freedom for Error | 72 |
| R-Squared | 0.868 |
| Adjusted R-Squared | 0.85 |
| AIC | 12.17 |
| BIC | 12.49 |
| Model Sum of Squares | 80,711,429 |
| Sum of Squared Errors | 12,286,038 |
| Mean Squared Error | 170639.42 |
| Std. Error of Regression | 413.09 |
| Mean Abs. Dev. (MAD) | 304.73 |
| Mean Abs. % Err. (MAPE) | 6.24% |
| Durbin-Watson Statistic | 1.94 |

***Residential APL Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| mBin.TrendVar2 | -54772290.45 | 1932932.1 | -28.336 | 0.00% |
| mBin.Jan | 57604372.73 | 1996880.1 | 28.847 | 0.00% |
| mBin.Feb | 57456320.73 | 1996944.7 | 28.772 | 0.00% |
| mBin.Mar | 57432871.43 | 1997009.1 | 28.759 | 0.00% |
| mBin.Apr | 57287154.77 | 1997073.4 | 28.686 | 0.00% |
| mBin.May | 57241319.34 | 1997137.4 | 28.662 | 0.00% |
| mBin.Jun | 57173947.46 | 1997201.2 | 28.627 | 0.00% |
| mBin.Jul | 57213505.6 | 1997264.8 | 28.646 | 0.00% |
| mBin.Aug | 57278052.36 | 1997328.2 | 28.677 | 0.00% |
| mBin.Sep | 57328959.59 | 1997391.4 | 28.702 | 0.00% |
| mBin.Oct | 57489580.6 | 1997454.4 | 28.781 | 0.00% |
| mBin.Nov | 57535134.6 | 1997517.2 | 28.803 | 0.00% |
| mBin.Dec | 57609263.83 | 1997579.9 | 28.84 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 1 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 119 |
| R-Squared | 0.974 |
| Adjusted R-Squared | 0.972 |
| AIC | 20.55 |
| BIC | 20.83 |
| Model Sum of Squares | 3,425,868,194,980 |
| Sum of Squared Errors | 90,749,636,712 |
| Mean Squared Error | 762601989.2 |
| Std. Error of Regression | 27615.25 |
| Mean Abs. Dev. (MAD) | 18480 |
| Mean Abs. % Err. (MAPE) | 2.36% |
| Durbin-Watson Statistic | 1.25 |

***SS Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| SS_Vars.XOther | 0.901 | 0.007 | 134.584 | 0.00% |
| SS_Vars.XHeat | 29.844 | 1.054 | 28.315 | 0.00% |
| SS_Vars.XCool | 9.875 | 0.186 | 53.193 | 0.00% |
| mBin.Jan | -3897.755 | 592.217 | -6.582 | 0.00% |
| mBin.Mar | 1284.559 | 478.516 | 2.684 | 0.83% |
| mBin.Nov | -2427.39 | 560.344 | -4.332 | 0.00% |
| mBin.Dec | -4381.034 | 617.595 | -7.094 | 0.00% |
| mBin.Jun19 | -4576.186 | 1536.143 | -2.979 | 0.35% |
| mBin.May20 | -2441.017 | 1546.083 | -1.579 | 11.71% |
| mBin.May21 | -19491.102 | 1546.904 | -12.6 | 0.00% |
| mBin.Yr2020Plus | 2451.768 | 895.417 | 2.738 | 0.71% |
| DSM_10YrML.SS_Constant | -0.476 | 0.065 | -7.328 | 0.00% |
| AR(1) | 0.432 | 0.084 | 5.116 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 12 |
| Adjusted Observations | 131 |
| Deg. of Freedom for Error | 118 |
| R-Squared | 0.979 |
| Adjusted R-Squared | 0.977 |
| AIC | 14.9366 |
| BIC | 15.2219 |
| Model Sum of Squares | 15,184,927,145 |
| Sum of Squared Errors | 329,583,200 |
| Mean Squared Error | 2793077.97 |
| Std. Error of Regression | 1671.25 |
| Mean Abs. Dev. (MAD) | 1252.479 |
| Mean Abs. % Err. (MAPE) | 1.21% |
| Durbin-Watson Statistic | 1.99 |

## ***SH Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| SH_Vars.XOther | 0.628 | 0.021 | 30.213 | 0.00% |
| SH_Vars.XHeat | 108.07 | 3.812 | 28.351 | 0.00% |
| SH_Vars.XCool | 8.587 | 1.162 | 7.393 | 0.00% |
| mBin.Jan | 3799.822 | 771.219 | 4.927 | 0.00% |
| mBin.Feb | 8475.99 | 891.778 | 9.505 | 0.00% |
| mBin.Mar | 8184.564 | 798.052 | 10.256 | 0.00% |
| mBin.Apr | 5424.527 | 792.726 | 6.843 | 0.00% |
| mBin.May | 4119.754 | 925.856 | 4.45 | 0.00% |
| mBin.Jun | 3454.764 | 1395.043 | 2.476 | 1.47% |
| mBin.Jul | 4520.725 | 1930.928 | 2.341 | 2.10% |
| mBin.Aug | 6695.713 | 1946.089 | 3.441 | 0.08% |
| mBin.Sep | 4611.447 | 1667.249 | 2.766 | 0.66% |
| mBin.Oct | 3597.529 | 905.269 | 3.974 | 0.01% |
| mBin.Jul19 | -2496.355 | 1662.148 | -1.502 | 13.59% |
| mBin.May21 | -4541.675 | 1855.725 | -2.447 | 1.59% |
| DSM_10YrML.SH_Constant | -2.019 | 0.278 | -7.26 | 0.00% |
| AR(1) | 0.495 | 0.085 | 5.83 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 11 |
| Adjusted Observations | 131 |
| Deg. of Freedom for Error | 114 |
| R-Squared | 0.981 |
| Adjusted R-Squared | 0.978 |
| AIC | 15.0812 |
| BIC | 15.4543 |
| Model Sum of Squares | 18,511,880,839 |
| Sum of Squared Errors | 358,273,571 |
| Mean Squared Error | 3142750.624 |
| Std. Error of Regression | 1772.78 |
| Mean Abs. Dev. (MAD) | 1327.376 |
| Mean Abs. % Err. (MAPE) | 2.98% |
| Durbin-Watson Statistic | 1.98 |

## ***SE Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | 1478.821 | 36.286 | 40.754 | 0.00% |
| mRevWthr.CDD65 | 0.777 | 0.136 | 5.719 | 0.00% |
| mRevWthr.HDD55 | 0.682 | 0.06 | 11.306 | 0.00% |
| mBin.Apr | -73.639 | 28.895 | -2.548 | 1.21% |
| mBin.Jul | -100.524 | 30.81 | -3.263 | 0.15% |
| mBin.Nov | -75.548 | 29.728 | -2.541 | 1.23% |
| mBin.Jun17 | -404.383 | 91.998 | -4.396 | 0.00% |
| mBin.Nov18 | -459.595 | 119.273 | -3.853 | 0.02% |
| mBin.Dec18 | -477.781 | 114.591 | -4.169 | 0.01% |
| mBin.May20 | -286.513 | 116.996 | -2.449 | 1.58% |
| mBin.Jun20 | -300.213 | 116.556 | -2.576 | 1.12% |
| mBin.Yr16Plus | -250.256 | 42.715 | -5.859 | 0.00% |
| mBin.Yr18Plus | -173.577 | 44.645 | -3.888 | 0.02% |
| MA(1) | 0.618 | 0.079 | 7.851 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 13 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 118 |
| R-Squared | 0.881 |
| Adjusted R-Squared | 0.867 |
| AIC | 9.5516 |
| BIC | 9.8574 |
| Model Sum of Squares | 11,082,513 |
| Sum of Squared Errors | 1,501,981 |
| Mean Squared Error | 12728.656 |
| Std. Error of Regression | 112.821 |
| Mean Abs. Dev. (MAD) | 85.702 |
| Mean Abs. % Err. (MAPE) | 5.77% |
| Durbin-Watson Statistic | 1.80 |

***CB Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | 29.409 | 1.843 | 15.96 | 0.00% |
| mRevWthr.HDD60 | 0.014 | 0.001 | 10.646 | 0.00% |
| mBin.Mar | 2.305 | 0.816 | 2.823 | 0.56% |
| mBin.Apr | 5.437 | 1.056 | 5.148 | 0.00% |
| mBin.May | 5.897 | 1.152 | 5.12 | 0.00% |
| mBin.Jun | 6.585 | 1.081 | 6.094 | 0.00% |
| mBin.Jul | 3.06 | 0.837 | 3.655 | 0.04% |
| mBin.Nov17 | -7.083 | 2.11 | -3.357 | 0.11% |
| AR(1) | 0.86 | 0.046 | 18.887 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 7 |
| Adjusted Observations | 131 |
| Deg. of Freedom for Error | 122 |
| R-Squared | 0.87 |
| Adjusted R-Squared | 0.862 |
| AIC | 2.12 |
| BIC | 2.32 |
| Model Sum of Squares | 6,374 |
| Sum of Squared Errors | 950 |
| Mean Squared Error | 7.79 |
| Std. Error of Regression | 2.79 |
| Mean Abs. Dev. (MAD) | 2 |
| Mean Abs. % Err. (MAPE) | 5.44% |
| Durbin-Watson Statistic | 2.12 |

***Small C&I APL Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| mBin.Jan | 3263.97 | 30.728 | 106.222 | 0.00% |
| mBin.Feb | 2797.399 | 31.228 | 89.579 | 0.00% |
| mBin.Mar | 2722.817 | 31.228 | 87.19 | 0.00% |
| mBin.Apr | 2248.109 | 31.228 | 71.989 | 0.00% |
| mBin.May | 2093.381 | 31.228 | 67.034 | 0.00% |
| mBin.Jun | 1883.179 | 31.228 | 60.303 | 0.00% |
| mBin.Jul | 2005.841 | 31.228 | 64.231 | 0.00% |
| mBin.Aug | 2201.231 | 31.228 | 70.488 | 0.00% |
| mBin.Sep | 2373.894 | 31.228 | 76.017 | 0.00% |
| mBin.Oct | 2911.022 | 31.228 | 93.217 | 0.00% |
| mBin.Nov | 3045.707 | 31.228 | 97.53 | 0.00% |
| mBin.Dec | 3265.756 | 30.956 | 105.496 | 0.00% |
| MA(1) | 0.453 | 0.082 | 5.509 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 8 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 119 |
| R-Squared | 0.966 |
| Adjusted R-Squared | 0.962 |
| AIC | 9.19 |
| BIC | 9.47 |
| Model Sum of Squares | 29,895,366 |
| Sum of Squared Errors | 1,058,878 |
| Mean Squared Error | 8898.14 |
| Std. Error of Regression | 94.33 |
| Mean Abs. Dev. (MAD) | 65.87 |
| Mean Abs. % Err. (MAPE) | 2.56% |
| Durbin-Watson Statistic | 1.71 |

***SL Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| SLVars.XOther | 261187.918 | 17576.84 | 14.86 | 0.00% |
| SLVars.XHeat | 87097.753 | 20977.9 | 4.152 | 0.01% |
| SLVars.XCool | 116056.093 | 3777.983 | 30.719 | 0.00% |
| mBin.Yr10Plus | 30327.284 | 15687.18 | 1.933 | 5.57% |
| mBin.Feb | 8166.226 | 2017.792 | 4.047 | 0.01% |
| mBin.Mar | 7507.893 | 1656.084 | 4.534 | 0.00% |
| mBin.May | 1879.011 | 1285.914 | 1.461 | 14.67% |
| mBin.Aug | 9484.18 | 1455.048 | 6.518 | 0.00% |
| mBin.Sep | 7778.766 | 1555.212 | 5.002 | 0.00% |
| mBin.Oct | 6391.572 | 1338.604 | 4.775 | 0.00% |
| mBin.Feb19 | 13847.104 | 4297.967 | 3.222 | 0.17% |
| mBin.Mar19 | 19203.746 | 4269.218 | 4.498 | 0.00% |
| mBin.May21 | -40819.119 | 3991.488 | -10.227 | 0.00% |
| mBin.Yr19Plus | -13248.09 | 2318.856 | -5.713 | 0.00% |
| COVID_Shift.SCI | -14786.925 | 4126.713 | -3.583 | 0.05% |
| DSM_10YrML.SL_Constant | -0.538 | 0.101 | -5.334 | 0.00% |
| AR(1) | 0.411 | 0.088 | 4.672 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 15 |
| Adjusted Observations | 131 |
| Deg. of Freedom for Error | 114 |
| R-Squared | 0.983 |
| Adjusted R-Squared | 0.98 |
| AIC | 16.7324 |
| BIC | 17.1055 |
| Model Sum of Squares | 105,205,103,172 |
| Sum of Squared Errors | 1,867,876,125 |
| Mean Squared Error | 16384878.29 |
| Std. Error of Regression | 4047.824 |
| Mean Abs. Dev. (MAD) | 2848.891 |
| Mean Abs. % Err. (MAPE) | 1.00% |
| Durbin-Watson Statistic | 2.02 |

***PL Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| PLVars.XOther | 1.03 | 0.006 | 185.439 | 0.00% |
| PLVars.XCool | 0.788 | 0.023 | 33.751 | 0.00% |
| mBin.Aug12 | -7254.925 | 3164.635 | -2.292 | 2.36% |
| mBin.Jul14 | -9048.608 | 3103.511 | -2.916 | 0.42% |
| mBin.Jun16 | -8107.395 | 3128.272 | -2.592 | 1.07% |
| mBin.Jun18 | -8992.955 | 3133.821 | -2.87 | 0.49% |
| mBin.Feb20 | -12461.053 | 3274.704 | -3.805 | 0.02% |
| mBin.Mar21 | 11702.828 | 3154.345 | 3.71 | 0.03% |
| mBin.Yr17Plus | -4464.835 | 1246.668 | -3.581 | 0.05% |
| mBin.Yr2020Plus | 16670.702 | 1419.94 | 11.74 | 0.00% |
| COVID_Shift.LCI | 336.822 | 3012.566 | 0.112 | 91.12% |
| DSM_10YrML.PL_Constant | -5.128 | 0.276 | -18.599 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 1 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 120 |
| R-Squared | 0.965 |
| Adjusted R-Squared | 0.962 |
| AIC | 16.14 |
| BIC | 16.4021 |
| Model Sum of Squares | 31,293,838,874 |
| Sum of Squared Errors | 1,124,920,762 |
| Mean Squared Error | 9374339.683 |
| Std. Error of Regression | 3061.754 |
| Mean Abs. Dev. (MAD) | 2213.306 |
| Mean Abs. % Err. (MAPE) | 2.28% |
| Durbin-Watson Statistic | 1.62 |

## ***H1 Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| HLVars.XOther | 0.903 | 0.008 | 117.146 | 0.00% |
| HLVars.XCool | 0.561 | 0.042 | 13.318 | 0.00% |
| mBin.Dec12 | -21173.023 | 5223.151 | -4.054 | 0.01% |
| mBin.Jan15 | 25636.931 | 5231.401 | 4.901 | 0.00% |
| mBin.Feb | 5020.474 | 1828 | 2.746 | 0.70% |
| mBin.Mar | 6982.98 | 1823.167 | 3.83 | 0.02% |
| mBin.Apr | 3107.894 | 1749.677 | 1.776 | 7.83% |
| mBin.May | 8048.586 | 1771.006 | 4.545 | 0.00% |
| mBin.Jun | 2064.69 | 1746.669 | 1.182 | 23.96% |
| mBin.Mar19 | -19712.162 | 5403.769 | -3.648 | 0.04% |
| mBin.Jun19 | -25557.508 | 5404.166 | -4.729 | 0.00% |
| mBin.Feb21 | -15943.406 | 5507.807 | -2.895 | 0.45% |
| mBin.May21 | -19731.765 | 5529.753 | -3.568 | 0.05% |
| mBin.Yr2020Plus | -9346.419 | 1209.903 | -7.725 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 1 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 118 |
| R-Squared | 0.791 |
| Adjusted R-Squared | 0.768 |
| AIC | 17.1923 |
| BIC | 17.4981 |
| Model Sum of Squares | 11,824,220,039 |
| Sum of Squared Errors | 3,126,011,107 |
| Mean Squared Error | 26491619.55 |
| Std. Error of Regression | 5147.001 |
| Mean Abs. Dev. (MAD) | 3765.673 |
| Mean Abs. % Err. (MAPE) | 3.39% |
| Durbin-Watson Statistic | 1.44 |

## ***H2 Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | 17378.085 | 204.522 | 84.969 | 0.00% |
| mCalWthr.CDD60 | 7.968 | 0.685 | 11.639 | 0.00% |
| mBin.Feb11 | -10760.636 | 1362.307 | -7.899 | 0.00% |
| mBin.Mar11 | 10006.314 | 1352.501 | 7.398 | 0.00% |
| mBin.Aug15 | -12923.661 | 1354.648 | -9.54 | 0.00% |
| mBin.Sep15 | 15932.889 | 1352.535 | 11.78 | 0.00% |
| mBin.Feb21 | -2088.038 | 1362.677 | -1.532 | 12.81% |
| mBin.Jan21 | -2121.336 | 1365.355 | -1.554 | 12.29% |
| COVID_Shift.LCI | -3723.244 | 1159.241 | -3.212 | 0.17% |
| mBin.Yr19Plus | -1527.146 | 381.061 | -4.008 | 0.01% |
| AR(1) | 0.167 | 0.091 | 1.829 | 6.99% |

| Model Statistics | |
|---|---|
| Iterations | 8 |
| Adjusted Observations | 131 |
| Deg. of Freedom for Error | 120 |
| R-Squared | 0.843 |
| Adjusted R-Squared | 0.83 |
| AIC | 14.4919 |
| BIC | 14.7334 |
| Model Sum of Squares | 1,169,089,007 |
| Sum of Squared Errors | 217,824,029 |
| Mean Squared Error | 1815200.241 |
| Std. Error of Regression | 1347.294 |
| Mean Abs. Dev. (MAD) | 1029.447 |
| Mean Abs. % Err. (MAPE) | 5.79% |
| Durbin-Watson Statistic | 2.08 |

***H3 Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| CONST | 21534.047 | 2263.945 | 9.512 | 0.00% |
| mCalWthr.CDD60 | 6.362 | 1.998 | 3.185 | 0.18% |
| mBin.May11Plus | 6633.034 | 2365.576 | 2.804 | 0.58% |
| mBin.YrPlus16 | -7524.763 | 806.722 | -9.328 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 1 |
| Adjusted Observations | 132 |
| Deg. of Freedom for Error | 128 |
| R-Squared | 0.437 |
| Adjusted R-Squared | 0.423 |
| AIC | 16.8658 |
| BIC | 16.9531 |
| Model Sum of Squares | 2,033,887,909 |
| Sum of Squared Errors | 2,624,009,711 |
| Mean Squared Error | 20500075.87 |
| Std. Error of Regression | 4527.701 |
| Mean Abs. Dev. (MAD) | 2278.675 |
| Mean Abs. % Err. (MAPE) | 258.51% |
| Durbin-Watson Statistic | 2.90 |

## ***Large C&I APL Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| mBin.Jan | 568.461 | 12.278 | 46.297 | 0.00% |
| mBin.Feb | 506.174 | 11.727 | 43.165 | 0.00% |
| mBin.Mar | 490.251 | 11.496 | 42.645 | 0.00% |
| mBin.Apr | 402.978 | 11.39 | 35.381 | 0.00% |
| mBin.May | 374.361 | 11.336 | 33.023 | 0.00% |
| mBin.Jun | 339.089 | 11.308 | 29.987 | 0.00% |
| mBin.Jul | 358.641 | 11.293 | 31.759 | 0.00% |
| mBin.Aug | 389.039 | 11.284 | 34.476 | 0.00% |
| mBin.Sep | 420.839 | 11.28 | 37.31 | 0.00% |
| mBin.Oct | 494.343 | 11.277 | 43.837 | 0.00% |
| mBin.Nov | 532.841 | 11.275 | 47.257 | 0.00% |
| mBin.Dec | 570.654 | 11.275 | 50.614 | 0.00% |
| mBin.Yr19Plus | -62.301 | 11.463 | -5.435 | 0.00% |
| AR(1) | 0.592 | 0.089 | 6.642 | 0.00% |

| Model Statistics | |
|---|---|
| Iterations | 9 |
| Adjusted Observations | 95 |
| Deg. of Freedom for Error | 81 |
| R-Squared | 0.939 |
| Adjusted R-Squared | 0.93 |
| AIC | 6.48 |
| BIC | 6.86 |
| Model Sum of Squares | 714,142 |
| Sum of Squared Errors | 46,068 |
| Mean Squared Error | 568.74 |
| Std. Error of Regression | 23.85 |
| Mean Abs. Dev. (MAD) | 14.91 |
| Mean Abs. % Err. (MAPE) | 3.46% |
| Durbin-Watson Statistic | 1.91 |

***Street Lighting Sales***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| Simple | 1.339 | 0.139 | 9.621 | 0 |
| Seasonal | 0.436 | 0.298 | 1.462 | 0.151 |

| Model Statistics | |
|---|---|
| Iterations | 29 |
| Adjusted Observations | 47 |
| Deg. of Freedom for Error | 45 |
| R-Squared | 0.964 |
| Adjusted R-Squared | 0.964 |
| AIC | 10.8 |
| BIC | 10.9 |
| Model Sum of Squares | 58,077,824 |
| Sum of Squared Errors | 2,139,302 |
| Mean Squared Error | 47540 |
| Std. Error of Regression | 218 |
| Mean Abs. Dev. (MAD) | 129 |
| Mean Abs. % Err. (MAPE) | 3.90% |
| Durbin-Watson Statistic | 2.21 |

***Peaks***

| Variable | Coefficient | StdErr | T-Stat | P-Value |
|---|---|---|---|---|
| mCPkEndUses.BaseVar | 1575.965 | 37.257 | 42.3 | 0.00% |
| mPkWthr.HeatVar | 921.328 | 49.627 | 18.565 | 0.00% |
| mPkWthr.CoolVar | 915.469 | 64.371 | 14.222 | 0.00% |
| mBin.Apr | 177.019 | 34.135 | 5.186 | 0.00% |
| mBin.May | 146.482 | 58.616 | 2.499 | 1.40% |
| mBin.Jun | 350.015 | 64.651 | 5.414 | 0.00% |
| mBin.Jul | 430.246 | 68.253 | 6.304 | 0.00% |
| mBin.Aug | 407.103 | 66.412 | 6.13 | 0.00% |
| mBin.Sep | 332.662 | 65.071 | 5.112 | 0.00% |
| mBin.Oct | 102.327 | 46.113 | 2.219 | 2.86% |
| mBin.Nov | -117.118 | 32.97 | -3.552 | 0.06% |
| mBin.Dec | -133.296 | 30.31 | -4.398 | 0.00% |
| mBin.May14 | 227.742 | 84.962 | 2.681 | 0.85% |
| mBin.Dec18 | 247.578 | 84.504 | 2.93 | 0.42% |
| mBin.Nov20 | 213.69 | 83.779 | 2.551 | 1.22% |

| Model Statistics | |
|---|---|
| Iterations | 1 |
| Adjusted Observations | 120 |
| Deg. of Freedom for Error | 105 |
| R-Squared | 0.947 |
| Adjusted R-Squared | 0.94 |
| AIC | 8.863 |
| BIC | 9.211 |
| Model Sum of Squares | 11,860,358 |
| Sum of Squared Errors | 660,103 |
| Mean Squared Error | 6286.7 |
| Std. Error of Regression | 79.29 |
| Mean Abs. Dev. (MAD) | 56.64 |
| Mean Abs. % Err. (MAPE) | 2.45% |
| Durbin-Watson Statistic | 1.89 |

# 6 Appendix B: Residential SAE Modeling Framework

The traditional approach to forecasting monthly sales for a customer class is to develop an econometric model that relates monthly sales to weather, seasonal variables, and economic conditions. From a forecasting perspective, econometric models are well suited to identify historical trends and to project these trends into the future. In contrast, the strength of the end-use modeling approach is the ability to identify the end-use factors that drive energy use. By incorporating end-use structure into an econometric model, the statistically adjusted end-use (SAE) modeling framework exploits the strengths of both approaches.

There are several advantages to this approach.

- The equipment efficiency and saturation trends, dwelling square footage, and thermal shell integrity changes embodied in the long-run end-use forecasts are introduced explicitly into the short-term monthly sales forecast. This provides a strong bridge between the two forecasts.
- By explicitly introducing trends in equipment saturations, equipment efficiency, dwelling square footage, and thermal integrity levels, it is easier to explain changes in usage levels and changes in weather-sensitivity over time.
- Data for short-term models are often not sufficiently robust to support estimation of a full set of price, economic, and demographic effects. By bundling these factors with equipment-oriented drivers, a rich set of elasticities can be incorporated into the final model.

This section describes the SAE approach, the associated supporting SAE spreadsheets, and the *MetrixND* project files that are used in the implementation. The source for the SAE spreadsheets is the 2021 Annual Energy Outlook (AEO) database provided by the Energy Information Administration (EIA).

## 6.2 Residential Statistically Adjusted End-Use Modeling Framework

The statistically adjusted end-use modeling framework begins by defining energy use ($USE_{y,m}$) in year (y) and month (m) as the sum of energy used by heating equipment ($Heat_{y,m}$), cooling equipment ($Cool_{y,m}$), and other equipment ($Other_{y,m}$). Formally,

$$\text{USE}_{y,m} = \text{Heat}_{y,m} + \text{Cool}_{y,m} + \text{Other}_{y,m} \quad (1)$$

Although monthly sales are measured for individual customers, the end-use components are not. Substituting estimates for the end-use elements gives the following econometric equation.

$$\text{USE}_{m} = a + b_1 \times \text{XHeat}_{m} + b_2 \times \text{XCool}_{m} + b_3 \times \text{XOther}_{m} + \varepsilon_{m} \quad (2)$$

$XHeat_m$, $XCool_m$, and $XOther_m$ are explanatory variables constructed from end-use information, dwelling data, weather data, and market data. As will be shown below, the equations used to construct these X-variables are simplified end-use models, and the X-variables are the estimated usage levels for each of the major end uses based on these models. The estimated model can then be thought of as a statistically adjusted end-use model, where the estimated slopes are the adjustment factors.

### 6.2.1 Constructing XHeat

As represented in the SAE spreadsheets, energy use by space heating systems depends on the following types of variables.

- Heating degree days
- Heating equipment saturation levels
- Heating equipment operating efficiencies
- Thermal integrity and footage of homes
- Average household size, household income, and energy prices

The heating variable is represented as the product of an annual equipment index and a monthly usage multiplier. That is,

$$XHeat_{y,m} = HeatIndex_{y,m} \times HeatUse_{y,m} \quad (3)$$

Where:

- $XHeat_{y,m}$ is estimated heating energy use in year (*y*) and month (*m*)
- $HeatIndex_{y,m}$ is the monthly index of heating equipment
- $HeatUse_{y,m}$ is the monthly usage multiplier

The heating equipment index is defined as a weighted average across equipment types of equipment saturation levels normalized by operating efficiency levels. Given a set of fixed weights, the index will change over time with changes in equipment saturations (*Sat*), operating efficiencies (*Eff*), building structural index (*StructuralIndex*), and energy prices. Formally, the equipment index is defined as:

$$HeatIndex_y = StructuralIndex_y \times \sum_{Type} Weight^{Type} \times \frac{\left( Sat_y^{Type} \middle/ Eff_y^{Type} \right)}{\left( Sat_{base\ yr}^{Type} \middle/ Eff_{base\ yr}^{Type} \right)} \quad (4)$$

The *StructuralIndex* is constructed by combining the EIA's building shell efficiency index trends with surface area estimates:

$$StructuralIndex_y = \frac{BuildingShellEfficiencyIndex_y \times SurfaceArea_y}{BuildingShellEfficiencyIndex_{base\ yr} \times SurfaceArea_{base\ yr}} \quad (5)$$

The *StructuralIndex* is defined on the *StructuralVars* tab of the SAE spreadsheets. Surface area is derived to account for roof and wall area of a standard dwelling based on the regional average square footage data obtained from EIA. The relationship between the square footage and surface area is constructed assuming an aspect ratio of 0.75 and an average of 25% two-story and 75% single-story. Given these assumptions, the approximate linear relationship for surface area is:

$$SurfaceArea_y = 892 + 1.44 \times Footage_y \quad (6)$$

For electric heating equipment, the SAE spreadsheets contain two equipment types: electric resistance furnaces/room units and electric space heating heat pumps. Examples of weights for these two equipment types for the U.S. are given in Table 6-1.

**Table 6-1: Electric Space Heating Equipment Weights**

| Equipment Type | Weight (kWh) |
|---|---|
| Electric Resistance Furnace/Room units | 767 |
| Electric Space Heating Heat Pump | 127 |

Data for the equipment saturation and efficiency trends are presented on the *Shares* and *Efficiencies* tabs of the SAE spreadsheets. The efficiency for electric space heating heat pumps is given in terms of Heating Seasonal Performance Factor [BTU/Wh], and the efficiencies for electric furnaces and room units are estimated as 100%, which is equivalent to 3.41 BTU/Wh.

**Heating system usage** levels are impacted on a monthly basis by several factors, including weather, household size, income levels, prices, and billing days. The estimates for space heating equipment usage levels are computed as follows:

$$HeatUse_{y,m} = \left(\frac{HDD_{y,m}}{HDD_{base\ yr}}\right) \times \left(\frac{HHSize_y}{HHSize_{base\ yr,m}}\right)^{0.25} \times \left(\frac{Income_y}{Income_{base\ yr,m}}\right)^{0.15} \times \left(\frac{Elec\ Price_{y,m}}{Elec\ Price_{base\ yr,m}}\right)^{-0.1} \quad (7)$$

Where:

- *HDD* is the number of heating degree days in year (*y*) and month (*m*).
- *HHSize* is average household size in a year (*y*)
- *Income* is average real income per household in year (*y*)
- *ElecPrice* is the average real price of electricity in month (*m*) and year (*y*)

By construction, the $HeatUse_{y,m}$ variable has an annual sum that is close to 1.0 in the base year. The first term, which involves heating degree days, serve to allocate annual values to months of the year. The remaining terms average to 1.0 in the base year. In other years, the values will reflect changes in the economic drivers, as transformed through the end-use elasticity parameters. The price impacts captured by the Usage equation represent short-term price response.

### 6.2.2 Constructing XCool

The explanatory variable for cooling loads is constructed in a similar manner. The amount of energy used by cooling systems depends on the following types of variables.

- Cooling degree days
- Cooling equipment saturation levels
- Cooling equipment operating efficiencies
- Thermal integrity and footage of homes
- Average household size, household income, and energy prices

The cooling variable is represented as the product of an equipment-based index and monthly usage multiplier. That is,

$$XCool_{y,m} = CoolIndex_y \times CoolUse_{y,m} \quad (8)$$

Where

- $XCool_{y,m}$ is estimated cooling energy use in year ($y$) and month ($m$)
- $CoolIndex_y$ is an index of cooling equipment
- $CoolUse_{y,m}$ is the monthly usage multiplier

As with heating, the cooling equipment index is defined as a weighted average across equipment types of equipment saturation levels normalized by operating efficiency levels. Formally, the cooling equipment index is defined as:

$$CoolIndex_y = StructuralIndex_y \times \sum_{Type} Weight^{Type} \times \frac{\left( Sat_y^{Type} \big/ Eff_y^{Type} \right)}{\left( Sat_{base\,yr}^{Type} \big/ Eff_{base\,yr}^{Type} \right)} \quad (9)$$

For cooling equipment, the SAE spreadsheets contain three equipment types: central air conditioning, space cooling heat pump, and room air conditioning. Examples of weights for these three equipment types for the U.S. are given in Table 6-2.

**Table 6-2: Space Cooling Equipment Weights**

| Equipment Type | Weight (kWh) |
|---|---|
| Central Air Conditioning | 1,219 |
| Space Cooling Heat Pump | 240 |
| Room Air Conditioning | 177 |

The equipment saturation and efficiency trends data are presented on the *Shares* and *Efficiencies* tabs of the SAE spreadsheets. The efficiency for space cooling heat pumps and central air conditioning (A/C) units are given in terms of Seasonal Energy Efficiency Ratio [BTU/Wh], and room A/C units efficiencies are given in terms of Energy Efficiency Ratio [BTU/Wh].

**Cooling system usage** levels are impacted on a monthly basis by several factors, including weather, household size, income levels, and prices. The estimates of cooling equipment usage levels are computed as follows:

$$CoolUse_{y,m} = \left(\frac{CDD_{y,m}}{CDD_{base\,yr}}\right) \times \left(\frac{HHSize_y}{HHSize_{base\,yr,m}}\right)^{0.25} \times \left(\frac{Income_y}{Income_{base\,yr,m}}\right)^{0.15} \times \left(\frac{Elec\,Price_{y,m}}{Elec\,Price_{base\,yr,m}}\right)^{-0.1} \quad (10)$$

Where:

- *CDD* is the number of cooling degree days in year (*y*) and month (*m*).
- *HHSize* is average household size in a year (*y*)
- *Income* is average real income per household in year (*y*)
- *ElecPrice* is the average real price of electricity in month (*m*) and year (*y*)

By construction, the *CoolUse* variable has an annual sum that is close to 1.0 in the base year. The first term, which involves cooling degree days, serves to allocate annual values to months of the year. The remaining terms average to 1.0 in the base year. In other years, the values will change to reflect changes in the economic driver changes.

### 6.2.3 Constructing XOther

Monthly estimates of non-weather sensitive sales can be derived in a similar fashion to space heating and cooling. Based on end-use concepts, other sales are driven by:

- Appliance and equipment saturation levels
- Appliance efficiency levels
- Average number of days in the billing cycle for each month
- Average household size, real income, and real prices

The explanatory variable for other uses is defined as follows:

$$XOther_{y,m} = OtherEqpIndex_{y,m} \times OtherUse_{y,m} \tag{11}$$

The first term on the right-hand side of this expression ($OtherEqpIndex_y$) embodies information about appliance saturation and efficiency levels and monthly usage multipliers. The second term (*OtherUse*) captures the impact of changes in prices, income, household size, and number of billing-days on appliance utilization.

End-use indices are constructed in the SAE models. A separate end-use index is constructed for each end-use equipment type using the following function form.

$$ApplianceIndex_{y,m} = Weight^{Type} \times \frac{\left( Sat_y^{Type} \Big/ \frac{1}{UEC_y^{Type}} \right)}{\left( Sat_{base\,yr}^{Type} \Big/ \frac{1}{UEC_{base\,yr}^{Type}} \right)} \times MoMult_m^{Type} \times \quad (12)$$

Where:

- *Weight* is the weight for each appliance type
- *Sat* represents the fraction of households, who own an appliance type
- $MoMult_m$ is a monthly multiplier for the appliance type in month (*m*)
- *Eff* is the average operating efficiency the appliance
- *UEC* is the unit energy consumption for appliances

This index combines information about trends in saturation levels and efficiency levels for the main appliance categories with monthly multipliers for lighting, water heating, and refrigeration.

The appliance saturation and efficiency trends data are presented on the *Shares* and *Efficiencies* tabs of the SAE spreadsheets.

Further monthly variation is introduced by multiplying by usage factors that cut across all end uses, constructed as follows:

$$ApplianceUse_{y,m} = \left(\frac{BDays_{y,m}}{30.5}\right) \times \left(\frac{HHSize_y}{HHSize_{base\,yr,m}}\right)^{0.26} \times \left(\frac{Income_y}{Income_{base\,yr,m}}\right)^{0.15} \times \left(\frac{Elec\,Price_{y,m}}{Elec\,Price_{base\,yr,m}}\right)^{-0.1} \quad (13)$$

The index for other uses is derived then by summing across the appliances:

$$OtherEqpIndex_{y,m} = \sum_k ApplianceIndex_{y,m} \times ApplianceUse_{y,m} \quad (14)$$

# 7 Appendix C: Commercial SAE Modeling Framework

The traditional approach to forecasting monthly sales for a customer class is to develop an econometric model that relates monthly sales to weather, seasonal variables, and economic conditions. From a forecasting perspective, the strength of econometric models is that they are well suited to identifying historical trends and to projecting these trends into the future. In contrast, the strength of the end-use modeling approach is the ability to identify the end-use factors that are driving energy use. By incorporating end-use structure into an econometric model, the statistically adjusted end-use (SAE) modeling framework exploits the strengths of both approaches.

There are several advantages to this approach.

- The equipment efficiency trends and saturation changes embodied in the long-run end-use forecasts are introduced explicitly into the short-term monthly sales forecast. This provides a strong bridge between the two forecasts.
- By explicitly introducing trends in equipment saturations and equipment efficiency levels, it is easier to explain changes in usage levels and changes in weather-sensitivity over time.
- Data for short-term models are often not sufficiently robust to support estimation of a full set of price, economic, and demographic effects. By bundling these factors with equipment-oriented drivers, a rich set of elasticities can be built into the final model.

This document describes this approach, the associated supporting Commercial SAE spreadsheets, and *MetrixND* project files that are used in the implementation. The source for the commercial SAE spreadsheets is the 2021 Annual Energy Outlook (AEO) database provided by the Energy Information Administration (EIA).

## 7.2 Commercial Statistically Adjusted End-Use Model Framework

The commercial statistically adjusted end-use model framework begins by defining energy use ($USE_{y,m}$) in year (y) and month (m) as the sum of energy used by heating equipment ($Heat_{y,m}$), cooling equipment ($Cool_{y,m}$) and other equipment ($Other_{y,m}$). Formally,

$$USE_{y,m} = Heat_{y,m} + Cool_{y,m} + Other_{y,m} \quad (1)$$

Although monthly sales are measured for individual customers, the end-use components are not. Substituting estimates for the end-use elements gives the following econometric equation.

$$USE_m = a + b_1 \times XHeat_m + b_2 \times XCool_m + b_3 \times XOther_m + \varepsilon_m \quad (2)$$

Here, $XHeat_m$, $XCool_m$, and $XOther_m$ are explanatory variables constructed from end-use information, weather data, and market data. As will be shown below, the equations used to construct these X-variables are simplified end-use models, and the X-variables are the estimated usage levels for each of the major end uses based on these models. The estimated model can then be thought of as a statistically adjusted end-use model, where the estimated slopes are the adjustment factors.

### 7.2.1 Constructing XHeat

As represented in the Commercial SAE spreadsheets, energy use by space heating systems depends on the following types of variables.

- Heating degree days,
- Heating equipment saturation levels,
- Heating equipment operating efficiencies,
- Commercial output, employment, population, and energy price.

The heating variable is represented as the product of an annual equipment index and a monthly usage multiplier. That is,

$$XHeat_{y,m} = HeatIndex_y \times HeatUse_{y,m} \quad (3)$$

Where:

- *$XHeat_{y,m}$ is estimated heating energy use in year (y) and month (m),*
- *$HeatInde_{xy}$ is the annual index of heating equipment, and*
- *$HeatUse_{y,m}$ is the monthly usage multiplier.*

The heating equipment index is composed of electric space heating equipment saturation levels normalized by operating efficiency levels. The index will change over time with changes in heating equipment saturations (*HeatShare*) and operating efficiencies (*Eff*). Formally, the equipment index is defined as:

$$HeatIndex_y = HeatSales_{base\ yr} \times \frac{\left(HeatShare_y / Eff_y\right)}{\left(HeatShare_{base\ yr} / Eff_{base\ yr}\right)} \tag{4}$$

The ratio on the right is equal to 1.0 in the base year. In other years, it will be greater than one if equipment saturation levels are above their base year level. This will be counteracted by higher efficiency levels, which will drive the index downward. Base year space heating sales are defined as follows.

$$HeatSales_{base\ yr} = \left(\frac{kWh}{Sqft}\right)_{Heating} \times \left(\frac{CommercialSales_{base\ yr}}{\sum_e kWh/Sqft_e}\right) \tag{5}$$

Here, base-year sales for space heating is the product of the average space heating intensity value and the ratio of total commercial sales in the base year over the sum of the end-use intensity values. In the Commercial SAE Spreadsheets, the space heating sales value is defined on the *BaseYrInput* tab. The resulting $HeatIndex_y$ value in the base year will be equal to the estimated annual heating sales in that year. Variations from this value in other years will be proportional to saturation and efficiency variations around their base values.

Heating system usage levels are impacted on a monthly basis by several factors, including weather, commercial level economic activity, prices and billing days. Using the COMMEND default elasticity parameters, the estimates for space heating equipment usage levels are computed as follows:

$$HeatUse_{y,m} = \left(\frac{HDD_{y,m}}{HDD_{base\ yr}}\right) \times \left(\frac{EconVar_{y,m}}{EconVar_{base\ yr,m}}\right) \times \left(\frac{Price_{y,m}}{Price_{base\ yr,m}}\right)^{-0.10} \tag{6}$$

Where:

- *HDD* is the number of heating degree days in month (m) and year (y).
- *EconVar* is the weighted commercial economic variable that blends Output, Employment, and Population in month (m), and year (y).
- *Price* is the average real price of electricity in month (m) and year (y).

By construction, the $HeatUse_{y,m}$ variable has an annual sum that is close to one in the base year. The first term, which involves heating degree days, serves to allocate annual values to months of the year. The remaining terms average to one in the base year. In other years, the values will reflect changes in commercial output and prices, as transformed through the end-use elasticity parameters. For example, if the real price of electricity goes up 10% relative to the base year value, the price term will contribute a multiplier of about .98 (computed as 1.10 to the -0.18 power).

### 7.2.2 Constructing XCool

The explanatory variable for cooling loads is constructed in a similar manner. The amount of energy used by cooling systems depends on the following types of variables.

- Cooling degree days,
- Cooling equipment saturation levels,
- Cooling equipment operating efficiencies,
- Commercial output, employment, population, and energy price.

The cooling variable is represented as the product of an equipment-based index and monthly usage multiplier. That is,

$$\mathrm{XCool}_{y,m} = \mathrm{CoolIndex}_{y} \times \mathrm{CoolUse}_{y,m} \qquad (7)$$

Where:

- $XCool_{y,m}$ is estimated cooling energy use in year (y) and month (m),
- $CoolIndex_{y}$ is an index of cooling equipment, and
- $CoolUse_{y,m}$ is the monthly usage multiplier.

As with heating, the cooling equipment index depends on equipment saturation levels (*CoolShare*) normalized by operating efficiency levels (*Eff*). Formally, the cooling equipment index is defined as:

$$CoolIndex_y = CoolSales_{base\ yr} \times \frac{\left( CoolShare_y / Eff_y \right)}{\left( CoolShare_{base\ yr} / Eff_{base\ yr} \right)} \qquad (8)$$

Data values in 2004 are used as a base year for normalizing the index, and the ratio on the right is equal to 1.0 in the base year. In other years, it will be greater than one if equipment saturation levels are above their base year level. This will be counteracted by higher efficiency levels, which will drive the index downward. Estimates of base year cooling sales are defined as follows.

$$CoolSales_{base\ yr} = \left( \frac{kWh}{Sqft} \right)_{Cooling} \times \left( \frac{CommercialSales_{base\ yr}}{\sum_e kWh / Sqft_e} \right) \qquad (9)$$

Here, base-year sales for space cooling is the product of the average space cooling intensity value and the ratio of total commercial sales in the base year over the sum of the end-use intensity values. In the Commercial SAE Spreadsheets, the space cooling sales value is defined on the *BaseYrInput* tab. The resulting *CoolIndex* value in the base year will be equal to the estimated annual cooling sales in that year. Variations from this value in other years will be proportional to saturation and efficiency variations around their base values.

Cooling system usage levels are impacted on a monthly basis by several factors, including weather, economic activity levels and prices. Using the COMMEND default parameters, the estimates of cooling equipment usage levels are computed as follows:

$$CoolUse_{y,m} = \left(\frac{CDD_{y,m}}{CDD_{base\ yr}}\right) \times \left(\frac{EconVar_{y,m}}{EconVar_{base\ yr,m}}\right) \times \left(\frac{Price_{y,m}}{Price_{base\ yr,m}}\right)^{-0.15} \quad (10)$$

Where:

- *HDD* is the number of heating degree days in month (m) and year (y).
- *EconVar* is the weighted commercial economic variable that blends Output, Employment, and Population in month (m), and year (y).
- *Price* is the average real price of electricity in month (m) and year (y).

By construction, the *CoolUse* variable has an annual sum that is close to one in the base year. The first term, which involves cooling degree days, serves to allocate annual values to months of the year. The remaining terms average to one in the base year. In other years, the values will change to reflect changes in commercial output and prices.

### 7.2.3 Constructing XOther

Monthly estimates of non-weather sensitive sales can be derived in a similar fashion to space heating and cooling. Based on end-use concepts, other sales are driven by:

- Equipment saturation levels,
- Equipment efficiency levels,
- Average number of days in the billing cycle for each month, and
- Real commercial output and real prices.

The explanatory variable for other uses is defined as follows:

$$\text{XOther}_{y,m} = \text{OtherIndex}_{y,m} \times \text{OtherUse}_{y,m} \quad (11)$$

The second term on the right-hand side of this expression embodies information about equipment saturation levels and efficiency levels. The equipment index for other uses is defined as follows:

$$OtherIndex_{y,m} = \sum_{Type} Weight_{base\ yr}^{Type} \times \left( \frac{Share_y^{Type} / Eff_y^{Type}}{Share_{base\ yr}^{Type} / Eff_{base\ yr}^{Type}} \right) \quad (12)$$

Where:

- *Weight* is the weight for each equipment type,
- *Share* represents the fraction of floor stock with an equipment type, and
- *Eff* is the average operating efficiency.

This index combines information about trends in saturation levels and efficiency levels for the main equipment categories. The weights are defined as follows.

$$Weight_{base\ yr}^{Type} = \left(\frac{kWh}{Sqft}\right)_{Type} \times \left(\frac{CommercialSales_{04}}{\sum_e {kWh}/{Sqft_e}}\right) \quad (13)$$

Further monthly variation is introduced by multiplying by usage factors that cut across all end-uses, constructed as follows:

$$OtherUse_{y,m} = \left(\frac{BDays_{y,m}}{30.5}\right) \times \left(\frac{EconVar_{y,m}}{EconVar_{base\ yr,m}}\right) \times \left(\frac{Price_{y.m}}{Price_{base\ yr,m}}\right)^{-0.15} \quad (14)$$

AES Indiana

# 2022 IRP

# Attachment 5-4

(AES Indiana's 2022 DER and Other Electrification MPS)

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

# AES INDIANA

aes Indiana

# *2022 Demand Side Management Market Potential Study*

*November 18,*
2022

## FINAL REPORT

*prepared by*

**GDS ASSOCIATES INC**

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

**AES INDIANA**

aes Indiana

# 2022 Market Potential Study Distributed Energy Resources and Electrification

*September 2,*
2022

**FINAL REPORT**

*prepared by*

**GDS ASSOCIATES INC**

# VOLUME I *2022 MPS – DER and Electrification Report*



## *Market Potential Study* ***List of Tables***

## *Market Potential Study* ***List of Figures***

# 1 Introduction

## 1.1 BACKGROUND & STUDY SCOPE

This distributed energy resource ("DER") and electrification Market Potential Study was conducted to as part of a broader effort that included an energy efficiency and demand response potential study in support of Integrated Resource Plan (IRP) and DSM planning for AES Indiana. The study included an analysis of various DER options including solar photovoltaics and combined heat and power, a study of transportation electrification, including both commercial sector and residential sector vehicles, and a building electrification analysis of the residential, commercial, and industrial sectors.

## 1.2 STUDY LIMITATIONS

This DER and Electrification Market Potential Study was developed using the best currently available data to inform the estimates of future potential. The long-term projections of these technologies remain highly uncertain as the cost-effectiveness of DER could change in future years and become a more attractive option, while electrification projections continue to evolve based on various factors such as policy decisions, manufacturer goals and consumer preferences.

## 1.3 ORGANIZATION OF REPORT

The remainder of this report is organized in seven sections as follows:

***Section 2 Distributed Energy Resources*** provides the approach to analyzing DER potential and the technical, economic and market potential for solar photovoltaics and combined heat and power.

***Section 3 Transportation Electrification*** provides the results of the analysis for commercial and residential transportation electrification.

***Section 4 Building Electrification*** provides approach and results of the building electrification analysis for the residential, commercial, and industrial sectors.

# 2 Distributed Energy Resources

The GDS Team considered distributed energy resources (DER) as sources of behind-the-meter customer-sited generation. The DER potential study followed the same method as the energy efficiency potential study in that the DER analysis reviewed the opportunity for technical, economic, and achievable potential. We used the same forecast data as used in the energy efficiency study to assess DER potential. The analysis limited resources for this potential study to technologies that are behind-the-meter and owned by the customer and did not consider market potential for supply-side resources. Specifically, this market potential assessment for DER focused on solar photovoltaic (PV) and combined heat and power (CHP) systems for the period 2023 to 2042.

## 2.1 APPROACH

The following section discusses the methods used to conduct the DER potential analysis. We detail approaches used to assess technical, economic, and achievable potential for solar PV and CHP.

### *2.1.1 Distributed Energy Resources Potential*

#### 2.1.1.1 Solar Photovoltaic Systems

Photovoltaic systems utilize solar panels, a packaged collection of photovoltaic cells, to convert sunlight into electricity. A system is constructed with multiple solar panels, a DC/AC inverter(s), a racking system to hold the panels, and electrical system interconnections. These systems are often roof-mounted and face south-west, south, and/or, south-east.

The study analyzed the potential associated with roof-mounted systems installed on residential and non-residential sector buildings. For the non-residential sector, the analysis also estimated potential for ground mounted (or covered parking) systems for a few specific business types. The analysis included battery storage as an additional configuration with each solar PV system type; however, due to the uncertainty associated with battery dispatch schedules, potential battery generation is excluded from this analysis. As noted above, this study did not explore the market potential associated utility-scale solar PV installations.

The approach to estimating technical potential required calculating the total square footage of suitable rooftop area within the AES-IN's territory and calculating solar PV system generation based on building and regional characteristics. Technical potential is computed using the following equation.

$$\boldsymbol{PV\ Technical\ Potential} = \boldsymbol{\Sigma}(\boldsymbol{Suitable\ Rooftop\ Square\ Footage}\ \times \boldsymbol{PV\ System\ Generation\ per\ Sq.Ft.})$$

The two key parameters in prior equation were estimated based on multiple data sources relevant to the AES-IN territory. Methods for defining these parameters are discussed below.

The GDS Team estimated total rooftop square footage using the forecast disaggregation analysis to characterize the residential and non-residential building stocks. The building stocks were characterized based on relevant parameters such as number of facilities, average number of floors, average premise consumption, and premise EUI. The GDS Team used these parameters to estimate the total rooftop square footage.

To estimate the fraction of the total roof area that is suitable for rooftop solar PV, the GDS Team relied on research completed by the National Renewable Energy Laboratory (NREL). NREL has developed estimates of the portion of total rooftops across the country that are suitable for solar PV based on analysis of LIDAR data. NREL criteria for suitable roof area include:

- **Contiguous rooftop area size:** Rooftops with fewer than 10 square meters of contiguous roof area excluded.

- **Rooftop orientation (tilt and azimuth):** Northeast through northwest orientation and roof pitches greater than 60 degrees excluded.
- **Shading:** Roof areas that had a minimum solar exposure of less than 80% relative to an unshaded roof were excluded.

Based on NREL's data, the GDS Team was able to apply unique suitability factors to estimate the total square footage of suitable rooftop for residential and non-residential buildings across AES-IN's territory.

The second key parameter – PV system generation – was estimated by developing standardized solar PV system configurations. These included system sizes for residential premises ranging from 3 to 20 kW (DC) and 10 to 2,000 kW (DC) for non-residential premises. Additionally, the GDS Team selected battery system sizes for each solar PV system size to dispatch energy for 2-4 hours.

The Team relied on NREL's PVWatts[1] (Version 6.1.4) and System Advisor Model (SAM)[2] tools to estimate system generation for both residential and non-residential sited systems. These tools model PV power density based on site specific data from NREL's LIDAR-based NSRDB to estimate total solar irradiance in conjunction with PV system specifications. The PV system simulations were generated based on Indianapolis, IN characteristics. The GDS Team based assumptions for PV system azimuth on rooftop orientation data sourced from Google's Project Sunroof, also based on Indianapolis, IN. The analysis assumptions are summarized in Table 2-1.

**TABLE 2-1: KEY ASSUMPTIONS IN SOLAR PV ANALYSIS**

| Parameter | Assumptions |
|---|---|
| Residential System Sizes (Nominal DC Capacity) | 3 kW, 5 kW, 7.5 kW, 10 kW, 15 kW, 20 kW |
| Non-Residential System Sizes (Nominal DC Capacity) | 10 kW, 15 kW, 20 kW, 25 kW, 50 kW, 100 kW, 250 kW, 500 kW, 1,000 kW, 2,000 kW |
| System losses | 14.1% |
| Tilt | By region |
| Azimuth: | By region |
| DC to AC size ratio | 1.2 |
| Inverter efficiency | 96% (micro-inverter) |
| Battery Round-Trip Efficiency | 85% |

Based on the simulations and resulting capacity factors for residential and non-residential buildings for the Indianapolis, we applied the state-specific capacity factor to the system size to estimate annual electricity generation. These system generation values were used to calculate total energy generation per square foot of rooftop and extrapolated based on the total suitable rooftop square footage to estimate overall all technical potential. As a final step, the GDS Team removed from the technical potential for any generation occurring from existing systems. Data on existing systems was provided directly by AES-IN.

#### 2.1.1.2 Combined Heat and Power

CHP systems generate electric power and useful thermal energy in a single integrated system. Heat that is normally wasted in conventional power generation is recovered as useful thermal energy. Due to the

1 PVWatts estimates solar PV energy production and costs. Developed by the National Renewable Energy Laboratory. (NREL) http://pvwatts.nrel.gov/

2 SAM estimates hourly solar PV energy production and costs with more detailed inputs and outputs than PVwatts. Developed by the National Renewable Energy Laboratory. (NREL) http:// https://sam.nrel.gov/

integration of both power and thermal generation, CHP systems are more efficient than separate sources for electric power generation and thermal energy production.

In most CHP applications, a heat engine creates shaft power that drives an electrical generator (fuel cells can produce electrical power directly from electrochemical reactions). The waste heat from the engine is then recovered to provide steam or hot water to meet on-site needs. By combining the thermal and electrical energy generation in one process, the total efficiency of a CHP application far exceeds that of a separate plant and boiler system. Overall, the efficiency of CHP technologies can reach 80% or more, while simple-cycle electricity generation reaches only 30% and combined cycle generation typically achieves 50%. When considering both thermal and electric energy generation, CHP requires 40% less energy input to achieve the same energy output as a separate plant and boiler system. Figure 2-1 illustrates this point.

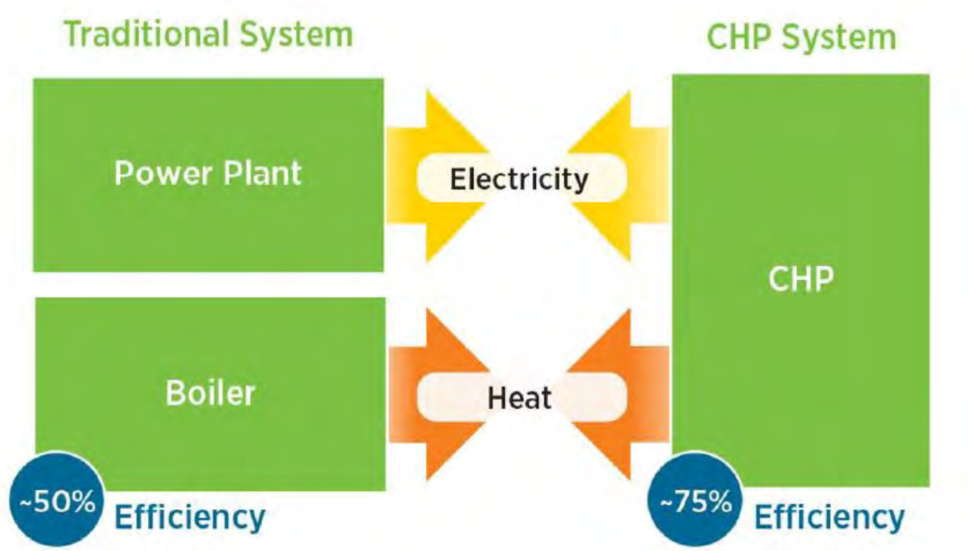



Figure courtesy of US DOE Energy Efficiency & Renewable Energy

**FIGURE 2-1: CHP ENERGY FLOW DIAGRAM**

Common technologies used in CHP applications and explored in this study include:

- Steam turbines
- Gas turbines
- Micro turbines
- Fuel Cells
- Reciprocating engines

Applications with steady demand for electricity and thermal energy are potentially good economic targets for CHP deployment. Industrial applications, particularly in industries with continuous processing and high steam requirements, are very economic and represent a large share of existing CHP capacity today. Commercial applications such as hospitals, nursing homes, laundries, and hotels with large hot water needs are well suited for CHP. Institutional applications such as colleges and schools, prisons, and residential and recreational facilities are also excellent prospects for CHP.

Selecting a specific CHP technology depends on several factors, which include but are not limited to power requirements, the duty cycle, space constraints, thermal energy needs, emission regulations, fuel availability, utility prices, and interconnection issues. Table 2-2 summarizes the CHP technologies evaluated in this study and their assumed operating parameters.

**TABLE 2-2: CHP TECHNOLOGY COMPARISON[3]**

| Parameter | Reciprocating Engine | Gas Turbine | Steam Turbine | Micro-Turbine | Fuel Cell |
|---|---|---|---|---|---|
| Size (kW) | 50-5,000 | 500-50,000 | 10-100,000 | 30-250 | 200-2,000 |
| Electric Efficiency | 28-39% | 25-40% (simple) 40-60% (combined) | 5-15% | 25-28% | 36-42% |
| Overall Efficiency | 73-79% | 64-72% | ~80% | 67-72% | 62%-67% |
| Fuels | Natural gas, biogas, propane, liquid fuels | Natural gas, biogas, propane, distillate oil | All | Natural gas, biogas, propane, distillate oil | Hydrogen, natural gas, propane |
| $NO_x$ Emissions (lb/MWh) | 0.15-2.17 | 0.55-0.68 | Function of boiler emissions | 0.14-0.17 | 0.01-0.04 |
| Uses for Heat Recovery | Hot water, low pressure steam, district heating | Direct heat, hot water-, low- or high-pressure steam, district heating | Low- or high-pressure steam, district heating | Direct heat, hot water, low pressure steam | Hot water-, low- or high-pressure steam |
| Thermal Output (Btu/kWh) | 3,000-6,100 | 3,200-5,000 | n/a | 4,800-6,300 | 1,500-3,000 |
| Useable Temp (°F) | 200-500 | 500-1,100 | n/a | 400-650 | 140-700 |

To estimate technical potential for CHP, the GDS Team first developed a screening process based on the DOE's national technical potential study of CHP resources[4] to identify probable CHP candidate premises. First, customers with less than 50,000 kWh annual consumption were removed from eligibility as a CHP candidate. Second, we considered customer loads to assess if and what CHP system type and size may be a potential match to a customer. To effectively utilize CHP, a facility must have coincident electric and thermal energy requirements for a large load factor of the year. A continuous process industry with nearly constant steam or hot water demand electric load is an excellent target, such as a chemicals manufacturer or a hospital. Facilities with intermittent electric and thermal loads are progressively less attractive as the number of hours of coincident load diminishes. We therefore screened for eligible customers based on the customer's annual kWh usage and an approximate sized CHP system based on a thermal factor.

The team calculated and applied a thermal factor to potential candidate customer loads to reflect thermal load considerations in CHP sizing. In most cases, on-site thermal energy demand is smaller than electrical demand. Thus, CHP size is usually dictated by the thermal load to achieve proper efficiencies and adequate returns on investment. The Team used power to heat ratios[5] for both the CHP technology as well as different market segments to calculate the thermal factor as shown in following equation.

[3] Combined Heat and Power Market Assessment. ICF International for the California Energy Commission, April 2010.
[4] U.S. Department of Energy. Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.
[5] Power to heat ratios were sourced from a combination of the following sources:
- U.S. Environmental Protection Agency Combined Heat and Power Partnership. Catalog of CHP Technologies, September 2017.
- U.S. Environmental Protection Agency Combined Heat and Power Partnership. Spark Spread Estimator Version 1.2
- U.S. Department of Energy. Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.

$$Thermal\ Factor = \frac{P/H\ (CHP\ System)}{P/H\ (Customer\ Segment)}$$

A thermal factor of one (1.0) would result in the CHP system capacity being equal to the electric demand of the facility. A thermal factor of less than one would indicate that the application is thermally limited, and the resulting CHP system size would be below the electric demand of the facility. A thermal factor greater than one indicates that a CHP system sized to the thermal load would produce more electricity than can be used on-site, resulting in excess power that could be exported to the grid. Following the method applied in the DOE national technical potential study, the thermal factor was multiplied by each customer's annual consumption to estimate the appropriate CHP system size. The GDS Team screened and removed any CHP technology that did not fall within +/- 15% generation of the customer's annual kWh consumption. A summary of the power to heat ratios by segment is listed in Table 2-3, as sourced from the DOE EPA CHP potential study.

**TABLE 2-3: POWER TO HEAT RATIO BY SEGMENT**

| Industrial Segment | Heat to Power Ratio | Commercial Segment | Heat to Power Ratio |
|---|---|---|---|
| Utilities | 1.29 | Education | 0.50 |
| Smelting | 0.26 | Healthcare | 0.75 |
| Food Manufacturing | 1.10 | Institutions | 0.94 |
| Transportation Manufacturing | 0.33 | Grocery | 0.62 |
| Paper Manufacturing | 2.37 | Lodging | 0.62 |
| Plastics Manufacturing | 0.31 | Office | 0.20 |
| Misc. Manufacturing | 1.34 | Retail | 0.84 |
| Agriculture | 0.25 | Warehouse | 0.68 |
| Construction | 0.25 | Misc. | 0.68 |
| Metal Manufacturing | 3.83 | | |

After applying the screening method, we reviewed which CHP systems were eligible matches for given customer sites. In cases where multiple CHP technologies were viable for a single customer site, an applicability factor was assigned for each eligible CHP technology. After assigning applicability factors, the GDS Team summed the total CHP generation across the population. The GDS Team removed from the technical potential any generation occurring from existing systems. Data on existing systems was provided directly by AES-IN.

### *2.1.2 Economic Potential*

Economic potential represents the DER generation possible given full adoption of all cost-effective DER measures. For the cost effectiveness analysis on solar PV and CHP, the GDS Team used a Total Resource Cost (TRC) hurdle of 1.0. To assess the TRC, the GDS Team relied on the same avoided energy and capacity costs used in the energy efficiency analysis. These avoided costs serve as the benefits while the costs are represented as the installation and O&M costs of the modeled solar PV and CHP measures.

#### 2.1.2.1 Solar Photovoltaic

To estimate economic potential for solar PV, we gathered pertinent data on system costs along with calculated generation benefits to use in the benefit-cost analysis, which we conducted at the system measure level. The GDS Team assessed system component costs based on data included in the National Renewable Energy Laboratory's (NREL) Q1 2020 Benchmarking report as well as public data files from Tracking the Sun[6] and compared these national cost parameters to AES-IN-specific values by using various market data provided by Energy Sage.[7] This analysis produced an estimated installation cost per watt installed, which we applied to each system size to estimate total installed cost. Additionally, the GDS Team included O&M costs that scale with system size.[8] Finally, we assumed the impact of the federal investment tax credit (ITC) to follow the existing schedule at the time of this report which equates to a 10% tax credit for commercial systems by 2024 and a 0% tax credit for residential systems by 2024.

In addition to modeling solar PV system costs, the GDS Team estimated cost impacts for solar PV systems coupled with battery storage based on analysis from NREL's Q1 2020 Benchmarking report and Lazard's Levelized Cost of Storage Analysis.[9] The GDS Team estimated an average lithium-ion battery installation cost of $1,093/kWh and $721/kWh for the residential and non-residential sectors, respectively, inclusive of the ITC. Table 2-4 provides the average solar PV installation cost by sector.

**TABLE 2-4: AVERAGE SOLAR PV INSTALLATION COST**

| Sector | System Cost ($/ DC W)[1] |
|---|---|
| Residential | $3.05 |
| Non-Residential (<100 kW) | $2.56 |
| Non-Residential (>100 kW) | $2.20 |
| Non-Residential - Tracking (<100 kW) | $3.95 |
| Non-Residential - Tracking (>100 kW) | $3.39 |

[1]Costs reflect impact of federal investment tax credit; battery systems not reflected in cost.

#### 2.1.2.2 Combined Heat and Power

To assess costs for the various CHP technologies analyzed in the potential study, the GDS Team relied on data sourced from the EPA Catalog of CHP Technologies.[10] Costs were calculated for fuel cell, gas turbine, micro turbine, reciprocating engine, and steam turbine CHP configurations at various capacity sizes. These costs reflect the inclusion of the ITC based on the existing schedule at the time of this report which equates to a 10% tax credit for CHP through 2023.

Table 2-5 summarizes detailed CHP cost considerations and assumptions utilized in the cost-effectiveness screening. These costs reflect the inclusion of the ITC based on the existing schedule at the time of this report which equates to a 10% tax credit for CHP through 2023.

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[6] Feldman, D, et. al., U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020. NREL, January 2021.
[7] https://www.energysage.com/solar-panels/in/; https://www.energysage.com/solar-panels/mi/ (accessed March 2021).
[8] Feldman, D, et. al., U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020. NREL, January 2021.
[9] Ibid.
[10] U.S. Environmental Protection Agency Combined Heat and Power Partnership. Catalog of CHP Technologies, September 2017.

**TABLE 2-5: DETAILED CHP COST CONSIDERATION SUMMARY**

| Technology Type | Size (kW) | Installed System Cost ($/W) | O&M Costs ($/kWh) |
|---|---|---|---|
| Fuel Cell | 125 | $17.33 | $0.35 |
| | 250 | $12.42 | $0.31 |
| | 500 | $6.69 | $0.27 |
| | 750 | $6.10 | $0.27 |
| | 1000 | $5.50 | $0.26 |
| | 1250 | $4.91 | $0.26 |
| | 1500 | $4.32 | $0.26 |
| | 2000 | $3.13 | $0.26 |
| Gas Turbine | 750 | $3.84 | $0.09 |
| | 1000 | $3.77 | $0.09 |
| | 1250 | $3.69 | $0.09 |
| | 1500 | $3.62 | $0.09 |
| | 2000 | $3.48 | $0.09 |
| | 2500 | $3.34 | $0.09 |
| | 3000 | $3.20 | $0.09 |
| | 3500 | $3.06 | $0.09 |
| | 4000 | $2.92 | $0.09 |
| | 4500 | $2.78 | $0.09 |
| | 5000 | $2.64 | $0.09 |
| | 5500 | $2.50 | $0.09 |
| | 6000 | $2.36 | $0.08 |
| Micro Turbine | 50 | $3.50 | $0.05 |
| | 100 | $3.30 | $0.05 |
| | 150 | $3.10 | $0.05 |
| | 200 | $2.90 | $0.05 |

| Technology Type | Size (kW) | Installed System Cost ($/W) | O&M Costs ($/kWh) |
|---|---|---|---|
| Reciprocating Engine | 125 | $2.85 | $0.07 |
| | 250 | $2.81 | $0.07 |
| | 500 | $2.73 | $0.07 |
| | 750 | $2.64 | $0.07 |
| | 1000 | $2.55 | $0.06 |
| | 1250 | $2.47 | $0.06 |
| | 1500 | $2.38 | $0.06 |
| | 2000 | $2.21 | $0.06 |
| | 2500 | $2.04 | $0.05 |
| | 3000 | $1.86 | $0.05 |
| | 3000 | $1.86 | $0.05 |
| | 4000 | $1.74 | $0.05 |
| | 4500 | $1.71 | $0.05 |
| | 5000 | $1.68 | $0.04 |
| Steam Turbine | 500 | $4.95 | $0.18 |
| | 750 | $4.95 | $0.18 |
| | 1000 | $4.95 | $0.18 |
| | 1250 | $4.95 | $0.18 |
| | 1500 | $4.95 | $0.18 |
| | 2000 | $4.95 | $0.18 |
| | 2500 | $4.95 | $0.18 |
| | 3000 | $4.95 | $0.18 |
| | 3500 | $4.95 | $0.18 |
| | 4000 | $4.95 | $0.18 |
| | 4500 | $4.95 | $0.18 |
| | 5000 | $4.95 | $0.18 |
| | 5500 | $4.95 | $0.18 |
| | 6000 | $4.95 | $0.18 |

### *2.1.3 Market Potential*

Market potential is the amount of energy that can realistically be saved given likely future utility program intervention and various market barriers. The anticipated approach to assess achievable potential for the DER potential analysis was to follow the same logic and methods as used in the energy efficiency achievable potential analysis. However, as discussed in Section 2.2 below, market potential was not assessed as neither the solar PV nor CHP technologies passed a TRC screen of 1.0.

## 2.2 DER POTENTIAL FINDINGS

This section of the report presents the Technical, Economic, Achievable (MAP and RAP) for CHP and solar PV.

### *2.2.1 Solar Photovoltaics*

Table 2-6 summarizes the solar PV cumulative annual potential estimates for electric demand and Table 2-7 for electric energy within AES-IN's territory. The residential 2042 technical market potential for solar PV represents 46.6% of the 2042 residential sector sales forecast. Additionally, the non-residential 2042 technical market potential represents 60.7% of the 2042 non-residential sector sales forecast.

**TABLE 2-6: SUMMART OF SOLAR PV ELECTRIC DEMAND MARKET POTENTIAL**

| Year | Technical DC Capacity (MW) | Technical Peak Capacity (MW) | Economic (MW) | MAP (MW) | RAP (MW) |
|---|---|---|---|---|---|
| 2023 | 319 | 104 | 0 | 0 | 0 |
| 2027 | 1,836 | 575 | 0 | 0 | 0 |
| 2032 | 5,416 | 1,695 | 0 | 0 | 0 |
| 2042 | 6,344 | 1,985 | 0 | 0 | 0 |

**TABLE 2-7: SUMMARY OF SOLAR PV ELECTRIC ENERGY MARKET POTENTIAL**

| Year | Technical (MWh) | Economic (MWh) | MAP (MWh) | RAP (MWh) |
|---|---|---|---|---|
| 2023 | 415,268 | 0 | 0 | 0 |
| 2027 | 2,297,314 | 0 | 0 | 0 |
| 2032 | 6,767,212 | 0 | 0 | 0 |
| 2042 | 7,926,314 | 0 | 0 | 0 |

Table 2-8 summarizes the cost effectiveness results for each technology and for the TRC cost-effectiveness perspective.

**TABLE 2-8: SUMMARY OF SOLAR PV COST-EFFECTIVENESS**

| Solar PV Technologies | TRC Test Range |
|---|---|
| Residential Roof-mounted (3 – 20 kW) | 0.40 |
| Residential Roof-mounted with Batteries (3 – 20 kW) | 0.19 – 0.35 |
| Non-residential Roof mounted (10 – 50 kW) | 0.42 |
| Non-residential Roof mounted with Batteries (10 – 50 kW) | 0.31 – 0.35 |
| Non-residential Ground mounted (100 kW – 2MW) | 0.48 |
| Non-residential Ground mounted with Batteries (100 kW – 2MW) | 0.41 – 0.42 |
| Non-residential Ground mounted Tracking (100 kW – 2MW) | 0.44 |
| Non-residential Ground mounted Tracking with Batteries (10 – 50 kW) | 0.39 – 0.40 |

It is notable that no solar PV technologies pass cost-effectiveness screening under the TRC. This test is the primary cost-effectiveness criteria used to determine whether a utility sponsored program intervention is prudent. Low avoided costs serve as the primary driver behind the cost effectiveness results. At a technology level, the introduction of battery storage reduces cost effectiveness despite potential capacity benefit gains. Similarly, benefits achieved through additional generation using tracking-enabled systems are ultimately outweighed by the higher installation cost associated with the tracking technology.

It is notable while the TRC test for solar PV systems doesn't meet a 1.0 cost-effectiveness threshold, AES-IN customers install solar PV systems at their homes and businesses. Consequently, a baseline, business-as-usual (BAU) forecast was developed for integration into the IRP modeling. The BAU forecasts are based upon the:

- AES-IN customer and rooftop characterization described earlier
- Number of existing systems
- Trend of existing system installation from 2015-2020
- Willingness to participate and market adoption data collected from AES-IN customers
- Bass-diffusion curve and coefficients based upon the NREL dGen model[11] and EIA DGPV interconnection and Census data

Three adoption scenarios for BAU solar PV installations are described below for the Residential sector:

- Low; up to 6% market adoption
- Medium; up to 15% market adoption
- High; up to 29% market adoption

The BAU forecasts for system and energy (MWh-DC) are shown in Figure 2-2 and Figure 2-3, respectfully.

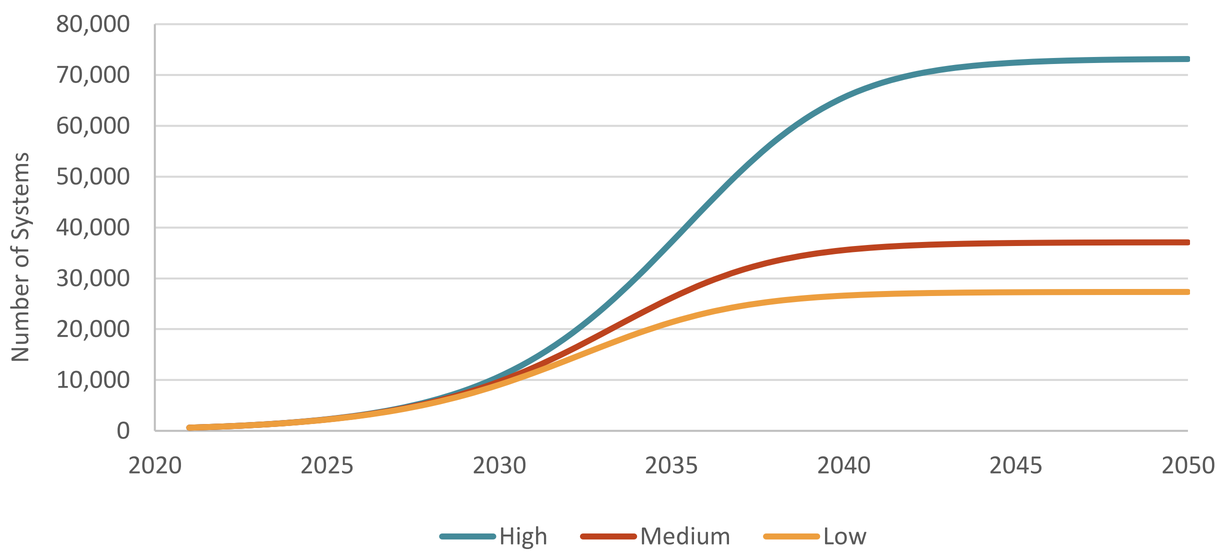


**FIGURE 2-2: RESIDENTIAL SOLAR PV SYSTEM FORECAST (BUSINESS-AS-USUAL)**

[11] https://www.nrel.gov/analysis/dgen/

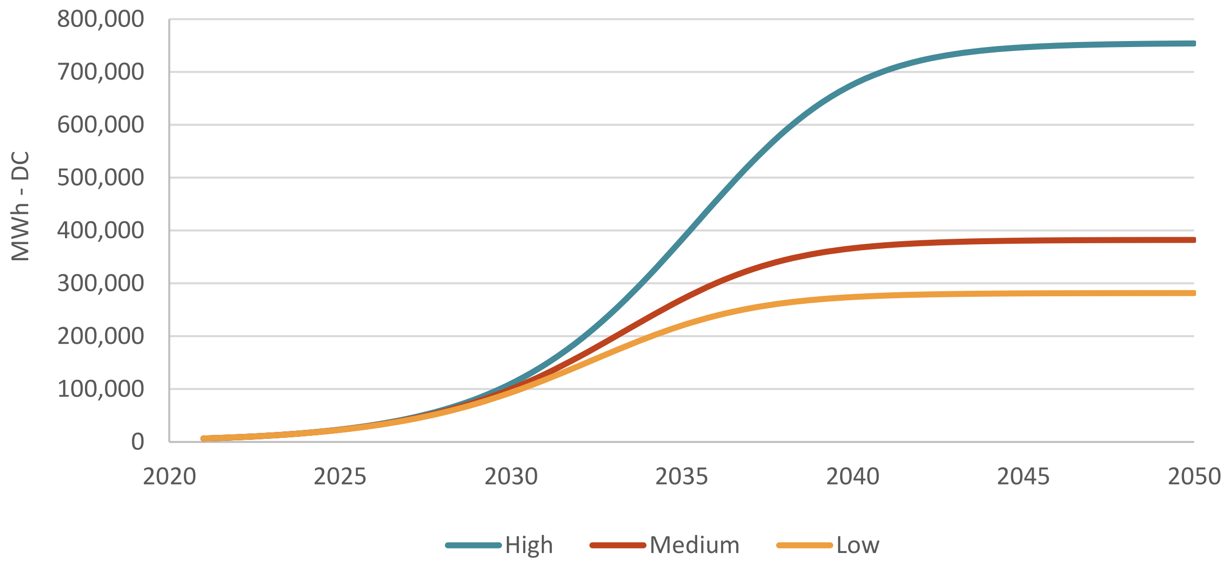


**FIGURE 2-3: RESIDENTIAL SOLAR PV SYSTEM ENERGY CONSUMPTION (MWH-DC) (BUSINESS-AS-USUAL)**

Three adoption scenarios for BAU solar PV installations are described below for the Non-residential sector:

- Low; up to 7% market adoption
- Medium; up to 19% market adoption
- High; up to 35% market adoption

The BAU forecasts for system and energy (MWh-DC) are shown in Figure 2-4 and Figure 2-5, respectfully.

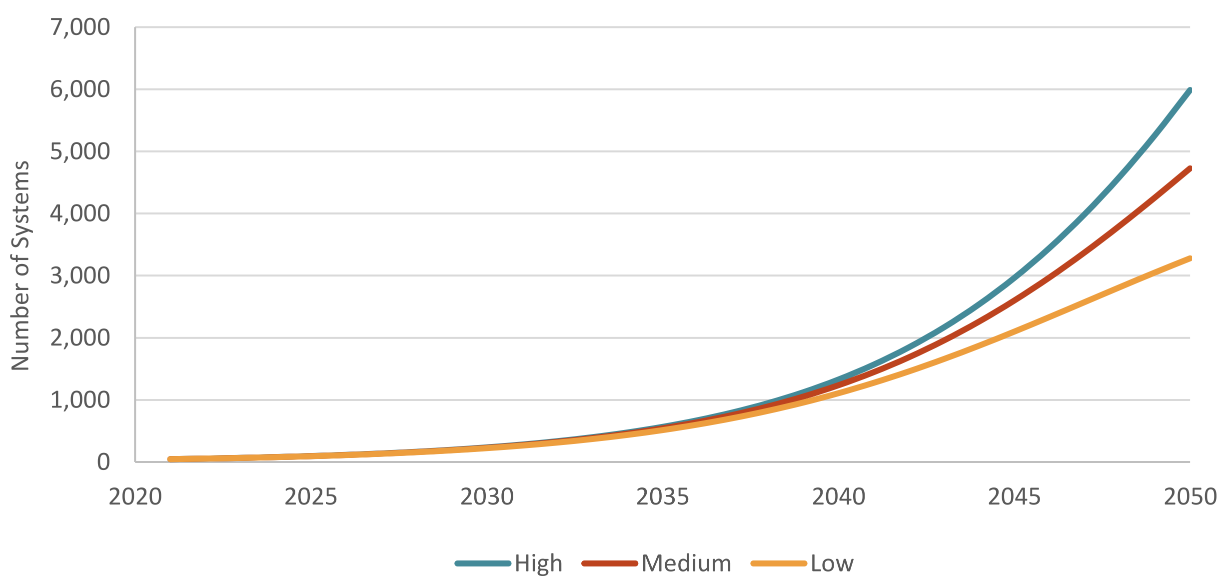


**FIGURE 2-4: NON-RESIDENTIAL SOLAR PV SYSTEM FORECAST (BUSINESS-AS-USUAL)**

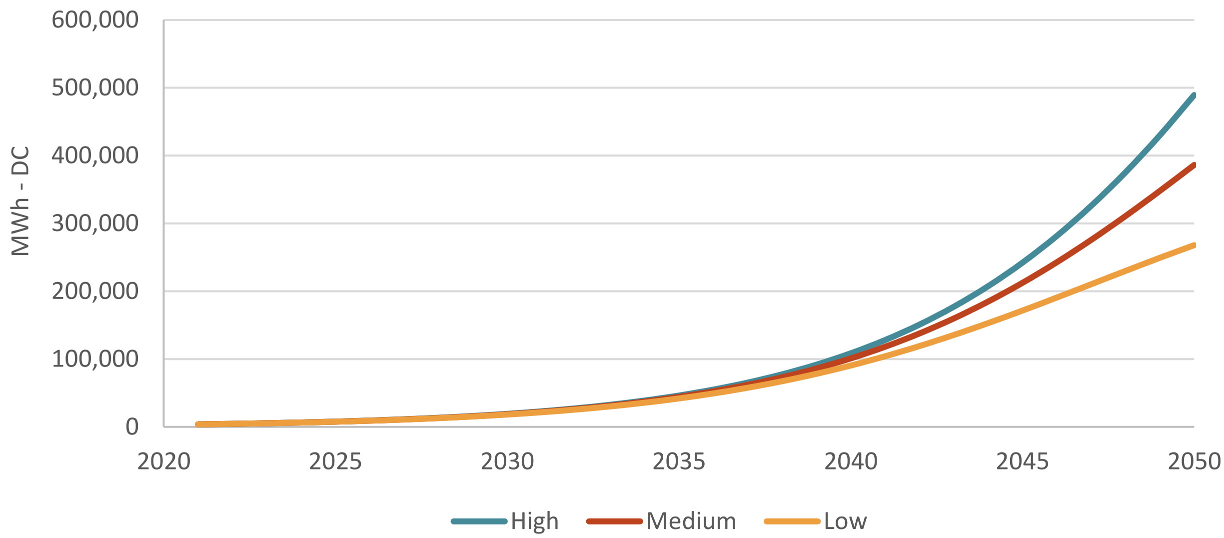


**FIGURE 2-5: NON-RESIDENTIAL SOLAR PV SYSTEM ENERGY CONSUMPTION (MWH-DC) (BUSINESS-AS-USUAL)**

### *2.2.2 Combined Heat & Power*

Table 2-9 summarizes the CHP cumulative annual potential estimates for electric demand and Table 2-10 for electric energy within AES-IN territory. 2042 technical market potential for CHP represents of the 2042 non-residential sector sales forecast.

**TABLE 2-9: SUMMARY OF CHP ELECTRIC DEMAND MARKET POTENTIAL**

| Year | Technical Peak Capacity (MW) | Economic (MW) | MAP (MW) | RAP (MW) |
|---|---|---|---|---|
| 2023 | 7 | 0 | 0 | 0 |
| 2027 | 40 | 0 | 0 | 0 |
| 2032 | 125 | 0 | 0 | 0 |
| 2042 | 150 | 0 | 0 | 0 |

**TABLE 2-10: SUMMARY OF CHP ELECTRIC MARKET POTENTIAL**

| Year | Technical (MWh) | Economic (MWh) | MAP (MWh) | RAP (MWh) |
|---|---|---|---|---|
| 2023 | 59,521 | 0 | 0 | 0 |
| 2027 | 346,669 | 0 | 0 | 0 |
| 2032 | 1,089,496 | 0 | 0 | 0 |
| 2042 | 1,308,179 | 0 | 0 | 0 |

Table 2-11 summarizes the cost effectiveness results for each technology and for the TRC cost-effectiveness perspective.

**TABLE 2-11: SUMMARY OF CHP COST-EFFECTIVENESS**

| CHP Technologies | TRC Test Range |
|---|---|
| Fuel Cell (125 – 2,000 kW) | 0.14 – 0.32 |
| Gas Turbine (750 – 6,000 kW) | 0.46 – 0.77 |
| Micro-Turbine (50 – 200 kW) | 0.26 – 0.30 |
| Reciprocating Engine (125 – 5,000 kW) | 0.32 – 0.54 |
| Steam Turbine (500 – 6,000KW) | Less than 0.1 |

It is notable that no CHP technologies pass cost-effectiveness screening under the TRC. This test is the primary cost-effectiveness criteria used to determine whether a utility sponsored program intervention is prudent. Low avoided costs serve as the primary driver behind the cost effectiveness results. However, it may be the case that certain site location conditions have important performance parameters that allow for a favorable cost-effectiveness assessment for that specific site, even if the average system and facility is not cost-effective as analyzed.

# 3 Transportation Electrification

Wide-scale adoption of EVs across the U.S. will necessitate a substantial amount of energy supply to meet the needs of consumers over time. As traditional internal combustion engine (ICE) vehicles are offset by both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), electric service providers will need to account for the expanding EV market in their resource planning efforts.[12] EVs increase the demand for electricity that regulated electric utilities like AES-IN are required to supply to customers in their service territory. The growing adoption of EVs amongst all customer classes (residential, commercial, and industrial) poses supply and demand challenges that may require increased focus towards the assessment of the transportation sector and how it effects retail electric rates.

As of December 2021, the Federal Highway Administration provides that there are over 275 million vehicles in the U.S., and roughly 6.1 million in Indiana.[13] The Department of Energy (DOE), in accordance with the National Renewable Energy Laboratory (NREL) estimates that for 2021, just over 1 million electric vehicles were registered in the U.S.[14] The annual number of EV sales has been steadily increasing over time as well. In 2010, there were just over 15,000 EVs sold in the U.S.; in 2015 that number grew to over 120,000; and in 2021, that number was up to over 600,000.[15] As of the beginning of 2022, the Environmental Protection Agency's (EPA) fuel economy report notes over 65 different makes and models of EV passenger cars are available to consumers, with new makes and models reported to hit the market year after year.

Differentiating between residential and commercial vehicles is the first step to determining the impact of new EVs in AES-IN's service territory. Residential vehicles can be typically defined as light- or medium-duty passenger vehicles or trucks used for daily commutes or recreational purposes. Commercial vehicles can be any type of vehicle used for business purposes (e.g., used for the transportation of goods or people; owned by a company or the public sector). This range of potential commercial vehicles can include light-duty passenger cars such as taxis and cop cars, all the way to vans, large trucks, and transit/school buses. Determining the number of each vehicle type takes a bottom-up approach before the energy consumption values can be approximated for AES-IN's service territory.

While EV passenger cars have a wide variety of options, the market for small delivery trucks and vans, large heavy-duty trucks (e.g., semi and tractor trailer trucks), limos, transit buses, school buses, is currently limited to a small number of makes and models, as of 2022. The adoption of these vehicles is still in its infancy. For example, car manufacturers like Tesla, Volvo, Dailmer, and BYD are still in the process of developing an EV semi-truck, with production estimates as early as Q4, 2022.[16] Additionally, regarding school buses, of the roughly 500,000 in the U.S. as of December 2021, less than 1% are electric.[17] Getting initial vehicle counts of these vehicle types is useful but forecasting out the adoption of each, and its associated energy usage has its limitations.

## 3.1 COMMERCIAL TRANSPORTATION ELECTRIFICATION

Within the market potential study, The GDS Team developed a commercial Electric Vehicle (EV) forecast for the AES-IN service territory over the 20-year resource planning period (2021-2041), to assess the potential energy and demand consumption attributed to increasing EV adoption by the commercial sector. This

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[12] For purposes of this report, "EV" will refer to both battery electric vehicles and plug-in hybrid vehicles.

[13] Federal Highway Administration, Highway Statistics Series "Highway Statistics 2020" (December 2021)

[14] U.S. Dept. of Energy, Alternative Fuels Data Center "10962-Electric Vehicle Registrations by State, 2021"

[15] U.S. Dept. of Energy, "New Plug-in Electric Vehicle Sales in the United States Nearly Doubled from 2020 to 2021"

[16] See U.S. News "Future Electric Semi Trucks" 02/18/22.

[17] See SchoolBusFleet "School Bus Statistics" Dec. 2021

analysis should be utilized as a supplement to support AES-IN's energy forecasting efforts. This analysis utilizes existing, publicly available, historical data and trends along with supplemental information supplied by AES-IN. The forecast in this report is solely a business-as-usual forecast; meaning there are no assumptions built in for utility intervention, or State or Federal policy implications throughout the planning period.

This section describes the overall methodology used to develop the commercial EV forecast. The structure of this report will be as follows:

- Characterizing the commercial EV market in AES-IN's service territory as it relates to commercial vehicle registrations, sales, and historical trends;
- Developing EV measures, segmented by measure group to determine unique energy consumption values;
- Defining EV market penetration scenarios (low, medium, and high case);
- Approach used to forecast vehicle classes and energy consumption through the 20-year resource planning period; and
- Offering concluding findings and remarks surrounding the forecasted scenarios considered, and challenges posed by future adoption of heavy-duty EVs.

### *3.1.1 Commercial EV Market Characterization*

First, to establish a forecasted value of commercial vehicles in AES-IN's service territory, an AES-IN provided baseline year of 2021 is used. Commercial vehicle types are determined, and primary data is collected for historical U.S. vehicle registrations from sources such as the U.S. Dept. of Transportation's Federal Highway Administration (FHA), and the DOE. Historical values are compared against national, state, and city population values year-over-year,[18] and number of registered vehicles in a specific State and County can be extrapolated for a single historical year. Commercial vehicle types are then grouped in segments based on characteristics.

#### 3.1.1.1 Vehicle Classification

The Federal government typically classifies vehicles based on the vehicle's Gross Vehicle Weight Rating (GVWR). Eight cohorts of vehicles are categorized ranging from Class 1 (GVWR < 6,000 lbs) to Class 8 (GVWR > 33,000 lbs. This analysis utilizes these classifications and further categorizes each based on current EV models available in the market today. Table 3-1 provides a listing of the federal commercial vehicle cohorts by GVWR.

**TABLE 3-1: FEDERAL COMMERCIAL VEHICLE COHORTS**

| Gross Vehicle Weight Rating (GWWR) (lbs) | Federal Highway Admin Vehicle Class | Federal Highway Admin GVWR Category |
|---|---|---|
| <6,000 | Class 1: <6,000 lbs | Light Duty (< 10,000 lbs) |
| 10,000 | Class 2: 6,001 - 10,000 lbs | |
| 14,000 | Class 3: 10,001 - 14,000 lbs | Medium Duty (10,001-19,500 lbs) |
| 16,000 | Class 4: 14,001 - 16,000 lbs | |
| 19,500 | Class 5: 16,001 - 19,500 lbs | Light Heavy Duty (19,001 -26,000 lbs) |
| 26,000 | Class 6: 19,501 - 26,000 lbs | |
| 33,000 | Class 7: 26,001 - 33,000 lbs | Heavy Duty (> 26,000 lbs) |
| >33,000 | Class 8: >33,000 lbs | |

[18] U.S. Census Bureau, U.S. population data, 2021

Classes 1 and 2 are typical passenger vehicle on the road today. Of the 275 million vehicles registered in the U.S. in 2020, 37% would be considered under this class. Semi and Tractor trailer trucks make up most of the Class 7 and 8 vehicles, with the FHA reporting that over 13 million registered in 2020. The amount of fuel needed to power these different Classes of vehicles varies greatly, and furthermore, the Miles Per Gallon ("MPG") of a Class 1 vehicle could dramatically differ from a Class 8 vehicle.[19] For an EV model of each class, the amount of electricity needed to supply one vehicle to travel equal distances will also greatly vary.

For purposes of this study, based on the data that was available to be collected, along with vehicle characteristics and EV models available, the federal classes discussed were further recategorized into unique segments for all commercial vehicle types. Table 3-2 shows each of the vehicle segments.

**TABLE 3-2: COMMERCIAL EV SEGMENTS**

| Segment | Class/ Additional Description |
|---|---|
| **Government Passenger Cars** | Light & Medium Duty, SUVS |
| **Government Trucks** | Light, Medium and Heavy Duty |
| **Police Cars** | Light & Medium Duty, SUVS |
| **Police Trucks** | Light, Medium and Heavy Duty |
| **Private Vehicle – Class 1** | Excluding all other segments |
| **Private Vehicle – Class 2** | Excluding all other segments |
| **Private Vehicle – Class 3 through 6** | Excluding all other segments |
| **Private Vehicle – Class 7 & 8** | Excluding all other segments |
| **School Buses** | - |
| **Transit Buses** | - |
| **Limos** | All Types |

Each segment was scaled to Marion County based on population changes year-over-year. A total count of vehicles was determined for 2021, to be used as the initial baseline for scenario development and forecasting efforts.

### *3.1.2 Technology Characterization*

Data on current makes and models of commercial EVs available in the U.S. market as of 2021 were collected and analyzed. Unique model characteristics such as Gross Vehicle Weight Rating (GVWR),[20] range, Manufacturer Suggested Retail Price (MSRP), Miles Per Gallon Equivalent (MPGe),[21] etc., were compared to models into unique commercial EV cohorts.

Based on the range and battery, miles per kWh was defined for each model, and then averaged within each vehicle cohort, if multiple products are available. The FHA publishes an annual Vehicle Miles Traveled (VMT) every year based on types of vehicles. Using the miles per kWh values, and VMT values regionalized to central States, annual kWh values are derived for each of the vehicle segments.

Along with the uniqueness of the vehicle segments, each has a useful life, which is the length of time that the individual vehicle will, on average, be replaced. The DOT, EPA and individual car manufacturers provide insight towards the useful life of different vehicle types. The values have been collected and averaged and are used in the forecast of commercial EVs. Table 3-3 provides a summary of the vehicle segments, useful life,

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[19] EPA ratings for Class 1 vehicles are on average 24.2 MPG, while Class 8 vehicles can range from 2.5 to 6.5 MPG.

[20] Values provided by the DOE, Office of Energy Efficiency & Renewable Energy.

[21] EPA unit used for alternative fuel vehicles. 1 U.S. gallon of unleaded gasoline equals 33.7 kilowatt-hours of electricity based on an energy standard of 115,000 BTUs (British thermal units) per gallon of gasoline.

and number of commercial vehicles within AES-IN's service territory used in this study. The turnover and new purchase for each commercial vehicle provides the opportunity for vehicle to switch to electric from internal combustion.

**TABLE 3-3: USEFUL LIFE AND BASELINE YEAR MARKET SIZE FOR EACH VEHICLE SEGMENT**

| Segment | Estimated Vehicles in 2021 | Useful Life (years) |
|---|---|---|
| **Government Passenger Cars** | 12 | 5,416 |
| **Government Trucks** | 8 | 2,267 |
| **Police Cars** | 5 | 1,326 |
| **Police Trucks** | 5 | 284 |
| **Private Vehicle – Class 1** | 12 | 100,524 |
| **Private Vehicle – Class 2** | 12 | 10,538 |
| **Private Vehicle – Class 3 through 6** | 15 | 32,405 |
| **Private Vehicle – Class 7 & 8** | 15 | 17,170 |
| **School Buses** | 14 | 288 |
| **Transit Buses** | 14 | 2,115 |
| **Limos** | 15 | 107 |

### *3.1.3 Forecasting Scenarios and Assumptions*

Various industry sources have offered opinions and projections towards the future of the U.S. EV market. For example, the Energy Information Administration (EIA),[22] the International Energy Agency (IEA),[23] and NREL[24] all publish annual studies on potential EV penetration and adoption, with unique sales forecasts for the U.S. The characterization of the current EV market and the best estimates of future trends are based on leveraging both national and local historical data to the extent possible. Local data was used when available, such as historical values of school and transit buses in Marion County, IN.

Due to the 20-yr length of the study timeframe, and the current state of the EV market, this study uses three linear-trend scenarios of EV shares of total vehicle sales as described below:

- Low – starting at 1.7% in 2020 rising to 9.1% in 2042
- Medium – starting at 1.7% in 2020 rising to 18.2% in 2042
- High – starting at 1.7% in 2020 rising to 36.0% in 2042

A linear regression analysis is utilized for each cohort to develop a projected of new commercial vehicle purchases and replacements for each cohort within the forecasted years in the planning period. The linear regression approach is used because of its simplicity and the uncertainty of the EV market. The forecast does not include any additional market interventions by AES-IN, such as customer incentives of exceptional energy rate structures.

### *3.1.4 Commercial Transportation Electrification Results*

Figure 3-1 and Figure 3-2 show the forecasts for incremental new commercial electric vehicles and incremental energy usage for all three scenarios (low, medium, high).

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[22] U.S. Energy Information Administration, Annual Energy Outlook 2022 (AEO2022) "Light-duty vehicle sales by technology or fuel type"

[23] International Energy Agency: Global EV Outlook 2021

[24] NREL: Electrification Futures Study ("EFS"), May 2021

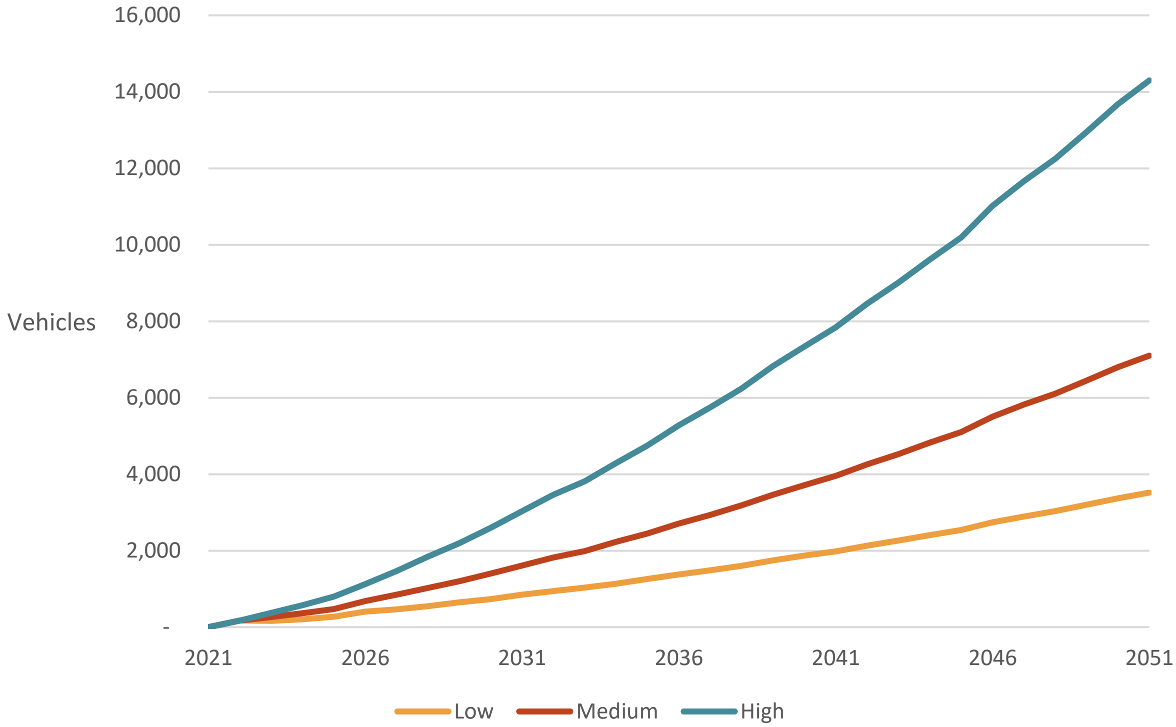



**FIGURE 3-1: INCREMENTAL NEW COMMERCIAL ELECTRIC VEHICLES**

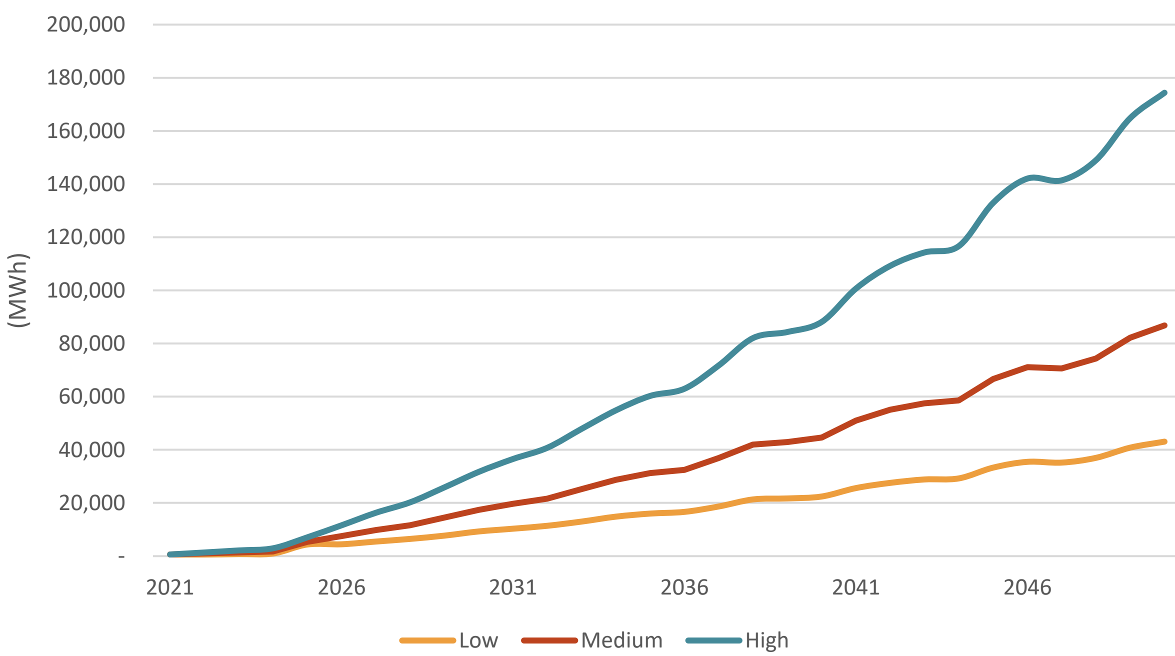



**FIGURE 3-2: INCREMENTAL ENERGY USAGE FROM NEW COMMERCIAL ELECTRIFICATION VEHICLES**

After the offset adoption of some of the larger vehicles is realized after 2024, the commercial EV's incremental energy usage takes a significant jump under all three scenarios. By 2030, under the "low scenario" the commercial EV sector will consume 7,700 MWh of energy supply. Under the high scenario, that energy supply increases to over 25,800 MWh. By 2041, incremental energy usage ranges from roughly 22k

MWh to 88k MWh between the low and high scenarios. Under all scenarios, Class 7 and 8 vehicles account for nearly 50% of all energy needs every year. The adoption of these vehicles has the most potential to influence the energy usage values of the commercial EV market. Table 3-4 shows the EV cumulative energy usage as percentage of total forecasted AES-IN non-residential energy sales through 2041 in the low and high scenarios.

**TABLE 3-4: CUMULATIVE ENERGY USAGE – NON-RESIDENTIAL EV**

| Year | Non-Residential Sales Forecast (GWh) | EV % (Low) | EV % (High) |
|---|---|---|---|
| **2022** | 8,025 | 0.01% | 0.01% |
| **2026** | 8,087 | 0.09% | 0.18% |
| **2031** | 8,080 | 0.51% | 1.48% |
| **2036** | 8,052 | 1.32% | 4.47% |
| **2041** | 8,080 | 2.57% | 9.30% |

It is notable that no commercial EV technologies pass cost-effectiveness screening under a TRC 1.0 threshold. This test is the primary cost-effectiveness criteria used to determine whether a utility sponsored program intervention is prudent. Consequently, no technical, economic, or achievable potential is estimated.

### *3.1.5 Conclusion*

As the EV market continues to develop, new EV models, technology enhancements, and overall public opinion will begin to influence the rate of EV adoption. Studies like this are a challenging exercise because they lack the ability to accurately take these factors into account with such a new and uncertain market. Electric utilities like AES-IN may need to account for the potential load on their distribution lines associated with more of their customers choosing to purchase EVs over conventional ICE vehicles. Assessing potential supply and demand needs is common practice with electric utilities although greater assessment will need to be done towards EV usage year-after-year.

Heavy-duty vehicles like tractor trailer and semi-trucks account for only 10% of all commercial vehicles in AES-IN's service territory but have the potential to account for roughly 50% of the commercial EV market's energy needs. Analysis of the adoption of these vehicles will need to be closely monitored by AES-IN as they evaluate their generation supply. Indiana is home to the second largest FedEx hub in the world and is ranked first in the U.S. in pass-through highways, with access to five major interstates. The need to supply these vehicles as more EV models are made and adopted, may result in greater EV energy usage in AES-IN's service territory relative to most other electric utilities.

Although this study utilizes forecast absent utility intervention, it is expected that federal and state policies can influence the adoption rate of EVs both on the residential and commercial level. AES-IN doesn't currently have a mandated requirement for energy efficiency, beneficial electrification, or EV adoption, but many States around the country do have these policies. Greater incentives towards adoption in these States, along with the Federal level can influence the levels of EV adoption seen in AES-IN's service territory. Thus, there remains a high level of uncertainty surrounding future deployment of commercial EVs in the AES-IN territory. This study is the result of publicly available data and trends available at the time of publication and should be used to aide AES-IN's resource planning efforts today and as more information becomes available.

## 3.2 RESIDENTIAL TRANSPORTATION ELECTRIFICATION

GDS developed a residential electric vehicle (EV) forecast for AES-IN, which includes low, base, and high scenarios for the number of residential EV's and the associated total energy consumption by the forecasted EV's. The forecasting model is based on many inputs and assumptions. This section describes the methodology, data inputs, some of which will be detailed below.

The first key input in the residential EV model is the number of AES-IN customers that make up potential EV owners. GDS utilized the most recently completed load forecast from AES-IN to input the number of residential customers on the system. The number of residential customers is essentially the number of households served by AES-IN, therefore the number of residential customers can be multiplied by the number of vehicles per household to estimate the total number of vehicles within the AES-IN service territory. The U.S. Census Bureau estimates there are 1.86 vehicles per household in the Indianapolis metropolitan area.

A second key assumption is the number of EV's currently in the AES-IN service territory. GDS utilized Indiana Bureau of Motor Vehicles (BMV) registration data and the 2021 residential consumer survey conducted for the 2021 MPS to determine the number of residential EV's served by AES-IN. Based on the data discussed above, GDS estimates that in 2021 3,575 EV's were served by AES-IN.

The final key assumption used in the EV model is the percentage of EV's that make up new vehicle sales. GDS started with publicly available data from the Energy Information Administration (EIA) and their published Annual Energy Outlook (AEO) for 2021.[25] The 2021 AEO projects that 11.7% of new vehicle sales will be EV's in the year 2050. GDS conducted broad and thorough EV industry research to understand the AEO projections and form a basis for what new vehicle sales percentage should be in alternate scenarios. The AEO estimate of 11.7% is on the low end of the current industry projections based on GDS research, so the AEO trend was closely followed for the low scenario. GDS then developed a base case and high case scenario based on the industry research. As seen in Figure 3-3 below, the various scenarios all produce a linear growth trend for EV sales as a percentage of new vehicle sales, with the Low scenario closely following the AEO projections and the Base and High scenarios representing more optimistic projections. While the High scenario may appear overly optimistic compared to the Low and Base scenarios, many auto manufacturers have stated goals for EV sales that far outpace the percentages in the High scenario.

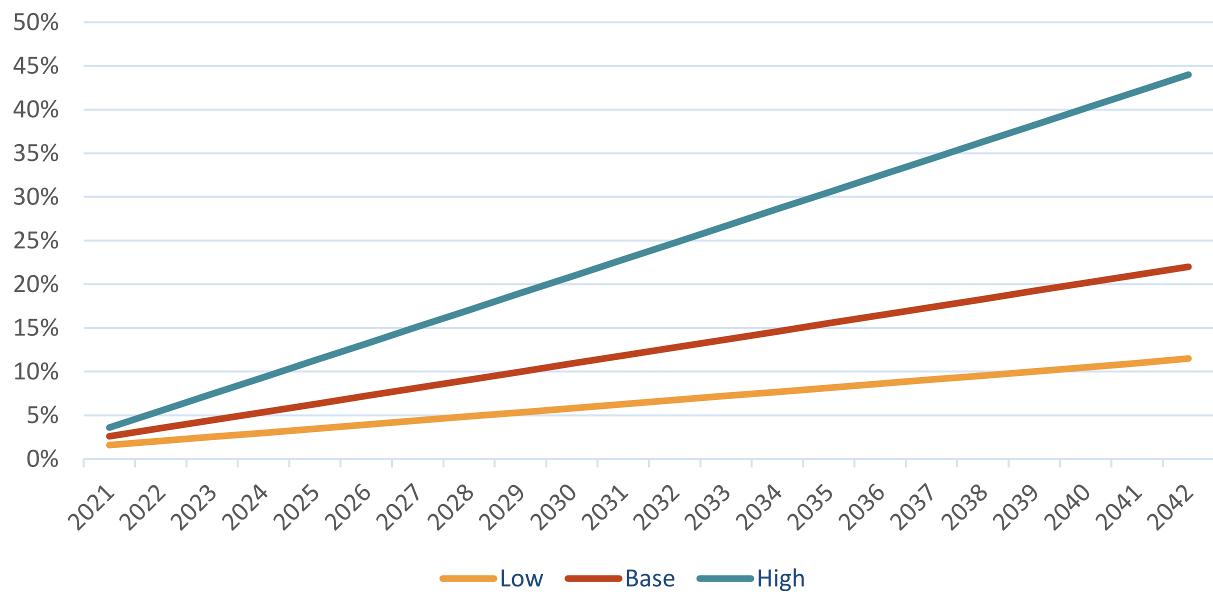



**FIGURE 3-3: EV SALES AS A PERCENTAGE OF NEW VEHICLE SALES**

Given the initial number of EV's in Indianapolis and the projected percentage of new vehicle EV sales, the cumulative number of EV's served by AES-IN can be projected annually. The projection for total number of EV's accounts for the typical "lifespan" of a vehicle as well. Figure 3-4 below shows the projections for total number of electric vehicles.

[25] https://www.eia.gov/outlooks/aeo/tables_ref.php

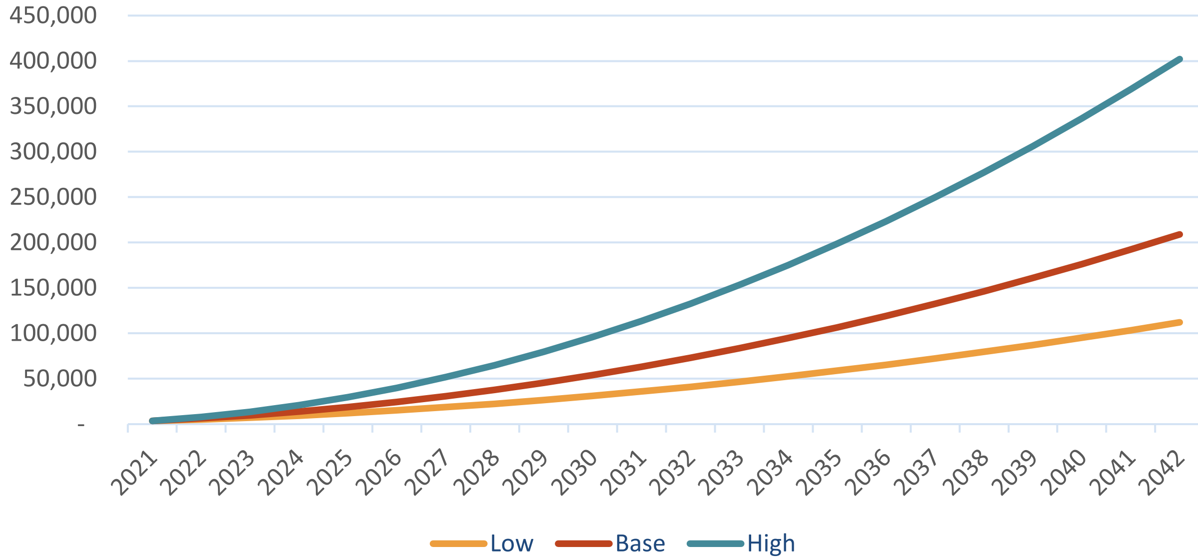



**FIGURE 3-4: TOTAL EV'S**

The total number of electric vehicles and several other inputs, including average miles driven per year and kWh per mile efficiency, are used to calculate the total energy sales attributable to the projected number of EV's on the AES-IN system. The expected average miles driven varies between scenarios, representing another layer of either optimistic or pessimistic assumptions regarding EV adoption and use. As seen below in Figure 3-5, the differences between the scenarios in expected MWh sales has increased due to the changing miles/year assumption.

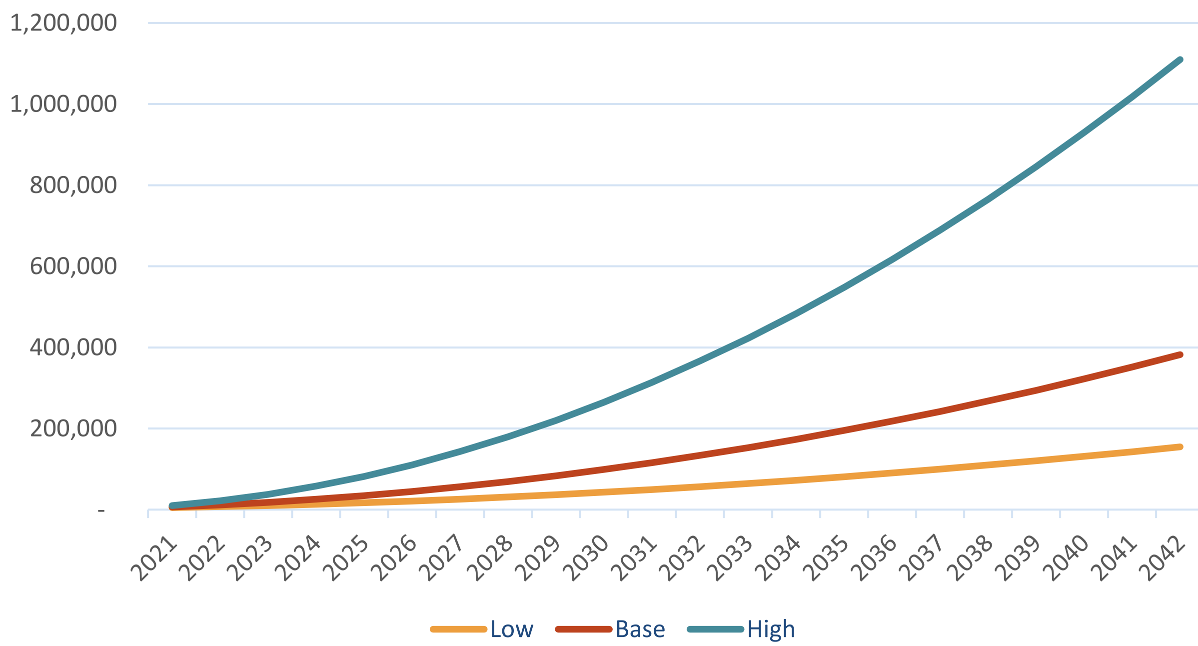



**FIGURE 3-5: MWH SALES ATTRIBUTABLE TO EV'S**

# 4 Building Electrification

This chapter describes a building electrification forecast to understand the cost-effectiveness of building electrification measures and a range of possible electrification adoption impacts on AES's base forecast of MWh sales. The forecast includes the residential, commercial, and industrial sectors.

## 4.1 OVERVIEW OF APPROACH

GDS approached the forecast of building electrification load impacts using three methods, varying by each sector. Each are summarized below. In all cases, GDS assumed that building electrification would offset natural gas consumption.

### *4.1.1 Residential Sector*

The residential building electrification forecast was developed using a bottom-up approach. In this approach, the count of single family and multifamily buildings using natural gas for space heating, water heating, cooking, and laundry had electrification measures applied to the natural gas loads. GDS first utilized AES customer data to understand the share of end-uses that utilize natural gas. Table 4-1 summarizes the share of homes currently using natural gas.

**TABLE 4-1: RESIDENTIAL USE OF NATURAL GAS BY END USE**

| Housing Type / End Use | Single Family | Multifamily | Total |
|---|---|---|---|
| Existing Customer Count | 341,467 | 121,225 | 462,692 |
| Space Heating Share | 55.25% | 22.89% | 46.8% |
| Water Heating | 49.71% | 20.97% | 42.2% |
| Gas range or stovetop | 29.48% | 14.32% | 25.5% |
| Gas oven | 24.75% | 16.41% | 22.6% |
| Gas clothes dryer | 8.31% | 5.34% | 7.5% |

GDS developed baseline technology models using assumptions from the Illinois TRM V10 for space heating and water heating natural gas consumption. GDS developed estimates of cooking equipment performance for gas ranges/stovetops and gas ovens. Gas clothes dryers were dropped from the model due to the limited share currently using natural gas. The resulting natural gas consumption was compared to reported natural gas sales by Citizens Energy Group in American Gas Association 2019 sales data. The bottom-up measure modeling estimated a total of 20,001,293 annual MMBTU of natural gas consumption, 96 percent of the 2019 Citizens Energy Group sales.

GDS applied assumptions regarding possible electrification alternatives to each end-use. These included:

- Dual-fuel and 100 percent offset HVAC heat pumps operating at a range of efficiencies from 16 SEER/8.1 HSPF to 21 SEER/9.0 HSPF, and ground-source heat pumps
- Electric resistance water heaters and heat pump water heaters
- Induction and electric resistance stovetops
- Electric resistance ovens

The technical performance of these measures developed electricity consumption estimates for each technology. GDS also applied assumptions regarding the technical feasibility for AES customers to incorporate a technology in their home.

GDS analyzed the economics of the natural gas and electrification technologies. As a starting point, customer perspectives based on equipment costs and retail rates for electricity and natural gas drove a life-cycle cost analysis and simple payback metric in which the cost of equipment, available AES incentives, and operational costs created a customer-based benefit-cost ratio. The metrics provide insight into the lifecycle cost of purchasing and operating equipment, as well as whether operational energy costs were more or less for the electrification technologies than their natural gas counterparts. Additionally, GDS developed an analysis of utility economics in which the additional revenue from electrification electricity sales was offset by wholesale energy costs and program incentives. While not used directly, this second economic analysis provides insight into utility economic thresholds for program costs or incentives. Under the Utility Cost Test (UCT) used in Indiana to gauge energy efficiency cost-effectiveness, electrification would not pass the test due to increasing energy sales. The UCT was not used in economic modeling.

The general outcome of the economic modeling found that:

- Air-source heat pumps were cost-effective for customers. Ground-source heat pumps were not due to equipment costs.
- Electric water heating was cost-effective for customers (electric resistance or heat pump).
- Electric resistance stovetops were cost-effective for customers, though induction stovetops and electric resistance ovens were not.
- For residential new construction, all end-uses could be cost-effectively electrified for customers, other than electric resistance ovens.

With the resulting cost-effectiveness results for customers, GDS then utilized a Bass diffusion curve to develop estimates of low, medium, and high scenarios for future market adoptions. For existing residential buildings, the adoption curves assumed that half of customers would adopt electrification over time. The medium adoption scenario assumed 25 percent would adopt electrification, and the low adoption scenario assumed 12.5 percent would adopt electrification. For the high scenario, the available annual equipment sales were confirmed to approach 100 percent of sales across HVAC and water heating annual unit sales but did not exceed that amount.

Finally, GDS compared the forecasted electrification electricity sales increase to NREL's 2018 Electrification Futures study reference case. The NREL study analyzed, nationally, residential electrification electricity sales. The NREL study's reference case was used as a "Business As Usual" (BAU) case from which the low, medium, and high adoption scenarios could reflect varying levels of possible program interventions.

### *4.1.2 Commercial Sector*

For the commercial building sector, GDS employed a top-down analysis. In this case, GDS began with the Citizens Energy Group 2019 commercial sector natural sales, as reported to the American Gas Association. GDS then disaggregated those sales into end-use consumption using a variety of data sources, including EIA's CBECS data for the Midwest region, USDOE's Energy Scout data, ACEEE reports, and other existing industry literature that presented estimates of commercial building natural gas consumption end-use shares. Of the possible commercial end-uses, only space heating, water heating, and cooking had data. As such, the analysis focuses on possible electrification from only those end uses. GDS acknowledges that other end uses of commercial natural gas exist, such as commercial laundry drying, gas-based cooling, or combined heat and power equipment. The electrification of those end-uses, due to the apparently low-share of commercial sector natural gas consumption, is expected to have minor impacts on overall electricity consumption. The general impact of electrifying space heating, water heating, and cooking end uses may also be representative of the impacts of electrifying the unaccounted-for end-uses and may be implicitly assumed in the forecast.

Table 4-2 describes the end-use share assumptions for each of the end-uses modeled for electrification.

**TABLE 4-2: COMMERCIAL SECTOR END-USE NATURAL GAS CONSUMPTION**

| End Use | Share |
|---|---|
| Space Heating | 60 percent |
| Water Heating | 30 percent |
| Cooking | 10 percent |

Within each end-use GDS developed a variety of technology models that captured a range of possible baseline and electrified equipment configurations. For all technologies, GDS developed the technology performance assumptions utilizing the Illinois TRM V10 for space heating and water heating. Parameters for high, low, and average use were developed to capture diversity within the commercial sector, though the sector was modeled as a whole and did not include measure permutations for different building types. For commercial cooking, GDS developed estimates of energy and cost impacts from its own research, focusing on commercial-scale professional cooking equipment.

For new construction, GDS utilized the AES commercial forecast to identify how new construction electricity load was expected to grow absent DSM programs. The aggregate growth of load absent DSM program was approximately 5.2 percent across the forecast period. GDS assumed that same growth rate for natural gas consumption, allowing that growth to occur at an equal level year-to-year to inform possible new natural gas consumption that could be electrified. New construction electrification potential was only applied to space heating and hot water loads due to the small share and high uncertainty regarding the presence of new gas cooking. Averages of the existing commercial sector measure performances were applied to these new construction loads.

GDS applied assumptions regarding possible electrification alternatives to each end-use. These included:

- Electric resistance and heat pump water heaters in distributed and central water heating configurations with higher and lower hot water consumption assumptions.
- Replacing residential-size furnaces and boilers with central or ductless heat pumps
- Replacing a boiler or furnace with rooftop or window air conditioning with ductless heat pumps
- Replacing a boiler or furnace with chillers with large VRF heat pumps and ground source heat pumps
- For HVAC systems, heating loads used configurations of average (IL TRM) loads, and then higher and lower HVAC loads to reflect more or less efficient commercial buildings

The purpose of the mix of technologies and consumption level assumptions was to understand the mix of possible energy loads and equipment configurations. GDS developed assumptions on the share of furnaces and boilers and cooling equipment using DOE's Energy Scout Data for the Indianapolis climate region. This mix provides a range of possible equipment costs and energy impacts to support the economic analysis and thermodynamic relationship of equipment type electrification impacts on utility electricity sales.

GDS analyzed the economics of the natural gas and electrification technologies. As a starting point, customer perspectives based on equipment costs and retail rates for electricity and natural gas drove a life-cycle cost analysis and simple payback metric in which the cost of equipment, available AES incentives, and operational costs created a customer-based benefit-cost ratio. The metrics provide insight into the lifecycle cost of purchasing and operating equipment, as well as whether operational energy costs were more or less for the electrification technologies than their natural gas counterparts. Additionally, GDS developed an analysis of utility economics in which the additional revenue from electrification electricity sales was offset by wholesale energy costs and program incentives. While not used directly, this second economic analysis provides insight into utility economic thresholds for program costs or incentives. Under the Utility Cost Test (UCT) used in Indiana to gauge energy efficiency cost-effectiveness, electrification would not pass the test due to increasing energy sales. The UCT was not used in economic modeling.

The general outcome of the economic modeling found that:

- Under current and forecasted retail rates, HVAC heat pumps and water heaters were not cost effective to electrify.
- Of cooking equipment, only combination ovens and steam cookers were shown to be cost effective to electrify

As a result of the economic analysis, GDS elected to provide flexibility in the potential adoption of electrification measures for the commercial sector. GDS reduced the threshold of cost-effectiveness to 0.70 and elected to assume that new construction HVAC and water heating electrification would be cost effective. This approach provides several benefits to the forecast:

- Allows for the diversity of the commercial sector to allow that cost-effective conditions may exist that could not be directly modeled with the available data.
- Accounts for commercial sector customers to that may choose to make sub-economic decisions.
- Acknowledges that some commercial sector customers in the economy are choosing to electrify despite sub-economic outcomes or that non-energy impacts may overcome energy economics.
- Allows that economic conditions, including equipment costs and relative costs of energy, may shift to favor electrification over the forecast period.

Nevertheless, GDS still found that electrification measures did not pass cost-effectiveness criteria. For HVAC, ground source heat pumps and larger commercial VRF systems remained non-cost effective when compared to natural gas options. For water heating, electric resistance water heating remained non-cost effective. For cooking, electric griddles and fryers remained not cost-effective. The outcome points to the importance of possible program interventions to encourage electrification.

To model the possible adoption of commercial sector electrification and its impact on AES electricity sales, GDS applied Bass diffusion curves based on NREL research. The scenarios all assumed that 50 percent of the commercial sector could ultimately adopt electrification. Three Bass diffusion curves were selected to model the adoption of electrification to reflect high/medium/low adoptions.

- High adoption utilized the residential sector Bass parameters, reflecting rapid adoption over time.
- Medium adoption utilized NREL's national estimate for commercial sector curves, reflecting a pace of adoption based on a national average, which may be more reflective of AES' service territory than the State as a whole.
- Low adoption utilized NREL's Indiana-specific commercial sector parameters, reflecting a slower pace to durable goods adoption.

The selection of these curves are compared to NREL's Electrification Futures Study reference case, which was used to estimate a "Business As Usual" (BAU) scenario. The High/Medium/Low adoptions envision program support and market acceptance above that of the BAU case.

### *4.1.3 Industrial Sector*

Despite challenging energy economics, the industrial sector, nationally, has exhibited some adoptions of electrification. The industrial sector differs from the residential and commercial sectors due to specialized process equipment that may consume considerable amounts of natural gas, though varies by industrial type. For example, using industrial heat pumps to provide low-grade process heat will have substantially different outcomes than replacing a gas steam boiler with an arc boiler using electricity. The specific timing and type of technology that may be adopted is highly uncertain, particularly for a specific utility service territory. Corporate decisions will be based on energy economics, possible decarbonization goals, and the timing for aging process equipment to be replaced.

GDS utilized data from NREL's Electrification Futures Study to estimate the possible impact of electrification growth in AES' industrial sector. The NREL study provides national-level estimates of industrial electrification, with NREL's reference case indicating zero industrial electrification. NREL's low and medium case envision nearly zero industrial adoptions of electrification. Only in NREL's high case does industrial electrification exhibit meaningful growth.

GDS began with AES' forecast of industrial sales across the forecast period. GDS notes that industrial electricity sales are approximately 15 percent of AES' total electricity sales, indicating that the industrial sector makes up a relatively small portion of AES' customer base, further suggesting caution at making assumptions for electrification for a specific service territory. To estimate the impact of NREL's high case for industrial electrification, GDS analyzed the NREL assumption regarding overall industrial load growth and removed the share of load growth already accounted for in AES' forecast. The remaining share was assumed to be driven by electrification. The growth occurs in the last decade of the forecast.

To model adoptions of industrial electrification and the resulting increase in electricity sales above the current forecast, GDS applied a compound annual growth rate that models the entire period's growth in industrial electrification. Three scenarios were developed to estimate the load impacts:

- A high scenario that utilizes NREL's high case
- A medium scenario that assumes two-thirds the growth of the high case occurs
- A low scenario that assumes one-third the growth of the high case occurs

These three scenarios can be compared to NREL's reference case, which serves as a "Business As Usual" (BAU) scenario. With NREL's reference case indicating that no industrial electrification would occur, the BAU case is inherently reflecting that AES' industrial sector would not adopt electrification technologies.

## 4.2 RESULTS

Below we present the results of the building electrification modeling in aggregate, by sector, and for each of the adoption scenarios. For the total across all sectors and for each sector, the results show the estimated impact of electrification and 2042 results compared to the base forecast for 2042.

### *4.2.1 All Sectors*

Table 4-3 shows the impact of additional electrification load compared to the AES base electricity sales forecast for the combined residential, commercial, and industrial sectors for selected forecast years. The 2042 electricity sales under the three electrification scenarios are compared to the base electrification forecast, which does not include any assumed electrification growth.

**TABLE 4-3: CUMULATIVE ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 8,910 | 16,954 | 52,983 | 109,200 | 163,058 | 187,904 | 1.3% |
| **Medium** | 10,709 | 22,653 | 74,905 | 181,388 | 301,705 | 347,890 | 2.4% |
| **High** | 12,727 | 29,661 | 111,370 | 329,653 | 598,830 | 654,627 | 4.4% |

The above results for additional load due to electrification show a range of 1.3 percent to 4.4 percent above the AES base forecast, which does not include electrification. As a comparison, the business-usual-case (BAU) based on NREL's Electrification Futures study Reference Case, was modeled as showing 0.9 percent growth above the base forecast by 2042. As a national model, the growth in total electric consumption does not necessarily mirror AES's forecast are not illustrative of year-on-year differences between scenarios that are specific to AES. In the BAU forecast, NREL's modeling assumes no incremental load growth due to electrification occurring for the industrial sector.

### *4.2.2 Residential Sector*

Table 4-4 presents the impact of additional electrification load compared to the AES base electricity sales forecast for the residential sector.

**TABLE 4-4: CUMULATIVE RESIDENTIAL BUILDING ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 3,786 | 7,150 | 28,233 | 60,645 | 73,712 | 75,624 | 1.2% |
| **Medium** | 3,807 | 7,322 | 32,907 | 95,698 | 140,253 | 146,732 | 2.3% |
| **High** | 3,818 | 7,410 | 35,760 | 131,534 | 254,286 | 278,720 | 4.4% |

The above results for additional load due to residential building electrification show a range of 1.2 percent to 4.4 percent above the AES base forecast, which does not include electrification. As a comparison, the business-usual-case (BAU) based on NREL's Electrification Futures study Reference Case, was modeled as showing 0.85 percent growth above the base forecast by 2042. A contributor to the residential sector results is that both single-family and multifamily buildings already exhibit relatively high shares of electric market penetration for end uses.

### *4.2.3 Commercial Sector*

Table 4-5 presents the impact of additional commercial building electrification load compared to the AES base electricity sales forecast for the commercial sector.

**TABLE 4-5: CUMULATIVE COMMERCIAL BUILDING ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 3,535 | 5,036 | 12,034 | 27,890 | 60,734 | 80,488 | 1.3% |
| **Medium** | 3,674 | 5,649 | 16,179 | 43,735 | 103,360 | 136,611 | 2.1% |
| **High** | 4,092 | 7,800 | 37,075 | 135,499 | 257,840 | 279,569 | 4.3% |

The above results for additional load due to commercial building electrification show a range of 1.25 percent to 4.3 percent above the AES base forecast, which does not include electrification. As a comparison, the business-usual-case (BAU) based on NREL's Electrification Futures study Reference Case, was modeled as showing 1.2 percent growth above the base forecast by 2042. That both the BAU case (derived from NREL) and the Low scenario result in similar load growth assumptions suggest that commercial sector electrification decision making regarding may be similar between national perspectives and AES's commercial sector.

### *4.2.4 Industrial Sector*

Table 4-6 presents the impact of additional electrification load compared to the AES base electricity sales forecast for the industrial sector.

**TABLE 4-6: CUMULATIVE INDUSTRIAL BUILDING ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 1,590 | 4,769 | 12,717 | 20,664 | 28,612 | 31,791 | 1.6% |
| **Medium** | 3,227 | 9,682 | 25,819 | 41,955 | 58,092 | 64,546 | 3.3% |
| **High** | 4,817 | 14,451 | 38,535 | 62,620 | 86,704 | 96,338 | 4.9% |

The above results for additional load due to industrial sector building electrification (including processes) show a range of 1.5% to 4.4% above the AES base forecast, which does not include electrification. NREL's Reference Case informs a BAU case, which indicates no industrial electrification load growth. Note that the High scenario directly utilizes NREL's High Case to inform the AES low growth assumption. As such, the High Scenario assumes the same general mix of industry types, processes, and other drivers of NREL's High Case. The Low and Medium Scenarios are assumed as multiples of the High Case to provide a range of possible impacts, though without reflection on the decision making, thermodynamics, and technologies that may drive electrification decisions by AES's industrial customers over the next two decades.

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

# AES INDIANA

aes Indiana

# 2022 Market Potential Study Distributed Energy Resources and Electrification

## FINAL REPORT

*September 2,* 2022

*prepared by*

**GDS ASSOCIATES INC**

Indiana

# 2022 IRP

# Attachment 5-6

(AES Indiana's 10-Year Energy and Peak Forecast)

Provided electronically

AES Indiana

# 2022 IRP

# Attachment 5-7a-b

(AES Indiana's 20-Year Base, High, and Low Load Forecasts)

Provided electronically

AES Indiana

# 2022 IRP

# Attachment 5-8

(Energy Forecast Drivers)

Provided electronically

# 2022 IRP

# Attachment 5-9

(Peak Forecast Drivers and Input Data)

Provided electronically

AES Indiana

# 2022 IRP

# Attachment 6-2

(Decrement Load Shapes Summary)

Provided electronically

AES Indiana

# 2022 IRP

# Attachment 6-3

(AES Indiana's 2022 Market Potential Study)

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

# AES INDIANA

aes Indiana

# *2022 Demand Side Management Market Potential Study*

*November 18,*
2022

**FINAL REPORT**

*prepared by*

**GDS ASSOCIATES INC**

# VOLUME I *2022 Demand Side Management Market Potential Study Report*

## *Market Potential Study* ***List of Tables***

## *Market Potential Study* ***List of Figures***

# VOLUME I

## *2022 AES INDIANA Demand Side Management Market Potential Study*

*prepared for*

AES Indiana

NOVEMBER 2022

# 1 Introduction

## 1.1 BACKGROUND & STUDY SCOPE

This Market Potential Study was conducted to support the Integrated Resource Plan (IRP) and DSM planning for AES Indiana. The study included primary market research and a comprehensive review of current programs, historical savings, and projected energy savings opportunities to develop estimates of technical, economic, and achievable potential. Separate estimates of electric energy efficiency and demand response potential were developed. The GDS Team worked collaboratively alongside AES Indiana and the AES Indiana Oversight Board to produce estimates of future saving potential, using the best available information and best practices for developing market potential saving estimates.

The Market Potential Study included primary market research at residential dwellings, as well as commercial and industrial facilities, to better understand the mix of customers, building characteristics, and efficiency trends for each customer segment. This research effort served to create more AES Indiana-specific saturation and efficiency profiles for both the Market Potential Study, but for future load forecasting efforts as well.

## 1.2 TYPES OF POTENTIAL ESTIMATED

The scope of this study distinguishes three types of energy efficiency potential: (1) technical, (2) economic, and (3) achievable.

- ***Technical Potential*** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is constrained only by factors such as technical feasibility and applicability of measures.
- ***Economic Potential*** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Economic potential follows the same adoption rates as technical potential. Like technical potential, the economic scenario ignores market barriers to ensuring actual implementation of efficiency. Finally, economic potential only considers the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them. This study uses the Utility Cost Test (UCT) to assess cost-effectiveness.
- ***Achievable Potential*** is the amount of energy that can realistically be saved given various market barriers. Achievable potential considers real-world barriers to encouraging end users to adopt efficiency measures; the non-measure costs of delivering programs (for administration, marketing, analysis, and EM&V); and the capability of programs and administrators to boost program activity over time. Barriers include financial, customer awareness and WTP in programs, technical constraints, and other barriers the "program intervention" is modeled to overcome. Additional considerations include political and/or regulatory constraints. The potential study evaluated two achievable potential scenarios:
- ***MAP*** estimates achievable potential on paying incentives equal to 100% of measure incremental costs and aggressive adoption rates.
- ***RAP*** estimates achievable potential with AES Indiana paying incentive levels (as a percent of incremental measure costs) closely calibrated to historical levels but is not constrained by any previously determined spending levels.

## 1.3 STUDY LIMITATIONS

As with any assessment of energy efficiency potential, this study necessarily builds on various assumptions and data sources, including the following:

- Energy efficiency measure lives, savings, and costs
- Projected penetration rates for energy efficiency measures
- Projections of electric avoided costs
- Future known changes to codes and standards

- AES Indiana load forecasts and assumptions on their disaggregation by sector, segment, and end use
- End-use saturations and fuel shares

While the GDS team has sought to use the best and most current available data, there are often reasonable alternative assumptions which would yield slightly different results.

## 1.4 ORGANIZATION OF REPORT

The remainder of this report is organized in seven sections as follows:

***Section 2 Market Research*** details the primary market research completed in conjunction with the market potential analysis.

***Section 3 Baseline Forecast*** provides an overview of the of the forecasted energy sales by sector.

***Section 4 Energy Efficiency Potential Analysis*** details the methodology used to develop the estimates of technical, economic, and achievable energy efficiency and demand response potential savings and provides sector-level results.

***Section 5 Demand Response Potential*** provides a breakdown of the technical, economic, and achievable potential demand response by program type.

***Appendices*** for the DSM Market Potential are included in Volume II of this report. MPS appendices include detailed measure level assumptions by customer segment, and C&I potential including opt-out customers.

# 2 Market Research

The initial step in the assessment of future potential is to develop a clear understanding of the current market segments, as well as a clear understanding of the market research data available in the AES Indiana service area. In late 2021 AES Indiana requested the GDS team to conduct market research that would inform critical elements of the market potential study. The research objectives were developed in coordination with AES Indiana and the potential study team. Primary market research activities were focused on collecting updated equipment penetration, saturation, and efficiency characteristics; as well as customer willingness to participate (WTP) in program offerings across select end-uses and measures.

The resulting data was used to develop updated estimates of baseline and efficient equipment saturation estimates in the market potential study and develop expected long-term adoption rates for energy efficiency, demand response, and DERs over the study horizon. The GDS team conducted surveys of business and residential customers during January and February of 2022 with the objectives of gathering primary data on the following topics:

- Willingness to participate in a variety of energy efficiency and demand response program scenarios.
- Baseline / Saturation of energy-using equipment
- Program awareness
- Barriers

Survey results served as inputs for the market potential model, enabling the market potential analysis to take into consideration the specific market conditions that exist in AES Indiana's service territory. Figure 2-1 presents a summary of the specific technologies and Demand Side Management (DSM) topic areas addressed within the business and residential surveys.

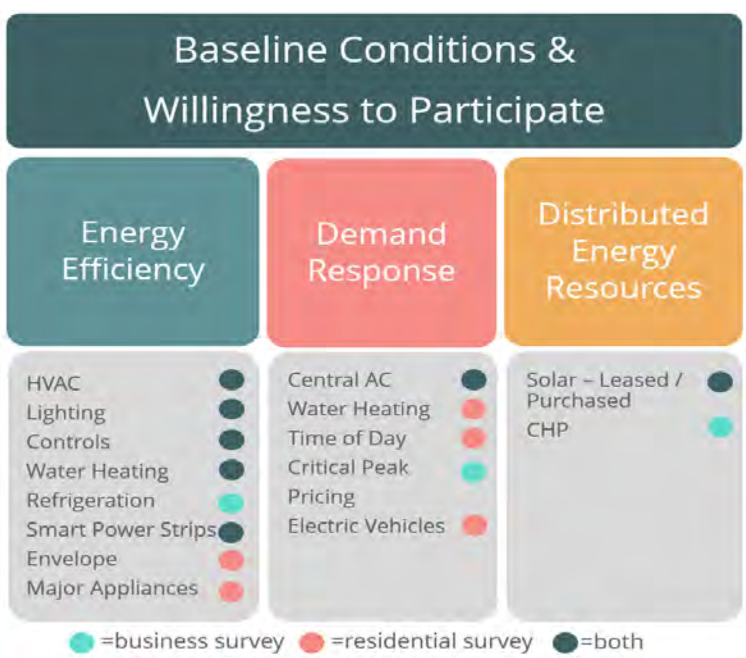



**FIGURE 2-1: SURVEY SCOPE**

Data collection results specific to the AES Indiana service area are provided below.

## 2.1 PRIMARY DATA COLLECTION

The following subsections provide an overview of the primary data collection activities conducted by the GDS team to support the market potential analysis of energy efficiency, demand response, and DER potential. The GDS team conducted survey research in the residential and non-residential sectors.

### *2.1.1 Survey Administration*

GDS administered an online baseline end-use survey and willingness to participate survey to both the business and residential groups. Surveys were administered in an online format, with email recruitment followed by reminder emails when necessary. The residential response rate was higher than expected, while the business response rate was about as expected.

### *2.1.2 Sampling Approach*

GDS administered an online baseline end-use survey and willingness to participate survey to both the business and residential groups. Surveys were administered in an online format, with email recruitment followed by reminder emails when necessary. The residential response rate was higher than expected, while the business response rate was about as expected.

The team developed a sampling approach with an objective of achieving industry-standard statistical significance (90% confidence, 10% relative precision, or 90/10) at the strata level for all questions, taking into consideration there would be variation in the different willingness to participate (WTP) modules included in each survey. Different WTP modules were included in the surveys to keep survey length manageable for respondents. The sample design assumed a coefficient of variation (CV) of 0.5 for the residential sample, and 0.7 for the business sample, assuming there would be greater variation among business responses.

Overall, the response outcomes were positive, and the survey effort produced a robust set of primary data. The team set aggressive sampling targets, with a goal of having high levels of statistical significance for sub-groups within the population. The response fell short on some of those targets, but the team gathered a strong data set that meets the needs of the analysis. Table 2-1 provides the sampling targets and response outcomes.

The business survey did not achieve 90/10 but did meet 85/15 statistical significance level. Even after splitting the baseline and WTP surveys, the length of the business survey could have been a factor in the low completion rate. The residential survey achieved 90/10 for all strata, and 95/5 for the non-multifamily strata and the combined non-residential customer group.

**TABLE 2-1: SURVEY SAMPLING TARGETS AND RESPONSE SUMMARY**

| Group | Emailed | Target Completes | Completed (Partial Survey) | Completed (Entire Survey) |
|---|---|---|---|---|
| **C&I Baseline Survey** | | | | |
| **Commercial** | 2,975 | 65 | 48 | 36 |
| **Industrial** | 249 | 3 | 3 | 2 |
| **Total** | 3,224 | 68 | 51 | 38 |
| **C&I Willingness to Participate Survey** | | | | |
| **Commercial** | 5,880 | 62 | 144 | 92 |
| **Industrial** | 545 | 6 | 9 | 5 |
| **Total** | 6,425 | 68 | 153 | 97 |
| **Residential Baseline Survey** | | | | |
| **Multifamily** | 2,720 | 68 | 44 | 135 |

| Group | Emailed | Target Completes | Completed (Partial Survey) | Completed (Entire Survey) |
|---|---|---|---|---|
| Non-Multifamily | 12,280 | 316 | 137 | 652 |
| Total | 15,000 | 384 | 181 | 787 |
| Residential Willingness to Participate Survey | | | | |
| Multifamily | 2,720 | 68 | 57 | 74 |
| Non-Multifamily | 12,280 | 316 | 186 | 388 |
| Total | 15,000 | 384 | 243 | 462 |

### 2.1.3 Residential Online Survey

The residential customer research targeted homeowners and tenants in the following key segments: customers occupying multifamily homes and non-multifamily homes. Multifamily homes were those customers living in an apartment, condominium, duplex, triplex, or quadraplex.

A baseline end-use residential online customer survey collected home characteristics, equipment penetration for key end-uses – such as heating, cooling, water heating, insulation, major appliances, energy conservation, and electric vehicles – and a separate survey collected information on barriers and willingness to adopt a range of energy efficient measures at varying incentive levels. Table 2-2 provides the targeted and completed baseline and willingness to participate residential online surveys.

**TABLE 2-2: TARGETED AND COMPLETED RESIDENTIAL SECTOR ONLINE SERVICES**

| Strata | Target Completes | Total Completed |
|---|---|---|
| Baseline End-Use Survey | | |
| Multifamily | 68 | 135 |
| Non-Multifamily | 316 | 652 |
| Willingness to Participate Survey | | |
| Multifamily | 68 | 74 |
| Non-Multifamily | 316 | 388 |

### 2.1.4 Business Sector Online Survey

Primary data collection was also conducted in the non-residential sector via a baseline end-use and a willingness to participate online survey with business customers. The baseline end-use survey collected business and facility characteristics, as well as equipment penetrations for key end-uses, such as lighting, heating, cooling, water heating, refrigeration, thermostats, and on-site generation (including solar PV systems). A separate non-residential online survey also collected information on barriers to energy efficiency and willingness-to-adopt energy efficient measures under various incentive offerings. In total, GDS collected complete survey data from 135 commercial and industrial customers, with 38 fully completing the baseline survey and 97 fully completing the willingness to participate survey.

## 2.2 RESIDENTIAL MARKET DATA

The tables below provide some key home and equipment characteristics by residential market segment. The results have been weighted to align the sample distribution with that of the overall residential populations in the AES Indiana service territory.

Table 2-3 provides current information on home type and some general house characteristics for residential customers. Some key characteristics for the market potential study are home type, multi-level or not, and home size.

**TABLE 2-3: RESIDENTIAL HOME INFORMATION**

| | Total | Single Family | Mobile Home | Duplex/ Triplex/ Condo | Apartment |
|---|---|---|---|---|---|
| **Home Type – Survey Responses** | N/A | 70% | 3% | 5% | 6% |
| **Home Type – AES Customer Data** | N/A | 82% | 3% | 2% | 13% |
| **Own Home** | 68% | 78% | 85% | 72% | 8% |
| **Multi-level Home** | 44% | 46% | 15% | 56% | 36% |
| **Have Basement** | 35% | 41% | 0% | 16% | 12% |
| **Over Four Occupants** | 9% | 10% | 31% | 4% | 6% |
| **1,800 sq ft Home or Larger** | 40% | 43% | 31% | 48% | 21% |
| **Have Crawlspace** | 33% | 37% | 46% | 16% | 12% |

Table 2-4 presents some key household and equipment characteristics for the residential sector by AES Indiana housing type. The data presented below includes the average number of occupants per household, and the average number of certain appliances within the various home types.

**TABLE 2-4: KEY HOUSEHOLD AND EQUIPMENT CHARACTERISTICS (AVG # PER HH)**

| Household Characteristics | Total | Single Family | Mobile Home | Duplex/ Triplex/ Condo | Apartment |
|---|---|---|---|---|---|
| **Average Number** | | | | | |
| Occupants | 2.5 | 2.5 | 3.3 | 2.4 | 2.2 |
| Electric Oven | 0.7 | 0.7 | 0.7 | 0.9 | 0.8 |
| Microwave Oven | 1.0 | 1.0 | 0.9 | 1.1 | 0.9 |
| Dishwasher | 0.8 | 0.7 | 0.5 | 1.0 | 0.9 |
| Sump Pump | 0.3 | 0.4 | 0.0 | 0.3 | 0.1 |
| Attic Fan | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 |
| Refrigerators | 1.1 | 1.2 | 1.1 | 1.1 | 1.0 |
| Stand-Alone Freezers | 0.4 | 0.5 | 0.4 | 0.3 | 0.2 |
| Smart Plugs/Outlets | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 |

Table 2-5 provides example summary data by market segment for major residential end-uses. These data points of electric appliances and water heating equipment penetrations help quantify the eligible population of equipment by market segment. In addition, the research also provided recent market conditions for remaining efficiency opportunities. For example, the research determined the percent of households that have emerging technologies such as heat pump water heaters, as well as the percent of homes with insulation and air sealing needs.

**TABLE 2-5: SELECT RESIDENTIAL MARKET RESEARCH RESULTS FOR KEY END-USES**

| End-Use | Equipment | Total | Single Family | Mobile Home | Duplex/ Triplex/ Condo | Apartment |
|---|---|---|---|---|---|---|
| WH | Electric WH | 52% | 47% | 93% | 67% | 72% |
| | Heat Pump WH *(as a % of electric WH)* | 5% | 3% | 0% | 4% | 13% |
| Shell | Uninsulated Attic | 6% | 4% | 23% | 8% | 16% |
| | Uninsulated Walls | 42% | 38% | 38% | 48% | 69% |
| | Uninsulated Window Shutters | 84% | 82% | 85% | 84% | 94% |
| | Uninsulated Bottom Floor | 90% | 89% | 62% | 96% | 94% |
| | Single Pane Windows | 62% | 57% | 77% | 72% | 90% |
| | No heating system pipe or duct insulation | 80% | 78% | 54% | 100% | 88% |
| | Windows that are not caulked or weather stripped | 52% | 46% | 62% | 56% | 83% |
| Appliance | In Unit Electric Clothes Washer | 88% | 93% | 100% | 89% | 62% |
| | In Unit Electric Clothes Dryer | 82% | 86% | 100% | 81% | 59% |
| | In Unit Gas Clothes Dryer | 8% | 9% | 0% | 15% | 4% |
| | Electric Vehicle | 2% | 2% | 0% | 4% | 1% |
| | PEV/EV Charger at Home | 2% | 2% | 0% | 0% | 0% |

## 2.3 BUSINESS MARKET DATA

Table 2-6 provides select demographic information in the business sector. Over half of AES Indiana businesses own their own building, indicating the authority to make decisions on building appliances and other energy efficiency matters. Additionally, 70% of AES Indiana business buildings are more than 20 years old.

**TABLE 2-6: COMMERCIAL BUILDING CHARACTERISTICS**

| | |
|---|---|
| **Own** | 56% |
| **Lease** | 40% |
| | |
| **Manage Building** | 61% |
| **Do not Manage Building** | 36% |
| | |
| **% of Facilities Built Before 2001** | 70% |
| **Average Size of Facility (Sq. Ft)** | 27,546 |
| **Average Weekday Hours of Operation** | 12.9 |
| **Average Weekend Hours of Operation** | 9.3 |

The penetration of different lighting fixtures in AES Indiana businesses is shown in Table 2-7. Linear LED fixtures are estimated to be in nearly 50% of all facilities. The table also includes the percent of facilities with different lighting control types as well as the percent of lighting that is controlled. Table 2-8 provides example end-use penetration levels for various major end-uses.

**TABLE 2-7: COMMERCIAL SECTOR LIGHTING END-USE CHARACTERISITCS**

| End Use | Equipment | Total |
|---|---|---|
| Lighting *(% with Type)* | Linear Fluorescent | 53% |
| | Linear LED | 49% |
| | Nonlinear LED | 33% |
| | Incandescent | 31% |
| | Compact Fluorescent | 7% |
| | High Intensity Discharge | 42% |
| Lighting *(% of all Lighting)* | Linear Fluorescent | 41% |
| | Linear LED | 25% |
| | Nonlinear LED | 5% |
| | Incandescent | 9% |
| | Compact Fluorescent | 3% |
| | High Intensity Discharge | 18% |
| Lighting Controls | Occupancy Sensors | 24% |
| | *% of Lighting Controlled* | 7% |
| | Daylight Dimming | 8% |
| | *% of Lighting Controlled* | 1% |
| | Time Controls | 8% |
| | *% of Lighting Controlled* | 0% |
| | Advanced Lighting Controls | 0% |
| | *% of Lighting Controlled* | 0% |

**TABLE 2-8: COMMERCIAL SECTOR EQUIPMENT PENETRATION ACROSS KEY END-USES**

| End Use | Equipment | Penetration |
|---|---|---|
| Heating | Boiler | 5% |
| | Furnace | 54% |
| | Heat Pump | 9% |
| | Electric Resistance | 4% |
| | Unit Heater | 11% |
| | Infrared | 0% |
| Cooling | Packaged System AC | 51% |
| | Split System AC | 29% |
| | Heat Pump (Ducted) | 7% |
| | Heat Pump (Ductless) | 2% |
| | Chiller | 2% |
| | Window AC | 9% |
| Thermostats | Smart Thermostats | 11% |
| | % of Space Controlled by Smart Thermostat | 12% |

| End Use | Equipment | Penetration |
|---|---|---|
| Ventilation | Demand Controlled Ventilation | 11% |
| | Vent Hoods | 20% |
| | Vent Hoods with Demand Controlled Vent. | 55% |
| Refrigeration | Has Commercial Refrigeration? | 8% |
| | Ice Machines | 5% |
| Smart Strips | Smart Strips (% of All Strips) | 12% |
| Water Heating | Electric WH | 58% |
| On-Site Generation | Renewable Energy Generation | 5% |
| | Emergency/Backup Generation | 5% |
| | Cogeneration/CHP | 0% |

## 2.4 ADOPTION CURVE MARKET DATA

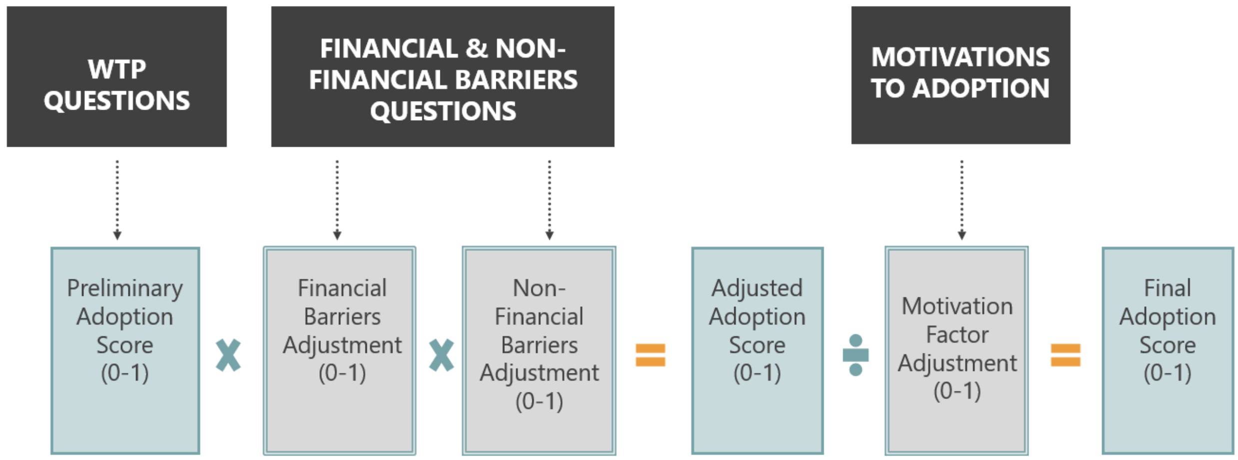
In addition to new primary research on building and end-use equipment characteristics, one of the major objectives of the primary research was to gather survey data that could be utilized to develop measure/program adoption curves to calculate estimates of achievable potential. Table 2-9 describes the end-uses or categories in which adoption rate estimates were developed for energy efficiency and demand response programs the GDS team.

**TABLE 2-9: ADOPTION RATE CATEGORIES ANALYZED**

| Willingness to Participate | EE End Uses | DR Programs |
|---|---|---|
| **Residential Customers** | Heating/Cooling Systems<br>Water Heating<br>Major Appliances<br>Insulation/Air Sealing | Thermostat Control<br>Water Heater Control<br>Time of Day Rate |
| **Business Customers** | Heating/Cooling Systems<br>Water Heating Equip.<br>Refrigeration<br>Lighting Equipment | Central AC Control<br>Customized DR<br>(Critical Peak Pricing) |

Adoption rate calculations were based on a battery of questions which assessed (1) the respondent's willingness to adopt energy efficiency technologies or participate in demand response programs in scenarios with varying levels of program support, (2) the magnitude of the respondent's financial and non-financial barriers as well as potential motivational factors to adoption/participation. Adoption rates were calculated based on the equation shown below.

**EQUATION 2-1 ADOPTION RATE FORMULA FOR FINAL ADOPTION SCORE**




Direct willingness-to-participate questions are the starting point of measure/program-specific adoption curve calculations. For each item, respondents were asked to rate the likelihood that they would purchase the energy efficient version of the equipment, or participate in the DR program, at various incentive levels, including no incentive and an incentive that covers the full incremental (or total) cost.

Responses to financial and non-financial barrier questions were then used to adjust the preliminary adoption score. If "cost" was a consideration to prevent customers from purchasing energy efficient equipment, GDS assumed a financial barrier adjustment. The 0% incentive level was reduced by 100%, the 25% incentive level was reduced by 80%, the 50% incentive level was reduced by 60%, the 75% incentive level was reduced by 40%, and the 100% incentive level was reduced by 20%.

If another reason (i.e., lack of knowledge, uncertainty about bill savings, etc.) was a consideration to prevent customers from purchasing energy efficient equipment, GDS assumed a non-financial barrier adjustment. The 0% incentive level was reduced by 50%, the 25% incentive level was reduced by 40%, the 50% incentive level was reduced by 30%, the 75% incentive level was reduced by 20%, and the 100% incentive level was reduced by 10%.

Last, if the respondent indicated a strong motivation for purchasing an efficient technology or participating in a demand response program (i.e. bill savings, progress towards sustainability goals, etc.) then the adjusted adoption score was increased. The 0% incentive was increased by 25%, the adjusted adoption rate at the 25% incentive level was increased by 66%, the 50% incentive level by 150%. Respondents who indicated a strong motivation factor were typically assigned a 100% adoption score at the 75% and 100% incentive levels.

### *2.4.1 Residential Sector Final Adoption Scores*

Table 2-10 presents the adjusted adoption scores (after financial and non-financial adjustments) for AES Indiana residential customers.

**TABLE 2-10: RESIDENTIAL FINAL ADOPTION SCORES BY INCENTIVE LEVEL**

| All Homeowners | Annual Incentive (% of incremental measure cost) | | | | |
|---|---|---|---|---|---|
| | 0% | 25% | 50% | 75% | 100% |
| Heating/Cooling | 28% | 52% | 67% | 80% | 89% |
| Water Heating | 22% | 36% | 49% | 61% | 72% |
| Insulation/Air Sealing | 16% | 31% | 47% | 63% | 80% |
| Appliances | 22% | 38% | 55% | 68% | 79% |

Final adoption scores for residential direct load control (DLC) of central AC and water heating systems are shown in Table 2-11, depending on varying annual incentive levels. Current annual incentive offerings are $20 for direct load control of central air conditioning systems for residential customers and $30 for C/I customers. Table 2-12 provides the final adoption score for a Time of Use (TOU) rate option based on a prescribed difference between peak and off-peak rates.

**TABLE 2-11: DLC DEMAND RESPONSE FINAL ADOPTION SCORES BY INCENTIVE LEVEL**

| DR – DLC | Annual Incentive (% of incremental measure cost) | | | | |
|---|---|---|---|---|---|
| **Market Rate** | **$0** | **$15** | **$25** | **$35** | **$50** |
| Central AC – SF | 23% | 41% | 58% | 67% | 73% |
| Central AC – MF | 27% | 40% | 50% | 63% | 83% |
| Water Heat – SF | 21% | 35% | 46% | 57% | 63% |
| Water Heat – MF | 28% | 37% | 56% | 68% | 76% |
| **Income-Eligible** | **$0** | **$15** | **$25** | **$35** | **$50** |
| Central AC – SF | 14% | 24% | 55% | 63% | 82% |
| Central AC – MF | N/A | N/A | N/A | N/A | N/A |
| Water Heat – SF | 13% | 16% | 22% | 23% | 24% |
| Water Heat – MF | 36% | 44% | 62% | 68% | 74% |

**TABLE 2-12: TOU DEMAND RESPONSE FINAL ADOPTION SCORES BY INCENTIVE LEVEL**

| DR – Rate | Lower off-peak rate | | | |
|---|---|---|---|---|
| **Market Rate** | **$0.08** | **$0.06** | **$0.04** | **$0.03** |
| DR-TOU – SF | 36% | 44% | 56% | 64% |
| DR TOU – MF | 37% | 48% | 58% | 65% |
| **Income-Eligible** | **$0.08** | **$0.06** | **$0.04** | **$0.03** |
| DR-TOU – SF | 37% | 40% | 43% | 47% |
| DR TOU – MF | 38% | 52% | 63% | 69% |

### *2.4.2 Business Sector Final Adoption Scores*

Table 2-13 presents the adjusted adoption scores (after financial and non-financial barrier and motivation factor adjustments) for AES Indiana non-residential customers across several end-uses, depending on whether the investment is a minor or major investment. Small businesses indicated a major investment to be on average approximately $7,500. Final adoption scores were similar regardless of the initial investment amount.

In contrast to the residential sector energy efficiency WTP research, the nonresidential WTP survey questions incentives were described in the form of payback periods to better align with how purchasing decisions are likely to considered.

**TABLE 2-13: NONRESIDENTIAL FINAL ADOPTION SCORES BY INCENTIVE LEVEL AND INVESTMENT TYPE**

| Minor Inv. | Payback Performance (after incentive) | | | | |
|---|---|---|---|---|---|
| | **10 Years** | **5 Years** | **3 Years** | **1 Year** | **0 Years** |
| HVAC | 29% | 46% | 65% | 73% | 81% |
| Lighting | 24% | 38% | 61% | 76% | 83% |
| Refrigeration | 30% | 51% | 66% | 74% | 79% |

| | | | | | |
|---|---|---|---|---|---|
| **Water Heating** | 27% | 43% | 61% | 72% | 74% |
| **Major Inv.** | **Payback Performance (after incentive)** | | | | |
| | **10 Years** | **5 Years** | **3 Years** | **1 Years** | **0 Years** |
| **HVAC** | 34% | 48% | 62% | 73% | 83% |
| **Lighting** | 23% | 41% | 63% | 78% | 85% |
| **Refrigeration** | 30% | 51% | 68% | 74% | 79% |
| **Water Heating** | 25% | 44% | 60% | 71% | 76% |

Final adoption scores for business sector demand response options are shown in Table 2-14, depending on varying annual incentive levels for direct load control as well as volunteer load reduction. The table also provides business sector responses for participation likelihood in a Critical Peak Pricing (CPP) DR rate program on a prescribed difference between peak and off-peak rates designs.

**TABLE 2-14: NONRESIDENTIAL DEMAND RESPONSE FINAL ADOPTION SCORES**

| **DR – DLC** | **Annual Incentive** | | | | |
|---|---|---|---|---|---|
| | **$0** | **$15** | **$25** | **$35** | **$50** |
| **Central AC** | 28% | 42% | 61% | 71% | 77% |

| **DR – Rates** | **Lower than current rate** | | | |
|---|---|---|---|---|
| | **5%** | **10%** | **20%** | **40%** |
| **Critical Peak Pricing** | 23% | 29% | 39% | 49% |

# 3 Baseline Forecast

The load forecast is a critical input into AES-Indiana's 2022 DSM Market Potential Study, having various uses in estimation of residential and business sector potential. Therefore, the GDS Team took considerable time and effort to review AES Indiana's most recently completed load forecast models and documentation to produce the various forecast components necessary as inputs into this analysis. The chapter describes the several ways in which the forecast is used for this study, presents the baseline and disaggregated forecasts, and describes the methodology and data sources used by GDS for the purposes of generating the load forecasts that were used in the potential analysis.

## 3.1 AES INDIANA LOAD FORECASTING SYSTEM

AES Indiana employs a sophisticated load forecasting system that uses econometric and Statistically Adjusted End-Use ("SAE") models to project number of consumers, average consumption per consumer, and total energy sales by class. Residential, Commercial, and Industrial consumers are projected using traditional econometric techniques. Residential average usage and commercial energy sales are projected using SAE model specifications. Industrial energy sales are projected using econometric techniques.

A residential SAE model specification takes end-use data drawn from utility, regional, and even national sources and develops monthly end-use indices designed to predict average household consumption. The end-use data includes market shares of key electric consuming appliances, average device efficiency trends, average building shell efficiency trends, price elasticity of demand, income elasticity of demand, and elasticity associated with the average number of people per household. A cooling index is developed to represent space cooling load and is further modified by Cooling Degree Days to incorporate summer weather into the model. Likewise, a heating index representing space heating is modified by Heating Degree Days. Finally, a base index is developed to represent consumption of all other end-uses in the home.

A commercial SAE model specification is like a residential specification, except end-use energy intensity indices are developed for each commercial building type based on area employment in various industry codes. National and regional commercial data is used to estimate end-use consumption for various industries (for example, restaurants will have higher cooking usage shares than offices).

AES Indiana also projects the impacts of DSM programs it has run in the past. The DSM impacts included in the load forecast based on the evaluated results of AES Indiana DSM programs.

## 3.2 ADJUSTMENTS TO THE AES-INDIANA LOAD FORECAST

Before assessing the future potential for energy efficiency and demand response in the AES Indiana service area, a few modifications to AES Indiana's 2021-vintage forecast were necessary to create an adjusted baseline forecast. These modifications are addressed in more detail below.

### *3.2.1 Appliance Market Share Adjustments*

The base case forecast AES Indiana developed uses the Energy Information Administration's (EIA) Residential Energy Consumption Survey (RECS) as inputs for residential appliance market share data. The RECS market share data can be summarized by U.S. Census Region, however that is the most detailed level of data published. GDS utilized the residential baseline end-use survey (Chapter 2) to update the market share inputs with data specific to AES Indiana residential customers. AES Indiana utilized the updated market share data to produce an adjusted baseline forecast for the residential class customers. Using such detailed market share data provides more confidence in the accuracy of the forecast and allows GDS to understand which appliance end-uses may be most useful for targeting with EE or DSM programs.

### *3.2.2 Adjustment for Large C&I Opt-Out Customers*

The 2021 AES Indiana business sector customer database containing usage and demographic data for all C&I customers, with indication for large customer opt-out of DSM/EE programs status was utilized to determine how to adjust for opt-out customers. The number of customers and total energy use was calculated both including and excluding opt-out customers. The load forecast for the C&I sectors was adjusted down by the percent of load attributed to opt-out customers from the customer database, in effect excluding from the potential analysis any load of opt-out customers. The opt-out adjustment was held constant for all years of the load forecast. In total, GDS removed approximately 28% of commercial energy sales and 76% of industrial energy sales due to large customer opt-out.

### *3.2.3 Reclassification of Load*

The 2021 AES Indiana C&I sector customer database designated commercial and industrial rate code based on current tariff definition. When only using the account type/tariff definition to classify customers as either commercial or industrial, there were several manufacturing type premises classified as commercial, as well as several customers that GDS typically classifies as commercial classified as industrial, (i.e. a retail service building coded as an industrial account).

Additionally, the dataset also identified each business by Standard Industry Code (SIC). To reclassify AES Indiana C&I sector data, GDS mapped industry codes to a specified building type and classified the building type as either commercial or industrial. Customers with a building type classified as “Industrial Manufacturing” were coded as Industrial customers, while all other building types were coded as Commercial. While the goal for this analysis is to determine the actual amount of energy sales attributable to the commercial and industrial customer classes, it is only achievable by analyzing individual customer data. The result of this reclassification was a shift of approximately 36% of industrial sector sales, or 1,049,746 MWh, to the commercial sector. This 36% shift was then applied to the AES Indiana base case forecasted sales for the commercial and industrial classes. It is important to have accurate energy sales by customer class so that specific DSM/EE programs have the correct amount of energy sales eligible for savings.

## 3.3 LOAD FORECAST DISAGGREGATION

The baseline forecasts represent projected total energy sales by class. For the potential studies, it is useful to have the class forecasts disaggregated in several different ways. This section presents the forecast disaggregation scenarios used by GDS to determine intensity by end-use.

### *3.3.1 Residential Sector*

The residential electric calibration effort led to an end-use intensity breakdown as shown below in Figure 3-1. Overall, we estimated per home consumption to be 11,133 kWh per year for 2021. The “Heating” end use is the leading end-use, confirming the heavy presence of electric heat sources within the AES Indiana service territory. The “Other” end use is the second leading end-use which includes plug loads such as electronics and miscellaneous small appliances. This reflects the increasing prominence of electronics and other plug-in load devices within the typical residential home.

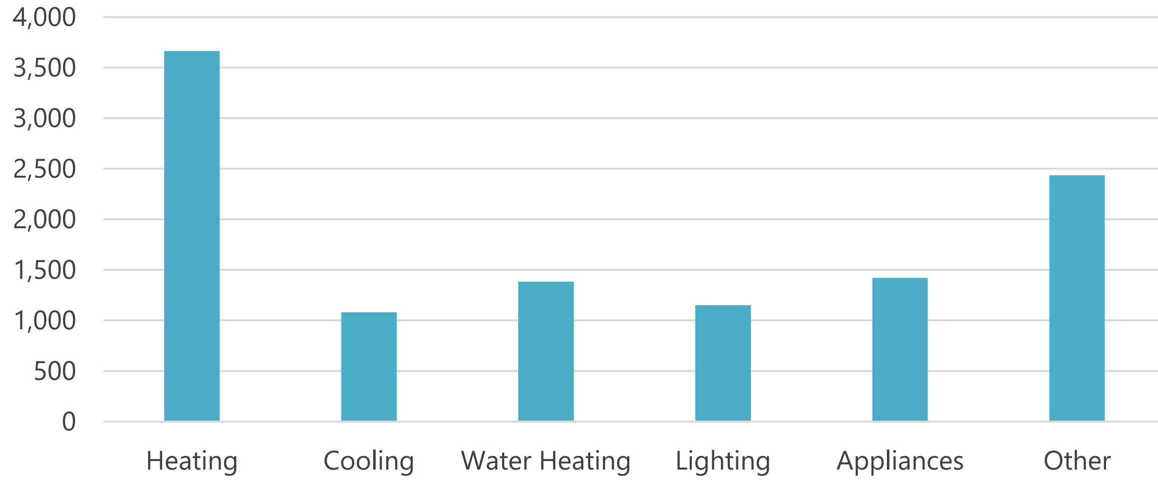



**FIGURE 3-1 RESIDENTIAL ELECTRIC END-USE BREAKDOWN**

### *3.3.2 C&I Sector*

In the C&I sector, disaggregated forecast data provides the foundation for the development of energy efficiency potential estimates. GDS received a base case sales forecast from AES Indiana for the residential, commercial, and industrial sectors. As noted above, the C&I forecast was adjusted from the base case by using SIC information from AES Indiana to reclassify usage as commercial or industrial. SIC information from AES Indiana, along with CBECS building type consumption tables, was then used to segment the forecast into building types. The forecast was further segmented into end-uses by building type using regional specifical projections of end-use consumption contained within EIA's Annual Evergy Outlook supporting workpapers. Figure 3-2 provides a breakdown of commercial electric sales by building type.[1]

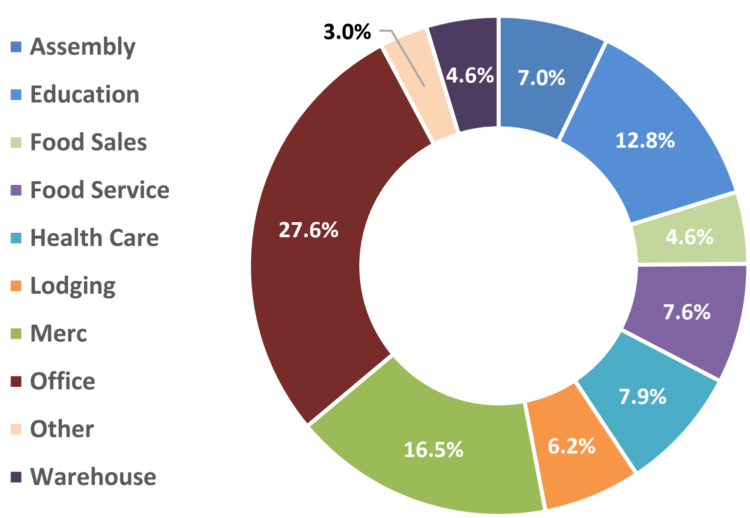



**FIGURE 3-2: COMMERCIAL ELECTRIC SALES BREAKDOWN BY BUILDING TYPE**

Figure 3-3 provides an illustration of the leading end-uses across all building types in the commercial sector. Lighting, space cooling, and ventilation are the primary end-uses with a significant share of load across most building types. Shares of refrigeration and office/computing are often dependent on the type of building, with

1 "Other" commercial building types include buildings that engage in several different activities, a majority of which are commercial (e.g. retail space), though the single largest activity may be industrial or agricultural; "other" also includes miscellaneous buildings that do not fit into any other category.

refrigeration loads greatest in food sales and food service while office/computing loads are greatest in offices and education. Miscellaneous plug load is also a significant share of load in some building types, indicating that various small electric devices are becoming more common in commercial buildings.

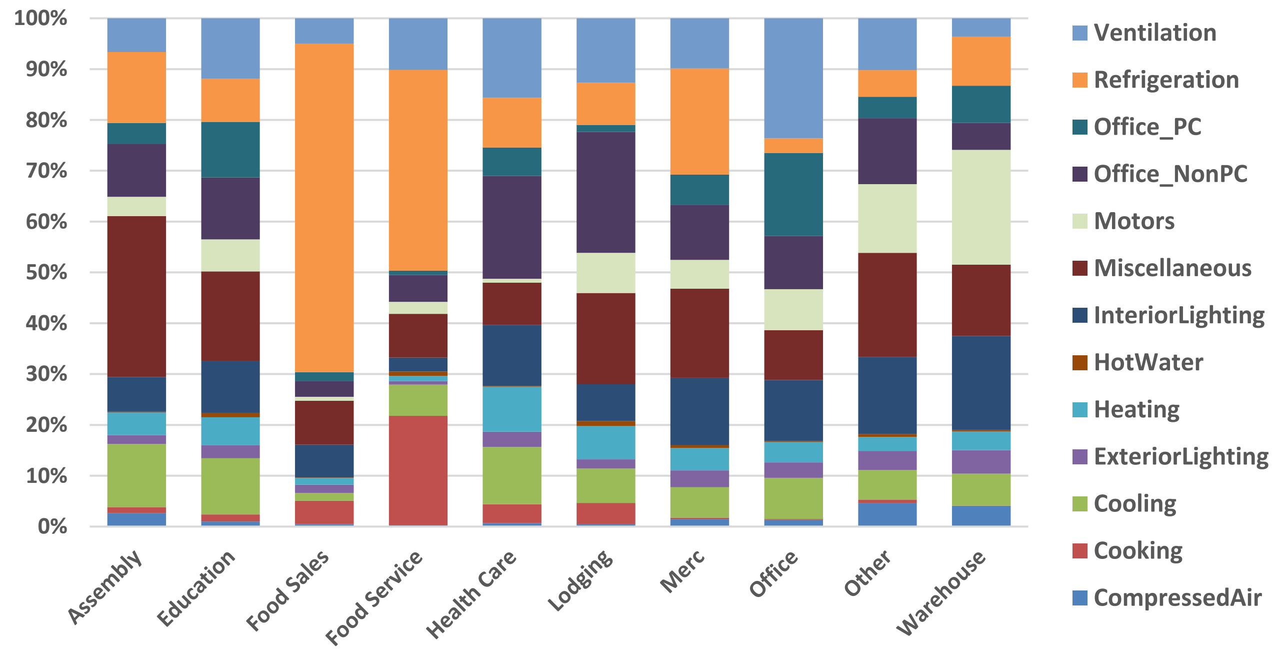



**FIGURE 3-3: COMMERCIAL ELECTRIC END-USE BREAKDOWN BY BUILDING TYPE**

Industrial sales were also segmented by end-use based on the overall distribution of sales by industry type and EIA MECS data on end-use consumption by industrial segment. Figure 3-4 provides a breakdown of the sales by end-use. Overall, the weighted average industrial sales by end-use in the AES Indiana service area was 42% Machine Drive, 14% Process Heat, 8% HVAC, 8% Compressed Air, 7% Lighting, and 7% Process Refrigeration. The remaining 12% was split between other process and other facility loads.

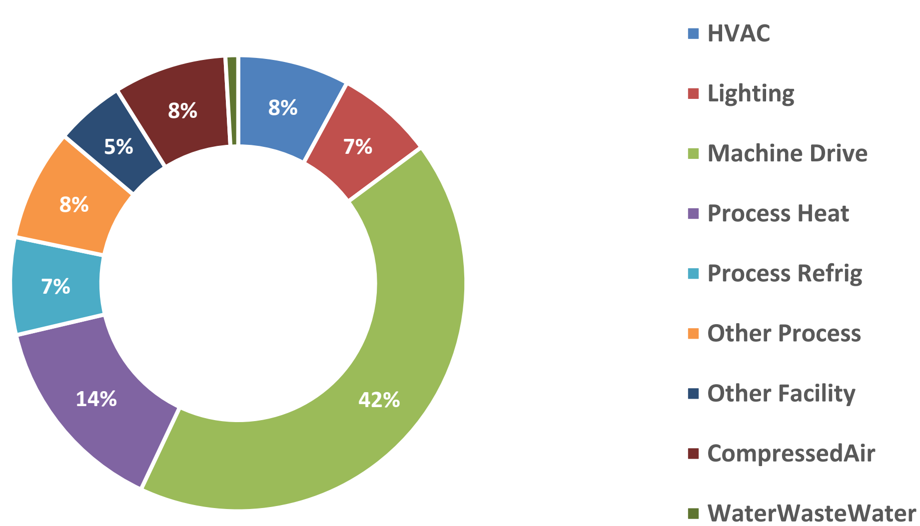



**FIGURE 3-4: INDUSTRIAL ELECTRIC END-USE BREAKDOWN BY BUILDING TYPE**

# 4 Energy Efficiency Potential Analysis

This section describes the overall methodology utilized to assess the electric energy efficiency potential in the AES Indiana service area. The main objectives of this Market Potential Study were to estimate the technical, economic, maximum, and realistic potential savings from energy efficiency in the AES Indiana service territory; and to quantify these estimates of potential in terms of MWh and MW savings, for each level of energy efficiency and demand response potential.

## 4.1 OVERVIEW OF APPROACH

For the residential sector, GDS utilized a bottom-up approach to the modeling of energy efficiency potential, whereby measure-level estimates of costs, savings, and useful lives were used as the basis for developing the technical, economic, and achievable potential estimates. The measure data was used to build-up the technical potential, by applying the data to each relevant market segment. The measure data allowed for benefit-cost screening to assess economic potential, which was in turn used as the basis for achievable potential, taking into consideration incentives and estimates of annual adoption rates. For the C&I sector, GDS employed a bottom-up modeling approach to first estimate measure-level savings, costs, and cost-effectiveness, and then applied measure savings to all applicable shares of energy load.

## 4.2 MARKET CHARACTERIZATION

The initial step in the analysis was to gather a clear understanding of the current market segments in the AES Indiana service area. The GDS team coordinated with AES Indiana to gather utility sales and customer data and existing market research to define appropriate market sectors, market segments, vintages, saturation data and end uses. This information served as the basis for completing a forecast disaggregation and market characterization of both the residential and nonresidential sectors.

### 4.2.1 Forecast Disaggregation

As noted in Chapter **Error! Reference source not found.**, through the development of the baseline forecasts, the GDS Team produced disaggregated forecasts by sector and end-use. The resulting aggregate baseline forecasts were disaggregated by sector and then further segmented as follows:

- ***Residential.*** The residential forecast was broken out by housing type between existing income qualified and market-rate customers as well as new construction.
- ***Commercial.*** Typically based on major EIA CBECS business types: retail, warehouse, food sales, office, lodging, health, food service, education, and miscellaneous.
- ***Industrial.*** As determined by actual load consumption shares and major industry types as defined by EIA's Manufacturing Energy Consumption Survey (MECS) data.

The segmentation analysis was performed by applying AES Indiana -specific segment and end-use consumption shares, derived from AES Indiana's customer database and SIC code analysis (building segmentation), and by EIA CBECS and MECS data (end-use segmentation) to forecast year sales. Within the residential, commercial, and industrial market segments, the sector level disaggregated forecasts were further segmented by the major end uses shown in Table 4-1.

**TABLE 4-1: ELECTRIC END-USE LOADS**

| Residential | C&I | |
|---|---|---|
| | Commercial | Industrial |
| Heating | Interior Lighting | Lighting |
| Cooling | Exterior Lighting | HVAC |
| Water Heating | Refrigeration | Machine Drive |
| Cooking | Space Cooling | Process Heat |
| Refrigerator | Space Heating | Process Cool / Refrigeration |

| | | |
|---|---|---|
| **Freezer** | **Ventilation** | **Other Process** |
| **Dishwasher** | **Water Heating** | **Process – Machine Drive** |
| **Clothes Washer** | **Plug Loads / Office Equipment** | **Other Facility** |
| **Dryer** | **Cooking** | **Compressed Air** |
| **TV** | **Other** | **Water / Wastewater** |
| **Light** | **Whole Building / Behavioral** | **Process – Agriculture** |
| **Miscellaneous** | | **Whole Building / Behavior** |
| | | |
| | | |

### *4.2.2 Eligible Opt-Out Customers*

In Indiana, individual commercial or industrial customer sites with a peak load greater than 1MW are eligible to opt out of utility-funded electric energy efficiency programs. In the AES Indiana service area, approximately 28% of total reclassified retail commercial sales have opted out of utility-funded electric energy efficiency programs, while 76% of total reclassified retail industrial sales have opted out.

Figure 4-1 shows the total sales for the C&I sectors, as well as the sales, by sector, which have currently opted out of paying the charge levied to support utility-administered energy efficiency programs. The portion of sales that have not opted out include both ineligible load (i.e., does not meet the 1 MW peak demand requirement) as well as eligible load that has not yet opted out.

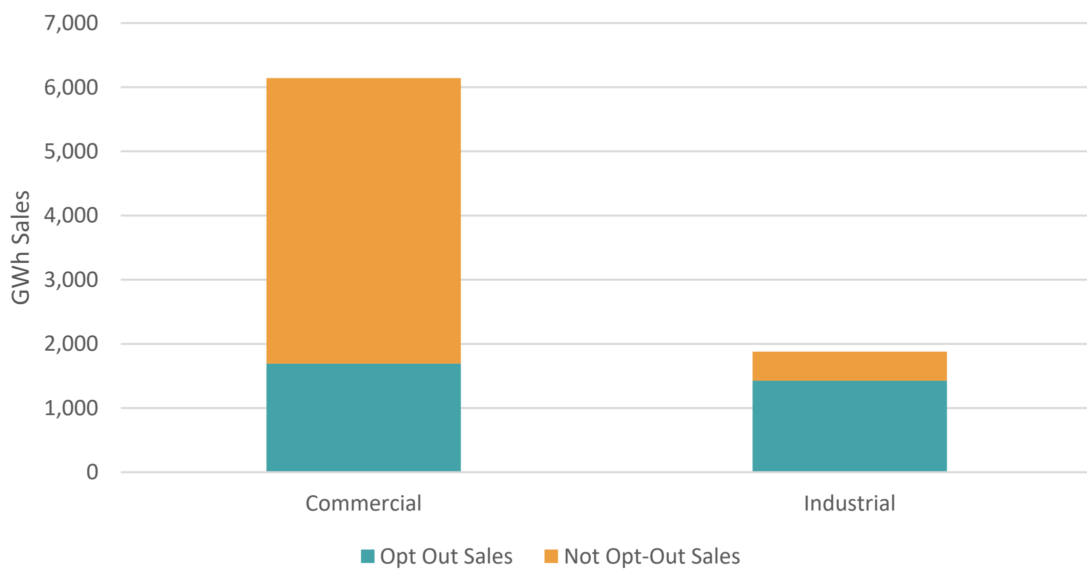



**FIGURE 4-1 OPT-OUT SALES BY C&I SECTOR**

GDS removed the sales from opt-out customers in the assessment of technical, economic, and achievable potential reflected in this report. As a sensitivity (included in Appendix A), GDS also examined the full potential in the C&I sector if these customers were no longer able to opt-out of utility-funded electric energy efficiency programs.

### *4.2.3 Building Stock/Equipment Saturation*

To assess the potential electric energy efficiency savings available, estimates of the current saturation of baseline equipment and energy efficiency measures are necessary.

#### 4.2.3.1 Residential Sector

For the residential sector, GDS relied on the research efforts described in Chapter 2. GDS also relied on online and onsite surveys of AES Indiana customers conducted by the GDS Team in 2018 for the previous potential study. Other data sources included ENERGY STAR unit shipment data, AES Indiana evaluation reports, and EIA Residential Energy Consumption Survey data. The ENERGY STAR unit shipment data filled data gaps related to the increased saturation of energy efficient equipment across the U.S. in the last decade.

#### 4.2.3.2 Business Sector

For the commercial sector, building stock and equipment saturation data was informed from a combination of primary market research (online surveys noted in Chapter **Error! Reference source not found.**), as well as other available regional or national data. The survey data helped inform the disaggregation of the end-use sales forecast further into measure groups consistent with the measures included in the potential analysis as well as saturation of energy efficient equipment.

Beyond the primary data collection, EIA regional data, as well as national studies on commercial energy consumption were used to inform consumption in the remaining end-uses where data from the primary market research was even more limited.[2] These sources typically informed estimates of base equipment saturation for cooking, refrigeration, water heating, plug loads, and other miscellaneous end-uses.

For the industrial sector, the analysis employed a top-down analysis at the end-use level. Accordingly, it was not critical to disaggregate the industrial sales at a measure-level. Instead, measures were developed to estimate savings at a total end-use level.

### *4.2.4 Remaining Factor*

The remaining factor is the proportion of a given market segment that is not yet efficient and can still be converted to an efficient alternative. It is the inverse of the saturation of an energy efficient measure, prior to any adjustments. In this study, two key adjustments were made to recognize that the energy efficient saturation does not necessarily always fully represent the state of market transformation. First, while a percentage of installed measures may already be efficient, some customers may backslide (i.e. revert to standard technologies, or otherwise less efficient alternatives in the future, based on considerations like measure cost and availability and customer preferences). For example, historically, some customers have disliked CFL light quality, and have reverted to incandescent and halogen bulbs after the CFLs burn out.

Second, for measures categorized as market opportunity (i.e. replace-on-burnout), we assumed that 50% of the instances in which an efficient measure is already installed, the burnout or failure of those measures would be eligible for inclusion in the estimate of future savings potential. This adjustment assumes that 50% of the market is transformed, and no future savings potential exists, whereas the remaining 50% of the market is not transformed and could backslide without the intervention of an AES-Indiana program and an incentive. Similarly, for retrofit measures, we assumed that only 10% of the instances in which an efficient measure is already installed, the burnout or failure of those measures would be eligible for inclusion in the estimate of future savings potential. This recognizes the more proactive nature of retrofit measures, as the implementation of these measures are more likely to be elective in nature, compared to market opportunity measures, which are more likely to be needs-based. The uncertainty in these assumptions is appropriate, as they factor in a key component of natural customer decision making.

[2] Examples of secondary research include: Energy Savings Potential RD&D Opportunities for Commercial Building Appliances. 2016. DOE and Energy Star Shipment Data.

## 4.3 MEASURE CHARACTERIZATION

### *4.3.1 Measure Lists*

The study's sector-level energy efficiency measure lists were informed by a range of sources including the Illinois TRM, current AES Indiana program offerings, measures included in other recent Indiana utility market potential studies, and commercially viable emerging technologies, among others. Measure list development was a collaborative effort in which GDS developed draft lists that were shared with AES Indiana and stakeholders. The final measure lists included in the study reflected the informed comments and considerations from the parties that participated in the measure list review process.

In total, GDS analyzed 353 measure types for this study. Several measures were included with multiple permutations to account for different specific market segments, such as different building types, efficiency levels, and replacement options. In total, GDS developed 2,106 measure permutations for this study. Each permutation was screened for cost-effectiveness under the UCT cost test. The parameters for cost-effectiveness under the UCT are discussed in detail later in Section 4.4.3.

**TABLE 4-2: NUMBER OF MEASURES EVALUATED**

| | # of Measures | Total # of Measure Permutations |
|---|---|---|
| **Residential** | 170 | 755 |
| **Commercial** | 184 | 1687 |
| ***Total*** | ***354*** | ***2,442*** |

### *4.3.2 Emerging Technologies*

GDS considered several specific emerging technologies as part of analyzing future potential. In the residential sector, these technologies include several smart technologies, including smart appliances, smart water heater (WH) tank controls, smart window coverings, smart TVs, heat pump dryers and smart vents/sensors. In the non-residential sector, specific emerging technologies that were considered as part of the analysis include several commercial behavioral options, triple pane windows, energy recovery ventilators, variable refrigerant flow heat pumps, switch reluctance motels, Q-Sync Motors for Refrigeration, ozone commercial laundry, advanced lighting controls, power distribution equipment upgrades, and server virtualization. While this is not an exhaustive list of possible emerging technologies over the next twenty years it does consider many of the known technologies that are available today but may not yet have widespread market acceptance and/or product availability.

In addition to these specific technologies, GDS acknowledges that there could be future opportunities for innovative technologies as equipment standards improve and market trends occur. While this analysis does not make any explicit assumption about unknown future technologies, the methodology assumes that subsequent equipment replacement that occurs over the course of the study timeframe, and at the end of the initial equipment's useful life, will continue to achieve similar levels of energy savings, relative to improved baselines, at similar incremental costs.

### *4.3.3 Assumptions & Sources*

A significant amount of data is needed to estimate the electric savings potential for individual energy efficiency measures or programs across the residential and nonresidential customer sectors. GDS utilized data specific to AES Indiana when it was available and current. GDS used the most recent AES Indiana evaluation report findings (as well as AES Indiana program planning documents), the Illinois TRM, and the Michigan Energy Measures Database (MEMD), and EIA data for a large amount of the data requirements. Additional source documents included American Council for an Energy-Efficient Economy (ACEEE) research reports covering topics like emerging technologies.

***Measure Savings:*** GDS relied on existing AES Indiana evaluation report findings and the Illinois TRM to inform calculations supporting estimates of annual measure savings as a percentage of base equipment usage. For custom measures and measures not included in the Illinois TRM, GDS estimated savings from a variety of sources, including:

- MEMD, IN TRM, and other regional/state TRMs
- Secondary sources such as the ACEEE, Department of Energy (DOE), EIA, ENERGY STAR©, and other technical potential studies

***Measure Costs:*** Measure costs represent either incremental or full costs. These costs typically include the incremental cost of measure installation, when appropriate based on the measure definition. For purposes of this study, nominal measure costs held constant over time.

GDS obtained measure cost estimates primarily from AES Indiana evaluation report findings and the Illinois TRM. GDS also used the following supplementary data sources:

- MEMD, IN, and other regional/state TRMs
- Secondary sources such as the ACEEE, ENERGY STAR, and NREL

Costs and savings for new construction and replace on burnout measures were calculated as the incremental difference between the code minimum equipment and the energy efficiency measure. This approach was utilized because the consumer must select an efficiency level that is at least the code minimum equipment when purchasing new equipment. The incremental cost is calculated as the difference between the cost of high efficiency and standard efficiency (code compliant) equipment. However, for retrofit or direct install measures, the measure cost was the “full” cost of the measure, as the baseline scenario assumes the consumer would not make energy efficiency improvements in the absence of a program. In general, the savings for retrofit measures are calculated as the difference between the energy use of the removed equipment and the energy use of the new high efficiency equipment (until the removed equipment would have reached the end of its useful life).

***Measure Life:*** Measure life represents the number of years that energy using equipment is expected to operate. GDS obtained measure life estimates from the AES Indiana evaluation report findings and the Illinois TRM:

- MEMD, IN TRM, and other regional/state TRMs
- Manufacturer data
- Savings calculators and life-cycle cost analyses

All measure savings, costs, and useful life assumption sources are documented in the Appendices volume of this report.

### 4.3.4 Treatment of Codes & Standards

Although this analysis does not attempt to predict how energy codes and standards will change over time, the analysis does attempt to reflect the latest legislated improvements to federal codes and standards. Where possible, improvements to baseline equipment standards can typically be met with incremental improvements to efficient equipment standards. However, in select case, such as screw-in lighting improvements to the baseline standard effectively were expected to eliminate the efficient technology from future consideration.

### 4.3.5 Net to Gross (NTG)

All estimates of technical, economic, and achievable potential, as well as measure level cost-effectiveness screening were conducted in terms of gross savings to reflect the absence of program design considerations in these phases of the analysis. The impacts of free-riders (participants who would have installed the high efficiency option in the absence of the program) and spillover customers (participants who install efficiency measures due to program activities, but never receive a program incentive) were considered in the development of DSM Inputs into AES Indiana’s upcoming IRP.

## 4.4 ENERGY EFFICIENCY POTENTIAL

### *4.4.1 Types of Potential*

This section reviews the types of potential analyzed in this report, as well as some key methodological considerations in the development of technical, economic, and achievable potential.

The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings from energy efficiency measures. Still, even the best-designed portfolio of programs is unlikely to capture 100% of the technical or economic potential. Therefore, achievable potential attempts to estimate what savings may realistically be achieved through market interventions, when it can be captured, and how much it would cost to do so. Figure 4-2 illustrates the types of energy efficiency potential considered in this analysis.

**FIGURE 4-2: TYPES OF ENERGY EFFICIENCY POTENTIAL**

| | | | | |
|---|---|---|---|---|
| *Not Technically Feasible* | TECHNICAL POTENTIAL | | | |
| *Not Technically Feasible* | *Not Cost Effective* | ECONOMIC POTENTIAL | | |
| *Not Technically Feasible* | *Not Cost Effective* | *Market Barriers* | MAXIMUM ACHIEVABLE POTENTIAL | |
| *Not Technically Feasible* | *Not Cost Effective* | *Market Barriers* | *Partial Incentives* | REALISTIC ACHIEVABLE POTENTIAL |

### *4.4.2 Technical Potential*

Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is only constrained by factors such as technical feasibility and applicability of measures. Under technical potential, GDS assumed that 100% of new construction and market opportunity measures are adopted as those opportunities become available (e.g., as new buildings are constructed, they immediately adopt efficiency measures, or as existing measures reach the end of their useful life). For retrofit measures, implementation was assumed to be resource constrained and that it was not possible to install all retrofit measures all at once. Rather, retrofit opportunities were assumed to be replaced incrementally until 100% of stock was converted to the efficient measure over a period of no more than 15 years.

The core equation used in the residential sector energy efficiency technical potential analysis for each individual efficiency measure is shown in Equation 4-1 below. The C&I sector employs a similar analytical approach.

**EQUATION 4-1 CORE EQUATION FOR RESIDENTIAL SECTOR TECHNICAL POTENTIAL**

TECHNICAL POTENTIAL OF EFFICIENT MEASURES = *Total Number of Households* X *Base Case End Use Intensity (kWh/unit)* X *Saturation Share* X *Remaining Factor* X *Feasibility Factor* X *Savings Factor*

**Where…**

**Base Case Equipment End-Use Intensity** = the electricity used per customer per year by each base-case technology in each market segment. In other words, the base case equipment end-use intensity is the consumption of the electrical energy using equipment that the efficient technology replaces or affects.

**Saturation Share** = the fraction of the end-use electrical energy that is applicable for the efficient technology in each market segment. For example, for residential water heating, the saturation share would be the fraction of all residential electric customers that have electric water heating in their household.

**Remaining Factor =** the fraction of equipment that is not considered to already be energy efficient. To extend the example above, the fraction of electric water heaters that is not already energy efficient.

**Feasibility Factor** = (also functions as the applicability factor) the fraction of the applicable units that is technically feasible for conversion to the most efficient available technology from an engineering perspective (e.g., it may not be possible to install heat pump water heaters in all homes because of space limitations).

**Savings Factor** = the percentage reduction in electricity consumption resulting from the application of the efficient technology.

#### 4.4.2.1 Competing Measures & Interactive Effects Adjustments

GDS prevents double-counting of savings, and accounts for competing measures and interactive savings effects, through three primary adjustment factors:

***Baseline Saturation Adjustment.*** Competing measure shares are factored into the baseline saturation estimates. For example, nearly all homes can receive insulation. To account for this, GDS' analysis used multiple measure permutations that account for varying impacts of different heating/cooling combinations and baseline saturations were applied to reflect the proportions of households with each heating/cooling combination.

***Applicability Factor Adjustment.*** Combined measures into measure groups, where total applicability factor across measures is set to 100%. For example, homes cannot receive a programmable thermostat, connected thermostat, and smart thermostat. In general, the models assign the measure with the most savings the greatest applicability factor in the measure group, with competing measures picking up any remaining share.

***Interactive Savings Adjustment.*** As savings are introduced from select measures, the per-unit savings from other measures need to be adjusted (downward) to avoid over-counting. The analysis typically prioritizes market opportunity equipment measures (versus retrofit measures that can be installed at any time). For example, the savings from a smart thermostat are adjusted down to reflect the efficiency gains of installing an efficient air source heat pump.

### *4.4.3 Economic Potential*

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the UCT) as compared to conventional supply-side energy resources.

#### 4.4.3.1 Utility Cost Test & Incentive Levels

The economic potential assessment included a screen for cost-effectiveness using the UCT at the measure level. In the AES-Indiana territory, the UCT considers electric energy, capacity, and transmission & distribution (T&D) savings as benefits, and utility incentives and direct install equipment expenses as the cost. Consistent with application of economic potential according to the National Action Plan for Energy Efficiency, the measure level economic screening does not consider non-incentive/measure delivery costs (e.g. admin, marketing, evaluation etc.) in determining cost-effectiveness.[3]

[3] National Action Plan for Energy Efficiency: Understanding Cost-Effectiveness of Energy Efficiency Programs. *Note: Non-incentive delivery costs are included in the assessment of achievable potential.*

Apart from the low-income segment of the residential sector, all measures were required to have a UCT benefit-cost ratio greater than 1.0 to be included in economic potential and all subsequent estimates of energy efficiency potential. Low-income measures were not required to be cost-effective.

For both the calculation of the measure-level UCT, as well as the determination of RAP, historical incentive levels (as a % of incremental measure cost) were calculated for current measure offerings. GDS relied on the prior AES-Indiana DSM plan estimates and historical AES Indiana evaluation reports files to map current measure offerings to their historical incentive levels.

- In the residential sector, incentives by program ranged from 20% to 100% and averaged 80%.
- In the non-residential sector, prescriptive incentives averaged 60% of the measure cost for interior lighting, 27% for exterior lighting and 37% for non-lighting measures.
- Custom measures received incentives equal to $0.08 per first-year kWh saved (up to 50% of the measure cost) with Retro Commissioning incentives typically equal to $17 per first-year kWh saved.
- In the MAP scenario, incentives were increased up to 100% of the incremental measure cost.[4]

#### 4.4.3.2 Avoided Costs

Avoided energy supply costs are used to assess the value of energy savings. Avoided cost values for electric energy, electric capacity, and avoided T&D were provided by AES Indiana as part of an initial data request. Electric energy is based on an annual system marginal cost. For years outside of the avoided cost forecast timeframe, future year avoided costs are escalated by the rate of inflation.

AES Indiana provided the GDS team with annual on and off-peak avoided energy costs. GDS used this data to create 8,760 avoided cost values for each forecast year. GDS then applied these avoided costs to the 8,760 savings from each measure based on assigned end-use load shapes[5] to determine the value of measures that save more energy during peak periods than those that might saving during off-peak periods. In addition, the avoided capacity and T&D avoided costs were applied to the estimated coincident peak demand savings for each measure.

### 4.4.4 Achievable Potential

Achievable potential is the amount of energy that can realistically be saved given various market barriers. Achievable potential considers real-world barriers to encouraging end users to adopt efficiency measures; the non-measure costs of delivering programs (for administration, marketing, analysis, and EM&V); and the capability of programs and administrators to boost program activity over time. Barriers include financial, customer awareness and WTP in programs, technical constraints, and other barriers the "program intervention" is modeled to overcome. Additional considerations include political and/or regulatory constraints. The potential study evaluated two achievable potential scenarios:

- ***MAP*** estimates achievable potential on paying incentives equal to 100% of measure incremental costs and aggressive adoption rates.
- ***RAP*** estimates achievable potential with AES Indiana paying incentive levels (as a percent of incremental measure costs) closely calibrated to historical levels but is not constrained by any previously determined spending levels.

[4] The GDS team lowered MAP incentives to less than 100% of measure incremental cost in some cases if 100% incentives would preclude the measure from being cost-effective. MAP incentives were lowered to either 75% or 50% of the incremental measure cost if either of those incentive levels would allow for a measure to remain cost-effective.

[5] End-use load shapes were derived from building energy simulation models created by housing type and building type, specific to the AES-Indiana service area.

#### 4.4.4.1 Market Adoption Rates

GDS assessed achievable potential on a measure-by-measure basis. In addition to accounting for the natural replacement cycle of equipment in the achievable potential scenario, GDS estimated measure specific maximum adoption rates that reflect the presence of market barriers and associated difficulties in achieving the 100% market adoption assumed in the technical and economic scenarios.

The initial step was to assess the long-term market adoption potential for energy efficiency technologies. Due to the wide variety of measures across multiple end-uses, GDS employed varied measure and end-use-specific ultimate adoption rates versus a singular universal market adoption curve. These long-term market adoption estimates were based on AES-Indiana-specific WTP market research. The AES-Indiana-specific research included questions to residential homeowners and nonresidential facility managers regarding their perceived willingness to purchase and install energy efficient technologies across various end uses and incentive/payback performance levels. This research is discussed in additional detail in Section 2.4.

One caveat to this approach is that the WTP adoption score is a simple function of incentive levels and/or payback performance. There are other factors that may influence a customer's willingness to purchase an energy efficiency measure. For example, increased marketing and education programs can have a critical impact on the success of energy efficiency programs.

GDS utilized likelihood and willingness-to-participate data to estimate the long-term market adoption potential for both the maximum and realistic achievable scenarios. Table 4-3 presents the long-term market adoption rates at varied incentive levels used for the residential sector. Most end-uses are based on the WTP primary market research. Behavior was set to 100% to reflect that the program design is typically opt-out and participation levels are dictated by the utility. Last, GDS adjusted the AES-Indiana-specific adoption curves to reflect observed differences in WTP between the income-qualified and market-rate customers.

**TABLE 4-3 RESIDENTIAL LONG-TERM MARKET ADOPTION RATES AT DISCRETE INCENTIVE LEVELS**

| End Use/Housing Type/Income | 0% Incentive | 25% Incentive | 50% Incentive | 75% Incentive | 100% Incentive |
|---|---|---|---|---|---|
| Water Heat – SF/NLI | 21% | 39% | 54% | 69% | 79% |
| Water Heat – SF/LI | 16% | 36% | 48% | 61% | 68% |
| Water Heat – MF/NLI | 21% | 35% | 50% | 60% | 70% |
| Water Heat – MF/LI | 20% | 35% | 51% | 60% | 70% |
| HVAC Equip – SF/NLI | 29% | 42% | 56% | 91% | 93% |
| HVAC Equip – SF/LI | 25% | 45% | 64% | 76% | 83% |
| HVAC Equip – MF/NLI | 24% | 33% | 65% | 77% | 80% |
| HVAC Equip – MF/LI | 25% | 39% | 59% | 67% | 78% |
| Appliances – SF/NLI | 22% | 39% | 58% | 71% | 82% |
| Appliances – SF/LI | 13% | 40% | 59% | 72% | 83% |
| Appliances – MF/NLI | 23% | 29% | 48% | 55% | 71% |
| Appliances – MF/LI | 23% | 37% | 48% | 62% | 71% |
| HVAC Shell – SF/NLI | 17% | 39% | 61% | 78% | 89% |
| HVAC Shell – SF/LI | 10% | 23% | 42% | 53% | 69% |
| HVAC Shell – MF/NLI | 19% | 33% | 47% | 59% | 70% |
| HVAC Shell – MF/LI | 19% | 33% | 49% | 60% | 71% |
| Behavior | 100% | 100% | 100% | 100% | 100% |

Table 4-4 presents the long-term market adoption rates used in the nonresidential sector. Again, the adoption scores were primarily informed by the AES-Indiana-specific WTP research. GDS included a 20-year payback performance level to reflect reduced adoption rates for measures with extremely long payback performance levels. The 20-year payback performance was set to 2/3rd of the 10-year level. The behavior adoption rate was limited to 90% to allow for control groups required in EM&V analyses.

**TABLE 4-4 NONRESIDENTIAL LONG-TERM MARKET ADOPTION RATES AT DISCRETE PAYBACK INTERVALS**

| End-Use | 20 Year Payback Period | 10 Year Payback Period | 5 Year Payback Period | 3 Year Payback Period | 1 Year Payback Period | 0 Year Payback Period |
|---|---|---|---|---|---|---|
| Lighting/Office | 15% | 23$ | 41% | 63% | 78% | 85% |
| HVAC | 23% | 34% | 48% | 62% | 73% | 83% |
| Refrigeration | 20% | 30% | 51% | 68% | 74% | 79% |
| Water Heat | 17% | 25% | 44% | 60% | 71% | 76% |
| Other | 23% | 34% | 48% | 62% | 73% | 83% |

GDS then estimated initial year adoption rates by reviewing the current saturation levels of efficient technologies and (if necessary) calibrating the estimates of 2023 annual potential to recent historical levels achieved by AES-Indiana's current DSM portfolio. One of the most impactful examples of this calibration was to front-load commercial lighting savings to achieve with AES-Indiana's recent program achievements related to LED lighting. To align with these efforts, it was necessary to move forward in time the estimated lighting potential savings. For other end-uses or programs, GDS had to slow down the initial pace of adoption in the near term, though this had minor impact on the long-term potential. GDS then assumed a non-linear ramp rate from the initial year market adoption rate to the various long-term market adoption rates for each specific end-use.

#### 4.4.4.2 Non-Incentive Costs

Consistent with National Action Plan for Energy Efficiency (NAPEE) guidelines[6], utility non-incentive costs were included in the overall assessment of cost-effectiveness at the RAP scenario. Program non-incentive costs were calibrated to recent projected levels (using the 2021 portfolio summary) and set at:

- $0.031 per PEER participant
- $0.216 per first year kWh saved for residential Appliance Recycling program measures
- $0.369 per first year kWh saved for Income-Qualified program measures
- $0.132-$0.265 per first year kWh saved for measures in the School Education, Efficient Products and Multifamily programs
- $0.21 per first year kWh saved for the remaining residential measures
- $0.040 per first year kWh saved for prescriptive C&I measures
- $0.083 per first year kWh saved for custom C&I measures.

Non-incentive costs were then escalated annually at the rate of inflation.[7]

[6] National Action Plan for Energy Efficiency (2007). Guide for Conducting Energy Efficiency Potential Studies. Prepared by Optimal Energy. This study notes that economic potential only considers the cost of efficiency measures themselves, ignoring programmatic costs. Conversely, achievable potential should consider the non-measures costs of delivering programs. Pg. 2-4.
[7] As noted earlier in the report, measure costs and utility incentives were not escalated over the 20-year analysis timeframe to keep those costs constant in nominal dollars.

## 4.5 RESIDENTIAL ENERGY EFFICIENCY POTENTIAL

This section provides the potential results for technical, economic, MAP and RAP for the residential sector. The cost-effectiveness results and budgets for the RAP scenario are also provided.

### *4.5.1 Scope of Measures & End Uses Analyzed*

There were 170 total unique residential electric measures included in the analysis. Table 4-5 provides the number of unique measures by end-use. The measure list was developed based on a review of current AES Indiana programs, the Indiana TRM, other regional TRMs, and industry documents related to emerging technologies. Data collection activities to characterize measures formed the basis of the assessment of incremental costs, electric energy and demand savings, and measure life.

**TABLE 4-5: RESIDENTIAL ENERGY EFFICIENCY MEASURES – BY END USE**

| End-Use | Number of Unique Measures |
|---|---|
| Appliances | 23 |
| Behavior | 4 |
| HVAC | 49 |
| Lighting | 14 |
| New Construction | 4 |
| Plug Loads | 4 |
| Pool/Pump | 4 |
| Shell | 53 |
| Water Heating | 15 |
| **Total** | **170** |

### *4.5.2 Summary of Residential Electric Potential*

Figure 4-3 provides the technical, economic, MAP and RAP results for the 3-year, 10-year, and 19-year timeframes. The 3-year technical potential is 16% of forecasted sales, and the economic potential is 11% of forecasted sales. The 3-year MAP is 4.1% and the RAP is 3.3%.

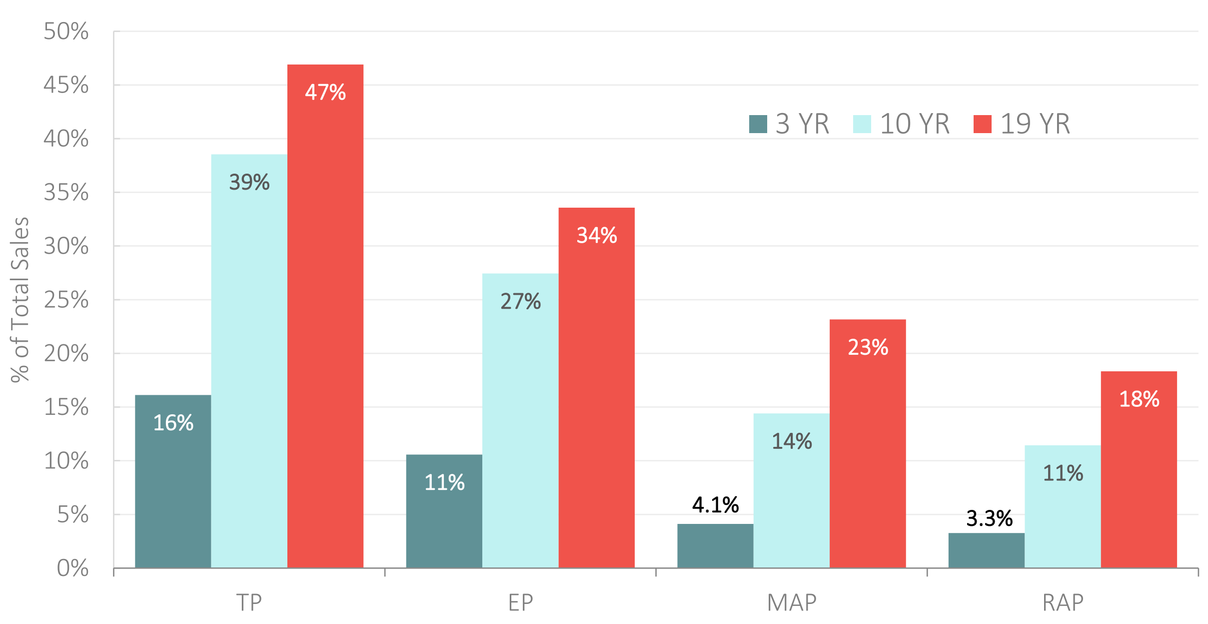



**FIGURE 4-3: RESIDENTIAL ELECTRIC ENERGY CUMULATIVE ANNUAL POTENTIAL (AS A % OF RESIDENTIAL SALES)**

Table 4-6 provides cumulative annual technical, economic, MAP and RAP energy savings, in total MWh and as a percentage of the sector-level sales forecast. The RAP increases to 3.3% cumulative annual savings over the next three years.

**TABLE 4-6: RESIDENTIAL CUMULATIVE ANNUAL ENERGY EFFICIENCY POTENTIAL SUMMARY**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MWh** | | | | | |
| **Technical** | 331,822 | 611,621 | 848,287 | 2,183,950 | 2,951,972 |
| **Economic** | 214,886 | 391,081 | 556,041 | 1,554,873 | 2,113,142 |
| **MAP** | 83,453 | 147,566 | 216,208 | 816,496 | 1,457,663 |
| **RAP** | 68,585 | 118,341 | 171,696 | 648,357 | 1,153,791 |
| **Forecasted Sales** | 5,197,247 | 5,221,823 | 5,259,705 | 5,666,996 | 6,292,981 |
| **Energy Savings (as % of Forecast)** | | | | | |
| **Technical** | 6.4% | 11.7% | 16.1% | 38.5% | 46.9% |
| **Economic** | 4.1% | 7.5% | 10.6% | 27.4% | 33.6% |
| **MAP** | 1.6% | 2.8% | 4.1% | 14.4% | 23.2% |
| **RAP** | 1.3% | 2.3% | 3.3% | 11.4% | 18.3% |

Table 4-7 provides the incremental annual technical, economic, MAP and RAP energy savings, in total MWh and as a percentage of the sector-level sales forecast. The incremental RAP ranges from 1.3% to 1.5% per year over the next three years.

**TABLE 4-7: RESIDENTIAL INCREMENTAL ANNUAL ENERGY EFFICIENCY POTENTIAL SUMMARY**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MWh** | | | | | |
| **Technical** | 331,822 | 324,480 | 319,559 | 294,148 | 292,261 |
| **Economic** | 214,886 | 211,401 | 208,809 | 197,030 | 200,159 |
| **MAP** | 83,453 | 86,756 | 92,822 | 133,956 | 148,545 |
| **RAP** | 68,585 | 72,355 | 77,385 | 114,551 | 125,716 |
| **Forecasted Sales** | 5,197,247 | 5,221,823 | 5,259,705 | 5,666,996 | 6,292,981 |
| **Energy Savings (as % of Forecast)** | | | | | |
| **Technical** | 6.4% | 6.2% | 6.1% | 5.2% | 4.6% |
| **Economic** | 4.1% | 4.0% | 4.0% | 3.5% | 3.2% |
| **MAP** | 1.6% | 1.7% | 1.8% | 2.4% | 2.4% |
| **RAP** | 1.3% | 1.4% | 1.5% | 2.0% | 2.0% |

### *4.5.3 Residential Technical & Economic Potential*

Table 4-8 provides cumulative annual technical and economic potential results across the 19-yr study timeframe. The technical potential is 47% of forecasted sales in 2042, and the economic potential is 34% of forecasted sales in 2042. The HVAC end use has the most technical and economic potential, with Water Heating and Shell end uses also contributing a significant amount of technical and economic potential as well.

**TABLE 4-8: TECHNICAL AND ECONOMIC RESIDENTIAL ELECTRIC POTENTIAL**

| | Technical Potential | | Economic Potential | |
|---|---|---|---|---|
| **End Use** | **Energy (MWh)** | **Peak Demand (MW)** | **Energy (MWh)** | **Peak Demand (MW)** |
| Appliances | 193,579 | 28.0 | 161,710 | 23.7 |
| Behavior | 25,936 | 3.0 | 27,249 | 3.1 |
| HVAC | 1,204,945 | 382.8 | 944,033 | 336.5 |
| Lighting | 152,241 | 187.8 | 152,241 | 187.8 |
| New Construction | 65,242 | 5.2 | 21,621 | 5.2 |

| End Use | Technical Potential Energy (MWh) | Technical Potential Peak Demand (MW) | Economic Potential Energy (MWh) | Economic Potential Peak Demand (MW) |
|---|---|---|---|---|
| Plug Loads | 261,268 | 29.8 | 101,630 | 11.6 |
| Pool/Pump | 131,955 | 19.4 | 108,265 | 16.7 |
| Shell | 490,697 | 165.9 | 287,576 | 79.4 |
| Water Heating | 426,109 | 55.3 | 308,816 | 44.5 |
| **Total** | **2,951,972** | **877** | **2,113,142** | **708** |
| **Savings as % of Forecast** | 46.9% | - | 33.6% | - |

### 4.5.4 Residential Achievable Potential Savings

Figure 4-4 provides the MAP and RAP across the 19-yr timeframe of the study. The green and red bars provide the respective incremental annual MAP and RAP in MWh per year energy savings. The green and orange lines provide the corresponding cumulative annual MAP and RAP as a percent of forecasted annual sales. The MAP rises to 23% by 2042, and the RAP rises to 18%.

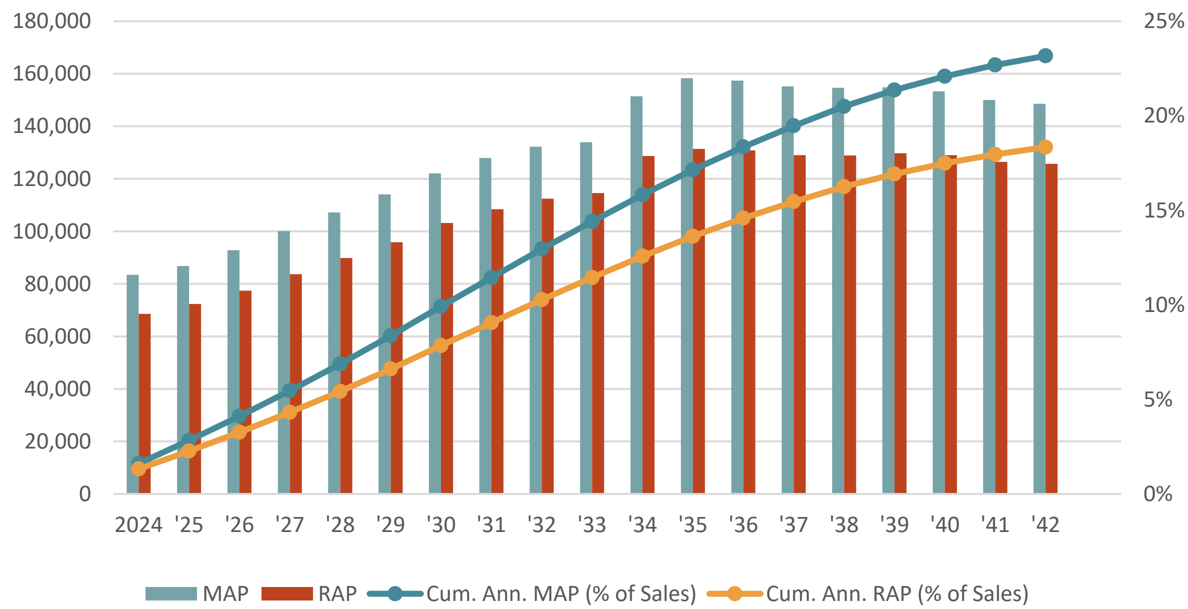



**FIGURE 4-4: RESIDENTIAL ANNUAL MAP AND RAP**

Figure 4-5 provides a breakdown of the RAP potential in 2042 across end-uses and building type market segments. As in technical and economic potential, HVAC is the leading end-use accounting for 37% of the total. The Shell and Water Heating end-uses combine to account for an additional 36% of the RAP. The single-family housing segment represents 59% of the potential and the multifamily segment represents 20% of the potential. The new construction segment accounts for 10% of potential, and measures dedicated to low-income customers account for 11% of potential.

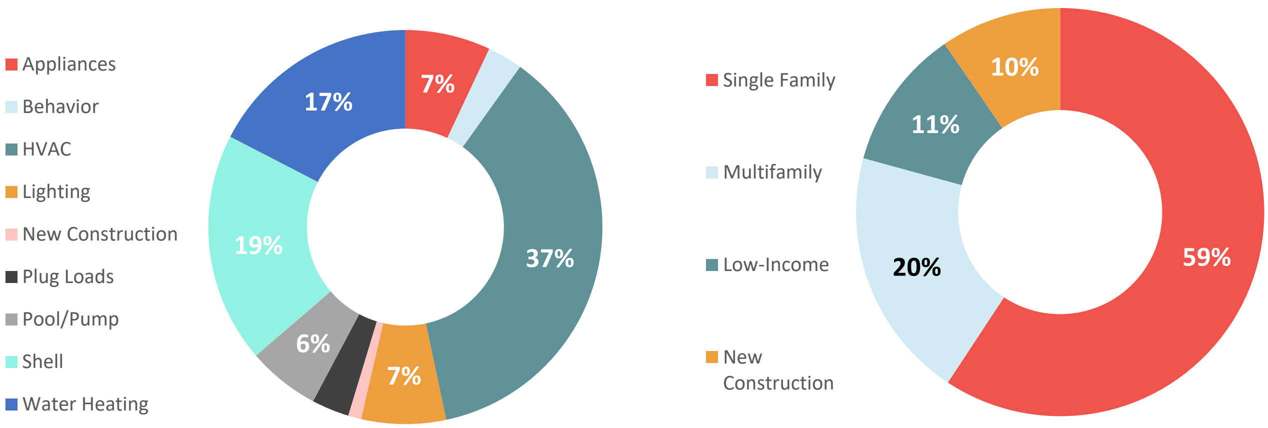



**FIGURE 4-5: RESIDENTIAL POTENTIAL BY END-USE AND BUILDING TYPE – RAP 2042**

Table 4-9 provides incremental and cumulative annual commercial sector energy and demand savings for MAP and RAP across the next three years as well as over the 10-yr and 19-yr time horizons. Incremental RAP energy savings begin at 68,600 MWh in 2024 followed by an increase over the next several years. Cumulative RAP energy savings rise to approximately 1.2 million MWh by 2042.

**TABLE 4-9: RESIDENTIAL ANNUAL MAP AND RAP**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **Incremental Annual Energy (MWh)** | | | | | |
| **MAP** | 83,453 | 86,756 | 92,822 | 133,956 | 148,545 |
| **RAP** | 68,585 | 72,355 | 77,385 | 114,551 | 125,716 |
| **Incremental Annual Energy (MW)** | | | | | |
| **MAP** | 25.8 | 27.7 | 29.5 | 38.8 | 43.2 |
| **RAP** | 19.3 | 21.1 | 22.6 | 33.3 | 36.2 |
| **Cumulative Annual Energy (MWh)** | | | | | |
| **MAP** | 83,453 | 147,566 | 216,208 | 816,496 | 1,457,663 |
| **RAP** | 68,585 | 118,341 | 171,696 | 648,357 | 1,153,791 |
| **Cumulative Annual Energy (MW)** | | | | | |
| **MAP** | 25.8 | 50.9 | 77.5 | 293.0 | 486.5 |
| **RAP** | 19.3 | 37.9 | 57.7 | 229.1 | 394.2 |

Table 4-10 provides additional end-use level detail for the cumulative annual residential MAP and RAP. The HVAC, Shell and Water Heating end-uses provide more than 75% of the MAP and RAP over the study timeframe.

**TABLE 4-10: RESIDENTIAL ANNUAL MAP AND RAP – END-USE DETAIL**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MAP Cumulative Annual MWh** | | | | | |
| Appliances | 3,638 | 7,637 | 12,035 | 47,268 | 92,274 |
| Behavior | 22,409 | 22,817 | 23,020 | 27,234 | 31,375 |
| HVAC | 22,432 | 47,145 | 74,049 | 325,196 | 680,912 |
| Lighting | 4,786 | 10,143 | 16,270 | 72,967 | 107,032 |
| New Construction | 431 | 1,009 | 1,436 | 7,515 | 13,884 |

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| Plug Loads | 225 | 521 | 918 | 9,581 | 36,814 |
| Pool/Pump | 1,660 | 3,798 | 6,229 | 34,749 | 76,958 |
| Shell | 16,146 | 33,733 | 52,372 | 180,757 | 203,118 |
| Water Heating | 11,726 | 20,763 | 29,880 | 111,229 | 215,297 |
| **Total** | **83,453** | **147,566** | **216,208** | **816,496** | **1,457,663** |
| **% of Forecasted Sales** | **1.6%** | **2.8%** | **4.1%** | **14.4%** | **23.2%** |
| **RAP Cumulative Annual MWh** | | | | | |
| Appliances | 3,479 | 7,273 | 11,407 | 42,752 | 80,813 |
| Behavior | 22,475 | 22,948 | 23,223 | 28,178 | 33,347 |
| HVAC | 12,789 | 27,094 | 42,864 | 196,547 | 424,338 |
| Lighting | 3,272 | 6,938 | 11,178 | 52,961 | 80,075 |
| New Construction | 376 | 880 | 1,254 | 6,617 | 12,362 |
| Plug Loads | 217 | 502 | 885 | 9,233 | 35,477 |
| Pool/Pump | 1,177 | 2,755 | 4,577 | 28,772 | 68,480 |
| Shell | 14,867 | 31,206 | 48,711 | 178,376 | 217,948 |
| Water Heating | 9,934 | 18,746 | 27,596 | 104,920 | 200,951 |
| **Total** | **68,585** | **118,341** | **171,696** | **648,357** | **1,153,791** |
| **% of Forecasted Sales** | **1.3%** | **2.3%** | **3.3%** | **11.4%** | **18.3%** |

### 4.5.5 Residential Achievable Potential Benefits & Costs

Table 4-11 provides the net present value (NPV) benefits and cost, as calculated using the UCT, across the 2024-2042 timeframe for the MAP and RAP scenarios. The overall UCT ratio in the RAP scenario is 1.17. The overall UCT ratio in the MAP scenario is 0.95 due to higher assumed incentive costs.

**TABLE 4-11: RESIDENTIAL MAP AND RAP NPV BENEFITS & COSTS**

| End Use | NPV Benefits | NPV Costs | UCT Ratio |
|---|---|---|---|
| **MAP** | $798,562,463 | $842,902,070 | 0.95 |
| **RAP** | $637,960,175 | $546,541,247 | 1.17 |

Figure 4-6 provides the budget for the RAP scenario. The budget is broken into incentive and non-incentive budgets for each year of the study timeframe. The RAP budget in 2024 is almost $28 million, which then rises to a peak of $63 million in 2035 before decreasing back down to $53 million in 2042.

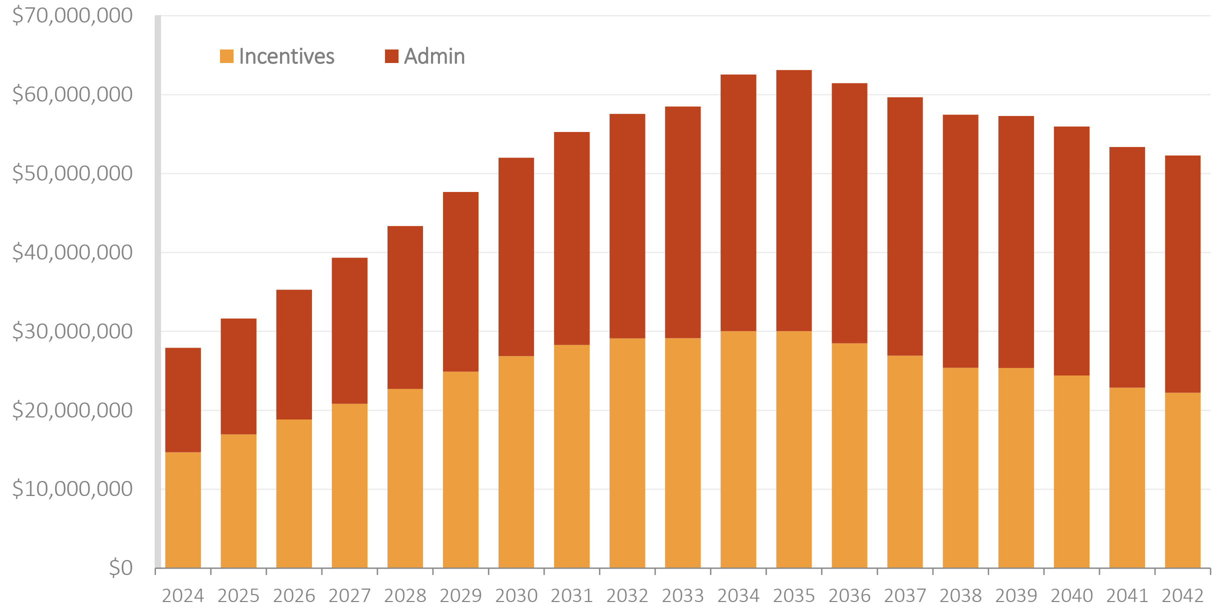



**FIGURE 4-6: RESIDENTIAL ANNUAL BUDGETS – RAP**

## 4.6 COMMERCIAL AND INDUSTRIAL ENERGY EFFICIENCY POTENTIAL

This section provides the potential results for technical, economic, MAP and RAP for the commercial and industrial sector. The cost-effectiveness results and budgets for the RAP scenario are also provided.

### *4.6.1 Scope of Measures & End Uses Analyzed*

There were 170 total unique commercial and industrial (C&I) electric measures included in the analysis. Table 4-12 provides the number of unique measures by end-use. The measure list was developed based on a review of current AES Indiana programs, the Indiana TRM, other regional TRMs, and industry documents related to emerging technologies. Data collection activities to characterize measures formed the basis of the assessment of incremental costs, electric energy and demand savings, and measure life.

**TABLE 4-12: COMMERCIAL AND INDUSTRIAL ENERGY EFFICIENCY MEASURES – BY END USE**

| End-Use | Number of Unique Measures |
|---|---|
| HVAC | 57 |
| Lighting | 33 |
| Refrigeration | 27 |
| Office Equipment | 11 |
| Whole Building | 10 |
| Cooking | 9 |
| Process | 8 |
| Compressed Air | 7 |
| Behavioral | 6 |
| Miscellaneous | 6 |
| Hot Water | 5 |
| Motors | 5 |
| **Total** | **184** |

### *4.6.2 Summary of Commercial and Industrial Electric Potential*

Figure 4-7 provides the technical, economic, MAP and RAP results for the 3-year, 10-year, and 19-year timeframes. The 3-year technical potential is 9.5% of forecasted sales, and the economic potential is 9.1% of forecasted sales. The 3-year MAP is 6.8% and the RAP is 5.1%.

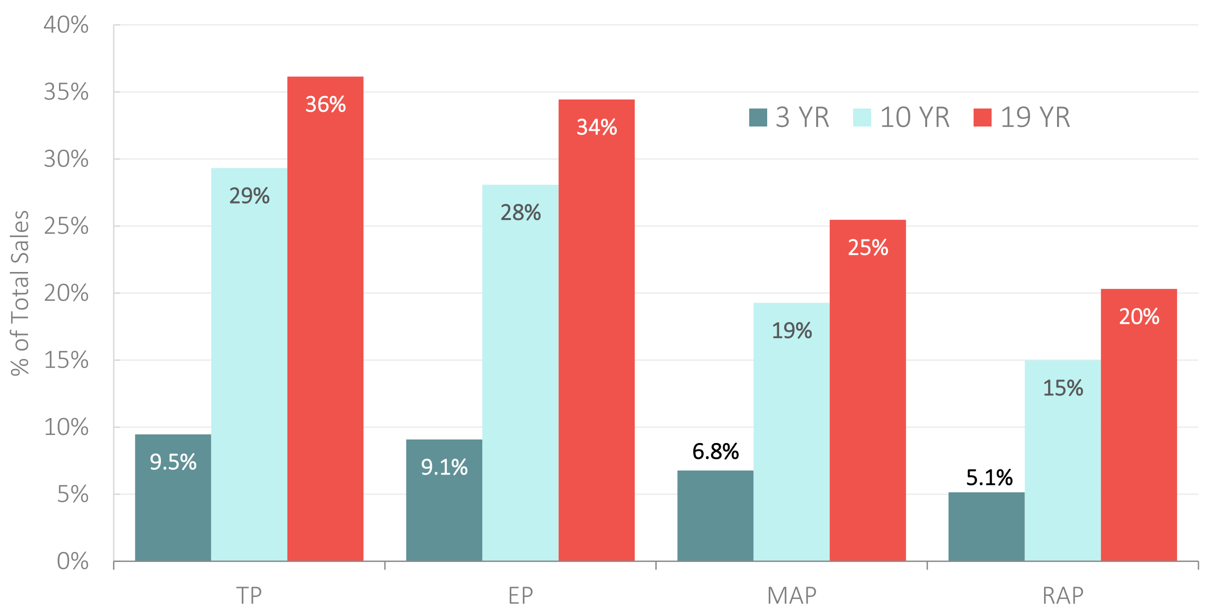



**FIGURE 4-7: C&I ELECTRIC ENERGY CUMULATIVE ANNUAL POTENTIAL (AS A % OF COMMERICAL AND INDUSTRIAL SALES)**

Table 4-13 provides cumulative annual technical, economic, MAP and RAP energy savings, in total MWh and as a percentage of the sector-level sales forecast. The RAP increases to 5.1% cumulative annual savings over the next three years.

**TABLE 4-13: C&I CUMULATIVE ANNUAL ENERGY EFFICIENCY POTENTIAL SUMMARY**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MWh** | | | | | |
| **Technical** | 147,558 | 307,038 | 472,225 | 1,475,613 | 1,864,325 |
| **Economic** | 141,926 | 294,720 | 453,156 | 1,412,934 | 1,776,582 |
| **MAP** | 121,920 | 230,491 | 337,295 | 969,667 | 1,313,569 |
| **RAP** | 91,365 | 174,522 | 256,589 | 754,309 | 1,048,015 |
| **Forecasted Sales** | 4,998,239 | 5,000,270 | 4,988,297 | 5,032,809 | 5,158,648 |
| | | | | | |
| **Technical** | 3.0% | 6.1% | 9.5% | 29.3% | 36.1% |
| **Economic** | 2.8% | 5.9% | 9.1% | 28.1% | 34.4% |
| **MAP** | 2.4% | 4.6% | 6.8% | 19.3% | 25.5% |
| **RAP** | 1.8% | 3.5% | 5.1% | 15.0% | 20.3% |

Table 4-14 provides the incremental annual technical, economic, MAP and RAP energy savings, in total MWh and as a percentage of the sector-level sales forecast. The incremental RAP ranges from 1.6% to 1.8% per year over the next three years.

**TABLE 4-14: C&I INCREMENTAL ANNUAL ENERGY EFFICIENCY POTENTIAL SUMMARY**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MWh** | | | | | |
| **Technical** | 147,558 | 159,480 | 166,589 | 168,954 | 204,800 |
| **Economic** | 141,926 | 152,794 | 158,491 | 149,080 | 173,394 |
| **MAP** | 121,920 | 108,570 | 106,840 | 92,060 | 77,940 |
| **RAP** | 91,365 | 83,157 | 82,103 | 76,579 | 63,010 |
| **Forecasted Sales** | 4,998,239 | 5,000,270 | 4,988,297 | 5,032,809 | 5,158,648 |
| | | | | | |
| **Technical** | 3.0% | 3.2% | 3.3% | 3.4% | 4.0% |
| **Economic** | 2.8% | 3.1% | 3.2% | 3.0% | 3.4% |
| **MAP** | 2.4% | 2.2% | 2.1% | 1.8% | 1.5% |
| **RAP** | 1.8% | 1.7% | 1.6% | 1.5% | 1.2% |

### *4.6.3 Commercial and Industrial Technical & Economic Potential*

Table 4-15 provides cumulative annual technical and economic potential results across the 19-yr study timeframe. The technical potential is 36% of forecasted sales in 2042, and the economic potential is 34% of forecasted sales in 2042. The HVAC end use has the most technical and economic potential, with the Lighting, Refrigeration and Office Equipment end uses also contributing a significant amount of technical and economic potential as well.

**TABLE 4-15: TECHNICAL AND ECONOMIC COMMERCIAL AND INDUSTRIAL ELECTRIC POTENTIAL**

| | Technical Potential | | Economic Potential | |
|---|---|---|---|---|
| **End Use** | **Energy (MWh)** | **Peak Demand (MW)** | **Energy (MWh)** | **Peak Demand (MW)** |
| HVAC | 441,141 | 197 | 440,736 | 197 |
| Lighting | 398,097 | 80 | 386,708 | 80 |
| Refrigeration | 221,392 | 35 | 219,827 | 35 |
| Office Equipment | 153,248 | 9 | 153,248 | 9 |
| Whole Building | 242,858 | 43 | 244,354 | 44 |
| Cooking | 28,725 | 3 | 28,725 | 3 |
| Compressed Air | 31,528 | 8 | 31,528 | 8 |
| Behavioral | 83,948 | 2 | 21,627 | 0 |
| Process | 56,085 | 10 | 56,085 | 10 |
| Miscellaneous | 108,104 | 21 | 94,545 | 21 |
| Hot Water | 12,050 | 2 | 12,050 | 2 |
| Motors | 87,150 | 14 | 87,150 | 14 |
| **Total** | 1,864,325 | 425 | 1,776,582 | 423 |
| **Savings as % of Forecast** | **36.1%** | **-** | **34.4%** | **-** |

### *4.6.4 Commercial and Industrial Achievable Potential*

Figure 4-8 provides the MAP and RAP across the 19-yr timeframe of the study. The green and red bars provide the respective incremental annual MAP and RAP in MWh per year energy savings. The green and orange lines provide the corresponding cumulative annual MAP and RAP as a percent of forecasted annual sales. The MAP rises to 25% by 2042, and the RAP rises to 20%.

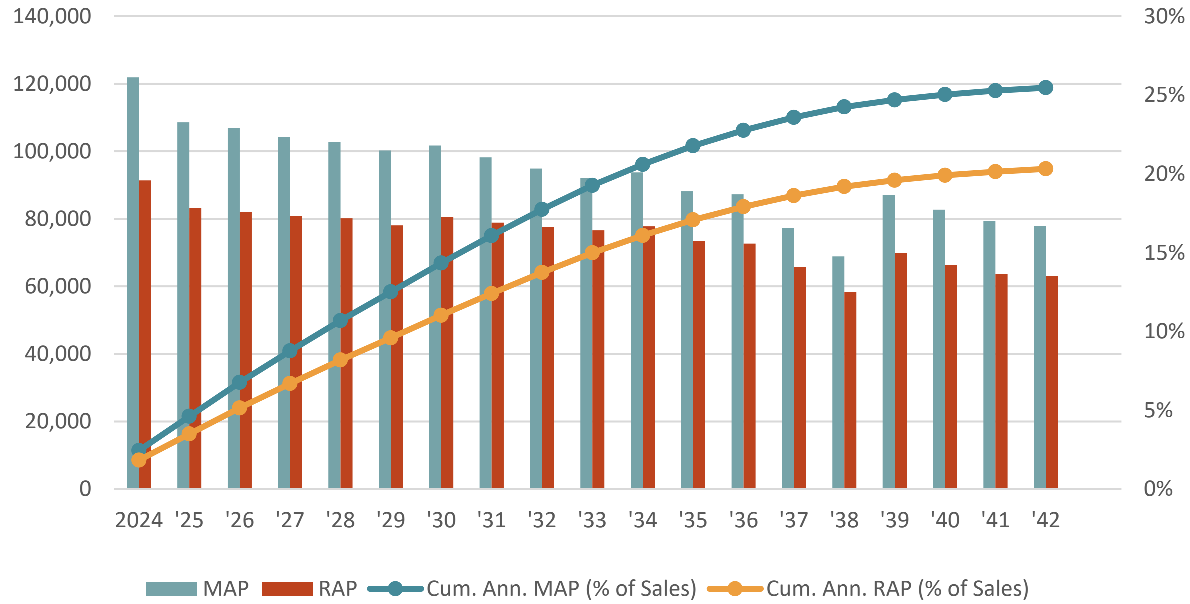
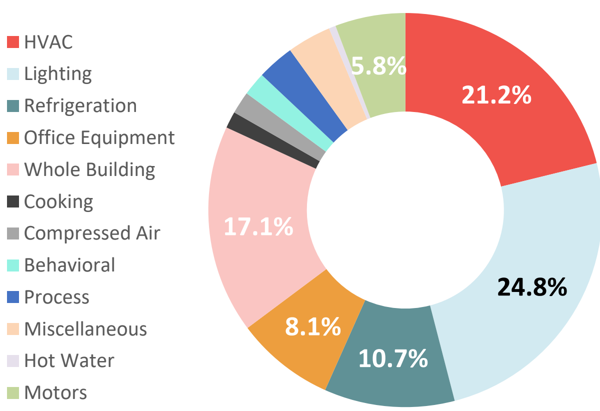



**FIGURE 4-8: COMMERCIAL AND INDUSTIRAL ANNUAL MAP AND RAP**

Figure 4-9 provides a breakdown of the RAP potential in 2042 across end-uses and building type market segments. As in technical and economic potential, HVAC and Lighting are the leading end-uses, accounting for 46% of the total. The Refrigeration, Office Equipment and Whole Building end-uses combine to account for an additional 36% of the RAP. The commercial sector represents 93% of the potential and the industrial sector represents 7% of the potential.



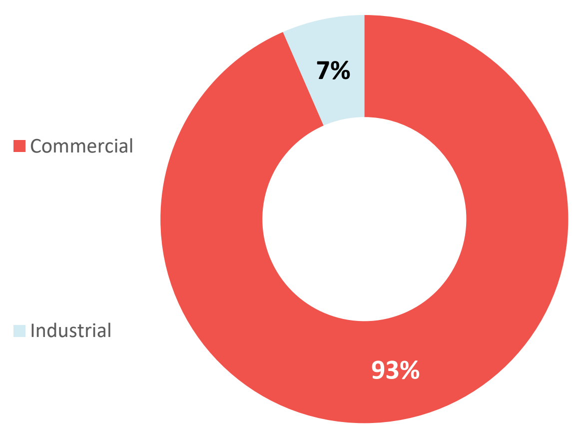




**FIGURE 4-9: COMMERCIAL AND INDUSTRIAL POTENTIAL BY END-USE AND BUILDING TYPE – RAP 2042**

Table 4-16 provides incremental and cumulative annual C&I sector energy and demand savings for MAP and RAP across the next three years as well as over the 10-yr and 19-yr time horizons. Incremental RAP energy savings begin at 91,400 MWh in 2024 followed by an increase over the next several years. Cumulative RAP energy savings rise to approximately 1 million MWh by 2042.

**TABLE 4-16: COMMERCIAL AND INDUSTRIAL ANNUAL MAP AND RAP**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **Incremental Annual Energy (MWh)** | | | | | |
| **MAP** | 121,920 | 108,570 | 106,840 | 92,060 | 77,940 |
| **RAP** | 91,365 | 83,157 | 82,103 | 76,579 | 63,010 |
| **Incremental Annual Energy (MW)** | | | | | |
| **MAP** | 21.8 | 22.5 | 22.4 | 19.6 | 15.5 |
| **RAP** | 16.3 | 16.6 | 16.5 | 14.4 | 11.8 |
| **Cumulative Annual Energy (MWh)** | | | | | |
| **MAP** | 121,920 | 230,491 | 337,295 | 969,667 | 1,313,569 |
| **RAP** | 91,365 | 174,522 | 256,589 | 754,309 | 1,048,015 |
| **Cumulative Annual Energy (MW)** | | | | | |
| **MAP** | 21.8 | 44.4 | 66.8 | 198.7 | 287.5 |
| **RAP** | 16.3 | 32.9 | 49.4 | 143.0 | 210.5 |

Table 4-17 provides additional end-use level detail for the cumulative annual commercial and industrial MAP and RAP. The HVAC, Lighting, and Refrigeration end-uses provide 60% of the MAP and RAP over the study timeframe.

**TABLE 4-17: COMMERCIAL AND INDUSTRIAL ANNUAL MAP AND RAP – END-USE DETAIL**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MAP Cumulative Annual MWh** | | | | | |
| HVAC | 18,514 | 39,584 | 62,075 | 225,703 | 326,144 |
| Lighting | 69,982 | 119,086 | 162,003 | 294,666 | 304,693 |
| Refrigeration | 11,897 | 24,348 | 36,883 | 106,473 | 128,095 |
| Office Equipment | 4,652 | 10,292 | 17,114 | 81,044 | 116,205 |
| Whole Building | 9,636 | 21,438 | 33,842 | 136,542 | 212,679 |
| Cooking | 497 | 1,099 | 1,808 | 9,474 | 17,434 |
| Compressed Air | 1,234 | 2,630 | 4,197 | 16,291 | 23,861 |
| Behavioral | 963 | 2,013 | 3,285 | 15,008 | 18,821 |
| Process | 1,311 | 2,841 | 4,568 | 20,156 | 39,043 |
| Miscellaneous | 910 | 2,024 | 3,324 | 20,136 | 48,650 |
| Hot Water | 322 | 671 | 1,049 | 3,597 | 7,174 |
| Motors | 2,003 | 4,466 | 7,148 | 40,577 | 70,770 |
| **Total** | 121,920 | 230,491 | 337,295 | 969,667 | 1,313,569 |
| **% of Forecasted Sales** | 2.4% | 4.6% | 6.8% | 19.3% | 25.5% |
| **RAP Cumulative Annual MWh** | | | | | |
| HVAC | 9,771 | 21,523 | 34,453 | 141,372 | 221,845 |
| Lighting | 56,232 | 97,950 | 134,739 | 248,668 | 259,927 |
| Refrigeration | 8,798 | 18,338 | 28,211 | 89,110 | 112,227 |
| Office Equipment | 3,516 | 7,742 | 12,862 | 60,826 | 85,021 |
| Whole Building | 7,263 | 16,302 | 25,798 | 109,891 | 179,170 |
| Cooking | 349 | 782 | 1,301 | 7,303 | 14,343 |
| Compressed Air | 916 | 1,966 | 3,133 | 12,772 | 19,256 |
| Behavioral | 970 | 2,032 | 3,327 | 15,695 | 20,183 |
| Process | 964 | 2,128 | 3,485 | 16,424 | 31,862 |

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| Miscellaneous | 659 | 1,467 | 2,413 | 15,135 | 37,827 |
| Hot Water | 266 | 553 | 861 | 2,835 | 5,902 |
| Motors | 1,660 | 3,741 | 6,006 | 34,278 | 60,451 |
| **Total** | 91,365 | 174,522 | 256,589 | 754,309 | 1,048,015 |
| **% of Forecasted Sales** | 1.8% | 3.5% | 5.1% | 15.0% | 20.3% |

### *4.6.5 Commercial and Industrial Achievable Potential Benefits & Costs*

Table 4-18 provides the net present value (NPV) benefits and cost, as calculated using the UCT, across the 2024-2042 timeframe for the MAP and RAP scenarios. The overall UCT ratio in the RAP scenario is 3.61. The overall UCT ratio in the MAP scenario is 1.79 due to higher assumed incentive costs and greater participation.

**TABLE 4-18: RESIDENTIAL MAP AND RAP NPV BENEFITS & COSTS**

| End Use | NPV Benefits | NPV Costs | UCT Ratio |
|---|---|---|---|
| **MAP** | $677,847,333 | $377,801,254 | 1.79 |
| **RAP** | $499,594,928 | $138,545,911 | 3.61 |

Figure 4-10 provides the budget for the RAP scenario. The budget is broken into incentive and non-incentive budgets for each year of the study timeframe. The RAP budget in 2024 is almost $13 million, which then rises to a peak of $14.3 million in 2034 before decreasing back down to $133 million in 2042.

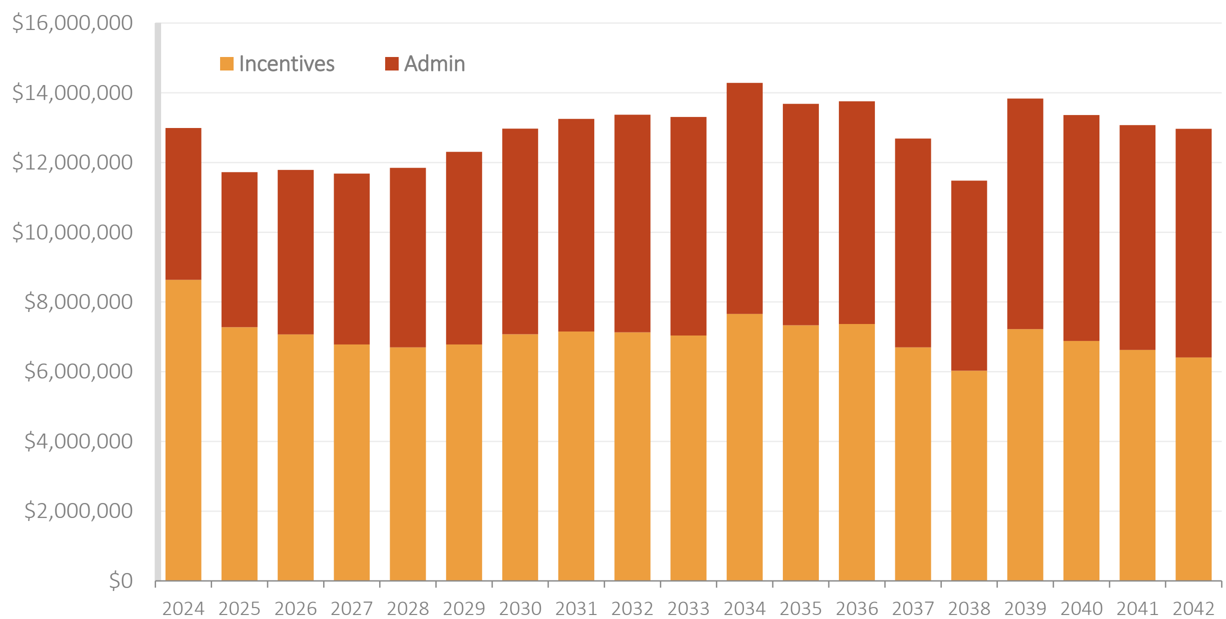



**FIGURE 4-10: COMMERCIAL AND INDUSTRIAL ANNUAL BUDGETS – RAP**

# 5 Demand Response Potential

This section provides the results of the MAP and RAP potential for the demand response analysis. Results are broken down by sector and program. The cost-effectiveness results and budgets for the MAP and RAP scenarios are also provided. Section 5.1 provides a description of the demand response methodology.

## 5.1 DEMAND RESPONSE PROGRAM OPTIONS

Table 5-1 Demand Response Program Options and Eligible MarketsTable 5-1 provides a brief description of the demand response program options considered and identifies the eligible customer segment for each demand response program that was considered in this study. This includes direct load control (DLC) and rate design options.

**TABLE 5-1 DEMAND RESPONSE PROGRAM OPTIONS AND ELIGIBLE MARKETS**

| Demand Response Program Option | Program Description | Eligible Markets |
|---|---|---|
| DLC AC (Switch) | The compressor of the air conditioner is remotely shut off (cycled) by the system operator for periods that may range from 7 ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle). GDS looked at both the one-way communicating Cannon switches and two-way communicating L+G switches. Both switch options were assumed to be phased out as customers switch to thermostats over time. | Residential and C&I Customers |
| DLC AC (Thermostat) | The system operator can remotely raise the AC's thermostat set point during peak load conditions, lowering AC load. GDS looked at the three options AES Indiana currently has: a customer is given a free thermostat to participate along with an annual incentive, a customer is given a rebate through the marketplace or a storefront along with an annual incentive, or the customer brings an existing thermostat and is only given an annual incentive. | Residential and C&I Customers |
| DLC Space Heating | The system operator can remotely lower the HVAC's thermostat set point during winter peak load conditions, lowering the heating load. This program is an add-on to the DLC AC Thermostat program. Only participants in the AC Thermostat program would be allowed to participate in the Space Heating program. | Residential and C&I Customers |
| DLC Water Heaters | The water heater is remotely shut off by the system operator for periods normally ranging from 2 to 8 hours. | Residential and C&I Customers |
| DLC Room AC | The compressor of the room air conditioner is remotely shut off (cycled) by the system operator for periods that may range from 7 ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle). Controlled via load control switch. Participant cannot override control. | Residential Customers |
| DLC Lighting | Part of the lighting load is remotely shut off by the system operator for periods normally ranging from 2 to 4 hours. | C&I Customers |

| Demand Response Program Option | Program Description | Eligible Markets |
|---|---|---|
| Battery Storage | Customer-sited stationary storage systems that are connected to the distribution system on the customer's side of the utility's service meter. The systems are installed on customer premises, provide savings or other benefits to the customers, and customers are typically the principal investors in the system. The primary drivers for customer adoption of BTM are opportunities for bill reductions, improving energy resilience, and mitigating power quality. | Residential Customers |
| Behavioral DR | Customers are given a rebate for less consumption during times selected as critical periods. | Residential Customers |
| Ice Storage Cooling Rate | The use of a cold storage medium such as ice, chilled water, or other liquids. Off-peak energy is used to produce chilled water or ice for use in cooling during peak hours. The cool storage process is limited to off-peak periods. | C&I Customers |
| Curtailable Rate (Day Of) | A discounted rate is offered to the customer for agreeing to interrupt or curtail load during peak period. | C&I Customers |
| Curtailable Rate (Day Ahead) | A discounted rate is offered to the customer for agreeing to interrupt or curtail load during peak period. | C&I Customers |
| Time of Use with Enabling Technology | A retail rate with different prices for usage during different blocks of time. Daily pricing blocks could include on-peak, mid-peak, and off-peak periods. Participants are required to have enabling technology (usually a smart thermostat) to help more consistently control the load during peak hours. | Residential and C&I Customers |
| Time of Use without Enabling Technology | A retail rate with different prices for usage during different blocks of time. Daily pricing blocks could include on-peak, mid-peak, and off-peak periods. Participants are not required to have enabling technology. | Residential and C&I Customers |
| Capacity Bidding | Flexible bidding program offering qualified businesses payments for agreeing to reduce load when an event is called. Participants make monthly nominations and receive capacity payments based on the amount of capacity reduction nominated each month, plus energy payments based on your actual kilowatt-hour (kWh) energy reduction when an event is called. The amount of capacity nomination can be adjusted on a monthly basis. The program can be Internet-based, providing ready access to program information and ease-of-use. Penalties occur if load nominations are not met. | C&I Customers |
| Demand Bidding | Year-round, flexible, Internet-based bidding program that offers business customers credits for voluntarily reducing power when a DBP event is called. | C&I Customers |

Double-counting savings from demand response programs that affect the same end uses is a common issue that must be addressed when calculating the demand response savings potential. For example, a direct load control (DLC) program of air conditioning and a rate program both assume load reduction of the customers' air conditioners. For this reason, it is typically assumed that customers cannot participate in programs that affect the same end uses. One cannot save a kW of load in a specific hour more than once. In general, the hierarchy of demand response programs is accounted for by subtracting the number participants in a higher priority program from the eligible market for a lower priority program. Table 5-2 shows the hierarchy for each sector, with 1 being the top priority. Note that only cost-effective programs are included in the hierarchy.

**TABLE 5-2 DR HIERARCHY FOR EACH SECTOR**

| Order | Residential Hierarchy | Small C&I Hierarchy | Large C&I Hierarchy |
|---|---|---|---|
| 1 | Direct Load Control | Direct Load Control | Interruptible Rate |
| 2 | Behavioral DR | Capacity Bidding | Capacity Bidding |
| 3 | Time of Use with Enabling Technology | Time of Use with Enabling Technology | Time of Use with Enabling Technology |
| 4 | Time of Use without Enabling Technology | Time of Use without Enabling Technology | Time of Use without Enabling Technology |

### *5.1.1 Demand Response Potential Assessment Approach Overview*

The analysis of demand response, where possible, closely followed the approach outlined for energy efficiency. The framework for assessing the cost-effectiveness of demand response programs is based *on A Framework for Evaluating the Cost-Effectiveness of Demand Response, prepared for the National Forum on the National Action Plan (NAPA) on Demand Response*.[8] Additionally, GDS reviewed the May 2017 National Standard Practice Manual published by the National Efficiency Screening Project.[9] GDS utilized this guide to define avoided ancillary services and energy and/or capacity price suppression benefits.

Direct load control and rate programs (excluding the interruptible rate program) demand response analysis was conducted using the GDS Demand Response Model. The interruptible rate program was analyzed using the Demand Side Analytics (DSA) program. GDS determined the estimated savings for each demand response program by performing a review of all benefits and cost associated with each program. A modeling approach that considers numerous required inputs for each program was used, including expected life, coincident peak (CP) kW load reductions, proposed incentive levels, program related expenses such as vendor service fees, marketing and evaluation cost and on-going O&M expenses.

The UCT was used to determine the cost-effectiveness of each demand response program. Benefits are based on avoided demand, energy (including load shifting), wholesale cost reductions and T&D costs. Costs include incremental program equipment costs (such as control switches or smart thermostats), fixed program capital costs (such as the cost of a central controller), program administrative, marketing, and evaluation costs. Incremental equipment program costs are included for both new and replacement units (such as control switches) to account for units that are replaced at the end of their useful life.

The demand response analysis includes estimates of technical, economic, and achievable potential. Achievable potential is broken into maximum achievable potential (MAP) and realistic achievable potential (RAP) in this study:

**MAP** represents an estimate of the maximum cost-effective demand response potential that can be achieved over the 19-year study period. For this study, this is defined as customer participation in demand response program options that reflect a "best practices" estimate of what could eventually be achieved. MAP assumes no barriers to effective delivery of programs.

**RAP** represents an estimate of the amount of demand response potential that can be realistically achieved over the 19-year study period. For this study, this is defined as achieving customer participation in demand response program options that reflect a realistic estimate of what could eventually be achieved assuming

[8] Study was prepared by Synapse Energy Economics and the Regulatory Assistance Project, February 2013.
[9] National Standard Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources, May 18, 2017, Prepared by The National Efficiency Screening Project

typical or "average" industry experience. RAP is a discounted MAP, by considering program barriers that limit participation, therefore reducing savings that could be achieved.

### *5.1.2 Avoided Costs*

Demand response avoided costs were consistent with those utilized in the energy efficiency potential analysis and were provided by AES Indiana. The primary benefit of demand response is avoided generation capacity, resulting from a reduction in the need for new peaking generation capacity. Demand response can also produce energy related benefits. If the demand response option is considered "load shifting," such as direct load control of electric water heating, the consumption of energy is shifted from the control period to the period immediately following the period of control. For this study, GDS assumed that the energy is shifted with no loss of energy. If the program is not considered to be "load shifting" the measure is turned off during peak control hours, and the energy is saved altogether. Demand response programs can also potentially delay the construction of new transmission and distribution lines and facilities, which is reflected in avoided T&D costs.

### *5.1.3 Demand Response Program Assumptions*

This section briefly discusses the general assumptions and sources used to complete the demand response potential analysis.

#### 5.1.3.1 Direct Load Control Program Assumptions

***Load Reduction:*** Demand reductions were based on load reductions found in AES Indiana's existing demand response programs, and various secondary data sources including the FERC and other industry reports, including demand response potential studies that conducted primary research. DLC and thermostat-based demand response options were typically calculated based on a per-unit kW demand reduction.

***Useful Life:*** The useful life of a smart thermostat is assumed to be 15 years . Load control switches have a useful life of 10 years. This life was used for all direct load control measures in this study.

***Program Costs:*** One-time program development costs included in the first year of the analysis for new programs. No program development costs are assumed for programs that already exist. Each new program includes an evaluation cost, with evaluation cost for existing programs already being included in the administration costs. It was assumed that there would be a cost of $50[10] per new participant for marketing for the DLC programs. Marketing costs are assumed to be 33.3% higher for MAP. All program costs were escalated each year by the general rate of inflation assumed for this study.

***Saturation:*** The number of control units per participant was assumed to be 1 for all direct load control programs using switches (such as water heaters and air conditioning switches), because load control switches can control up to two units. However, for controllable thermostats, some participants have more than one thermostat. The average number of residential thermostats per single family home was assumed to be 1.063 thermostats[11].

***Program Adoption Levels:*** Long-term program adoption levels (or "steady state" participation) represent the enrollment rate once the fully achievable participation has been reached. GDS reviewed industry data and program adoption levels from several utility demand response programs. The main sources of participant rates are several studies completed by the Brattle Group. As noted earlier in this section, for direct load control programs, MAP participation rates rely on industry best adoption rates and RAP participation rates are based on industry average adoption levels. For the rate programs, the MAP steady-state participation rates assumed programs were opt-out based and RAP participation assumed opt-in status.

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[10] TVA Potential Study Volume III: Demand Response Potential, Global Energy Partners, December 2011
[11] IPL/GDS Residential Survey Questionnaire

Customer participation in new demand response programs is assumed to reach the steady state take rate over a five-year period. The path to steady state customer participation follows an "S-shaped" curve, in which participation growth accelerates over the first half of the five-year period, and then slows over the second half of the period (see Figure 5-1). Existing programs have already gone through this ramp-up period, so they were escalated linearly to the final participation rate.

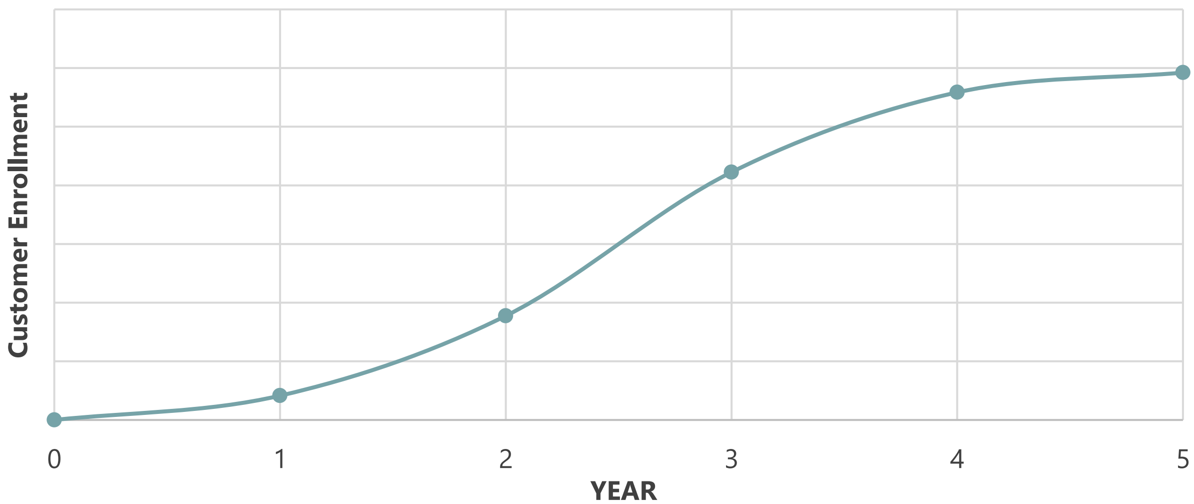


**FIGURE 5-1: ILLUSTRATION OF S-SHAPED MARKET ADOPTION CURVE**

#### 5.1.3.2 Rate Program Assumptions

***Load Reduction:*** Demand reductions were based on various secondary data sources including the FERC and other industry reports, including demand response potential studies that conducted primary research. Rate-based demand response options were typically assumed to reduce a percentage of the total facility coincident peak load.

***Useful Life:*** The useful life of a smart thermostat is assumed to be 15 years . Smart thermostats were assumed to be the enabling technology required for the TOU with Enabling Technology program. For other rate programs that did not require any additional technology, the only equipment needed is a smart meter. The life of a smart meter was assumed to be 20 years.

***Program Costs:*** One-time program development costs included in the first year of the analysis for new programs. No program development costs are assumed for programs that already exist. Each new program includes an evaluation cost, with evaluation cost for existing programs already being included in the administration costs. It was assumed that there would be a cost of $50[12] per new participant for marketing for the DLC programs. Marketing costs are assumed to be 33.3% higher for MAP. All program costs were escalated each year by the general rate of inflation assumed for this study.

#### 5.1.3.3 C&I Interruptible Rate Program Assumptions

One of the most prominent forms of demand response among non-residential customers is load curtailment agreements where the utility, or an aggregator on the utility's behalf, enters financial agreements with businesses to reduce load when dispatched. Load curtailment potential is driven by a few key factors – incentive payments, the frequency of events, the duration of events, and the level of notification participants are given about pending events. The directional effect these factors have on demand response potential is shown in Figure 5-2.

[12] TVA Potential Study Volume III: Demand Response Potential, Global Energy Partners, December 2011

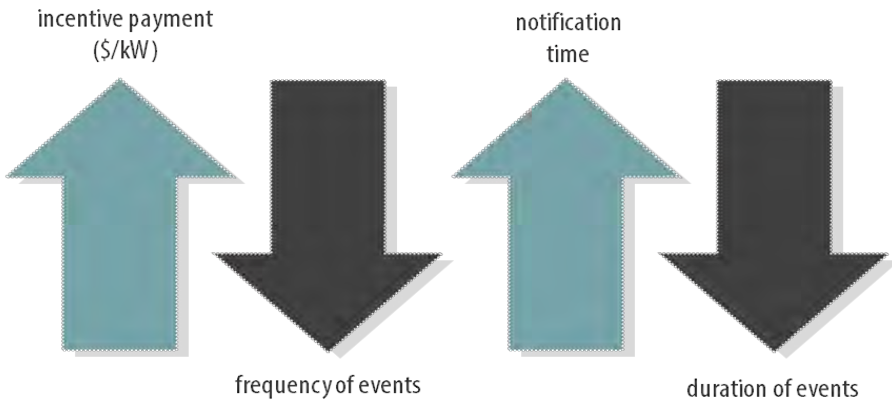


**FIGURE 5-2: DRIVERS OF DR POTENTIAL**

Several different estimates of Curtailment Load potential can be produced by turning levers related to these four inputs. Rather than producing several different scenario-based estimates, the research team made several simplifying assumptions regarding program design. Components of program design include how many demand response events will be called, how long the demand response events will last, how far in advance participants are notified of the upcoming demand response event, and the incentive payment participants receive (the amount and how it is distributed – annually, monthly, per event, etc.).

***Program Design:*** Previous Indiana research suggests short demand response events would serve the region better than long events, as summer peaks are concentrated between 2:00 PM and 6:00 PM. Thus, our estimates of potential assume a four-hour event duration. We are also assuming that there will be an average of seven summer events will be called (28 total event hours for the summer).

Results were calculated for both a “day-ahead” notification design and a “day-of” notification design. “Day-ahead” notification assumes a 24-hour notice, and “day-of” notification assumes a 3-to-6-hour notice. Potential is higher under the “day-ahead” notification design, as this provides participants greater opportunities to shift energy-intensive tasks to off-peak periods.

***Participant Incentive:*** For C&I Curtailable demand response, our team modeled the incentive as a reservation payment. This is an annual payment provided to the participant. In exchange, the participant agrees to curtail load when events are dispatched. For RAP, our approach to setting incentive levels involved optimizing net benefits. To determine the optimal incentive level, the research team performed a simulation where the critical input was the incentive level and the critical output was the net benefit of the demand response program. The simulation leveraged several of the inputs discussed herein. The results indicated that the optimal incentive level in 2020 is $21/kW-year.

For MAP, the goal of the simulation was not to optimize net benefits. Instead, we used the simulation to determine the greatest possible incentive level that would produce a cost-effective program (e.g., largest incentive value such that the UCT ratio does not fall below 1). The results indicated an incentive level of $39/kW-year should be used in estimating MAP for summer 2020.

In both cases, the incentive level is escalated annually at a rate that matches the growth rate of avoided costs. This growth rate is largely driven by the generation component (avoided cost of generation capacity was provided by AES Indiana).

***Price Elasticity of Demand Coefficients:*** The price elasticity of demand coefficients used in this research were derived from two years of demand response performance data for C&I demand response participants in Pennsylvania. Information about sector (small/large), incentive levels, and the peak load share of each participant was used in the development of the elasticity coefficients. Traditional elasticity formulas were used.

Leveraging the inputs discussed above, C&I Curtailable load potential estimates were developed via a "top-down" approach. At a high level, the approach entails disaggregating the peak load forecast into peak load forecasts by sector, and then combining these forecasts with the price elasticity of demand coefficients to estimate potential. Price elasticity of demand can be thought of as the percentage change in the quantity of electricity demanded divided by the percentage change in the price (including an incentive) of demand response:

$$Elasticity = \frac{\%\ change\ in\ Quantity}{\%\ change\ in\ Price}$$

Rearranging the terms in the elasticity equation yields the following:

$$\%\ change\ in\ Quantity = (Elasticity) \times (\%\ change\ in\ Price)$$

Note that "% change in Quantity" can also be expressed as:

$$\%\ change\ in\ Quantity = \frac{(Summer\ peak -\ DR\ potential) - Summer\ Peak}{Summer\ Peak} * 100\%$$

Combing these two "% change in Quantity" equations yields:

$$(Elasticity) \times (\%\ change\ in\ Price) = \frac{(Summer\ peak -\ DR\ potential) - Summer\ Peak}{Summer\ Peak} * 100\%$$

By making assumptions about price elasticity, the percentage change in price (related to electric retail rates and the incentive level), and the summer peak load, it is possible to estimate how much demand response potential exists in each market segment by solving for "demand response potential." It is important to note that the estimates of C&I Curtailable Load demand response potential discussed in this section are not incremental to existing AES Indiana programs. That is, we are not estimating how much Curtailable Load demand response potential exists beyond the existing AES Indiana resources. It is also important to note that this top-down methodology produces estimates of Curtailable Load demand response potential at the system-level (inclusive of line losses).

## 5.2 TOTAL DEMAND RESPONSE POTENTIAL

Table 5-3 and Table 5-4 show the achievable cumulative annual potential savings for the Years 1-3, 10 and 19. Achievable potential includes a participation rate to estimate the realistic number of customers that are expected to participate in each cost-effective demand response program option. These values are at the customer meter. The MAP assumes the maximum participation that would happen in the real-world, while the RAP considers additional barriers to program implementation that could limit the amount of savings achieved. Programs marked with an asterisk were those that were found to not be cost-effective, and therefore do not provide any achievable potential. Two scenarios were looked at for the curtailable rate program: day of notifications and day ahead notifications. The non-residential sector sub-totals and residential and non-residential combined totals reflect these two scenarios.

**TABLE 5-3: MAP SAVINGS BY PROGRAM**

| Sector | Program | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|---|
| Residential | DLC AC - Switch | 13 | 13 | 12 | 7 | 0 |
| | DLC AC - Thermostat | 22 | 29 | 36 | 89 | 163 |
| | DLC Space Heating | 0 | 0 | 5 | 50 | 53 |
| | DLC Water Heating | 2 | 5 | 8 | 65 | 147 |
| | DLC Electric Vehicles* | 0 | 0 | 0 | 0 | 0 |
| | DLC Room AC* | 0 | 0 | 0 | 0 | 0 |
| | Battery Storage* | 0 | 0 | 0 | 0 | 0 |
| | Behavioral DR | 0 | 0 | 2 | 14 | 9 |
| | Time of Use with Enabling Technology | 0 | 0 | 2 | 13 | 7 |
| | Time of Use without Enabling Technology | 0 | 0 | 1 | 8 | 5 |
| | **Sector Total** | **38** | **47** | **66** | **247** | **385** |
| C&I | DLC AC - Switch* | 0 | 0 | 0 | 0 | 0 |
| | DLC AC - Thermostat | 2 | 4 | 6 | 19 | 38 |
| | DLC Space Heating | 0 | 0 | 0 | 5 | 5 |
| | DLC Water Heating | 1 | 2 | 4 | 6 | 6 |
| | Ice Storage Cooling Rate* | 0 | 0 | 0 | 0 | 0 |
| | DLC Lighting* | 0 | 0 | 0 | 0 | 0 |
| | Curtailable (Day Of) | 0 | 0 | 34 | 68 | 70 |
| | Curtailable (Day Ahead) | 0 | 0 | 62 | 127 | 129 |
| | Capacity Bidding | 7 | 23 | 48 | 74 | 78 |
| | Demand Bidding* | 0 | 0 | 0 | 0 | 0 |
| | Time of Use with Enabling Technology | 0 | 0 | 1 | 7 | 3 |
| | Time of Use without Enabling Technology | 0 | 0 | 1 | 4 | 3 |
| | **Sector Total (Curtailable Day Of)** | **9** | **29** | **94** | **184** | **203** |
| | **Sector Total (Curtailable Day Ahead)** | **9** | **29** | **122** | **242** | **263** |
| **Residential & Non-Residential Total (Curtailable Day Of)** | | **48** | **76** | **160** | **430** | **588** |
| **Residential & Non-Residential Total (Curtailable Day Ahead)** | | **48** | **76** | **188** | **489** | **648** |

**TABLE 5-4 RAP SAVINGS BY PROGRAM**

| Sector | Program | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|---|
| Residential | DLC AC - Switch | 13 | 13 | 12 | 7 | 0 |
| | DLC AC - Thermostat | 19 | 23 | 27 | 55 | 94 |
| | DLC Space Heating | 0 | 0 | 4 | 38 | 40 |
| | DLC Water Heating | 1 | 3 | 4 | 35 | 79 |
| | DLC Electric Vehicles* | 0 | 0 | 0 | 0 | 0 |
| | DLC Room AC* | 0 | 0 | 0 | 0 | 0 |

| Sector | Program | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|---|
| | Battery Storage* | 0 | 0 | 0 | 0 | 0 |
| | Behavioral DR | 0 | 0 | 1 | 9 | 8 |
| | Time of Use with Enabling Technology | 0 | 0 | 2 | 13 | 12 |
| | Time of Use without Enabling Technology | 0 | 0 | 1 | 8 | 7 |
| | **Sector Total** | **34** | **39** | **50** | **166** | **241** |
| C&I | DLC AC - Switch* | 0 | 0 | 0 | 0 | 0 |
| | DLC AC - Thermostat | 1 | 2 | 3 | 10 | 21 |
| | DLC Space Heating | 0 | 0 | 0 | 1 | 1 |
| | DLC Water Heating | 0 | 1 | 2 | 3 | 3 |
| | Ice Storage Cooling Rate* | 0 | 0 | 0 | 0 | 0 |
| | DLC Lighting* | 0 | 0 | 0 | 0 | 0 |
| | Curtailable (Day Of) | 0 | 0 | 18 | 36 | 36 |
| | Curtailable (Day Ahead) | 0 | 0 | 33 | 67 | 68 |
| | Capacity Bidding | 1 | 3 | 7 | 8 | 6 |
| | Demand Bidding* | 0 | 0 | 0 | 0 | 0 |
| | Time of Use with Enabling Technology | 0 | 0 | 1 | 7 | 5 |
| | Time of Use without Enabling Technology | 0 | 0 | 0 | 4 | 3 |
| | **Sector Total (Curtailable Day Of)** | **2** | **6** | **30** | **69** | **76** |
| | **Sector Total (Curtailable Day Ahead)** | **2** | **6** | **45** | **99** | **107** |
| **Residential & Non-Residential Total (Curtailable Day Of)** | | **36** | **45** | **81** | **235** | **317** |
| **Residential & Non-Residential Total (Curtailable Day Ahead)** | | **36** | **45** | **96** | **265** | **348** |

## 5.3 BENEFITS & COSTS

Table 5-5 shows the MAP and RAP budget requirements (for only cost-effective programs) across the 2024-2042 timeframe that would be required to achieve the cumulative annual potential for each of the thermostat scenarios. The current and future hardware and software cost of a Demand Response Management System and the cost of non-equipment incentives are included in these budgets.

**TABLE 5-5 SUMMARY OF MAP AND RAP BUDGET REQUIREMENTS**

| Year | MAP | RAP |
|---|---|---|
| 2024 | $6,777,944 | $4,186,325 |
| 2025 | $9,137,878 | $4,853,491 |
| 2026 | $20,775,617 | $9,271,984 |
| 2033 | $28,921,182 | $14,312,257 |
| 2042 | $52,205,177 | $26,727,240 |

Figure 5-3 shows the cumulative annual RAP (MW) by sector. The residential sector RAP rises from 34 MW in 2024 to 241 MW in 2042. The commercial sector RAP starts at just 2 MW in the 2024 but rises to 76 MW by 2042.

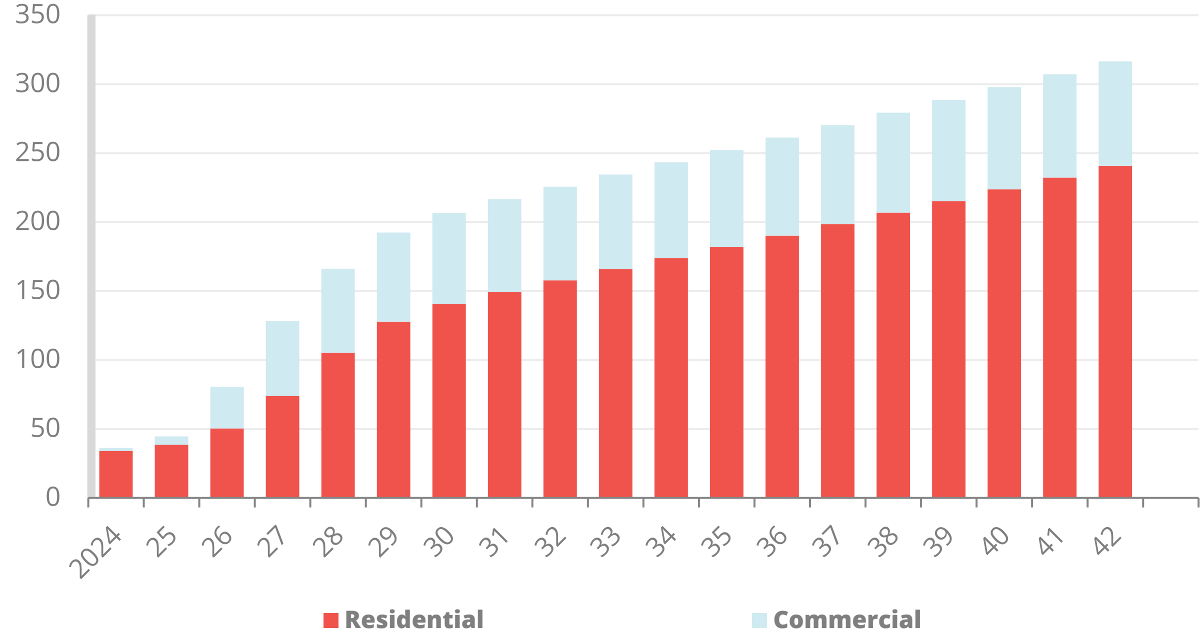


**FIGURE 5-3 RESIDENTIAL AND COMMERCIAL DEMAND RESPONSE RAP**

Figure 5-4 shows the cumulative annual RAP (MW) by program in the residential sector. The DLC AC – Switch program initially contributes 13 MW towards the RAP, but then fades out over the timeframe of the study. The DLC AC – Thermostat and DLC Space Heating and DLC Water Heating programs collectively account for about 90% of the residential RAP, with the total RAP exceeding 240 MW by 2042.

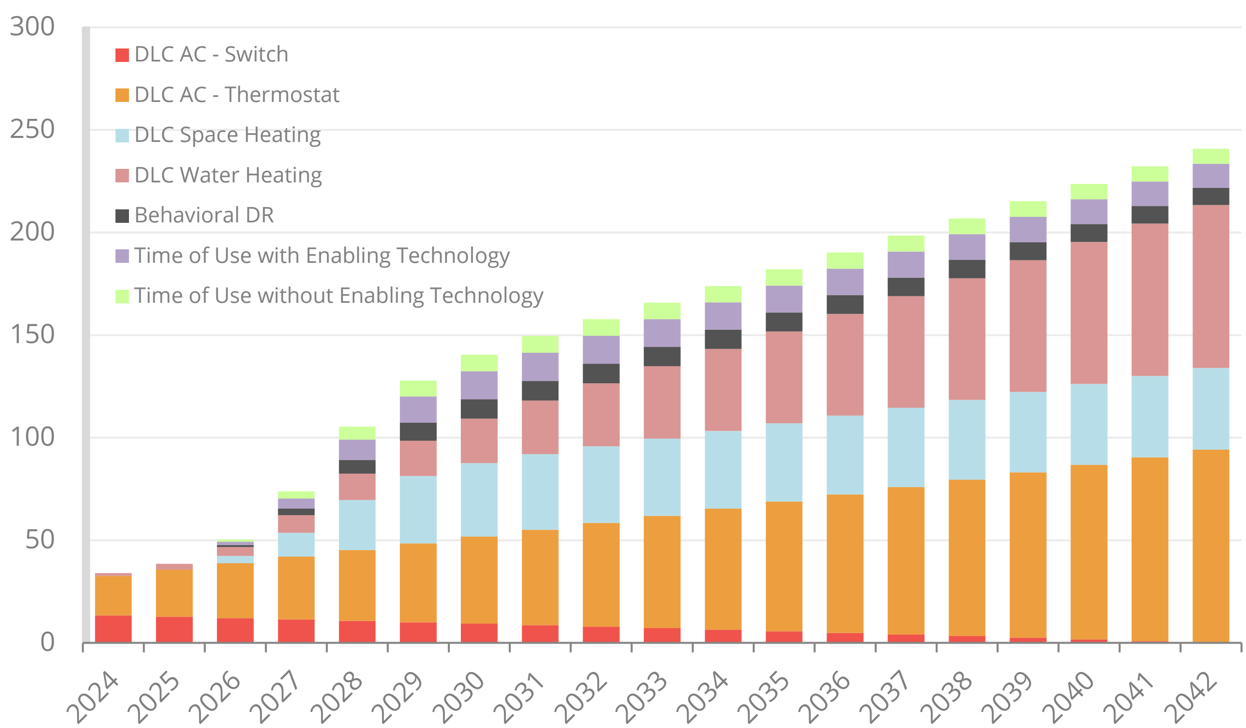


**FIGURE 5-4 RESIDENTIAL SECTOR DEMAND RESPONSE RAP – BY PROGRAM**

Figure 5-5 shows the cumulative annual RAP (MW) by program in the non-residential sector. The DLC AC – Thermostat and Curtailable (Day of) programs account for about 80% of the non-residential RAP, with the total RAP exceeding 75 MW by 2042.

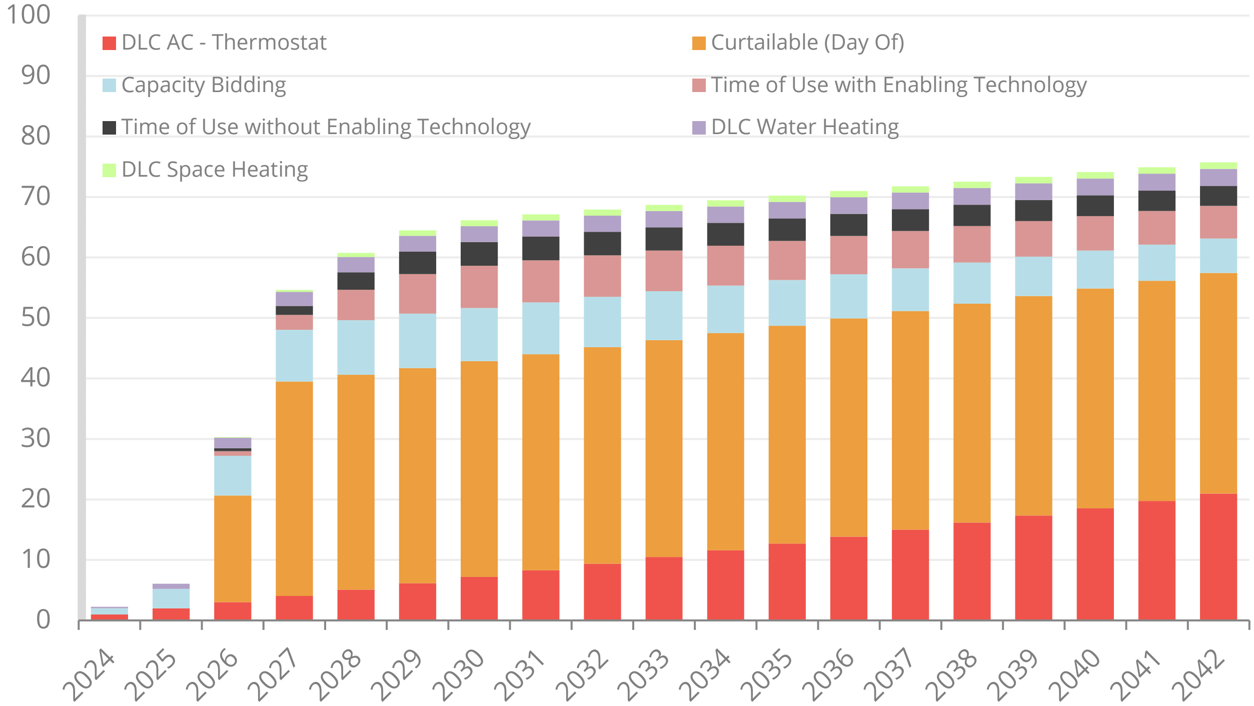


**FIGURE 5-5 NON-RESIDENTIAL SECTOR DEMAND RESPONSE RAP – BY PROGRAM**

Table 5-6 and Table 5-7 show the MAP and RAP residential NPVs of the total benefits, costs, and savings, along with the UCT ratio for each program for the length of the study. Programs marked with an asterisk were those that were found to not be cost-effective, and therefore do not provide any achievable potential.

**TABLE 5-6 MAP NPV BENEFITS, COSTS, AND UCT RATIOS FOR EACH DEMAND RESPONSE PROGRAM**

| Sector | Program | NPV Benefits | NPV Costs | UCT Ratio |
|---|---|---|---|---|
| Residential | DLC AC - Switch | $16,994,154 | $10,893,267 | 1.56 |
| | DLC AC - Thermostat | $144,949,535 | $70,067,246 | 2.07 |
| | DLC Space Heating | $65,203,724 | $13,415,022 | 4.86 |
| | DLC Water Heating | $155,288,336 | $89,578,503 | 1.73 |
| | DLC Electric Vehicles* | $6,887,478 | $6,918,672 | 1.00 |
| | DLC Room AC* | $1,411,659 | $25,040,656 | 0.06 |
| | Battery Storage* | $117,699,550 | $562,165,765 | 0.21 |
| | Behavioral DR | $16,588,369 | $5,447,273 | 3.05 |
| | Time of Use with Enabling Technology | $15,942,936 | $14,316,735 | 1.11 |
| | Time of Use without Enabling Technology | $9,755,166 | $5,892,742 | 1.66 |
| | **Sector Total** | **$550,720,909** | **$803,735,882** | **0.69** |
| C&I | DLC AC - Switch* | $68,515 | $417,639 | 0.16 |
| | DLC AC - Thermostat | $30,643,265 | $13,484,146 | 2.27 |

| Sector | Program | NPV Benefits | NPV Costs | UCT Ratio |
|---|---|---|---|---|
| | DLC Space Heating | $6,151,103 | $1,749,239 | 3.52 |
| | DLC Water Heating | $14,061,705 | $6,631,955 | 2.12 |
| | Ice Storage Cooling Rate* | $3,201,634 | $20,436,899 | 0.16 |
| | DLC Lighting* | $1,192,459 | $5,089,217 | 0.23 |
| | Curtailable (Day Of) | $104,708,768 | $105,539,639 | 0.99 |
| | Curtailable (Day Ahead) | $104,708,768 | $105,539,639 | 0.99 |
| | Capacity Bidding | $107,306,214 | $15,380,782 | 6.98 |
| | Demand Bidding* | $3,501,063 | $3,966,402 | 0.88 |
| | Time of Use with Enabling Technology | $7,772,625 | $1,563,219 | 4.97 |
| | Time of Use without Enabling Technology | $4,966,307 | $903,961 | 5.49 |
| | **Sector Total (Curtailable Day Of)** | **$235,305,353** | **$126,505,610** | **1.86** |
| | **Sector Total (Curtailable Day Ahead)** | **$283,573,659** | **$175,163,099** | **1.62** |
| **Residential & Commercial Total (Curtailable Day Of)** | | **$786,026,261** | **$930,241,492** | **0.84** |
| **Residential & Commercial Total (Curtailable Day Ahead)** | | **$834,294,568** | **$978,898,982** | **0.85** |

**TABLE 5-7 RAP NPV BENEFITS, COSTS, AND UCT RATIOS FOR EACH DEMAND RESPONSE PROGRAM**

| Sector | Program | NPV Benefits | NPV Costs | UCT Ratio |
|---|---|---|---|---|
| Residential | DLC AC - Switch | $16,994,154 | $10,893,267 | 1.56 |
| | DLC AC - Thermostat | $90,315,885 | $46,492,661 | 1.94 |
| | DLC Space Heating | $48,902,793 | $8,421,482 | 5.81 |
| | DLC Water Heating | $84,022,859 | $45,329,467 | 1.85 |
| | DLC Electric Vehicles* | $2,702,531 | $4,146,957 | 0.65 |
| | DLC Room AC* | $910,748 | $16,143,042 | 0.06 |
| | Battery Storage* | $59,377,971 | $281,948,247 | 0.21 |
| | Behavioral DR | $11,321,347 | $2,675,998 | 4.23 |
| | Time of Use with Enabling Technology | $16,886,284 | $9,309,688 | 1.81 |
| | Time of Use without Enabling Technology | $10,346,266 | $2,162,256 | 4.78 |
| | **Sector Total** | **$341,780,839** | **$427,523,065** | **0.80** |
| C&I | DLC AC - Switch* | $68,515 | $417,641 | 0.16 |
| | DLC AC - Thermostat | $16,714,508 | $6,612,372 | 2.53 |
| | DLC Space Heating | $1,318,093 | $904,715 | 1.46 |
| | DLC Water Heating | $6,151,996 | $3,281,157 | 1.87 |
| | Ice Storage Cooling Rate* | $632,421 | $4,994,248 | 0.13 |
| | DLC Lighting* | $256,290 | $1,855,151 | 0.14 |
| | Curtailable (Day Of) | $29,555,726 | $16,039,314 | 1.84 |
| | Curtailable (Day Ahead) | $54,832,515 | $29,759,733 | 1.84 |
| | Capacity Bidding | $11,584,967 | $1,706,987 | 6.79 |
| | Demand Bidding* | $437,633 | $1,010,520 | 0.43 |

| Sector | Program | NPV Benefits | NPV Costs | UCT Ratio |
|---|---|---|---|---|
| | Time of Use with Enabling Technology | $8,348,705 | $1,112,685 | 7.50 |
| | Time of Use without Enabling Technology | $4,838,368 | $482,537 | 10.03 |
| | **Sector Total (Curtailable Day Of)** | **$79,907,223** | **$38,417,327** | **2.08** |
| | **Sector Total (Curtailable Day Ahead)** | **$105,184,012** | **$52,137,745** | **2.02** |
| **Residential & Commercial Total (Curtailable Day Of)** | | **$421,688,062** | **$465,940,392** | **0.91** |
| **Residential & Commercial Total (Curtailable Day Ahead)** | | **$446,964,851** | **$479,660,810** | **0.93** |

# VOLUME II

## *Appendices*

*prepared for*

aes Indiana

NOVEMBER 2022

# Appendix A. Commercial Opt-Out Results

This section provides the potential results for technical, economic, MAP and RAP for the commercial sector, with opt-out customers included. A comparison of the RAP scenario (with without opt-out customers included) savings potential and RAP budgets is also provided.

Table A-1 provides cumulative annual technical, economic, MAP and RAP energy savings, in total MWh and as a percentage of the sector-level sales forecast. The RAP increases to 5.0% cumulative annual savings over the next three years.

**TABLE A-1: C&I CUMULATIVE ANNUAL ENERGY EFFICIENCY POTENTIAL SUMMARY – INCLUDING OPT-OUT**

| | 2024 | 2025 | 2026 | 2033 | 2042 |
|---|---|---|---|---|---|
| **MWh** | | | | | |
| **Technical** | 228,329 | 475,728 | 733,191 | 2,309,163 | 2,912,075 |
| **Economic** | 220,511 | 458,786 | 707,070 | 2,226,896 | 2,800,577 |
| **MAP** | 194,166 | 368,083 | 538,853 | 1,535,536 | 2,082,694 |
| **RAP** | 145,886 | 279,028 | 409,805 | 1,188,323 | 1,649,814 |
| **Forecasted Sales** | 8,175,708 | 8,179,029 | 8,159,445 | 8,232,254 | 8,438,092 |
| | | | | | |
| **Technical** | 2.8% | 5.8% | 9.0% | 28.1% | 34.5% |
| **Economic** | 2.7% | 5.6% | 8.7% | 27.1% | 33.2% |
| **MAP** | 2.4% | 4.5% | 6.6% | 18.7% | 24.7% |
| **RAP** | 1.8% | 3.4% | 5.0% | 14.4% | 19.6% |

Figure A-1 provides the RAP results for the 3-year, 10-year, and 19-year timeframes for both the RAP scenario and the RAP scenario including opt-out customers. The savings as a percentage of forecasted sales is slightly higher in the RAP scenario, through total MWh savings are higher in the scenario in which opt-out customers are included in the analysis.

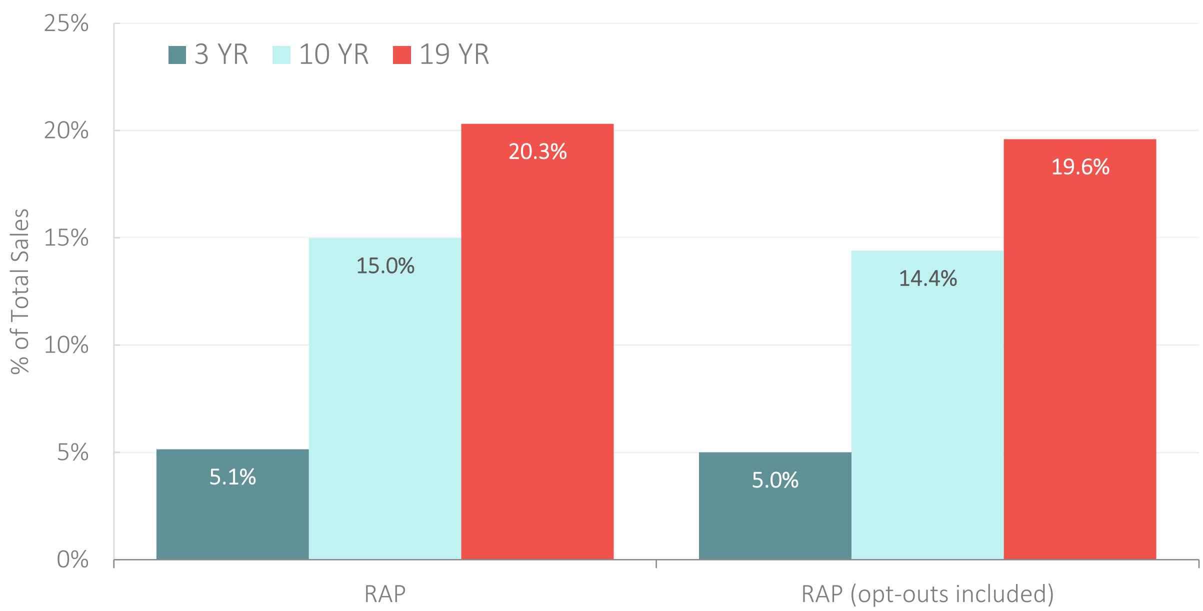


**FIGURE A-1: C&I ELECTRIC ENERGY CUMULATIVE ANNUAL POTENTIAL (AS A % OF COMMERICAL AND INDUSTRIAL SALES)**

Figure A-2 provides the annual budgets for commercial RAP, with and without opt-out customers. The budgets in the RAP scenario range from $12 million to $14 million, while the budgets in the RAP scenario with opt-out customers included range from $17 million to $20 million.

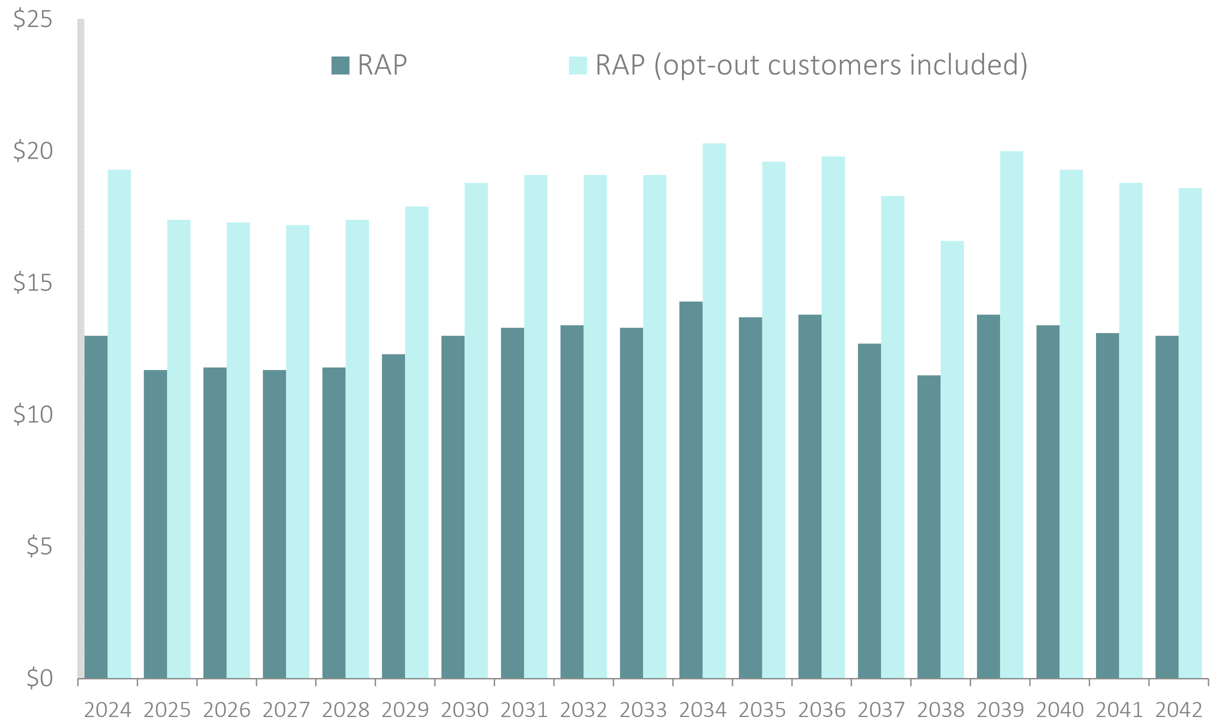


**FIGURE A-2: C&I RAP BUDGETS – WITHOUT AND WITH OPT-OUT CUSTOMERS**

# Appendix B. Residential Sector Measure Detail

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1001 | Appliances | ENERGY STAR Air Purifier | Efficient Products | SF | MO | 533 | 57% | 303 | 0.03 | 9 | $92 | 100% | 54% | 54% | PUR-1 | 12% | 29% | 78.6% | 52.8% | 52.8% | 2.3 |
| 1002 | Appliances | ENERGY STAR Air Purifier | Efficient Products | SF | NC | 533 | 57% | 303 | 0.03 | 9 | $92 | 100% | 54% | 54% | PUR-2 | 12% | 0% | 81.8% | 59.8% | 59.8% | 2.3 |
| 1003 | Appliances | ENERGY STAR Air Purifier | Efficient Products | MF | MO | 533 | 57% | 303 | 0.03 | 9 | $92 | 100% | 54% | 54% | PUR-3 | 12% | 29% | 66.3% | 41.8% | 41.8% | 2.4 |
| 1004 | Appliances | ENERGY STAR Air Purifier | Efficient Products | MF | NC | 533 | 57% | 303 | 0.03 | 9 | $92 | 100% | 54% | 54% | PUR-4 | 12% | 0% | 71.2% | 50.4% | 50.4% | 2.4 |
| 1005 | Appliances | ENERGY STAR Refrigerator - early replacement | IQW | SF | ER1 | 1,028 | 68% | 696 | 0.10 | 6 | $580 | 130% | 100% | 100% | REF-2 | 99% | 62% | 39.7% | 35.3% | 35.3% | 0.3 |
| 1006 | Appliances | ENERGY STAR Refrigerator - early replacement | IQW | MF | ER1 | 1,028 | 68% | 696 | 0.10 | 6 | $580 | 130% | 100% | 100% | REF-5 | 98% | 55% | 41.6% | 41.6% | 41.6% | 0.3 |
| 1007 | Appliances | ENERGY STAR Refrigerator - early replacement | Multifamily | MF | ER1 | 1,028 | 68% | 696 | 0.10 | 6 | $755 | 100% | 100% | 100% | REF-4 | 98% | 55% | 43.3% | 43.3% | 43.3% | 0.3 |
| 1008 | Appliances | ENERGY STAR Refrigerator | Efficient Products | SF | MO | 369 | 10% | 37 | 0.01 | 17 | $40 | 80% | 80% | 80% | REF-1 | 99% | 62% | 62.0% | 62.0% | 62.0% | 0.8 |
| 1009 | Appliances | ENERGY STAR Refrigerator | Efficient Products | SF | NC | 369 | 10% | 37 | 0.01 | 17 | $40 | 80% | 80% | 80% | REF-3 | 99% | 0% | 72.7% | 72.7% | 72.7% | 0.8 |
| 1010 | Appliances | ENERGY STAR Refrigerator | Efficient Products | MF | MO | 369 | 10% | 37 | 0.01 | 17 | $40 | 80% | 80% | 80% | REF-4 | 98% | 55% | 56.4% | 50.2% | 50.2% | 0.8 |
| 1011 | Appliances | ENERGY STAR Refrigerator | Efficient Products | MF | NC | 369 | 10% | 37 | 0.01 | 17 | $40 | 80% | 80% | 80% | REF-6 | 98% | 0% | 63.7% | 63.7% | 63.7% | 0.8 |
| 1012 | Appliances | CEE Tier 2 Refrigerator | Efficient Products | SF | MO | 369 | 15% | 55 | 0.01 | 17 | $140 | 80% | 80% | 80% | REF-1 | 99% | 62% | 62.0% | 62.0% | 62.0% | 0.3 |
| 1013 | Appliances | CEE Tier 2 Refrigerator | Efficient Products | SF | NC | 369 | 15% | 55 | 0.01 | 17 | $140 | 80% | 80% | 80% | REF-3 | 99% | 0% | 72.7% | 72.7% | 72.7% | 0.3 |
| 1014 | Appliances | CEE Tier 2 Refrigerator | Efficient Products | MF | MO | 369 | 15% | 55 | 0.01 | 17 | $140 | 80% | 80% | 80% | REF-4 | 98% | 55% | 56.4% | 50.2% | 50.2% | 0.3 |
| 1015 | Appliances | CEE Tier 2 Refrigerator | Efficient Products | MF | NC | 369 | 15% | 55 | 0.01 | 17 | $140 | 80% | 80% | 80% | REF-6 | 98% | 0% | 63.7% | 63.7% | 63.7% | 0.3 |
| 1016 | Appliances | Smart Refrigerator | Efficient Products | SF | MO | 369 | 20% | 74 | 0.01 | 17 | $1,078 | 80% | 80% | 80% | REF-1 | 99% | 62% | 62.0% | 62.0% | 62.0% | 0.1 |
| 1017 | Appliances | Smart Refrigerator | Efficient Products | SF | NC | 369 | 20% | 74 | 0.01 | 17 | $1,078 | 80% | 80% | 80% | REF-3 | 99% | 0% | 72.7% | 72.7% | 72.7% | 0.1 |
| 1018 | Appliances | Smart Refrigerator | Efficient Products | MF | MO | 369 | 20% | 74 | 0.01 | 17 | $1,078 | 80% | 80% | 80% | REF-4 | 98% | 55% | 56.4% | 50.2% | 50.2% | 0.1 |
| 1019 | Appliances | Smart Refrigerator | Efficient Products | MF | NC | 369 | 20% | 74 | 0.01 | 17 | $1,078 | 80% | 80% | 80% | REF-6 | 98% | 0% | 63.7% | 63.7% | 63.7% | 0.1 |
| 1020 | Appliances | Refrigerator Recycling | Appliance Recycling | SF | Recycle | 956 | 100% | 956 | 0.12 | 7 | $50 | 100% | 100% | 100% | RR-1 | 17% | 0% | 81.8% | 81.8% | 81.8% | 6.3 |
| 1021 | Appliances | Refrigerator Recycling | Appliance Recycling | MF | Recycle | 956 | 100% | 956 | 0.12 | 7 | $50 | 100% | 100% | 100% | RR-2 | 4% | 0% | 71.2% | 71.2% | 71.2% | 6.3 |
| 1022 | Appliances | Freezer Recycling | Appliance Recycling | SF | Recycle | 576 | 100% | 576 | 0.07 | 7 | $50 | 100% | 100% | 100% | FR-1 | 3% | 0% | 81.8% | 81.8% | 81.8% | 3.7 |
| 1023 | Appliances | Freezer Recycling | Appliance Recycling | MF | Recycle | 576 | 100% | 576 | 0.07 | 7 | $50 | 100% | 100% | 100% | FR-2 | 0% | 0% | 71.2% | 71.2% | 71.2% | 3.7 |
| 1024 | Appliances | Dehumidifier Recycling | Appliance Recycling | SF | Recycle | 1,000 | 100% | 1,000 | 0.00 | 7 | $20 | 100% | 100% | 100% | DEH-1 | 24% | 0% | 81.8% | 81.8% | 81.8% | 11.0 |
| 1025 | Appliances | Dehumidifier Recycling | Appliance Recycling | MF | Recycle | 1,000 | 100% | 1,000 | 0.00 | 7 | $20 | 100% | 100% | 100% | DEH-2 | 13% | 0% | 71.2% | 71.2% | 71.2% | 11.7 |
| 1026 | Appliances | ENERGY STAR Freezer - Chest | Efficient Products | SF | MO | 311 | 10% | 31 | 0.01 | 22 | $35 | 71% | 71% | 71% | FRZ-1 | 43% | 64% | 63.3% | 58.0% | 58.0% | 1.0 |
| 1027 | Appliances | ENERGY STAR Freezer - Chest | Efficient Products | SF | NC | 311 | 10% | 31 | 0.01 | 22 | $35 | 71% | 71% | 71% | FRZ-2 | 43% | 0% | 68.6% | 68.6% | 68.6% | 1.0 |
| 1028 | Appliances | ENERGY STAR Freezer - Chest | Efficient Products | MF | MO | 311 | 10% | 31 | 0.01 | 22 | $35 | 71% | 71% | 71% | FRZ-3 | 19% | 70% | 67.9% | 63.3% | 63.3% | 1.0 |
| 1029 | Appliances | ENERGY STAR Freezer - Chest | Efficient Products | MF | NC | 311 | 10% | 31 | 0.01 | 22 | $35 | 71% | 71% | 71% | FRZ-4 | 19% | 0% | 59.7% | 59.7% | 59.7% | 1.0 |
| 1030 | Appliances | ENERGY STAR Freezer - Compact Upright | Efficient Products | SF | MO | 467 | 10% | 47 | 0.01 | 22 | $35 | 100% | 71% | 71% | FRZ-1 | 43% | 64% | 73.1% | 58.0% | 58.0% | 1.5 |
| 1031 | Appliances | ENERGY STAR Freezer - Compact Upright | Efficient Products | SF | NC | 467 | 10% | 47 | 0.01 | 22 | $35 | 100% | 71% | 71% | FRZ-2 | 43% | 0% | 81.8% | 68.6% | 68.6% | 1.5 |
| 1032 | Appliances | ENERGY STAR Freezer - Compact Upright | Efficient Products | MF | MO | 467 | 10% | 47 | 0.01 | 22 | $35 | 100% | 71% | 71% | FRZ-3 | 19% | 70% | 67.9% | 63.3% | 63.3% | 1.5 |
| 1033 | Appliances | ENERGY STAR Freezer - Compact Upright | Efficient Products | MF | NC | 467 | 10% | 47 | 0.01 | 22 | $35 | 100% | 71% | 71% | FRZ-4 | 19% | 0% | 71.2% | 59.7% | 59.7% | 1.5 |
| 1034 | Appliances | ENERGY STAR Dehumidifier | Efficient Products | SF | MO | 1,095 | 12% | 134 | 0.03 | 12 | $10 | 250% | 100% | 100% | DEH-1 | 24% | 94% | 92.5% | 91.4% | 91.4% | 3.3 |
| 1035 | Appliances | ENERGY STAR Dehumidifier | Efficient Products | SF | NC | 1,095 | 12% | 134 | 0.03 | 12 | $10 | 250% | 100% | 100% | DEH-2 | 24% | 0% | 81.8% | 81.8% | 81.8% | 3.3 |
| 1036 | Appliances | ENERGY STAR Dehumidifier | Efficient Products | MF | MO | 1,095 | 12% | 134 | 0.03 | 12 | $10 | 250% | 100% | 100% | DEH-3 | 13% | 94% | 92.5% | 91.4% | 91.4% | 3.4 |
| 1037 | Appliances | ENERGY STAR Dehumidifier | Efficient Products | MF | NC | 1,095 | 12% | 134 | 0.03 | 12 | $10 | 250% | 100% | 100% | DEH-4 | 13% | 0% | 71.2% | 71.2% | 71.2% | 3.4 |
| 1038 | Appliances | ENERGY STAR Most Efficient Dehumidifier | Efficient Products | SF | MO | 1,095 | 17% | 189 | 0.04 | 12 | $75 | 100% | 35% | 35% | DEH-1 | 24% | 94% | 92.5% | 91.4% | 91.4% | 4.4 |
| 1039 | Appliances | ENERGY STAR Most Efficient Dehumidifier | Efficient Products | SF | NC | 1,095 | 17% | 189 | 0.04 | 12 | $75 | 100% | 35% | 35% | DEH-2 | 24% | 0% | 81.8% | 45.6% | 45.6% | 4.4 |
| 1040 | Appliances | ENERGY STAR Most Efficient Dehumidifier | Efficient Products | MF | MO | 1,095 | 17% | 189 | 0.04 | 12 | $75 | 100% | 35% | 35% | DEH-3 | 13% | 94% | 92.5% | 91.4% | 91.4% | 4.5 |
| 1041 | Appliances | ENERGY STAR Most Efficient Dehumidifier | Efficient Products | MF | NC | 1,095 | 17% | 189 | 0.04 | 12 | $75 | 100% | 35% | 35% | DEH-4 | 13% | 0% | 71.2% | 41.3% | 41.3% | 4.5 |
| 1042 | Appliances | ENERGY STAR Dishwasher (E WH) | Efficient Products | SF | MO | 307 | 12% | 37 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-1 | 37% | 83% | 79.4% | 76.4% | 76.4% | 0.3 |
| 1043 | Appliances | ENERGY STAR Dishwasher (E WH) | Efficient Products | SF | NC | 307 | 12% | 37 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-2 | 37% | 0% | 65.7% | 65.7% | 65.7% | 0.3 |
| 1044 | Appliances | ENERGY STAR Dishwasher (E WH) | Efficient Products | MF | MO | 307 | 12% | 37 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-3 | 69% | 83% | 79.4% | 76.4% | 76.4% | 0.3 |
| 1045 | Appliances | ENERGY STAR Dishwasher (E WH) | Efficient Products | MF | NC | 307 | 12% | 37 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-4 | 69% | 0% | 56.7% | 56.7% | 56.7% | 0.3 |
| 1046 | Appliances | ENERGY STAR Dishwasher (NG WH) | Efficient Products | SF | MO | 135 | 12% | 16 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-5 | 36% | 83% | 79.4% | 76.4% | 76.4% | 0.1 |
| 1047 | Appliances | ENERGY STAR Dishwasher (NG WH) | Efficient Products | SF | NC | 135 | 12% | 16 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-6 | 36% | 0% | 65.7% | 65.7% | 65.7% | 0.1 |
| 1048 | Appliances | ENERGY STAR Dishwasher (NG WH) | Efficient Products | MF | MO | 135 | 12% | 16 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-7 | 18% | 83% | 79.4% | 76.4% | 76.4% | 0.1 |
| 1049 | Appliances | ENERGY STAR Dishwasher (NG WH) | Efficient Products | MF | NC | 135 | 12% | 16 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-8 | 18% | 0% | 56.7% | 56.7% | 56.7% | 0.1 |
| 1050 | Appliances | Smart Dishwasher (E WH) | Efficient Products | SF | MO | 307 | 8% | 24 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-1 | 37% | 83% | 79.4% | 76.4% | 76.4% | 0.2 |
| 1051 | Appliances | Smart Dishwasher (E WH) | Efficient Products | SF | NC | 307 | 8% | 24 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-2 | 37% | 0% | 65.7% | 65.7% | 65.7% | 0.2 |
| 1052 | Appliances | Smart Dishwasher (E WH) | Efficient Products | MF | MO | 307 | 8% | 24 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-3 | 69% | 83% | 79.4% | 76.4% | 76.4% | 0.2 |
| 1053 | Appliances | Smart Dishwasher (E WH) | Efficient Products | MF | NC | 307 | 8% | 24 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-4 | 69% | 0% | 56.7% | 56.7% | 56.7% | 0.2 |
| 1054 | Appliances | Smart Dishwasher (NG WH) | Efficient Products | SF | MO | 135 | 8% | 11 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-5 | 36% | 83% | 79.4% | 76.4% | 76.4% | 0.1 |
| 1055 | Appliances | Smart Dishwasher (NG WH) | Efficient Products | SF | NC | 135 | 8% | 11 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-6 | 36% | 0% | 65.7% | 65.7% | 65.7% | 0.1 |
| 1056 | Appliances | Smart Dishwasher (NG WH) | Efficient Products | MF | MO | 135 | 8% | 11 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-7 | 18% | 83% | 79.4% | 76.4% | 76.4% | 0.1 |
| 1057 | Appliances | Smart Dishwasher (NG WH) | Efficient Products | MF | NC | 135 | 8% | 11 | 0.00 | 11 | $76 | 66% | 66% | 66% | DW-8 | 18% | 0% | 56.7% | 56.7% | 56.7% | 0.1 |
| 1058 | Appliances | ENERGY STAR Clothes Washer (Electrc WH/Dryer) | Efficient Products | SF | MO | 590 | 21% | 126 | 0.02 | 14 | $84 | 75% | 60% | 60% | CW-1 | 47% | 65% | 63.7% | 58.5% | 58.5% | 1.4 |
| 1059 | Appliances | ENERGY STAR Clothes Washer (Electrc WH/Dryer) | Efficient Products | SF | NC | 590 | 21% | 126 | 0.02 | 14 | $84 | 75% | 60% | 60% | CW-2 | 47% | 0% | 70.5% | 62.4% | 62.4% | 1.4 |
| 1060 | Appliances | ENERGY STAR Clothes Washer (Electrc WH/Dryer) | Efficient Products | MF | MO | 590 | 21% | 126 | 0.02 | 14 | $84 | 75% | 60% | 60% | CW-3 | 47% | 35% | 53.9% | 43.3% | 43.3% | 1.4 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1061 | Appliances | ENERGY STAR Clothes Washer (Electrc WH/Dryer) | Efficient Products | MF | NC | 590 | 21% | 126 | 0.02 | 14 | $84 | 75% | 60% | 60% | CW-4 | 47% | 0% | 61.9% | 53.1% | 53.1% | 1.4 |
| 1062 | Appliances | ENERGY STAR Clothes Washer (NG WH/E Dryer) | Efficient Products | SF | MO | 434 | 26% | 115 | 0.01 | 14 | $84 | 75% | 60% | 60% | CW-5 | 52% | 65% | 63.7% | 58.5% | 58.5% | 1.3 |
| 1063 | Appliances | ENERGY STAR Clothes Washer (NG WH/E Dryer) | Efficient Products | SF | NC | 434 | 26% | 115 | 0.01 | 14 | $84 | 75% | 60% | 60% | CW-6 | 52% | 0% | 70.5% | 62.4% | 62.4% | 1.3 |
| 1064 | Appliances | ENERGY STAR Clothes Washer (NG WH/E Dryer) | Efficient Products | MF | MO | 434 | 26% | 115 | 0.01 | 14 | $84 | 75% | 60% | 60% | CW-7 | 14% | 35% | 53.9% | 43.3% | 43.3% | 1.2 |
| 1065 | Appliances | ENERGY STAR Clothes Washer (NG WH/E Dryer) | Efficient Products | MF | NC | 434 | 26% | 115 | 0.01 | 14 | $84 | 75% | 60% | 60% | CW-8 | 14% | 0% | 61.9% | 53.1% | 53.1% | 1.2 |
| 1066 | Appliances | Smart/CEE Tier 2 Clothes Washer (Electrc WH/Dryer) | Efficient Products | SF | MO | 590 | 40% | 236 | 0.03 | 14 | $141 | 75% | 35% | 35% | CW-1 | 47% | 65% | 63.7% | 58.5% | 58.5% | 2.6 |
| 1067 | Appliances | Smart/CEE Tier 2 Clothes Washer (Electrc WH/Dryer) | Efficient Products | SF | NC | 590 | 40% | 236 | 0.03 | 14 | $141 | 75% | 35% | 35% | CW-2 | 47% | 0% | 70.5% | 45.9% | 45.9% | 2.6 |
| 1068 | Appliances | Smart/CEE Tier 2 Clothes Washer (Electrc WH/Dryer) | Efficient Products | MF | MO | 590 | 40% | 236 | 0.03 | 14 | $141 | 75% | 35% | 35% | CW-3 | 47% | 35% | 53.9% | 36.8% | 36.8% | 2.6 |
| 1069 | Appliances | Smart/CEE Tier 2 Clothes Washer (Electrc WH/Dryer) | Efficient Products | MF | NC | 590 | 40% | 236 | 0.03 | 14 | $141 | 75% | 35% | 35% | CW-4 | 47% | 0% | 61.9% | 41.5% | 41.5% | 2.6 |
| 1070 | Appliances | Smart/CEE Tier 2 Clothes Washer (NG WH/E Dryer) | Efficient Products | SF | MO | 434 | 26% | 114 | 0.01 | 14 | $141 | 35% | 35% | 35% | CW-5 | 52% | 65% | 63.7% | 58.5% | 58.5% | 1.3 |
| 1071 | Appliances | Smart/CEE Tier 2 Clothes Washer (NG WH/E Dryer) | Efficient Products | SF | NC | 434 | 26% | 114 | 0.01 | 14 | $141 | 35% | 35% | 35% | CW-6 | 52% | 0% | 45.9% | 45.9% | 45.9% | 1.3 |
| 1072 | Appliances | Smart/CEE Tier 2 Clothes Washer (NG WH/E Dryer) | Efficient Products | MF | MO | 434 | 26% | 114 | 0.01 | 14 | $141 | 50% | 35% | 35% | CW-7 | 14% | 35% | 44.7% | 36.8% | 36.8% | 1.2 |
| 1073 | Appliances | Smart/CEE Tier 2 Clothes Washer (NG WH/E Dryer) | Efficient Products | MF | NC | 434 | 26% | 114 | 0.01 | 14 | $141 | 50% | 35% | 35% | CW-8 | 14% | 0% | 48.4% | 41.5% | 41.5% | 1.2 |
| 1074 | Appliances | ENERGY STAR Clothes Dryer (Electric) | Efficient Products | SF | MO | 769 | 21% | 160 | 0.02 | 16 | $152 | 50% | 35% | 35% | DRY-1 | 87% | 60% | 60.4% | 54.7% | 54.7% | 1.9 |
| 1075 | Appliances | ENERGY STAR Clothes Dryer (Electric) | Efficient Products | SF | NC | 769 | 21% | 160 | 0.02 | 16 | $152 | 50% | 35% | 35% | DRY-2 | 87% | 0% | 57.9% | 45.6% | 45.6% | 1.9 |
| 1076 | Appliances | ENERGY STAR Clothes Dryer (Electric) | Efficient Products | MF | MO | 769 | 21% | 160 | 0.02 | 16 | $152 | 50% | 35% | 35% | DRY-3 | 62% | 35% | 45.1% | 37.2% | 37.2% | 1.8 |
| 1077 | Appliances | ENERGY STAR Clothes Dryer (Electric) | Efficient Products | MF | NC | 769 | 21% | 160 | 0.02 | 16 | $152 | 50% | 35% | 35% | DRY-4 | 62% | 0% | 48.4% | 41.3% | 41.3% | 1.8 |
| 1078 | Appliances | Smart Clothes Dryer (Electric) | Efficient Products | SF | MO | 769 | 7% | 54 | 0.01 | 16 | $636 | 35% | 35% | 35% | DRY-1 | 87% | 60% | 60.4% | 54.7% | 54.7% | 0.1 |
| 1079 | Appliances | Smart Clothes Dryer (Electric) | Efficient Products | SF | NC | 769 | 7% | 54 | 0.01 | 16 | $636 | 35% | 35% | 35% | DRY-2 | 87% | 0% | 45.6% | 45.6% | 45.6% | 0.1 |
| 1080 | Appliances | Smart Clothes Dryer (Electric) | Efficient Products | MF | MO | 769 | 7% | 54 | 0.01 | 16 | $636 | 35% | 35% | 35% | DRY-3 | 62% | 35% | 45.1% | 37.2% | 37.2% | 0.1 |
| 1081 | Appliances | Smart Clothes Dryer (Electric) | Efficient Products | MF | NC | 769 | 7% | 54 | 0.01 | 16 | $636 | 35% | 35% | 35% | DRY-4 | 62% | 0% | 41.3% | 41.3% | 41.3% | 0.1 |
| 1082 | Appliances | Heat Pump Dryer | Efficient Products | SF | MO | 769 | 49% | 378 | 0.14 | 16 | $900 | 35% | 35% | 35% | DRY-1 | 87% | 60% | 60.4% | 54.7% | 54.7% | 1.2 |
| 1083 | Appliances | Heat Pump Dryer | Efficient Products | SF | NC | 769 | 49% | 378 | 0.14 | 16 | $900 | 35% | 35% | 35% | DRY-2 | 87% | 0% | 45.6% | 45.6% | 45.6% | 1.2 |
| 1084 | Appliances | Heat Pump Dryer | Efficient Products | MF | MO | 769 | 49% | 378 | 0.14 | 16 | $900 | 100% | 35% | 35% | DRY-3 | 62% | 35% | 65.0% | 37.2% | 37.2% | 1.1 |
| 1085 | Appliances | Heat Pump Dryer | Efficient Products | MF | NC | 769 | 49% | 378 | 0.14 | 16 | $900 | 100% | 35% | 35% | DRY-4 | 62% | 0% | 71.2% | 41.3% | 41.3% | 1.1 |
| 2001 | Behavior | Home Energy Reports | PEER | SF | MO | 12,290 | 1% | 96 | 0.01 | 1 | $0 | 100% | 35% | 35% | HER-1 | 100% | 57% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2002 | Behavior | Home Energy Reports | PEER | SF | NC | 12,290 | 1% | 96 | 0.01 | 1 | $0 | 100% | 35% | 35% | HER-2 | 100% | 0% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2003 | Behavior | Home Energy Reports | PEER | MF | MO | 7,866 | 2% | 96 | 0.01 | 1 | $0 | 100% | 35% | 35% | HER-3 | 100% | 57% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2004 | Behavior | Home Energy Reports | PEER | MF | NC | 7,866 | 2% | 96 | 0.01 | 1 | $0 | 100% | 35% | 35% | HER-4 | 100% | 0% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2005 | Behavior | Audit Recommendations | Efficient Products | SF | Retrofit | 12,290 | 2% | 188 | 0.02 | 1 | $100 | 100% | 100% | 100% | AUD-1 | 100% | 0% | 100.0% | 100.0% | 100.0% | 0.1 |
| 2006 | Behavior | Audit Recommendations | Efficient Products | MF | Retrofit | 7,866 | 2% | 188 | 0.02 | 1 | $100 | 100% | 100% | 100% | AUD-2 | 100% | 0% | 100.0% | 100.0% | 100.0% | 0.1 |
| 2007 | Behavior | Audit Recommendations | IQW | SF | Retrofit | 12,290 | 2% | 188 | 0.02 | 1 | $106 | 100% | 100% | 100% | AUD-3 | 100% | 0% | 100.0% | 100.0% | 100.0% | 0.1 |
| 2008 | Behavior | Audit Recommendations | IQW | MF | Retrofit | 7,866 | 2% | 188 | 0.02 | 1 | $106 | 100% | 100% | 100% | AUD-4 | 100% | 0% | 100.0% | 100.0% | 100.0% | 0.1 |
| 2009 | Behavior | Customer Education | Efficient Products | SF | MO | 12,290 | 0% | 27 | 0.00 | 1 | $0 | 100% | 35% | 35% | CUST-1 | 100% | 0% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2010 | Behavior | Customer Education | Efficient Products | SF | NC | 12,290 | 0% | 27 | 0.00 | 1 | $0 | 100% | 35% | 35% | CUST-2 | 100% | 0% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2011 | Behavior | Customer Education | Efficient Products | MF | MO | 7,866 | 0% | 27 | 0.00 | 1 | $0 | 100% | 35% | 35% | CUST-3 | 100% | 0% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2012 | Behavior | Customer Education | Efficient Products | MF | NC | 7,866 | 0% | 27 | 0.00 | 1 | $0 | 100% | 35% | 35% | CUST-4 | 100% | 0% | 100.0% | 100.0% | 100.0% | 1.0 |
| 2013 | Behavior | AMI Data Portal | AMI | SF | MO | 12,290 | 2% | 246 | 0.03 | 1 | $0 | 100% | 100% | 100% | AMI-1 | 100% | 0% | 100.0% | 100.0% | 100.0% | 43.1 |
| 2014 | Behavior | AMI Data Portal | AMI | SF | NC | 12,290 | 2% | 246 | 0.03 | 1 | $0 | 100% | 100% | 100% | AMI-2 | 100% | 0% | 100.0% | 100.0% | 100.0% | 43.1 |
| 2015 | Behavior | AMI Data Portal | AMI | MF | MO | 7,866 | 2% | 157 | 0.02 | 1 | $0 | 100% | 100% | 100% | AMI-3 | 100% | 0% | 100.0% | 100.0% | 100.0% | 27.6 |
| 2016 | Behavior | AMI Data Portal | AMI | MF | NC | 7,866 | 2% | 157 | 0.02 | 1 | $0 | 100% | 100% | 100% | AMI-4 | 100% | 0% | 100.0% | 100.0% | 100.0% | 27.6 |
| 3001 | HVAC | ASHP Tune Up | Efficient Products | SF | Retrofit | 6,061 | 5% | 303 | 0.04 | 3 | $160 | 31% | 31% | 31% | TUNE-1 | 13% | 54% | 37.2% | 28.3% | 28.3% | 1.0 |
| 3002 | HVAC | ASHP Tune Up | Efficient Products | MF | Retrofit | 2,573 | 5% | 129 | 0.03 | 3 | $160 | 35% | 35% | 35% | TUNE-2 | 13% | 54% | 37.2% | 28.3% | 28.3% | 0.4 |
| 3003 | HVAC | Air Source Heat Pump 16 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 7% | 435 | 0.13 | 16 | $1,233 | 20% | 20% | 20% | HP-1 | 13% | 48% | 52.2% | 45.4% | 45.4% | 1.5 |
| 3004 | HVAC | Air Source Heat Pump 16 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 7% | 435 | 0.13 | 16 | $1,233 | 20% | 20% | 20% | HP-2 | 42% | 0% | 47.2% | 47.2% | 47.2% | 1.5 |
| 3005 | HVAC | Air Source Heat Pump 16 SEER - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 7% | 184 | 0.09 | 16 | $1,233 | 20% | 20% | 20% | HP-3 | 13% | 48% | 52.2% | 45.4% | 45.4% | 0.8 |
| 3006 | HVAC | Air Source Heat Pump 16 SEER - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 7% | 184 | 0.09 | 16 | $1,233 | 20% | 20% | 20% | HP-4 | 74% | 0% | 40.2% | 40.2% | 40.2% | 0.8 |
| 3007 | HVAC | Air Source Heat Pump 17 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 10% | 612 | 0.25 | 16 | $1,644 | 35% | 35% | 35% | HP-1 | 13% | 48% | 52.2% | 45.4% | 45.4% | 1.1 |
| 3008 | HVAC | Air Source Heat Pump 17 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 10% | 612 | 0.25 | 16 | $1,644 | 35% | 35% | 35% | HP-2 | 42% | 0% | 58.5% | 58.5% | 58.5% | 1.1 |
| 3009 | HVAC | Air Source Heat Pump 17 SEER - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 10% | 261 | 0.17 | 16 | $1,644 | 21% | 21% | 21% | HP-3 | 13% | 48% | 52.2% | 45.4% | 45.4% | 1.0 |
| 3010 | HVAC | Air Source Heat Pump 17 SEER - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 10% | 261 | 0.17 | 16 | $1,644 | 21% | 21% | 21% | HP-4 | 74% | 0% | 41.2% | 41.2% | 41.2% | 1.0 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3011 | HVAC | Air Source Heat Pump 18 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 16% | 986 | 0.35 | 16 | $2,055 | 35% | 35% | 35% | HP-1 | 13% | 48% | 52.2% | 45.4% | 45.4% | 1.3 |
| 3012 | HVAC | Air Source Heat Pump 18 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 16% | 986 | 0.35 | 16 | $2,055 | 35% | 35% | 35% | HP-2 | 42% | 0% | 58.5% | 58.5% | 58.5% | 1.3 |
| 3013 | HVAC | Air Source Heat Pump 18 SEER - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 16% | 419 | 0.23 | 16 | $2,055 | 27% | 27% | 27% | HP-3 | 13% | 48% | 52.2% | 45.4% | 45.4% | 1.0 |
| 3014 | HVAC | Air Source Heat Pump 18 SEER - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 16% | 419 | 0.23 | 16 | $2,055 | 27% | 27% | 27% | HP-4 | 74% | 0% | 46.4% | 46.4% | 46.4% | 1.0 |
| 3015 | HVAC | Air Source Heat Pump 21 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 21% | 1,302 | 0.60 | 16 | $2,055 | 50% | 35% | 35% | HP-1 | 13% | 48% | 57.2% | 45.4% | 45.4% | 2.0 |
| 3016 | HVAC | Air Source Heat Pump 21 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 21% | 1,302 | 0.60 | 16 | $2,055 | 50% | 35% | 35% | HP-2 | 42% | 0% | 67.5% | 58.5% | 58.5% | 2.0 |
| 3017 | HVAC | Air Source Heat Pump 21 SEER - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 22% | 558 | 0.40 | 16 | $2,055 | 35% | 35% | 35% | HP-3 | 13% | 48% | 52.2% | 45.4% | 45.4% | 1.2 |
| 3018 | HVAC | Air Source Heat Pump 21 SEER - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 22% | 558 | 0.40 | 16 | $2,055 | 35% | 35% | 35% | HP-4 | 74% | 0% | 52.1% | 52.1% | 52.1% | 1.2 |
| 3019 | HVAC | Ground Source Heat Pump 20 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 14% | 864 | 0.53 | 25 | $11,871 | 80% | 80% | 80% | HP-1 | 13% | 48% | 76.8% | 76.8% | 76.8% | 0.2 |
| 3020 | HVAC | Ground Source Heat Pump 20 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 14% | 864 | 0.53 | 25 | $11,871 | 80% | 80% | 80% | HP-2 | 42% | 0% | 82.4% | 82.4% | 82.4% | 0.2 |
| 3021 | HVAC | Ground Source Heat Pump 21.5 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 22% | 1,320 | 0.64 | 25 | $11,871 | 80% | 80% | 80% | HP-1 | 13% | 48% | 76.8% | 76.8% | 76.8% | 0.2 |
| 3022 | HVAC | Ground Source Heat Pump 21.5 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 22% | 1,320 | 0.64 | 25 | $11,871 | 80% | 80% | 80% | HP-2 | 42% | 0% | 82.4% | 82.4% | 82.4% | 0.2 |
| 3023 | HVAC | Ground Source Heat Pump 23.5 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 28% | 1,716 | 0.76 | 25 | $11,871 | 80% | 80% | 80% | HP-1 | 13% | 48% | 76.8% | 76.8% | 76.8% | 0.3 |
| 3024 | HVAC | Ground Source Heat Pump 23.5 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 28% | 1,716 | 0.76 | 25 | $11,871 | 80% | 80% | 80% | HP-2 | 42% | 0% | 82.4% | 82.4% | 82.4% | 0.3 |
| 3025 | HVAC | Ground Source Heat Pump 29 SEER - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 35% | 2,126 | 1.02 | 25 | $11,871 | 80% | 80% | 80% | HP-1 | 13% | 48% | 76.8% | 76.8% | 76.8% | 0.3 |
| 3026 | HVAC | Ground Source Heat Pump 29 SEER - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 35% | 2,126 | 1.02 | 25 | $11,871 | 80% | 80% | 80% | HP-2 | 42% | 0% | 82.4% | 82.4% | 82.4% | 0.3 |
| 3027 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 8% | 493 | 0.25 | 15 | $267 | 112% | 100% | 100% | HP-1 | 13% | 48% | 86.8% | 86.8% | 86.8% | 1.9 |
| 3028 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 8% | 493 | 0.25 | 15 | $267 | 112% | 100% | 100% | HP-2 | 42% | 0% | 90.0% | 90.0% | 90.0% | 1.9 |
| 3029 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 8% | 212 | 0.17 | 15 | $267 | 112% | 100% | 100% | HP-3 | 13% | 48% | 77.9% | 77.9% | 77.9% | 1.1 |
| 3030 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 8% | 212 | 0.17 | 15 | $267 | 112% | 100% | 100% | HP-4 | 74% | 0% | 83.3% | 83.3% | 83.3% | 1.1 |
| 3031 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 10% | 590 | 0.44 | 15 | $267 | 112% | 100% | 100% | HP-1 | 13% | 48% | 86.8% | 86.8% | 86.8% | 3.0 |
| 3032 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 10% | 590 | 0.44 | 15 | $267 | 112% | 100% | 100% | HP-2 | 42% | 0% | 90.0% | 90.0% | 90.0% | 3.0 |
| 3033 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 10% | 258 | 0.30 | 15 | $267 | 112% | 100% | 100% | HP-3 | 13% | 48% | 77.9% | 77.9% | 77.9% | 1.8 |
| 3034 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 10% | 258 | 0.30 | 15 | $267 | 112% | 100% | 100% | HP-4 | 74% | 0% | 83.3% | 83.3% | 83.3% | 1.8 |
| 3035 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 15% | 901 | 0.60 | 15 | $533 | 100% | 98% | 98% | HP-1 | 13% | 48% | 86.8% | 86.0% | 86.0% | 2.4 |
| 3036 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 15% | 901 | 0.60 | 15 | $533 | 100% | 98% | 98% | HP-2 | 42% | 0% | 90.0% | 89.4% | 89.4% | 2.4 |
| 3037 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 15% | 392 | 0.40 | 15 | $533 | 100% | 98% | 98% | HP-3 | 13% | 48% | 77.9% | 77.4% | 77.4% | 1.4 |
| 3038 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 15% | 392 | 0.40 | 15 | $533 | 100% | 98% | 98% | HP-4 | 74% | 0% | 83.3% | 82.8% | 82.8% | 1.4 |
| 3039 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | SF | MO | 6,061 | 16% | 966 | 0.73 | 15 | $820 | 100% | 88% | 88% | HP-1 | 13% | 48% | 86.8% | 80.9% | 80.9% | 2.0 |
| 3040 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 16% | 966 | 0.73 | 15 | $820 | 100% | 88% | 88% | HP-2 | 42% | 0% | 90.0% | 85.5% | 85.5% | 2.0 |
| 3041 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | MF | MO | 2,573 | 16% | 423 | 0.49 | 15 | $820 | 100% | 88% | 88% | HP-3 | 13% | 48% | 77.9% | 73.6% | 73.6% | 1.2 |
| 3042 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 16% | 423 | 0.49 | 15 | $820 | 100% | 88% | 88% | HP-4 | 74% | 0% | 83.3% | 79.9% | 79.9% | 1.2 |
| 3043 | HVAC | Air Source Heat Pump 16 SEER - Furnace baseline | Efficient Products | SF | MO | 11,926 | 60% | 7,110 | 0.28 | 16 | $1,233 | 100% | 35% | 35% | HP-5 | 26% | 48% | 86.8% | 45.4% | 45.4% | 7.8 |
| 3044 | HVAC | Air Source Heat Pump 16 SEER - Furnace baseline | Efficient Products | SF | NC | 11,926 | 60% | 7,110 | 0.28 | 16 | $1,233 | 100% | 35% | 35% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 7.8 |
| 3045 | HVAC | Air Source Heat Pump 16 SEER - Furnace baseline | Efficient Products | MF | MO | 4,166 | 59% | 2,462 | 0.19 | 16 | $1,233 | 100% | 35% | 35% | HP-7 | 50% | 48% | 77.9% | 45.4% | 45.4% | 3.0 |
| 3046 | HVAC | Air Source Heat Pump 16 SEER - Furnace baseline | Efficient Products | MF | NC | 4,166 | 59% | 2,462 | 0.19 | 16 | $1,233 | 100% | 35% | 35% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 3.0 |
| 3047 | HVAC | Air Source Heat Pump 17 SEER - Furnace baseline | Efficient Products | SF | MO | 11,926 | 61% | 7,264 | 0.40 | 16 | $1,644 | 100% | 35% | 35% | HP-5 | 26% | 48% | 86.8% | 45.4% | 45.4% | 6.3 |
| 3048 | HVAC | Air Source Heat Pump 17 SEER - Furnace baseline | Efficient Products | SF | NC | 11,926 | 61% | 7,264 | 0.40 | 16 | $1,644 | 100% | 35% | 35% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 6.3 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3049 | HVAC | Air Source Heat Pump 17 SEER - Furnace baseline | Efficient Products | MF | MO | 4,166 | 60% | 2,517 | 0.27 | 16 | $1,644 | 75% | 35% | 35% | HP-7 | 50% | 48% | 68.7% | 45.4% | 45.4% | 2.5 |
| 3050 | HVAC | Air Source Heat Pump 17 SEER - Furnace baseline | Efficient Products | MF | NC | 4,166 | 60% | 2,517 | 0.27 | 16 | $1,644 | 75% | 35% | 35% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 2.5 |
| 3051 | HVAC | Air Source Heat Pump 18 SEER - Furnace baseline | Efficient Products | SF | MO | 11,926 | 64% | 7,583 | 0.50 | 16 | $2,055 | 100% | 35% | 35% | HP-5 | 26% | 48% | 86.8% | 45.4% | 45.4% | 5.4 |
| 3052 | HVAC | Air Source Heat Pump 18 SEER - Furnace baseline | Efficient Products | SF | NC | 11,926 | 64% | 7,583 | 0.50 | 16 | $2,055 | 100% | 35% | 35% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 5.4 |
| 3053 | HVAC | Air Source Heat Pump 18 SEER - Furnace baseline | Efficient Products | MF | MO | 4,166 | 63% | 2,630 | 0.34 | 16 | $2,055 | 75% | 35% | 35% | HP-7 | 50% | 48% | 68.7% | 45.4% | 45.4% | 2.2 |
| 3054 | HVAC | Air Source Heat Pump 18 SEER - Furnace baseline | Efficient Products | MF | NC | 4,166 | 63% | 2,630 | 0.34 | 16 | $2,055 | 75% | 35% | 35% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 2.2 |
| 3055 | HVAC | Air Source Heat Pump 21 SEER - Furnace baseline | Efficient Products | SF | MO | 11,926 | 66% | 7,859 | 0.75 | 16 | $2,055 | 100% | 35% | 35% | HP-5 | 26% | 48% | 86.8% | 45.4% | 45.4% | 6.1 |
| 3056 | HVAC | Air Source Heat Pump 21 SEER - Furnace baseline | Efficient Products | SF | NC | 11,926 | 66% | 7,859 | 0.75 | 16 | $2,055 | 100% | 35% | 35% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 6.1 |
| 3057 | HVAC | Air Source Heat Pump 21 SEER - Furnace baseline | Efficient Products | MF | MO | 4,166 | 66% | 2,730 | 0.50 | 16 | $2,055 | 75% | 35% | 35% | HP-7 | 50% | 48% | 68.7% | 45.4% | 45.4% | 2.6 |
| 3058 | HVAC | Air Source Heat Pump 21 SEER - Furnace baseline | Efficient Products | MF | NC | 4,166 | 66% | 2,730 | 0.50 | 16 | $2,055 | 75% | 35% | 35% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 2.6 |
| 3059 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | SF | MO | 11,926 | 60% | 7,163 | 0.40 | 15 | $1,004 | 100% | 35% | 35% | HP-5 | 26% | 48% | 86.8% | 45.4% | 45.4% | 9.7 |
| 3060 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | SF | NC | 11,926 | 60% | 7,163 | 0.40 | 15 | $1,004 | 100% | 35% | 35% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 9.7 |
| 3061 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | MF | MO | 4,166 | 60% | 2,482 | 0.27 | 15 | $1,004 | 100% | 35% | 35% | HP-7 | 50% | 48% | 77.9% | 45.4% | 45.4% | 3.9 |
| 3062 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | MF | NC | 4,166 | 60% | 2,482 | 0.27 | 15 | $1,004 | 100% | 35% | 35% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 3.9 |
| 3063 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | SF | MO | 11,926 | 61% | 7,253 | 0.60 | 15 | $1,004 | 100% | 35% | 35% | HP-5 | 26% | 48% | 86.8% | 45.4% | 45.4% | 10.6 |
| 3064 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | SF | NC | 11,926 | 61% | 7,253 | 0.60 | 15 | $1,004 | 100% | 35% | 35% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 10.6 |
| 3065 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | MF | MO | 4,166 | 60% | 2,517 | 0.40 | 15 | $1,004 | 100% | 35% | 35% | HP-7 | 50% | 48% | 77.9% | 45.4% | 45.4% | 4.4 |
| 3066 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric furnace baseline | Efficient Products | MF | NC | 4,166 | 60% | 2,517 | 0.40 | 15 | $1,004 | 100% | 35% | 35% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 4.4 |
| 3067 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | SF | MO | 11,926 | 63% | 7,521 | 0.75 | 15 | $1,070 | 100% | 49% | 49% | HP-5 | 26% | 48% | 86.8% | 56.4% | 56.4% | 7.8 |
| 3068 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | SF | NC | 11,926 | 63% | 7,521 | 0.75 | 15 | $1,070 | 100% | 49% | 49% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 7.8 |
| 3069 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | MF | MO | 4,166 | 63% | 2,613 | 0.50 | 15 | $1,070 | 100% | 49% | 49% | HP-7 | 50% | 48% | 77.9% | 51.9% | 51.9% | 3.3 |
| 3070 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | MF | NC | 4,166 | 63% | 2,613 | 0.50 | 15 | $1,070 | 100% | 49% | 49% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 3.3 |
| 3071 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | SF | MO | 11,926 | 64% | 7,581 | 0.89 | 15 | $1,557 | 100% | 47% | 47% | HP-5 | 26% | 48% | 86.8% | 54.3% | 54.3% | 5.9 |
| 3072 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | SF | NC | 11,926 | 64% | 7,581 | 0.89 | 15 | $1,557 | 100% | 47% | 47% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 5.9 |
| 3073 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | MF | MO | 4,166 | 63% | 2,637 | 0.59 | 15 | $1,557 | 100% | 47% | 47% | HP-7 | 50% | 48% | 77.9% | 49.1% | 49.1% | 2.6 |
| 3074 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric furnace baseline | Efficient Products | MF | NC | 4,166 | 63% | 2,637 | 0.59 | 15 | $1,557 | 100% | 47% | 47% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 2.6 |
| 3075 | HVAC | AC Tune Up | Efficient Products | SF | Retrofit | 1,081 | 5% | 54 | 0.04 | 3 | $160 | 35% | 35% | 35% | TUNE-3 | 80% | 54% | 37.2% | 28.3% | 28.3% | 0.4 |
| 3076 | HVAC | AC Tune Up | Efficient Products | MF | Retrofit | 422 | 5% | 21 | 0.03 | 3 | $160 | 35% | 35% | 35% | TUNE-4 | 79% | 54% | 37.2% | 28.3% | 28.3% | 0.2 |
| 3077 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | SF | MO | 11,565 | 66% | 7,610 | 0.40 | 15 | $2,324 | 100% | 35% | 35% | HP-9 | 4% | 48% | 86.8% | 45.4% | 45.4% | 4.4 |
| 3078 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | SF | NC | 11,565 | 66% | 7,610 | 0.40 | 15 | $2,324 | 100% | 35% | 35% | HP-10 | 0% | 0% | 0.0% | 0.0% | 0.0% | 4.4 |
| 3079 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | MF | MO | 3,935 | 66% | 2,597 | 0.27 | 15 | $2,324 | 50% | 35% | 35% | HP-11 | 11% | 48% | 53.0% | 45.4% | 45.4% | 1.7 |
| 3080 | HVAC | Ductless Heat Pump 17 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | MF | NC | 3,935 | 66% | 2,597 | 0.27 | 15 | $2,324 | 50% | 35% | 35% | HP-12 | 0% | 0% | 0.0% | 0.0% | 0.0% | 1.7 |
| 3081 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | SF | MO | 11,565 | 67% | 7,708 | 0.60 | 15 | $2,324 | 100% | 35% | 35% | HP-9 | 4% | 48% | 86.8% | 45.4% | 45.4% | 4.8 |
| 3082 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | SF | NC | 11,565 | 67% | 7,708 | 0.60 | 15 | $2,324 | 100% | 35% | 35% | HP-10 | 0% | 0% | 0.0% | 0.0% | 0.0% | 4.8 |
| 3083 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | MF | MO | 3,935 | 67% | 2,633 | 0.40 | 15 | $2,324 | 50% | 35% | 35% | HP-11 | 11% | 48% | 53.0% | 45.4% | 45.4% | 2.0 |
| 3084 | HVAC | Ductless Heat Pump 19 SEER 9.5 HSPF - Electric baseboard baseline | Efficient Products | MF | NC | 3,935 | 67% | 2,633 | 0.40 | 15 | $2,324 | 50% | 35% | 35% | HP-12 | 0% | 0% | 0.0% | 0.0% | 0.0% | 2.0 |
| 3085 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | SF | MO | 11,565 | 69% | 7,994 | 0.75 | 15 | $2,590 | 100% | 35% | 35% | HP-9 | 4% | 48% | 86.8% | 45.4% | 45.4% | 4.7 |
| 3086 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | SF | NC | 11,565 | 69% | 7,994 | 0.75 | 15 | $2,590 | 100% | 35% | 35% | HP-10 | 0% | 0% | 0.0% | 0.0% | 0.0% | 4.7 |
| 3087 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | MF | MO | 3,935 | 69% | 2,734 | 0.50 | 15 | $2,590 | 50% | 35% | 35% | HP-11 | 11% | 48% | 53.0% | 45.4% | 45.4% | 2.0 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3088 | HVAC | Ductless Heat Pump 21 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | MF | NC | 3,935 | 69% | 2,734 | 0.50 | 15 | $2,590 | 50% | 35% | 35% | HP-12 | 0% | 0% | 0.0% | 0.0% | 0.0% | 2.0 |
| 3089 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | SF | MO | 11,565 | 70% | 8,059 | 0.89 | 15 | $2,877 | 100% | 35% | 35% | HP-9 | 4% | 48% | 86.8% | 45.4% | 45.4% | 4.5 |
| 3090 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | SF | NC | 11,565 | 70% | 8,059 | 0.89 | 15 | $2,877 | 100% | 35% | 35% | HP-10 | 0% | 0% | 0.0% | 0.0% | 0.0% | 4.5 |
| 3091 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | MF | MO | 3,935 | 70% | 2,758 | 0.59 | 15 | $2,877 | 50% | 35% | 35% | HP-11 | 11% | 48% | 53.0% | 45.4% | 45.4% | 1.9 |
| 3092 | HVAC | Ductless Heat Pump 23 SEER 10.0 HSPF - Electric baseboard baseline | Efficient Products | MF | NC | 3,935 | 70% | 2,758 | 0.59 | 15 | $2,877 | 50% | 35% | 35% | HP-12 | 0% | 0% | 0.0% | 0.0% | 0.0% | 1.9 |
| 3093 | HVAC | Central Air Conditioner 15 SEER | Efficient Products | SF | MO | 1,081 | 7% | 72 | 0.15 | 18 | $104 | 192% | 100% | 100% | CAC-1 | 54% | 48% | 86.8% | 86.8% | 86.8% | 1.4 |
| 3094 | HVAC | Central Air Conditioner 15 SEER | Efficient Products | SF | NC | 1,081 | 7% | 72 | 0.15 | 18 | $104 | 192% | 100% | 100% | CAC-2 | 80% | 0% | 90.0% | 90.0% | 90.0% | 1.4 |
| 3095 | HVAC | Central Air Conditioner 15 SEER | Efficient Products | MF | MO | 422 | 7% | 28 | 0.10 | 18 | $104 | 192% | 100% | 100% | CAC-3 | 29% | 48% | 77.9% | 77.9% | 77.9% | 0.9 |
| 3096 | HVAC | Central Air Conditioner 15 SEER | Efficient Products | MF | NC | 422 | 7% | 28 | 0.10 | 18 | $104 | 192% | 100% | 100% | CAC-4 | 79% | 0% | 83.3% | 83.3% | 83.3% | 0.9 |
| 3097 | HVAC | Central Air Conditioner 16 SEER | Efficient Products | SF | MO | 1,081 | 13% | 135 | 0.28 | 18 | $221 | 136% | 100% | 100% | CAC-1 | 54% | 48% | 86.8% | 86.8% | 86.8% | 1.8 |
| 3098 | HVAC | Central Air Conditioner 16 SEER | Efficient Products | SF | NC | 1,081 | 13% | 135 | 0.28 | 18 | $221 | 136% | 100% | 100% | CAC-2 | 80% | 0% | 90.0% | 90.0% | 90.0% | 1.8 |
| 3099 | HVAC | Central Air Conditioner 16 SEER | Efficient Products | MF | MO | 422 | 13% | 53 | 0.19 | 18 | $221 | 136% | 100% | 100% | CAC-3 | 29% | 48% | 77.9% | 77.9% | 77.9% | 1.1 |
| 3100 | HVAC | Central Air Conditioner 16 SEER | Efficient Products | MF | NC | 422 | 13% | 53 | 0.19 | 18 | $221 | 136% | 100% | 100% | CAC-4 | 79% | 0% | 83.3% | 83.3% | 83.3% | 1.1 |
| 3101 | HVAC | Central Air Conditioner 17 SEER | Efficient Products | SF | MO | 1,081 | 18% | 191 | 0.40 | 18 | $620 | 100% | 56% | 56% | CAC-1 | 54% | 48% | 86.8% | 61.4% | 61.4% | 2.1 |
| 3102 | HVAC | Central Air Conditioner 17 SEER | Efficient Products | SF | NC | 1,081 | 18% | 191 | 0.40 | 18 | $620 | 100% | 56% | 56% | CAC-2 | 80% | 0% | 90.0% | 70.7% | 70.7% | 2.1 |
| 3103 | HVAC | Central Air Conditioner 17 SEER | Efficient Products | MF | MO | 422 | 18% | 74 | 0.27 | 18 | $620 | 75% | 56% | 56% | CAC-3 | 29% | 48% | 68.7% | 56.8% | 56.8% | 1.4 |
| 3104 | HVAC | Central Air Conditioner 17 SEER | Efficient Products | MF | NC | 422 | 18% | 74 | 0.27 | 18 | $620 | 75% | 56% | 56% | CAC-4 | 79% | 0% | 76.3% | 67.2% | 67.2% | 1.4 |
| 3105 | HVAC | Central Air Conditioner 18 SEER | Efficient Products | SF | MO | 1,081 | 22% | 240 | 0.50 | 18 | $620 | 100% | 65% | 65% | CAC-1 | 54% | 48% | 86.8% | 66.8% | 66.8% | 2.4 |
| 3106 | HVAC | Central Air Conditioner 18 SEER | Efficient Products | SF | NC | 1,081 | 22% | 240 | 0.50 | 18 | $620 | 100% | 65% | 65% | CAC-2 | 80% | 0% | 90.0% | 74.8% | 74.8% | 2.4 |
| 3107 | HVAC | Central Air Conditioner 18 SEER | Efficient Products | MF | MO | 422 | 22% | 94 | 0.34 | 18 | $620 | 75% | 65% | 65% | CAC-3 | 29% | 48% | 68.7% | 61.8% | 61.8% | 1.5 |
| 3108 | HVAC | Central Air Conditioner 18 SEER | Efficient Products | MF | NC | 422 | 22% | 94 | 0.34 | 18 | $620 | 75% | 65% | 65% | CAC-4 | 79% | 0% | 76.3% | 71.0% | 71.0% | 1.5 |
| 3109 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 8% | 514 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-1 | 13% | 62% | 76.8% | 31.3% | 31.3% | 4.4 |
| 3110 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 8% | 514 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-1 | 13% | 62% | 76.8% | 31.3% | 31.3% | 4.4 |
| 3111 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 8% | 514 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-4 | 13% | 62% | 83.9% | 31.3% | 31.3% | 4.4 |
| 3112 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 8% | 514 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-4 | 13% | 62% | 83.9% | 31.3% | 31.3% | 4.4 |
| 3113 | HVAC | Smart Thermostat - Heat pump baseline | IQW | SF | Retrofit | 6,061 | 8% | 514 | 0.19 | 11 | $250 | 100% | 100% | 100% | TSTAT-4 | 13% | 62% | 83.9% | 83.9% | 83.9% | 1.5 |
| 3114 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 8% | 514 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-7 | 42% | 0% | 90.0% | 58.5% | 58.5% | 4.4 |
| 3115 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 75% | 35% | 35% | TSTAT-10 | 13% | 39% | 64.5% | 27.4% | 27.4% | 2.5 |
| 3116 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 75% | 35% | 35% | TSTAT-10 | 13% | 39% | 64.5% | 27.4% | 27.4% | 2.5 |
| 3117 | HVAC | Smart Thermostat - Heat pump baseline | Multifamily | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-10 | 13% | 39% | 74.5% | 74.5% | 74.5% | 0.9 |
| 3118 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-13 | 13% | 39% | 69.8% | 24.8% | 24.8% | 2.5 |
| 3119 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-13 | 13% | 39% | 69.8% | 24.8% | 24.8% | 2.5 |
| 3120 | HVAC | Smart Thermostat - Heat pump baseline | Multifamily | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-13 | 13% | 39% | 69.8% | 69.8% | 69.8% | 0.9 |
| 3121 | HVAC | Smart Thermostat - Heat pump baseline | IQW | MF | Retrofit | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-13 | 13% | 39% | 69.8% | 69.8% | 69.8% | 0.9 |
| 3122 | HVAC | Smart Thermostat - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 8% | 218 | 0.13 | 11 | $250 | 75% | 35% | 35% | TSTAT-16 | 74% | 0% | 76.3% | 52.1% | 52.1% | 2.5 |
| 3123 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 8% | 1,013 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-2 | 26% | 62% | 76.8% | 31.3% | 31.3% | 6.3 |
| 3124 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 8% | 1,013 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-2 | 26% | 62% | 76.8% | 31.3% | 31.3% | 6.3 |
| 3125 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 8% | 1,013 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-5 | 26% | 62% | 83.9% | 31.3% | 31.3% | 6.3 |
| 3126 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 8% | 1,013 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-5 | 26% | 62% | 83.9% | 31.3% | 31.3% | 6.3 |
| 3127 | HVAC | Smart Thermostat - Furnace baseline | IQW | SF | Retrofit | 11,926 | 8% | 1,013 | 0.19 | 11 | $250 | 100% | 100% | 100% | TSTAT-5 | 26% | 62% | 83.9% | 83.9% | 83.9% | 2.2 |
| 3128 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | SF | NC | 11,926 | 8% | 1,013 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 6.3 |
| 3129 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-11 | 50% | 39% | 74.5% | 27.4% | 27.4% | 3.0 |
| 3130 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-11 | 50% | 39% | 74.5% | 27.4% | 27.4% | 3.0 |
| 3131 | HVAC | Smart Thermostat - Furnace baseline | Multifamily | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-11 | 50% | 39% | 74.5% | 74.5% | 74.5% | 1.0 |
| 3132 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-14 | 50% | 39% | 69.8% | 24.8% | 24.8% | 3.0 |
| 3133 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-14 | 50% | 39% | 69.8% | 24.8% | 24.8% | 3.0 |
| 3134 | HVAC | Smart Thermostat - Furnace baseline | Multifamily | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-14 | 50% | 39% | 69.8% | 69.8% | 69.8% | 1.0 |
| 3135 | HVAC | Smart Thermostat - Furnace baseline | IQW | MF | Retrofit | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-14 | 50% | 39% | 69.8% | 69.8% | 69.8% | 1.0 |
| 3136 | HVAC | Smart Thermostat - Furnace baseline | Efficient Products | MF | NC | 4,166 | 8% | 354 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-17 | 0% | 0% | 0.0% | 0.0% | 0.0% | 3.0 |
| 3137 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 8% | 115 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-3 | 53% | 62% | 76.8% | 31.3% | 31.3% | 3.0 |
| 3138 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 8% | 115 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-3 | 53% | 62% | 76.8% | 31.3% | 31.3% | 3.0 |
| 3139 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 8% | 115 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-6 | 53% | 62% | 83.9% | 31.3% | 31.3% | 3.0 |
| 3140 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 8% | 115 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-6 | 53% | 62% | 83.9% | 31.3% | 31.3% | 3.0 |
| 3141 | HVAC | Smart Thermostat - Gas/CAC baseline | IQW | SF | Retrofit | 1,368 | 8% | 115 | 0.19 | 11 | $250 | 100% | 100% | 100% | TSTAT-6 | 53% | 62% | 83.9% | 83.9% | 83.9% | 1.0 |
| 3142 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | SF | NC | 1,368 | 8% | 115 | 0.19 | 11 | $250 | 100% | 35% | 35% | TSTAT-9 | 53% | 0% | 90.0% | 58.5% | 58.5% | 3.0 |
| 3143 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 50% | 35% | 35% | TSTAT-12 | 21% | 39% | 45.7% | 27.4% | 27.4% | 1.8 |
| 3144 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 50% | 35% | 35% | TSTAT-12 | 21% | 39% | 45.7% | 27.4% | 27.4% | 1.8 |
| 3145 | HVAC | Smart Thermostat - Gas/CAC baseline | Multifamily | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-12 | 21% | 39% | 74.5% | 74.5% | 74.5% | 0.6 |
| 3146 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-15 | 21% | 39% | 69.8% | 24.8% | 24.8% | 1.8 |
| 3147 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 100% | 35% | 35% | TSTAT-15 | 21% | 39% | 69.8% | 24.8% | 24.8% | 1.8 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3148 | HVAC | Smart Thermostat - Gas/CAC baseline | Multifamily | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-15 | 21% | 39% | 69.8% | 69.8% | 69.8% | 0.6 |
| 3149 | HVAC | Smart Thermostat - Gas/CAC baseline | IQW | MF | Retrofit | 530 | 8% | 45 | 0.13 | 11 | $250 | 100% | 100% | 100% | TSTAT-15 | 21% | 39% | 69.8% | 69.8% | 69.8% | 0.6 |
| 3150 | HVAC | Smart Thermostat - Gas/CAC baseline | Efficient Products | MF | NC | 530 | 8% | 45 | 0.13 | 11 | $250 | 50% | 35% | 35% | TSTAT-18 | 21% | 0% | 64.4% | 52.1% | 52.1% | 1.8 |
| 3151 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTHP Baseline SEER 10.5 HPSF 7.7 | Efficient Products | SF | MO | 6,061 | 36% | 2,170 | 1.15 | 15 | $1,434 | 100% | 80% | 80% | HP-1 | 13% | 48% | 86.8% | 76.8% | 76.8% | 2.2 |
| 3152 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTHP Baseline SEER 10.5 HPSF 7.7 | Efficient Products | SF | NC | 6,061 | 36% | 2,170 | 1.15 | 15 | $1,434 | 100% | 80% | 80% | HP-2 | 42% | 0% | 90.0% | 82.4% | 82.4% | 2.2 |
| 3153 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTHP Baseline SEER 10.5 HPSF 7.7 | Efficient Products | MF | MO | 2,573 | 36% | 923 | 0.77 | 15 | $1,434 | 100% | 80% | 80% | HP-3 | 13% | 48% | 77.9% | 70.5% | 70.5% | 1.3 |
| 3154 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTHP Baseline SEER 10.5 HPSF 7.7 | Efficient Products | MF | NC | 2,573 | 36% | 923 | 0.77 | 15 | $1,434 | 100% | 80% | 80% | HP-4 | 74% | 0% | 83.3% | 77.6% | 77.6% | 1.3 |
| 3155 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTAC SEER 10.5 Electric Resistance Heat | Efficient Products | SF | MO | 11,926 | 68% | 8,165 | 1.15 | 15 | $1,434 | 100% | 80% | 80% | HP-5 | 26% | 48% | 86.8% | 76.8% | 76.8% | 4.3 |
| 3156 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTAC SEER 10.5 Electric Resistance Heat | Efficient Products | SF | NC | 11,926 | 68% | 8,165 | 1.15 | 15 | $1,434 | 100% | 80% | 80% | HP-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 4.3 |
| 3157 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTAC SEER 10.5 Electric Resistance Heat | Efficient Products | MF | MO | 4,166 | 68% | 2,838 | 0.77 | 15 | $1,434 | 100% | 80% | 80% | HP-7 | 50% | 48% | 77.9% | 70.5% | 70.5% | 1.9 |
| 3158 | HVAC | PTHP Variable Speed SEER 17 11.9 HPSF Upgrade from PTAC SEER 10.5 Electric Resistance Heat | Efficient Products | MF | NC | 4,166 | 68% | 2,838 | 0.77 | 15 | $1,434 | 100% | 80% | 80% | HP-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 1.9 |
| 3159 | HVAC | Filter whistle - Heat pump baseline | School Education | SF | Retrofit | 6,061 | 1% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-1 | 13% | 54% | 80.2% | 80.2% | 80.2% | 5.3 |
| 3160 | HVAC | Filter whistle - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 2% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-1 | 13% | 54% | 80.2% | 80.2% | 80.2% | 13.6 |
| 3161 | HVAC | Filter whistle - Heat pump baseline | School Education | SF | Retrofit | 6,061 | 1% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-4 | 13% | 54% | 86.3% | 86.3% | 86.3% | 5.3 |
| 3162 | HVAC | Filter whistle - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 2% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-4 | 13% | 54% | 86.3% | 86.3% | 86.3% | 13.6 |
| 3163 | HVAC | Filter whistle - Heat pump baseline | IQW | SF | Retrofit | 6,061 | 2% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-4 | 13% | 54% | 86.3% | 86.3% | 86.3% | 13.6 |
| 3164 | HVAC | Filter whistle - Heat pump baseline | School Education | SF | NC | 6,061 | 1% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-7 | 13% | 0% | 90.0% | 90.0% | 90.0% | 5.3 |
| 3165 | HVAC | Filter whistle - Heat pump baseline | School Education | MF | Retrofit | 2,573 | 2% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-10 | 13% | 54% | 68.1% | 68.1% | 68.1% | 5.3 |
| 3166 | HVAC | Filter whistle - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 5% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-10 | 13% | 54% | 68.1% | 68.1% | 68.1% | 13.5 |
| 3167 | HVAC | Filter whistle - Heat pump baseline | Multifamily | MF | Retrofit | 2,573 | 5% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-10 | 13% | 54% | 68.1% | 68.1% | 68.1% | 13.5 |
| 3168 | HVAC | Filter whistle - Heat pump baseline | School Education | MF | Retrofit | 2,573 | 2% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-13 | 13% | 54% | 62.2% | 62.2% | 62.2% | 5.3 |
| 3169 | HVAC | Filter whistle - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 5% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-13 | 13% | 54% | 62.2% | 62.2% | 62.2% | 13.5 |
| 3170 | HVAC | Filter whistle - Heat pump baseline | Multifamily | MF | Retrofit | 2,573 | 5% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-13 | 13% | 54% | 62.2% | 62.2% | 62.2% | 13.5 |
| 3171 | HVAC | Filter whistle - Heat pump baseline | IQW | MF | Retrofit | 2,573 | 5% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-13 | 13% | 54% | 62.2% | 62.2% | 62.2% | 13.5 |
| 3172 | HVAC | Filter whistle - Heat pump baseline | School Education | MF | NC | 2,573 | 2% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-16 | 13% | 0% | 83.3% | 83.3% | 83.3% | 5.3 |
| 3173 | HVAC | Filter whistle - Furnace baseline | School Education | SF | Retrofit | 11,926 | 0% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-2 | 26% | 54% | 80.2% | 80.2% | 80.2% | 5.3 |
| 3174 | HVAC | Filter whistle - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 1% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-2 | 26% | 54% | 80.2% | 80.2% | 80.2% | 13.6 |
| 3175 | HVAC | Filter whistle - Furnace baseline | School Education | SF | Retrofit | 11,926 | 0% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-5 | 26% | 54% | 86.3% | 86.3% | 86.3% | 5.3 |
| 3176 | HVAC | Filter whistle - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 1% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-5 | 26% | 54% | 86.3% | 86.3% | 86.3% | 13.6 |
| 3177 | HVAC | Filter whistle - Furnace baseline | IQW | SF | Retrofit | 11,926 | 1% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-5 | 26% | 54% | 86.3% | 86.3% | 86.3% | 13.6 |
| 3178 | HVAC | Filter whistle - Furnace baseline | School Education | SF | NC | 11,926 | 0% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 5.3 |
| 3179 | HVAC | Filter whistle - Furnace baseline | School Education | MF | Retrofit | 4,166 | 1% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-11 | 50% | 54% | 68.1% | 68.1% | 68.1% | 5.3 |
| 3180 | HVAC | Filter whistle - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 3% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-11 | 50% | 54% | 68.1% | 68.1% | 68.1% | 13.5 |
| 3181 | HVAC | Filter whistle - Furnace baseline | Multifamily | MF | Retrofit | 4,166 | 3% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-11 | 50% | 54% | 68.1% | 68.1% | 68.1% | 13.5 |
| 3182 | HVAC | Filter whistle - Furnace baseline | School Education | MF | Retrofit | 4,166 | 1% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-14 | 50% | 54% | 62.2% | 62.2% | 62.2% | 5.3 |
| 3183 | HVAC | Filter whistle - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 3% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-14 | 50% | 54% | 62.2% | 62.2% | 62.2% | 13.5 |
| 3184 | HVAC | Filter whistle - Furnace baseline | Multifamily | MF | Retrofit | 4,166 | 3% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-14 | 50% | 54% | 62.2% | 62.2% | 62.2% | 13.5 |
| 3185 | HVAC | Filter whistle - Furnace baseline | IQW | MF | Retrofit | 4,166 | 3% | 137 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-14 | 50% | 54% | 62.2% | 62.2% | 62.2% | 13.5 |
| 3186 | HVAC | Filter whistle - Furnace baseline | School Education | MF | NC | 4,166 | 1% | 53 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-17 | 0% | 0% | 0.0% | 0.0% | 0.0% | 5.3 |
| 3187 | HVAC | Filter whistle - Gas/CAC baseline | School Education | SF | Retrofit | 1,368 | 1% | 14 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-3 | 53% | 54% | 80.2% | 80.2% | 80.2% | 3.8 |
| 3188 | HVAC | Filter whistle - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 3% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-3 | 53% | 54% | 80.2% | 80.2% | 80.2% | 9.7 |
| 3189 | HVAC | Filter whistle - Gas/CAC baseline | School Education | SF | Retrofit | 1,368 | 1% | 14 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-6 | 53% | 54% | 86.3% | 86.3% | 86.3% | 3.8 |
| 3190 | HVAC | Filter whistle - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 3% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-6 | 53% | 54% | 86.3% | 86.3% | 86.3% | 9.7 |
| 3191 | HVAC | Filter whistle - Gas/CAC baseline | IQW | SF | Retrofit | 1,368 | 3% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-6 | 53% | 54% | 86.3% | 86.3% | 86.3% | 9.7 |
| 3192 | HVAC | Filter whistle - Gas/CAC baseline | School Education | SF | NC | 1,368 | 1% | 14 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-9 | 53% | 0% | 90.0% | 90.0% | 90.0% | 3.8 |
| 3193 | HVAC | Filter whistle - Gas/CAC baseline | School Education | MF | Retrofit | 530 | 3% | 14 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-12 | 21% | 54% | 68.1% | 68.1% | 68.1% | 3.8 |
| 3194 | HVAC | Filter whistle - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 7% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-12 | 21% | 54% | 68.1% | 68.1% | 68.1% | 9.6 |
| 3195 | HVAC | Filter whistle - Gas/CAC baseline | Multifamily | MF | Retrofit | 530 | 7% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-12 | 21% | 54% | 68.1% | 68.1% | 68.1% | 9.6 |
| 3196 | HVAC | Filter whistle - Gas/CAC baseline | School Education | MF | Retrofit | 530 | 3% | 14 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-15 | 21% | 54% | 62.2% | 62.2% | 62.2% | 3.8 |
| 3197 | HVAC | Filter whistle - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 7% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-15 | 21% | 54% | 62.2% | 62.2% | 62.2% | 9.6 |
| 3198 | HVAC | Filter whistle - Gas/CAC baseline | Multifamily | MF | Retrofit | 530 | 7% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-15 | 21% | 54% | 62.2% | 62.2% | 62.2% | 9.6 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3199 | HVAC | Filter whistle - Gas/CAC baseline | IQW | MF | Retrofit | 530 | 7% | 37 | 0.07 | 3 | $3 | 100% | 100% | 100% | WHISTLE-15 | 21% | 54% | 62.2% | 62.2% | 62.2% | 9.6 |
| 3200 | HVAC | Filter whistle - Gas/CAC baseline | School Education | MF | NC | 530 | 3% | 14 | 0.03 | 3 | $3 | 100% | 100% | 100% | WHISTLE-18 | 21% | 0% | 83.3% | 83.3% | 83.3% | 3.8 |
| 3201 | HVAC | ENERGY STAR Room Air Conditioner | Efficient Products | SF | MO | 259 | 9% | 24 | 0.07 | 12 | $40 | 100% | 63% | 63% | RAC-1 | 17% | 49% | 86.7% | 65.3% | 65.3% | 3.9 |
| 3202 | HVAC | ENERGY STAR Room Air Conditioner | Efficient Products | SF | NC | 259 | 9% | 24 | 0.07 | 12 | $40 | 100% | 63% | 63% | RAC-2 | 17% | 0% | 90.0% | 73.8% | 73.8% | 3.9 |
| 3203 | HVAC | ENERGY STAR Room Air Conditioner | Efficient Products | MF | MO | 259 | 9% | 24 | 0.07 | 12 | $40 | 100% | 63% | 63% | RAC-3 | 12% | 49% | 77.9% | 60.4% | 60.4% | 3.9 |
| 3204 | HVAC | ENERGY STAR Room Air Conditioner | Efficient Products | MF | NC | 259 | 9% | 24 | 0.07 | 12 | $40 | 100% | 63% | 63% | RAC-4 | 12% | 0% | 83.3% | 70.1% | 70.1% | 3.9 |
| 3205 | HVAC | Smart Room AC | Efficient Products | SF | MO | 259 | 3% | 8 | 0.02 | 12 | $40 | 75% | 63% | 63% | RAC-1 | 17% | 49% | 74.3% | 65.3% | 65.3% | 1.3 |
| 3206 | HVAC | Smart Room AC | Efficient Products | SF | NC | 259 | 3% | 8 | 0.02 | 12 | $40 | 75% | 63% | 63% | RAC-2 | 17% | 0% | 80.6% | 73.8% | 73.8% | 1.3 |
| 3207 | HVAC | Smart Room AC | Efficient Products | MF | MO | 259 | 3% | 8 | 0.02 | 12 | $40 | 75% | 63% | 63% | RAC-3 | 12% | 49% | 68.6% | 60.4% | 60.4% | 1.3 |
| 3208 | HVAC | Smart Room AC | Efficient Products | MF | NC | 259 | 3% | 8 | 0.02 | 12 | $40 | 75% | 63% | 63% | RAC-4 | 12% | 0% | 76.3% | 70.1% | 70.1% | 1.3 |
| 3209 | HVAC | Room AC Recycling | Appliance Recycling | SF | Recycle | 227 | 100% | 227 | 0.21 | 4 | $20 | 100% | 100% | 100% | RACR-1 | 17% | 0% | 90.0% | 90.0% | 90.0% | 6.6 |
| 3210 | HVAC | Room AC Recycling | Appliance Recycling | MF | Recycle | 227 | 100% | 227 | 0.21 | 4 | $20 | 100% | 100% | 100% | RACR-2 | 14% | 0% | 83.3% | 83.3% | 83.3% | 6.7 |
| 3211 | HVAC | Smart Vents/Sensors - Heat pump baseline | Efficient Products | SF | Retrofit | 6,061 | 5% | 303 | 0.11 | 15 | $1,625 | 80% | 80% | 80% | SVS-1 | 13% | 10% | 80.6% | 80.6% | 80.6% | 0.2 |
| 3212 | HVAC | Smart Vents/Sensors - Heat pump baseline | Efficient Products | SF | NC | 6,061 | 5% | 303 | 0.11 | 15 | $1,625 | 80% | 80% | 80% | SVS-2 | 42% | 0% | 82.4% | 82.4% | 82.4% | 0.2 |
| 3213 | HVAC | Smart Vents/Sensors - Heat pump baseline | Efficient Products | MF | Retrofit | 2,573 | 5% | 129 | 0.08 | 15 | $1,040 | 80% | 80% | 80% | SVS-3 | 13% | 10% | 75.3% | 75.3% | 75.3% | 0.2 |
| 3214 | HVAC | Smart Vents/Sensors - Heat pump baseline | Efficient Products | MF | NC | 2,573 | 5% | 129 | 0.08 | 15 | $1,040 | 80% | 80% | 80% | SVS-4 | 74% | 0% | 77.6% | 77.6% | 77.6% | 0.2 |
| 3215 | HVAC | Smart Vents/Sensors - Furnace baseline | Efficient Products | SF | Retrofit | 11,926 | 5% | 596 | 0.11 | 15 | $1,625 | 80% | 80% | 80% | SVS-5 | 26% | 10% | 80.6% | 80.6% | 80.6% | 0.3 |
| 3216 | HVAC | Smart Vents/Sensors - Furnace baseline | Efficient Products | SF | NC | 11,926 | 5% | 596 | 0.11 | 15 | $1,625 | 80% | 80% | 80% | SVS-6 | 0% | 0% | 0.0% | 0.0% | 0.0% | 0.3 |
| 3217 | HVAC | Smart Vents/Sensors - Furnace baseline | Efficient Products | MF | Retrofit | 4,166 | 5% | 208 | 0.08 | 15 | $1,040 | 80% | 80% | 80% | SVS-7 | 50% | 10% | 75.3% | 75.3% | 75.3% | 0.2 |
| 3218 | HVAC | Smart Vents/Sensors - Furnace baseline | Efficient Products | MF | NC | 4,166 | 5% | 208 | 0.08 | 15 | $1,040 | 80% | 80% | 80% | SVS-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 0.2 |
| 3219 | HVAC | Smart Vents/Sensors - Gas/CAC baseline | Efficient Products | SF | Retrofit | 1,368 | 5% | 68 | 0.11 | 15 | $1,625 | 80% | 80% | 80% | SVS-9 | 53% | 10% | 80.6% | 80.6% | 80.6% | 0.1 |
| 3220 | HVAC | Smart Vents/Sensors - Gas/CAC baseline | Efficient Products | SF | NC | 1,368 | 5% | 68 | 0.11 | 15 | $1,625 | 80% | 80% | 80% | SVS-10 | 53% | 0% | 82.4% | 82.4% | 82.4% | 0.1 |
| 3221 | HVAC | Smart Vents/Sensors - Gas/CAC baseline | Efficient Products | MF | Retrofit | 530 | 5% | 26 | 0.08 | 15 | $1,040 | 80% | 80% | 80% | SVS-11 | 21% | 10% | 75.3% | 75.3% | 75.3% | 0.1 |
| 3222 | HVAC | Smart Vents/Sensors - Gas/CAC baseline | Efficient Products | MF | NC | 530 | 5% | 26 | 0.08 | 15 | $1,040 | 80% | 80% | 80% | SVS-12 | 21% | 0% | 77.6% | 77.6% | 77.6% | 0.1 |
| 3223 | HVAC | Whole House Attic Fan | Efficient Products | SF | Retrofit | 1,081 | 18% | 195 | 0.41 | 15 | $711 | 80% | 80% | 80% | AF-1 | 80% | 9% | 80.8% | 80.8% | 80.8% | 1.2 |
| 3224 | HVAC | Whole House Attic Fan | Efficient Products | SF | NC | 1,081 | 18% | 195 | 0.41 | 15 | $711 | 80% | 80% | 80% | AF-2 | 80% | 0% | 82.4% | 82.4% | 82.4% | 1.2 |
| 3225 | HVAC | Whole House Attic Fan | Efficient Products | MF | Retrofit | 1,081 | 7% | 76 | 0.27 | 15 | $711 | 80% | 80% | 80% | AF-3 | 80% | 9% | 75.5% | 75.5% | 75.5% | 0.8 |
| 3226 | HVAC | Whole House Attic Fan | Efficient Products | MF | NC | 1,081 | 7% | 76 | 0.27 | 15 | $711 | 80% | 80% | 80% | AF-4 | 80% | 0% | 77.6% | 77.6% | 77.6% | 0.8 |
| 3227 | HVAC | Attic Fan | Efficient Products | SF | Retrofit | 422 | 21% | 87 | 0.18 | 15 | $125 | 100% | 80% | 80% | AF-1 | 79% | 7% | 89.3% | 81.2% | 81.2% | 3.0 |
| 3228 | HVAC | Attic Fan | Efficient Products | SF | NC | 422 | 21% | 87 | 0.18 | 15 | $125 | 100% | 80% | 80% | AF-2 | 79% | 0% | 90.0% | 82.4% | 82.4% | 3.0 |
| 3229 | HVAC | Attic Fan | Efficient Products | MF | Retrofit | 422 | 8% | 34 | 0.12 | 15 | $125 | 100% | 80% | 80% | AF-3 | 79% | 7% | 82.1% | 76.1% | 76.1% | 1.9 |
| 3230 | HVAC | Attic Fan | Efficient Products | MF | NC | 422 | 8% | 34 | 0.12 | 15 | $125 | 100% | 80% | 80% | AF-4 | 79% | 0% | 83.3% | 77.6% | 77.6% | 1.9 |
| 3231 | HVAC | ENERGY STAR Bath Vent Fan | Efficient Products | SF | Retrofit | 49 | 61% | 30 | 0.02 | 19 | $44 | 100% | 46% | 46% | BATH FAN-1 | 100% | 9% | 89.0% | 61.7% | 61.7% | 2.7 |
| 3232 | HVAC | ENERGY STAR Bath Vent Fan | Efficient Products | SF | NC | 49 | 61% | 30 | 0.02 | 19 | $44 | 100% | 46% | 46% | BATH FAN-2 | 100% | 0% | 90.0% | 65.0% | 65.0% | 2.7 |
| 3233 | HVAC | ENERGY STAR Bath Vent Fan | Efficient Products | MF | Retrofit | 49 | 61% | 30 | 0.02 | 19 | $44 | 100% | 46% | 46% | BATH FAN-3 | 100% | 9% | 81.7% | 57.2% | 57.2% | 2.7 |
| 3234 | HVAC | ENERGY STAR Bath Vent Fan | Efficient Products | MF | NC | 49 | 61% | 30 | 0.02 | 19 | $44 | 100% | 46% | 46% | BATH FAN-4 | 100% | 0% | 83.3% | 60.8% | 60.8% | 2.7 |
| 3235 | HVAC | Energy Recovery Ventilator - Heat Pump | Efficient Products | SF | Retrofit | 6,061 | 55% | 3,317 | 0.26 | 15 | $3,000 | 100% | 100% | 100% | ERV-1 | 13% | 0% | 90.0% | 90.0% | 90.0% | 0.6 |
| 3236 | HVAC | Energy Recovery Ventilator - Electric Resistance | Efficient Products | SF | Retrofit | 11,926 | 37% | 4,396 | 0.34 | 15 | $3,000 | 75% | 100% | 100% | ERV-2 | 26% | 0% | 80.6% | 90.0% | 90.0% | 0.7 |
| 3237 | HVAC | Energy Recovery Ventilator - Heat Pump | Efficient Products | SF | NC | 6,061 | 55% | 3,317 | 0.26 | 15 | $3,000 | 100% | 100% | 100% | ERV-3 | 42% | 0% | 90.0% | 90.0% | 90.0% | 0.6 |
| 3238 | HVAC | Energy Recovery Ventilator - Electric Resistance | Efficient Products | SF | NC | 11,926 | 37% | 4,396 | 0.34 | 15 | $3,000 | 75% | 100% | 100% | ERV-4 | 0% | 0% | 0.0% | 0.0% | 0.0% | 0.7 |
| 3239 | HVAC | Energy Recovery Ventilator - Heat Pump | Efficient Products | MF | Retrofit | 2,573 | 71% | 1,815 | 0.14 | 15 | $3,000 | 100% | 100% | 100% | ERV-5 | 13% | 0% | 83.3% | 83.3% | 83.3% | 0.3 |
| 3240 | HVAC | Energy Recovery Ventilator - Electric Resistance | Efficient Products | MF | Retrofit | 4,166 | 58% | 2,404 | 0.19 | 15 | $3,000 | 100% | 100% | 100% | ERV-6 | 50% | 0% | 83.3% | 83.3% | 83.3% | 0.4 |
| 3241 | HVAC | Energy Recovery Ventilator - Heat Pump | Efficient Products | MF | NC | 2,573 | 71% | 1,815 | 0.14 | 15 | $3,000 | 100% | 100% | 100% | ERV-7 | 74% | 0% | 83.3% | 83.3% | 83.3% | 0.3 |
| 3242 | HVAC | Energy Recovery Ventilator - Electric Resistance | Efficient Products | MF | NC | 4,166 | 58% | 2,404 | 0.19 | 15 | $3,000 | 100% | 100% | 100% | ERV-8 | 0% | 0% | 0.0% | 0.0% | 0.0% | 0.4 |
| 4001 | Lighting | LED Standard | School Education | SF | MO | 37 | 62% | 23 | 0.00 | 10 | $4 | 100% | 100% | 100% | LED-1 | 2667% | 61% | 75.0% | 75.0% | 75.0% | 2.8 |
| 4002 | Lighting | LED Standard | School Education | SF | MO | 37 | 62% | 23 | 0.00 | 10 | $4 | 100% | 100% | 100% | LED-2 | 2667% | 61% | 60.4% | 58.7% | 58.7% | 2.8 |
| 4003 | Lighting | LED Standard | CBL | SF | MO | 37 | 43% | 16 | 0.00 | 10 | $2 | 100% | 59% | 59% | LED-2 | 2667% | 61% | 60.4% | 54.8% | 54.8% | 5.7 |
| 4004 | Lighting | LED Standard | IQW | SF | MO | 37 | 77% | 29 | 0.00 | 10 | $2 | 100% | 100% | 100% | LED-2 | 2667% | 61% | 60.4% | 58.7% | 58.7% | 6.5 |
| 4005 | Lighting | LED Standard | School Education | MF | MO | 37 | 62% | 23 | 0.00 | 10 | $4 | 100% | 100% | 100% | LED-3 | 1599% | 61% | 60.4% | 58.8% | 58.8% | 2.6 |
| 4006 | Lighting | LED Standard | School Education | MF | MO | 37 | 62% | 23 | 0.00 | 10 | $4 | 100% | 100% | 100% | LED-4 | 1599% | 61% | 60.4% | 57.5% | 57.5% | 2.6 |
| 4007 | Lighting | LED Standard | CBL | MF | MO | 37 | 43% | 16 | 0.00 | 10 | $2 | 100% | 59% | 59% | LED-4 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 5.3 |
| 4008 | Lighting | LED Standard | IQW | MF | MO | 37 | 77% | 29 | 0.00 | 10 | $2 | 100% | 100% | 100% | LED-4 | 1599% | 61% | 60.4% | 57.5% | 57.5% | 6.1 |
| 4009 | Lighting | LED Reflector | Efficient Products | SF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-1 | 951% | 61% | 75.0% | 54.8% | 54.8% | 28.5 |
| 4010 | Lighting | LED Reflector | School Education | SF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-1 | 951% | 61% | 75.0% | 54.8% | 54.8% | 28.5 |
| 4011 | Lighting | LED Reflector | Efficient Products | SF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-2 | 951% | 61% | 60.4% | 54.8% | 54.8% | 28.5 |
| 4012 | Lighting | LED Reflector | School Education | SF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-2 | 951% | 61% | 60.4% | 54.8% | 54.8% | 28.5 |
| 4013 | Lighting | LED Reflector | IQW | SF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 100% | 100% | REFL-2 | 951% | 61% | 60.4% | 58.7% | 58.7% | 11.4 |
| 4014 | Lighting | LED Reflector | Efficient Products | SF | NC | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-3 | 951% | 0% | 81.8% | 49.4% | 49.4% | 28.5 |
| 4015 | Lighting | LED Reflector | Efficient Products | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-4 | 570% | 61% | 60.4% | 54.8% | 54.8% | 28.1 |
| 4016 | Lighting | LED Reflector | School Education | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-4 | 570% | 61% | 60.4% | 54.8% | 54.8% | 28.1 |
| 4017 | Lighting | LED Reflector | Multifamily | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 100% | 100% | REFL-4 | 570% | 61% | 60.4% | 58.8% | 58.8% | 11.2 |
| 4018 | Lighting | LED Reflector | Efficient Products | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-5 | 570% | 61% | 60.4% | 54.8% | 54.8% | 28.1 |
| 4019 | Lighting | LED Reflector | School Education | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-5 | 570% | 61% | 60.4% | 54.8% | 54.8% | 28.1 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4020 | Lighting | LED Reflector | Multifamily | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 100% | 100% | REFL-5 | 570% | 61% | 60.4% | 57.5% | 57.5% | 11.2 |
| 4021 | Lighting | LED Reflector | IQW | MF | MO | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 100% | 100% | REFL-5 | 570% | 61% | 60.4% | 57.5% | 57.5% | 11.2 |
| 4022 | Lighting | LED Reflector | Efficient Products | MF | NC | 65 | 75% | 49 | 0.04 | 10 | $5 | 100% | 40% | 40% | REFL-6 | 570% | 0% | 71.2% | 43.6% | 43.6% | 28.1 |
| 4023 | Lighting | LED Specialty | Efficient Products | SF | MO | 44 | 75% | 33 | 0.02 | 10 | $3 | 100% | 44% | 44% | SPEC-1 | 573% | 61% | 75.0% | 54.8% | 54.8% | 22.2 |
| 4024 | Lighting | LED Specialty | Efficient Products | SF | MO | 44 | 75% | 33 | 0.02 | 10 | $3 | 100% | 44% | 44% | SPEC-2 | 573% | 61% | 60.4% | 54.8% | 54.8% | 22.2 |
| 4025 | Lighting | LED Specialty | IQW | SF | MO | 44 | 75% | 33 | 0.02 | 10 | $2 | 100% | 100% | 100% | SPEC-2 | 573% | 61% | 60.4% | 58.7% | 58.7% | 14.8 |
| 4026 | Lighting | LED Specialty | Efficient Products | SF | NC | 44 | 75% | 33 | 0.02 | 10 | $3 | 100% | 44% | 44% | SPEC-3 | 573% | 0% | 81.8% | 52.5% | 52.5% | 22.2 |
| 4027 | Lighting | LED Specialty | Efficient Products | MF | MO | 44 | 75% | 33 | 0.02 | 10 | $3 | 100% | 44% | 44% | SPEC-4 | 344% | 61% | 60.4% | 54.8% | 54.8% | 21.8 |
| 4028 | Lighting | LED Specialty | Multifamily | MF | MO | 44 | 75% | 33 | 0.02 | 10 | $2 | 100% | 100% | 100% | SPEC-4 | 344% | 61% | 60.4% | 58.8% | 58.8% | 14.5 |
| 4029 | Lighting | LED Specialty | Efficient Products | MF | MO | 44 | 75% | 33 | 0.02 | 10 | $3 | 100% | 44% | 44% | SPEC-5 | 344% | 61% | 60.4% | 54.8% | 54.8% | 21.8 |
| 4030 | Lighting | LED Specialty | Multifamily | MF | MO | 44 | 75% | 33 | 0.02 | 10 | $2 | 100% | 100% | 100% | SPEC-5 | 344% | 61% | 60.4% | 57.5% | 57.5% | 14.5 |
| 4031 | Lighting | LED Specialty | IQW | MF | MO | 44 | 75% | 33 | 0.02 | 10 | $2 | 100% | 100% | 100% | SPEC-5 | 344% | 61% | 60.4% | 57.5% | 57.5% | 14.5 |
| 4032 | Lighting | LED Specialty | Efficient Products | MF | NC | 44 | 75% | 33 | 0.02 | 10 | $3 | 100% | 44% | 44% | SPEC-6 | 344% | 0% | 71.2% | 45.4% | 45.4% | 21.8 |
| 4033 | Lighting | Exterior LED Lamp | IQW | SF | MO | 127 | 43% | 55 | 0.00 | 7 | $2 | 100% | 100% | 100% | EXT LED-1 | 466% | 61% | 60.4% | 58.7% | 58.7% | 7.1 |
| 4034 | Lighting | Exterior LED Lamp | Multifamily | MF | MO | 127 | 43% | 55 | 0.00 | 7 | $2 | 100% | 100% | 100% | EXT LED-2 | 252% | 61% | 60.4% | 58.8% | 58.8% | 7.2 |
| 4035 | Lighting | Exterior LED Lamp | Multifamily | MF | MO | 127 | 43% | 55 | 0.00 | 7 | $2 | 100% | 100% | 100% | EXT LED-3 | 252% | 61% | 60.4% | 57.5% | 57.5% | 7.2 |
| 4036 | Lighting | Exterior LED Lamp | IQW | MF | MO | 127 | 43% | 55 | 0.00 | 7 | $2 | 100% | 100% | 100% | EXT LED-3 | 252% | 61% | 60.4% | 57.5% | 57.5% | 7.2 |
| 4037 | Lighting | LED Nightlights | Efficient Products | SF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-1 | 14% | 61% | 75.0% | 75.0% | 75.0% | 1.2 |
| 4038 | Lighting | LED Nightlights | School Education | SF | MO | 15 | 26% | 4 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-1 | 14% | 61% | 75.0% | 75.0% | 75.0% | 0.3 |
| 4039 | Lighting | LED Nightlights | Efficient Products | SF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-2 | 14% | 61% | 60.4% | 58.7% | 58.7% | 1.2 |
| 4040 | Lighting | LED Nightlights | School Education | SF | MO | 15 | 26% | 4 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-2 | 14% | 61% | 60.4% | 58.7% | 58.7% | 0.3 |
| 4041 | Lighting | LED Nightlights | IQW | SF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-2 | 14% | 61% | 60.4% | 58.7% | 58.7% | 1.2 |
| 4042 | Lighting | LED Nightlights | Efficient Products | SF | NC | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-3 | 14% | 0% | 81.8% | 81.8% | 81.8% | 1.2 |
| 4043 | Lighting | LED Nightlights | Efficient Products | MF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-4 | 8% | 61% | 60.4% | 58.8% | 58.8% | 1.1 |
| 4044 | Lighting | LED Nightlights | School Education | MF | MO | 15 | 26% | 4 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-4 | 8% | 61% | 60.4% | 58.8% | 58.8% | 0.3 |
| 4045 | Lighting | LED Nightlights | Multifamily | MF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-4 | 8% | 61% | 60.4% | 58.8% | 58.8% | 1.1 |
| 4046 | Lighting | LED Nightlights | Efficient Products | MF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-5 | 8% | 61% | 60.4% | 57.5% | 57.5% | 1.1 |
| 4047 | Lighting | LED Nightlights | School Education | MF | MO | 15 | 26% | 4 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-5 | 8% | 61% | 60.4% | 57.5% | 57.5% | 0.3 |
| 4048 | Lighting | LED Nightlights | Multifamily | MF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-5 | 8% | 61% | 60.4% | 57.5% | 57.5% | 1.1 |
| 4049 | Lighting | LED Nightlights | IQW | MF | MO | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-5 | 8% | 61% | 60.4% | 57.5% | 57.5% | 1.1 |
| 4050 | Lighting | LED Nightlights | Efficient Products | MF | NC | 15 | 93% | 14 | 0.00 | 8 | $3 | 100% | 100% | 100% | NIGHT-6 | 8% | 0% | 71.2% | 71.2% | 71.2% | 1.1 |
| 4051 | Lighting | Ceiling Fan | Efficient Products | SF | MO | 110 | 75% | 82 | 0.00 | 10 | $46 | 54% | 54% | 54% | LED-1 | 92% | 61% | 60.4% | 54.8% | 54.8% | 1.0 |
| 4052 | Lighting | Ceiling Fan | Efficient Products | SF | NC | 110 | 75% | 82 | 0.00 | 10 | $46 | 54% | 54% | 54% | LED-5 | 92% | 0% | 59.9% | 59.9% | 59.9% | 1.0 |
| 4053 | Lighting | Ceiling Fan | Efficient Products | MF | MO | 110 | 75% | 82 | 0.00 | 10 | $46 | 54% | 54% | 54% | LED-3 | 98% | 61% | 60.4% | 54.8% | 54.8% | 1.0 |
| 4054 | Lighting | Ceiling Fan | Efficient Products | MF | NC | 110 | 75% | 82 | 0.00 | 10 | $46 | 54% | 54% | 54% | LED-6 | 98% | 0% | 50.5% | 50.5% | 50.5% | 1.0 |
| 4055 | Lighting | LED 3-Way Bulb | Efficient Products | SF | MO | 11 | 75% | 9 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-1 | 2667% | 61% | 75.0% | 54.8% | 54.8% | 2.5 |
| 4056 | Lighting | LED 3-Way Bulb | Efficient Products | SF | MO | 11 | 75% | 9 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-2 | 2667% | 61% | 60.4% | 54.8% | 54.8% | 2.5 |
| 4057 | Lighting | LED 3-Way Bulb | IQW | SF | MO | 11 | 75% | 8 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-2 | 2667% | 61% | 60.4% | 54.8% | 54.8% | 4.6 |
| 4058 | Lighting | LED 3-Way Bulb | Efficient Products | SF | NC | 11 | 75% | 9 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-5 | 2667% | 0% | 81.8% | 57.9% | 57.9% | 2.5 |
| 4059 | Lighting | LED 3-Way Bulb | Efficient Products | MF | MO | 11 | 75% | 9 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-3 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 2.3 |
| 4060 | Lighting | LED 3-Way Bulb | Multifamily | MF | MO | 35 | 75% | 27 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-3 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 7.9 |
| 4061 | Lighting | LED 3-Way Bulb | Efficient Products | MF | MO | 11 | 75% | 9 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-4 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 2.3 |
| 4062 | Lighting | LED 3-Way Bulb | Multifamily | MF | MO | 35 | 75% | 27 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-4 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 7.9 |
| 4063 | Lighting | LED 3-Way Bulb | IQW | MF | MO | 11 | 75% | 8 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-4 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 4.5 |
| 4064 | Lighting | LED 3-Way Bulb | Efficient Products | MF | NC | 11 | 75% | 9 | 0.00 | 10 | $3 | 100% | 50% | 50% | LED-6 | 1599% | 0% | 71.2% | 48.4% | 48.4% | 2.3 |
| 4065 | Lighting | Linear LED | Efficient Products | SF | MO | 23 | 44% | 10 | 0.01 | 9 | $7 | 100% | 80% | 80% | LINEAR-1 | 179% | 61% | 73.9% | 60.8% | 60.8% | 3.0 |
| 4066 | Lighting | Linear LED | Efficient Products | SF | NC | 23 | 44% | 10 | 0.01 | 9 | $3 | 100% | 80% | 80% | LINEAR-2 | 179% | 0% | 81.8% | 72.7% | 72.7% | 8.4 |
| 4067 | Lighting | Linear LED | Efficient Products | MF | MO | 23 | 44% | 10 | 0.01 | 9 | $7 | 100% | 80% | 80% | LINEAR-3 | 107% | 61% | 60.4% | 54.8% | 54.8% | 3.0 |
| 4068 | Lighting | Linear LED | Efficient Products | MF | NC | 23 | 44% | 10 | 0.01 | 9 | $3 | 100% | 80% | 80% | LINEAR-4 | 107% | 0% | 71.2% | 63.7% | 63.7% | 8.3 |
| 4069 | Lighting | Smart LED | Efficient Products | SF | MO | 19 | 10% | 2 | 0.00 | 10 | $2 | 80% | 80% | 80% | LED-1 | 2667% | 61% | 60.8% | 60.8% | 60.8% | 0.4 |
| 4070 | Lighting | Smart LED | Efficient Products | SF | NC | 19 | 10% | 2 | 0.00 | 10 | $2 | 80% | 80% | 80% | LED-3 | 2667% | 0% | 72.7% | 72.7% | 72.7% | 0.4 |
| 4071 | Lighting | Smart LED | Efficient Products | MF | MO | 19 | 10% | 2 | 0.00 | 10 | $2 | 80% | 80% | 80% | LED-4 | 1599% | 61% | 60.4% | 54.8% | 54.8% | 0.4 |
| 4072 | Lighting | Smart LED | Efficient Products | MF | NC | 19 | 10% | 2 | 0.00 | 10 | $2 | 80% | 80% | 80% | LED-6 | 1599% | 0% | 63.7% | 63.7% | 63.7% | 0.4 |
| 4073 | Lighting | LED Fixture | Efficient Products | SF | MO | 82 | 59% | 49 | 0.06 | 15 | $26 | 100% | 80% | 80% | LED-1 | 2096% | 61% | 73.9% | 60.8% | 60.8% | 5.2 |
| 4074 | Lighting | LED Fixture | Efficient Products | SF | NC | 82 | 59% | 49 | 0.06 | 15 | $3 | 100% | 80% | 80% | LED-3 | 2096% | 0% | 81.8% | 72.7% | 72.7% | 52.3 |
| 4075 | Lighting | LED Fixture | Efficient Products | MF | MO | 82 | 59% | 49 | 0.06 | 15 | $26 | 100% | 80% | 80% | LED-4 | 1256% | 61% | 60.4% | 54.8% | 54.8% | 5.2 |
| 4076 | Lighting | LED Fixture | Efficient Products | MF | NC | 82 | 59% | 49 | 0.06 | 15 | $3 | 100% | 80% | 80% | LED-6 | 1256% | 0% | 71.2% | 63.7% | 63.7% | 51.8 |
| 4077 | Lighting | Occupancy Sensor | Efficient Products | SF | Retrofit | 124 | 30% | 37 | 0.05 | 10 | $30 | 100% | 80% | 80% | OCC-1 | 1048% | 31% | 74.8% | 62.1% | 62.1% | 2.6 |
| 4078 | Lighting | Occupancy Sensor | Efficient Products | SF | NC | 124 | 30% | 37 | 0.05 | 10 | $30 | 100% | 80% | 80% | OCC-2 | 1048% | 0% | 81.8% | 72.7% | 72.7% | 2.6 |
| 4079 | Lighting | Occupancy Sensor | Efficient Products | MF | Retrofit | 124 | 30% | 37 | 0.05 | 10 | $30 | 100% | 80% | 80% | OCC-3 | 628% | 31% | 60.1% | 49.6% | 49.6% | 2.5 |
| 4080 | Lighting | Occupancy Sensor | Efficient Products | MF | NC | 124 | 30% | 37 | 0.05 | 10 | $30 | 100% | 80% | 80% | OCC-4 | 628% | 0% | 71.2% | 63.7% | 63.7% | 2.5 |
| 4081 | Lighting | Smart Lighting Switch | Efficient Products | SF | Retrofit | 124 | 17% | 21 | 0.05 | 10 | $43 | 100% | 47% | 47% | OCC-1 | 1048% | 31% | 74.8% | 37.9% | 37.9% | 2.8 |
| 4082 | Lighting | Smart Lighting Switch | Efficient Products | SF | NC | 124 | 17% | 21 | 0.05 | 10 | $43 | 100% | 47% | 47% | OCC-2 | 1048% | 0% | 81.8% | 55.2% | 55.2% | 2.8 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4083 | Lighting | Smart Lighting Switch | Efficient Products | MF | Retrofit | 124 | 17% | 21 | 0.05 | 10 | $43 | 100% | 47% | 47% | OCC-3 | 628% | 31% | 60.1% | 26.4% | 26.4% | 2.8 |
| 4084 | Lighting | Smart Lighting Switch | Efficient Products | MF | NC | 124 | 17% | 21 | 0.05 | 10 | $43 | 100% | 47% | 47% | OCC-4 | 628% | 0% | 71.2% | 46.9% | 46.9% | 2.8 |
| 4085 | Lighting | Exterior Lighting Controls | Efficient Products | SF | Retrofit | 146 | 44% | 65 | 0.03 | 10 | $30 | 100% | 80% | 80% | ELC-1 | 233% | 35% | 73.4% | 60.1% | 60.1% | 2.0 |
| 4086 | Lighting | Exterior Lighting Controls | Efficient Products | SF | NC | 146 | 44% | 65 | 0.03 | 10 | $30 | 100% | 80% | 80% | ELC-2 | 233% | 0% | 81.8% | 72.7% | 72.7% | 2.0 |
| 4087 | Lighting | Exterior Lighting Controls | Efficient Products | MF | Retrofit | 146 | 44% | 65 | 0.03 | 10 | $30 | 100% | 80% | 80% | ELC-3 | 126% | 35% | 58.0% | 46.9% | 46.9% | 2.0 |
| 4088 | Lighting | Exterior Lighting Controls | Efficient Products | MF | NC | 146 | 44% | 65 | 0.03 | 10 | $30 | 100% | 80% | 80% | ELC-4 | 126% | 0% | 71.2% | 63.7% | 63.7% | 2.0 |
| 4089 | Lighting | ENERGY STAR LED Trim Kits | Efficient Products | SF | MO | 18 | 70% | 13 | 0.00 | 10 | $5 | 100% | 100% | 100% | REFL-1 | 951% | 61% | 75.0% | 75.0% | 75.0% | 1.2 |
| 4090 | Lighting | ENERGY STAR LED Trim Kits | Efficient Products | SF | MO | 18 | 70% | 13 | 0.00 | 10 | $5 | 100% | 100% | 100% | REFL-2 | 951% | 61% | 60.4% | 58.7% | 58.7% | 1.2 |
| 4091 | Lighting | ENERGY STAR LED Trim Kits | IQW | SF | MO | 66 | 70% | 46 | 0.01 | 10 | $5 | 100% | 100% | 100% | REFL-2 | 951% | 61% | 60.4% | 58.7% | 58.7% | 4.1 |
| 4092 | Lighting | ENERGY STAR LED Trim Kits | Efficient Products | SF | NC | 18 | 70% | 13 | 0.00 | 10 | $5 | 100% | 100% | 100% | REFL-3 | 951% | 0% | 81.8% | 81.8% | 81.8% | 1.2 |
| 4093 | Lighting | ENERGY STAR LED Trim Kits | Efficient Products | MF | MO | 18 | 70% | 13 | 0.00 | 10 | $5 | 100% | 100% | 100% | REFL-4 | 570% | 61% | 60.4% | 58.8% | 58.8% | 1.2 |
| 4094 | Lighting | ENERGY STAR LED Trim Kits | Multifamily | MF | MO | 66 | 70% | 46 | 0.01 | 10 | $5 | 100% | 100% | 100% | REFL-4 | 570% | 61% | 60.4% | 58.8% | 58.8% | 3.9 |
| 4095 | Lighting | ENERGY STAR LED Trim Kits | Efficient Products | MF | MO | 18 | 70% | 13 | 0.00 | 10 | $5 | 100% | 100% | 100% | REFL-5 | 570% | 61% | 60.4% | 57.5% | 57.5% | 1.2 |
| 4096 | Lighting | ENERGY STAR LED Trim Kits | Multifamily | MF | MO | 66 | 70% | 46 | 0.01 | 10 | $5 | 100% | 100% | 100% | REFL-5 | 570% | 61% | 60.4% | 57.5% | 57.5% | 3.9 |
| 4097 | Lighting | ENERGY STAR LED Trim Kits | IQW | MF | MO | 66 | 70% | 46 | 0.01 | 10 | $5 | 100% | 100% | 100% | REFL-5 | 570% | 61% | 60.4% | 57.5% | 57.5% | 3.9 |
| 4098 | Lighting | ENERGY STAR LED Trim Kits | Efficient Products | MF | NC | 18 | 70% | 13 | 0.00 | 10 | $5 | 100% | 100% | 100% | REFL-6 | 570% | 0% | 71.2% | 71.2% | 71.2% | 1.2 |
| 5001 | Pool/Pump | Variable Speed Pool Pump | Efficient Products | SF | MO | 1,167 | 26% | 308 | 0.22 | 7 | $314 | 75% | 64% | 64% | VSPP-1 | 6% | 31% | 65.2% | 58.0% | 58.0% | 1.2 |
| 5002 | Pool/Pump | Variable Speed Pool Pump | Efficient Products | SF | NC | 1,167 | 26% | 308 | 0.22 | 7 | $314 | 75% | 64% | 64% | VSPP-2 | 6% | 0% | 70.5% | 64.5% | 64.5% | 1.2 |
| 5003 | Pool/Pump | Variable Speed Pool Pump | Efficient Products | MF | MO | 1,167 | 26% | 308 | 0.22 | 7 | $314 | 75% | 64% | 64% | VSPP-3 | 2% | 31% | 55.0% | 47.2% | 47.2% | 1.2 |
| 5004 | Pool/Pump | Variable Speed Pool Pump | Efficient Products | MF | NC | 1,167 | 26% | 308 | 0.22 | 7 | $314 | 75% | 64% | 64% | VSPP-4 | 2% | 0% | 61.9% | 55.4% | 55.4% | 1.2 |
| 5005 | Pool/Pump | Pool Timer | Efficient Products | SF | MO | 1,167 | 40% | 467 | 0.00 | 2 | $25 | 100% | 80% | 80% | PTIMER-1 | 6% | 31% | 78.5% | 67.7% | 67.7% | 2.0 |
| 5006 | Pool/Pump | Pool Timer | Efficient Products | SF | NC | 1,167 | 40% | 467 | 0.00 | 2 | $25 | 100% | 80% | 80% | PTIMER-2 | 6% | 0% | 81.8% | 72.7% | 72.7% | 2.0 |
| 5007 | Pool/Pump | Pool Timer | Efficient Products | MF | MO | 1,167 | 40% | 467 | 0.00 | 2 | $25 | 100% | 80% | 80% | PTIMER-3 | 2% | 31% | 66.0% | 57.0% | 57.0% | 2.0 |
| 5008 | Pool/Pump | Pool Timer | Efficient Products | MF | NC | 1,167 | 40% | 467 | 0.00 | 2 | $25 | 100% | 80% | 80% | PTIMER-4 | 2% | 0% | 71.2% | 63.7% | 63.7% | 2.0 |
| 5009 | Pool/Pump | Pool Heater | Efficient Products | SF | MO | 2,364 | 80% | 1,892 | 0.00 | 8 | $1,250 | 80% | 80% | 80% | PHEATER-1 | 6% | 21% | 69.4% | 69.4% | 69.4% | 0.5 |
| 5010 | Pool/Pump | Pool Heater | Efficient Products | SF | NC | 2,364 | 80% | 1,892 | 0.00 | 8 | $1,250 | 80% | 80% | 80% | PHEATER-2 | 6% | 0% | 72.7% | 72.7% | 72.7% | 0.5 |
| 5011 | Pool/Pump | Pool Heater | Efficient Products | MF | MO | 2,364 | 80% | 1,892 | 0.00 | 8 | $1,250 | 80% | 80% | 80% | PHEATER-3 | 2% | 21% | 59.4% | 59.4% | 59.4% | 0.5 |
| 5012 | Pool/Pump | Pool Heater | Efficient Products | MF | NC | 2,364 | 80% | 1,892 | 0.00 | 8 | $1,250 | 80% | 80% | 80% | PHEATER-4 | 2% | 0% | 63.7% | 63.7% | 63.7% | 0.5 |
| 5013 | Pool/Pump | Well Pump | Efficient Products | SF | MO | 411 | 33% | 136 | 0.02 | 20 | $110 | 80% | 80% | 80% | WELL-1 | 9% | 31% | 67.7% | 67.7% | 67.7% | 1.0 |
| 5014 | Pool/Pump | Well Pump | Efficient Products | SF | NC | 411 | 33% | 136 | 0.02 | 20 | $110 | 80% | 80% | 80% | WELL-2 | 9% | 0% | 72.7% | 72.7% | 72.7% | 1.0 |
| 5015 | Pool/Pump | Well Pump | Efficient Products | MF | MO | 411 | 33% | 136 | 0.02 | 20 | $110 | 80% | 80% | 80% | WELL-3 | 5% | 31% | 57.0% | 57.0% | 57.0% | 1.0 |
| 5016 | Pool/Pump | Well Pump | Efficient Products | MF | NC | 411 | 33% | 136 | 0.02 | 20 | $110 | 80% | 80% | 80% | WELL-4 | 5% | 0% | 63.7% | 63.7% | 63.7% | 1.0 |
| 6001 | New Construction | Gold Star HERS 67- All Electric | Efficient Products | SF | NC | 14,512 | 33% | 4,789 | 0.55 | 25 | $3,319 | 100% | 80% | 80% | NC-1 | 45% | 0% | 87.7% | 78.5% | 78.5% | 1.3 |
| 6002 | New Construction | Platinum Star HERS 60 Gas & Electric | Efficient Products | SF | NC | 9,819 | 40% | 3,928 | 0.45 | 25 | $3,049 | 80% | 80% | 80% | NC-2 | 55% | 0% | 78.5% | 78.5% | 78.5% | 1.2 |
| 6003 | New Construction | Gold Star HERS 67- Gas & Electric | Efficient Products | SF | NC | 9,819 | 33% | 3,240 | 0.37 | 25 | $3,319 | 80% | 80% | 80% | NC-2 | 45% | 0% | 78.5% | 78.5% | 78.5% | 0.9 |
| 6004 | New Construction | Silver Star HERS 75 - Gas & Electric | Efficient Products | SF | NC | 9,819 | 25% | 2,455 | 0.28 | 25 | $3,049 | 80% | 80% | 80% | NC-2 | 55% | 0% | 78.5% | 78.5% | 78.5% | 0.7 |
| 6005 | New Construction | Gold Star HERS 67- All Electric | Efficient Products | MF | NC | 10,414 | 33% | 3,437 | 0.39 | 25 | $3,319 | 80% | 80% | 80% | NC-3 | 77% | 0% | 61.2% | 61.2% | 61.2% | 1.0 |
| 6006 | New Construction | Platinum Star HERS 60 Gas & Electric | Efficient Products | MF | NC | 8,371 | 40% | 3,348 | 0.38 | 25 | $3,049 | 80% | 80% | 80% | NC-4 | 23% | 0% | 61.2% | 61.2% | 61.2% | 1.0 |
| 6007 | New Construction | Gold Star HERS 67- Gas & Electric | Efficient Products | MF | NC | 8,371 | 33% | 2,762 | 0.32 | 25 | $3,319 | 80% | 80% | 80% | NC-4 | 77% | 0% | 61.2% | 61.2% | 61.2% | 0.8 |
| 6008 | New Construction | Silver Star HERS 75 - Gas & Electric | Efficient Products | MF | NC | 8,371 | 25% | 2,093 | 0.24 | 25 | $3,049 | 80% | 80% | 80% | NC-4 | 23% | 0% | 61.2% | 61.2% | 61.2% | 0.6 |
| 7001 | Plug Loads | Smart Power Strips - Tier 1 | Efficient Products | SF | Retrofit | 466 | 12% | 57 | 0.01 | 7 | $10 | 100% | 80% | 80% | STRIP-1 | 178% | 14% | 79.1% | 68.6% | 68.6% | 2.3 |
| 7002 | Plug Loads | Smart Power Strips - Tier 1 | Efficient Products | SF | NC | 466 | 12% | 57 | 0.01 | 7 | $10 | 100% | 80% | 80% | STRIP-2 | 178% | 0% | 81.8% | 72.7% | 72.7% | 2.3 |
| 7003 | Plug Loads | Smart Power Strips - Tier 1 | Efficient Products | MF | Retrofit | 466 | 12% | 57 | 0.01 | 7 | $10 | 100% | 80% | 80% | STRIP-3 | 139% | 10% | 80.0% | 69.9% | 69.9% | 2.2 |
| 7004 | Plug Loads | Smart Power Strips - Tier 1 | Efficient Products | MF | NC | 466 | 12% | 57 | 0.01 | 7 | $10 | 100% | 80% | 80% | STRIP-4 | 139% | 0% | 81.8% | 72.7% | 72.7% | 2.2 |
| 7005 | Plug Loads | Smart Power Strips - Tier 2 | Efficient Products | SF | MO | 466 | 29% | 136 | 0.02 | 7 | $15 | 100% | 100% | 100% | STRIP-5 | 100% | 14% | 79.6% | 79.6% | 79.6% | 3.4 |
| 7006 | Plug Loads | Smart Power Strips - Tier 2 | Efficient Products | SF | MO | 466 | 29% | 136 | 0.02 | 7 | $15 | 100% | 100% | 100% | STRIP-6 | 100% | 14% | 66.4% | 66.4% | 66.4% | 3.4 |
| 7007 | Plug Loads | Smart Power Strips - Tier 2 | IQW | SF | MO | 466 | 29% | 136 | 0.02 | 7 | $70 | 100% | 35% | 35% | STRIP-6 | 100% | 14% | 66.4% | 24.2% | 24.2% | 2.1 |
| 7008 | Plug Loads | Smart Power Strips - Tier 2 | Efficient Products | SF | NC | 466 | 29% | 136 | 0.02 | 7 | $15 | 100% | 100% | 100% | STRIP-7 | 100% | 0% | 81.8% | 81.8% | 81.8% | 3.4 |
| 7009 | Plug Loads | Smart Power Strips - Tier 2 | Efficient Products | MF | MO | 466 | 29% | 136 | 0.02 | 7 | $15 | 100% | 100% | 100% | STRIP-8 | 100% | 10% | 68.0% | 68.0% | 68.0% | 3.4 |
| 7010 | Plug Loads | Smart Power Strips - Tier 2 | Multifamily | MF | MO | 466 | 29% | 136 | 0.02 | 7 | $70 | 75% | 35% | 35% | STRIP-8 | 100% | 10% | 57.6% | 34.8% | 34.8% | 2.1 |
| 7011 | Plug Loads | Smart Power Strips - Tier 2 | Efficient Products | MF | MO | 466 | 29% | 136 | 0.02 | 7 | $15 | 100% | 100% | 100% | STRIP-9 | 100% | 10% | 67.1% | 67.1% | 67.1% | 3.4 |
| 7012 | Plug Loads | Smart Power Strips - Tier 2 | Multifamily | MF | MO | 466 | 29% | 136 | 0.02 | 7 | $70 | 100% | 35% | 35% | STRIP-9 | 100% | 10% | 67.1% | 32.3% | 32.3% | 2.1 |
| 7013 | Plug Loads | Smart Power Strips - Tier 2 | IQW | MF | MO | 466 | 29% | 136 | 0.02 | 7 | $70 | 100% | 35% | 35% | STRIP-9 | 100% | 10% | 67.1% | 32.3% | 32.3% | 2.1 |
| 7014 | Plug Loads | Smart Power Strips - Tier 2 | Efficient Products | MF | NC | 466 | 29% | 136 | 0.02 | 7 | $15 | 100% | 100% | 100% | STRIP-10 | 100% | 0% | 71.2% | 71.2% | 71.2% | 3.4 |
| 7015 | Plug Loads | Smart Television | Efficient Products | SF | MO | 83 | 20% | 17 | 0.00 | 6 | $0 | 100% | 100% | 100% | T V-1 | 270% | 61% | 53.7% | 53.7% | 53.7% | 0.1 |
| 7016 | Plug Loads | Smart Television | Efficient Products | SF | NC | 83 | 20% | 17 | 0.00 | 6 | $0 | 100% | 100% | 100% | T V-2 | 270% | 0% | 81.8% | 81.8% | 81.8% | 0.1 |
| 7017 | Plug Loads | Smart Television | Efficient Products | MF | MO | 83 | 20% | 17 | 0.00 | 6 | $0 | 100% | 100% | 100% | T V-3 | 207% | 61% | 30.0% | 26.9% | 26.9% | 0.1 |
| 7018 | Plug Loads | Smart Television | Efficient Products | MF | NC | 83 | 20% | 17 | 0.00 | 6 | $0 | 100% | 100% | 100% | T V-4 | 207% | 0% | 71.2% | 71.2% | 71.2% | 0.1 |
| 7019 | Plug Loads | Smart Outlets | Efficient Products | SF | Retrofit | 466 | 6% | 28 | 0.00 | 7 | $50 | 80% | 80% | 80% | SO-1 | 100% | 14% | 68.6% | 68.6% | 68.6% | 0.2 |
| 7020 | Plug Loads | Smart Outlets | Efficient Products | SF | NC | 466 | 6% | 28 | 0.00 | 7 | $50 | 80% | 80% | 80% | SO-2 | 100% | 0% | 72.7% | 72.7% | 72.7% | 0.2 |
| 7021 | Plug Loads | Smart Outlets | Efficient Products | MF | Retrofit | 466 | 6% | 28 | 0.00 | 7 | $50 | 80% | 80% | 80% | SO-3 | 100% | 10% | 60.0% | 60.0% | 60.0% | 0.2 |
| 7022 | Plug Loads | Smart Outlets | Efficient Products | MF | NC | 466 | 6% | 28 | 0.00 | 7 | $50 | 80% | 80% | 80% | SO-4 | 100% | 0% | 63.7% | 63.7% | 63.7% | 0.2 |
| 8001 | Shell | Advanced Walls - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 10% | 606 | 0.23 | 20 | $2,470 | 80% | 80% | 80% | WALL-1 | 13% | 96% | 80.0% | 77.1% | 77.1% | 0.3 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8002 | Shell | Advanced Walls - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 10% | 257 | 0.23 | 20 | $1,581 | 80% | 80% | 80% | WALL-7 | 13% | 96% | 80.0% | 77.1% | 77.1% | 0.4 |
| 8003 | Shell | Advanced Walls - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 10% | 1,193 | 0.23 | 20 | $2,470 | 80% | 80% | 80% | WALL-2 | 26% | 96% | 80.0% | 77.1% | 77.1% | 0.5 |
| 8004 | Shell | Advanced Walls - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 10% | 417 | 0.23 | 20 | $1,581 | 80% | 80% | 80% | WALL-9 | 50% | 96% | 80.0% | 77.1% | 77.1% | 0.5 |
| 8005 | Shell | Advanced Walls - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 10% | 137 | 0.23 | 20 | $2,470 | 80% | 80% | 80% | WALL-3 | 53% | 96% | 80.0% | 77.1% | 77.1% | 0.2 |
| 8006 | Shell | Advanced Walls - Gas Heating | Efficient Products | MF | Retrofit | 530 | 10% | 53 | 0.23 | 20 | $1,581 | 80% | 80% | 80% | WALL-11 | 21% | 96% | 80.0% | 77.1% | 77.1% | 0.3 |
| 8007 | Shell | Air Sealing Average Sealing - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 4% | 238 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-1 | 13% | 75% | 65.7% | 65.7% | 65.7% | 1.0 |
| 8008 | Shell | Air Sealing Average Sealing - Heat pump | IQW | SF | Retrofit | 6,061 | 4% | 238 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-2 | 13% | 75% | 46.0% | 38.3% | 38.3% | 1.0 |
| 8009 | Shell | Air Sealing Average Sealing - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 6% | 153 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-3 | 13% | 94% | 72.3% | 68.4% | 68.4% | 0.8 |
| 8010 | Shell | Air Sealing Average Sealing - Heat pump | IQW | MF | Retrofit | 2,573 | 6% | 153 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-4 | 13% | 94% | 72.3% | 68.4% | 68.4% | 0.8 |
| 8011 | Shell | Air Sealing Inadequate Sealing - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 17% | 1,003 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-5 | 13% | 84% | 54.4% | 53.7% | 53.7% | 2.8 |
| 8012 | Shell | Air Sealing Inadequate Sealing - Heat pump | IQW | SF | Retrofit | 6,061 | 17% | 1,003 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-6 | 13% | 84% | 54.4% | 47.9% | 47.9% | 2.8 |
| 8013 | Shell | Air Sealing Inadequate Sealing - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 25% | 642 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-7 | 13% | 78% | 48.3% | 41.0% | 41.0% | 2.0 |
| 8014 | Shell | Air Sealing Inadequate Sealing - Heat pump | IQW | MF | Retrofit | 2,573 | 25% | 642 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-8 | 13% | 78% | 48.3% | 41.0% | 41.0% | 2.0 |
| 8015 | Shell | Air Sealing Poor Sealing - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 29% | 1,768 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-9 | 13% | 94% | 74.2% | 70.5% | 70.5% | 4.6 |
| 8016 | Shell | Air Sealing Poor Sealing - Heat pump | IQW | SF | Retrofit | 6,061 | 29% | 1,768 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-10 | 13% | 94% | 74.2% | 70.5% | 70.5% | 4.6 |
| 8017 | Shell | Air Sealing Poor Sealing - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 44% | 1,132 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-11 | 13% | 49% | 48.3% | 48.3% | 48.3% | 3.1 |
| 8018 | Shell | Air Sealing Poor Sealing - Heat pump | IQW | MF | Retrofit | 2,573 | 44% | 1,132 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-12 | 13% | 49% | 37.5% | 37.5% | 37.5% | 3.1 |
| 8019 | Shell | Air Sealing Average Sealing - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 4% | 444 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-13 | 26% | 75% | 65.7% | 65.7% | 65.7% | 1.5 |
| 8020 | Shell | Air Sealing Average Sealing - Electric furnace | IQW | SF | Retrofit | 11,926 | 4% | 444 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-14 | 26% | 75% | 46.0% | 38.3% | 38.3% | 1.5 |
| 8021 | Shell | Air Sealing Average Sealing - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 7% | 284 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-15 | 50% | 94% | 72.3% | 68.4% | 68.4% | 1.1 |
| 8022 | Shell | Air Sealing Average Sealing - Electric furnace | IQW | MF | Retrofit | 4,166 | 7% | 284 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-16 | 50% | 94% | 72.3% | 68.4% | 68.4% | 1.1 |
| 8023 | Shell | Air Sealing Inadequate Sealing - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 16% | 1,869 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-17 | 26% | 84% | 54.4% | 53.7% | 53.7% | 4.8 |
| 8024 | Shell | Air Sealing Inadequate Sealing - Electric furnace | IQW | SF | Retrofit | 11,926 | 16% | 1,869 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-18 | 26% | 84% | 54.4% | 47.9% | 47.9% | 4.8 |
| 8025 | Shell | Air Sealing Inadequate Sealing - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 29% | 1,196 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-19 | 50% | 78% | 48.3% | 41.0% | 41.0% | 3.2 |
| 8026 | Shell | Air Sealing Inadequate Sealing - Electric furnace | IQW | MF | Retrofit | 4,166 | 29% | 1,196 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-20 | 50% | 78% | 48.3% | 41.0% | 41.0% | 3.2 |
| 8027 | Shell | Air Sealing Poor Sealing - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 28% | 3,293 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-21 | 26% | 94% | 74.2% | 70.5% | 70.5% | 8.1 |
| 8028 | Shell | Air Sealing Poor Sealing - Electric furnace | IQW | SF | Retrofit | 11,926 | 28% | 3,293 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-22 | 26% | 94% | 74.2% | 70.5% | 70.5% | 8.1 |
| 8029 | Shell | Air Sealing Poor Sealing - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 51% | 2,108 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-23 | 50% | 49% | 48.3% | 48.3% | 48.3% | 5.3 |
| 8030 | Shell | Air Sealing Poor Sealing - Electric furnace | IQW | MF | Retrofit | 4,166 | 51% | 2,108 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-24 | 50% | 49% | 37.5% | 37.5% | 37.5% | 5.3 |
| 8031 | Shell | Air Sealing - Average Sealing - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 3% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-25 | 53% | 75% | 65.7% | 65.7% | 65.7% | 0.5 |
| 8032 | Shell | Air Sealing - Average Sealing - Gas Heating | IQW | SF | Retrofit | 1,368 | 3% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-26 | 53% | 75% | 46.0% | 38.3% | 38.3% | 0.5 |
| 8033 | Shell | Air Sealing - Average Sealing - Gas Heating | Efficient Products | MF | Retrofit | 530 | 8% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-27 | 21% | 94% | 72.3% | 68.4% | 68.4% | 0.6 |
| 8034 | Shell | Air Sealing - Average Sealing - Gas Heating | IQW | MF | Retrofit | 530 | 8% | 41 | 0.05 | 20 | $100 | 200% | 100% | 100% | AIR SEAL-28 | 21% | 94% | 72.3% | 68.4% | 68.4% | 0.6 |
| 8035 | Shell | Air Sealing - Inadequate Sealing - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 3% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-29 | 53% | 84% | 54.4% | 53.7% | 53.7% | 0.5 |
| 8036 | Shell | Air Sealing - Inadequate Sealing - Gas Heating | IQW | SF | Retrofit | 1,368 | 3% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-30 | 53% | 84% | 54.4% | 47.9% | 47.9% | 0.5 |
| 8037 | Shell | Air Sealing - Inadequate Sealing - Gas Heating | Efficient Products | MF | Retrofit | 530 | 8% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-31 | 21% | 78% | 48.3% | 41.0% | 41.0% | 0.6 |
| 8038 | Shell | Air Sealing - Inadequate Sealing - Gas Heating | IQW | MF | Retrofit | 530 | 8% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-32 | 21% | 78% | 48.3% | 41.0% | 41.0% | 0.6 |
| 8039 | Shell | Air Sealing - Poor Sealing - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 3% | 42 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-33 | 53% | 94% | 74.2% | 70.5% | 70.5% | 0.5 |
| 8040 | Shell | Air Sealing - Poor Sealing - Gas Heating | IQW | SF | Retrofit | 1,368 | 3% | 42 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-34 | 53% | 94% | 74.2% | 70.5% | 70.5% | 0.5 |
| 8041 | Shell | Air Sealing - Poor Sealing - Gas Heating | Efficient Products | MF | Retrofit | 530 | 8% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-35 | 21% | 49% | 48.3% | 48.3% | 48.3% | 0.6 |
| 8042 | Shell | Air Sealing - Poor Sealing - Gas Heating | IQW | MF | Retrofit | 530 | 8% | 41 | 0.05 | 20 | $200 | 100% | 100% | 100% | AIR SEAL-36 | 21% | 49% | 37.5% | 37.5% | 37.5% | 0.6 |
| 8043 | Shell | Attic Insulation - Average Insulation - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 3% | 183 | 0.07 | 20 | $898 | 33% | 33% | 33% | ATTIC-1 | 13% | 77% | 47.7% | 40.2% | 40.2% | 0.7 |
| 8044 | Shell | Attic Insulation - Average Insulation - Heat pump | IQW | SF | Retrofit | 6,061 | 3% | 183 | 0.07 | 20 | $898 | 49% | 49% | 49% | ATTIC-2 | 13% | 77% | 47.7% | 40.2% | 40.2% | 0.5 |
| 8045 | Shell | Attic Insulation - Average Insulation - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 3% | 83 | 0.04 | 20 | $575 | 52% | 52% | 52% | ATTIC-3 | 13% | 96% | 80.6% | 77.8% | 77.8% | 0.4 |
| 8046 | Shell | Attic Insulation - Average Insulation - Heat pump | IQW | MF | Retrofit | 2,573 | 3% | 83 | 0.04 | 20 | $575 | 76% | 76% | 76% | ATTIC-4 | 13% | 96% | 80.6% | 77.8% | 77.8% | 0.3 |
| 8047 | Shell | Attic Insulation - Inadequate Insulation - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 7% | 404 | 0.15 | 20 | $1,597 | 25% | 25% | 25% | ATTIC-5 | 13% | 71% | 44.0% | 36.0% | 36.0% | 1.2 |
| 8048 | Shell | Attic Insulation - Inadequate Insulation - Heat pump | IQW | SF | Retrofit | 6,061 | 7% | 404 | 0.15 | 20 | $1,597 | 97% | 97% | 97% | ATTIC-6 | 13% | 71% | 44.0% | 36.0% | 36.0% | 0.3 |
| 8049 | Shell | Attic Insulation - Inadequate Insulation - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 7% | 177 | 0.10 | 20 | $1,022 | 39% | 39% | 39% | ATTIC-7 | 13% | 73% | 45.2% | 37.4% | 37.4% | 0.6 |
| 8050 | Shell | Attic Insulation - Inadequate Insulation - Heat pump | IQW | MF | Retrofit | 2,573 | 7% | 177 | 0.10 | 20 | $1,022 | 151% | 100% | 100% | ATTIC-8 | 13% | 73% | 45.2% | 37.4% | 37.4% | 0.2 |
| 8051 | Shell | Attic Insulation - Poor Insulation - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 11% | 665 | 0.27 | 20 | $1,597 | 50% | 35% | 35% | ATTIC-9 | 13% | 90% | 63.2% | 57.9% | 57.9% | 1.4 |
| 8052 | Shell | Attic Insulation - Poor Insulation - Heat pump | IQW | SF | Retrofit | 6,061 | 11% | 665 | 0.27 | 20 | $1,597 | 100% | 97% | 97% | ATTIC-10 | 13% | 90% | 63.2% | 57.9% | 57.9% | 0.5 |
| 8053 | Shell | Attic Insulation - Poor Insulation - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 11% | 291 | 0.17 | 20 | $1,022 | 100% | 39% | 39% | ATTIC-11 | 13% | 38% | 55.8% | 24.6% | 24.6% | 1.1 |
| 8054 | Shell | Attic Insulation - Poor Insulation - Heat pump | IQW | MF | Retrofit | 2,573 | 11% | 291 | 0.17 | 20 | $1,022 | 151% | 100% | 100% | ATTIC-12 | 13% | 38% | 46.5% | 46.5% | 46.5% | 0.3 |
| 8055 | Shell | Attic Insulation - Average Insulation - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 3% | 357 | 0.08 | 20 | $898 | 33% | 33% | 33% | ATTIC-13 | 26% | 77% | 47.7% | 40.2% | 40.2% | 1.0 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8056 | Shell | Attic Insulation - Average Insulation - Electric furnace | IQW | SF | Retrofit | 11,926 | 3% | 357 | 0.08 | 20 | $898 | 50% | 49% | 49% | ATTIC-14 | 26% | 77% | 47.7% | 40.2% | 40.2% | 0.7 |
| 8057 | Shell | Attic Insulation - Average Insulation - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 4% | 168 | 0.06 | 20 | $575 | 52% | 52% | 52% | ATTIC-15 | 50% | 96% | 80.6% | 77.8% | 77.8% | 0.6 |
| 8058 | Shell | Attic Insulation - Average Insulation - Electric furnace | IQW | MF | Retrofit | 4,166 | 4% | 168 | 0.06 | 20 | $575 | 76% | 76% | 76% | ATTIC-16 | 50% | 96% | 80.6% | 77.8% | 77.8% | 0.4 |
| 8059 | Shell | Attic Insulation - Inadequate Insulation - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 7% | 795 | 0.18 | 20 | $1,597 | 100% | 35% | 35% | ATTIC-17 | 26% | 71% | 68.6% | 36.0% | 36.0% | 1.2 |
| 8060 | Shell | Attic Insulation - Inadequate Insulation - Electric furnace | IQW | SF | Retrofit | 11,926 | 7% | 795 | 0.18 | 20 | $1,597 | 97% | 97% | 97% | ATTIC-18 | 26% | 71% | 44.0% | 36.0% | 36.0% | 0.4 |
| 8061 | Shell | Attic Insulation - Inadequate Insulation - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 8% | 325 | 0.12 | 20 | $1,022 | 100% | 39% | 39% | ATTIC-19 | 50% | 73% | 45.2% | 37.4% | 37.4% | 0.9 |
| 8062 | Shell | Attic Insulation - Inadequate Insulation - Electric furnace | IQW | MF | Retrofit | 4,166 | 8% | 325 | 0.12 | 20 | $1,022 | 151% | 100% | 100% | ATTIC-20 | 50% | 73% | 45.2% | 37.4% | 37.4% | 0.2 |
| 8063 | Shell | Attic Insulation - Poor Insulation - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 11% | 1,367 | 0.32 | 20 | $1,597 | 75% | 35% | 35% | ATTIC-21 | 26% | 90% | 63.2% | 57.9% | 57.9% | 2.2 |
| 8064 | Shell | Attic Insulation - Poor Insulation - Electric furnace | IQW | SF | Retrofit | 11,926 | 11% | 1,367 | 0.32 | 20 | $1,597 | 100% | 97% | 97% | ATTIC-22 | 26% | 90% | 63.2% | 57.9% | 57.9% | 0.8 |
| 8065 | Shell | Attic Insulation - Poor Insulation - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 13% | 526 | 0.21 | 20 | $1,022 | 50% | 39% | 39% | ATTIC-23 | 50% | 38% | 34.1% | 24.6% | 24.6% | 1.5 |
| 8066 | Shell | Attic Insulation - Poor Insulation - Electric furnace | IQW | MF | Retrofit | 4,166 | 13% | 526 | 0.21 | 20 | $1,022 | 151% | 100% | 100% | ATTIC-24 | 50% | 38% | 46.5% | 46.5% | 46.5% | 0.4 |
| 8067 | Shell | Attic Insulation - Average Insulation - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 2% | 29 | 0.05 | 20 | $898 | 33% | 33% | 33% | ATTIC-25 | 53% | 77% | 47.7% | 40.2% | 40.2% | 0.4 |
| 8068 | Shell | Attic Insulation - Average Insulation - Gas Heating | IQW | SF | Retrofit | 1,368 | 2% | 29 | 0.05 | 20 | $898 | 49% | 49% | 49% | ATTIC-26 | 53% | 77% | 47.7% | 40.2% | 40.2% | 0.3 |
| 8069 | Shell | Attic Insulation - Average Insulation - Gas Heating | Efficient Products | MF | Retrofit | 530 | 8% | 42 | 0.12 | 20 | $575 | 52% | 52% | 52% | ATTIC-27 | 21% | 96% | 80.6% | 77.8% | 77.8% | 0.8 |
| 8070 | Shell | Attic Insulation - Average Insulation - Gas Heating | IQW | MF | Retrofit | 530 | 8% | 42 | 0.12 | 20 | $575 | 100% | 76% | 76% | ATTIC-28 | 21% | 96% | 80.6% | 77.8% | 77.8% | 0.5 |
| 8071 | Shell | Attic Insulation - Inadequate Insulation - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 4% | 55 | 0.11 | 20 | $1,597 | 25% | 25% | 25% | ATTIC-29 | 53% | 71% | 44.0% | 36.0% | 36.0% | 0.5 |
| 8072 | Shell | Attic Insulation - Inadequate Insulation - Gas Heating | IQW | SF | Retrofit | 1,368 | 4% | 55 | 0.11 | 20 | $1,597 | 97% | 97% | 97% | ATTIC-30 | 53% | 71% | 44.0% | 36.0% | 36.0% | 0.1 |
| 8073 | Shell | Attic Insulation - Inadequate Insulation - Gas Heating | Efficient Products | MF | Retrofit | 530 | 10% | 51 | 0.15 | 20 | $1,022 | 39% | 39% | 39% | ATTIC-31 | 21% | 73% | 45.2% | 37.4% | 37.4% | 0.7 |
| 8074 | Shell | Attic Insulation - Inadequate Insulation - Gas Heating | IQW | MF | Retrofit | 530 | 10% | 51 | 0.15 | 20 | $1,022 | 151% | 100% | 100% | ATTIC-32 | 21% | 73% | 45.2% | 37.4% | 37.4% | 0.2 |
| 8075 | Shell | Attic Insulation - Poor Insulation - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 8% | 105 | 0.21 | 20 | $1,597 | 25% | 25% | 25% | ATTIC-33 | 53% | 90% | 63.2% | 57.9% | 57.9% | 1.1 |
| 8076 | Shell | Attic Insulation - Poor Insulation - Gas Heating | IQW | SF | Retrofit | 1,368 | 8% | 105 | 0.21 | 20 | $1,597 | 97% | 97% | 97% | ATTIC-34 | 53% | 90% | 63.2% | 57.9% | 57.9% | 0.3 |
| 8077 | Shell | Attic Insulation - Poor Insulation - Gas Heating | Efficient Products | MF | Retrofit | 530 | 13% | 67 | 0.20 | 20 | $1,022 | 50% | 39% | 39% | ATTIC-35 | 21% | 38% | 34.1% | 24.6% | 24.6% | 1.0 |
| 8078 | Shell | Attic Insulation - Poor Insulation - Gas Heating | IQW | MF | Retrofit | 530 | 13% | 67 | 0.20 | 20 | $1,022 | 151% | 100% | 100% | ATTIC-36 | 21% | 38% | 46.5% | 46.5% | 46.5% | 0.3 |
| 8079 | Shell | Duct Sealing - Average Sealing - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 6% | 364 | 0.17 | 20 | $450 | 111% | 100% | 100% | DUCT-1 | 13% | 78% | 62.1% | 62.1% | 62.1% | 0.9 |
| 8080 | Shell | Duct Sealing - Average Sealing - Heat pump | IQW | SF | Retrofit | 6,061 | 6% | 364 | 0.17 | 20 | $450 | 100% | 100% | 100% | DUCT-2 | 13% | 78% | 48.5% | 41.2% | 41.2% | 1.0 |
| 8081 | Shell | Duct Sealing - Average Sealing - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 8% | 212 | 0.13 | 20 | $288 | 174% | 100% | 100% | DUCT-3 | 13% | 97% | 83.0% | 80.6% | 80.6% | 0.7 |
| 8082 | Shell | Duct Sealing - Average Sealing - Heat pump | IQW | MF | Retrofit | 2,573 | 8% | 212 | 0.13 | 20 | $288 | 156% | 100% | 100% | DUCT-4 | 13% | 97% | 83.0% | 80.6% | 80.6% | 0.7 |
| 8083 | Shell | Duct Sealing - Inadequate Sealing - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 11% | 649 | 0.30 | 20 | $450 | 111% | 100% | 100% | DUCT-5 | 13% | 73% | 67.5% | 67.5% | 67.5% | 1.7 |
| 8084 | Shell | Duct Sealing - Inadequate Sealing - Heat pump | IQW | SF | Retrofit | 6,061 | 11% | 649 | 0.30 | 20 | $450 | 100% | 100% | 100% | DUCT-6 | 13% | 73% | 44.8% | 36.9% | 36.9% | 1.9 |
| 8085 | Shell | Duct Sealing - Inadequate Sealing - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 16% | 421 | 0.27 | 20 | $288 | 174% | 100% | 100% | DUCT-7 | 13% | 78% | 48.2% | 40.8% | 40.8% | 1.3 |
| 8086 | Shell | Duct Sealing - Inadequate Sealing - Heat pump | IQW | MF | Retrofit | 2,573 | 16% | 421 | 0.27 | 20 | $288 | 156% | 100% | 100% | DUCT-8 | 13% | 78% | 48.2% | 40.8% | 40.8% | 1.5 |
| 8087 | Shell | Duct Sealing/Insulation - Poor Sealing - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 15% | 921 | 0.43 | 20 | $450 | 111% | 100% | 100% | DUCT-9 | 13% | 90% | 64.1% | 59.0% | 59.0% | 2.4 |
| 8088 | Shell | Duct Sealing/Insulation - Poor Sealing - Heat pump | IQW | SF | Retrofit | 6,061 | 15% | 921 | 0.43 | 20 | $450 | 100% | 100% | 100% | DUCT-10 | 13% | 90% | 64.1% | 59.0% | 59.0% | 2.7 |
| 8089 | Shell | Duct Sealing/Insulation - Poor Sealing - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 41% | 1,043 | 0.70 | 20 | $288 | 174% | 100% | 100% | DUCT-11 | 13% | 48% | 48.7% | 48.7% | 48.7% | 3.4 |
| 8090 | Shell | Duct Sealing/Insulation - Poor Sealing - Heat pump | IQW | MF | Retrofit | 2,573 | 41% | 1,043 | 0.70 | 20 | $288 | 156% | 100% | 100% | DUCT-12 | 13% | 48% | 38.0% | 38.0% | 38.0% | 3.8 |
| 8091 | Shell | Duct Sealing - Average Sealing - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 6% | 716 | 0.18 | 20 | $450 | 111% | 100% | 100% | DUCT-13 | 26% | 78% | 62.1% | 62.1% | 62.1% | 1.3 |
| 8092 | Shell | Duct Sealing - Average Sealing - Electric furnace | IQW | SF | Retrofit | 11,926 | 6% | 716 | 0.18 | 20 | $450 | 100% | 100% | 100% | DUCT-14 | 26% | 78% | 48.5% | 41.2% | 41.2% | 1.4 |
| 8093 | Shell | Duct Sealing - Average Sealing - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 8% | 333 | 0.14 | 20 | $288 | 174% | 100% | 100% | DUCT-15 | 50% | 97% | 83.0% | 80.6% | 80.6% | 0.8 |
| 8094 | Shell | Duct Sealing - Average Sealing - Electric furnace | IQW | MF | Retrofit | 4,166 | 8% | 333 | 0.14 | 20 | $288 | 156% | 100% | 100% | DUCT-16 | 50% | 97% | 83.0% | 80.6% | 80.6% | 0.9 |
| 8095 | Shell | Duct Sealing - Inadequate Sealing - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 11% | 1,276 | 0.32 | 20 | $450 | 111% | 100% | 100% | DUCT-17 | 26% | 73% | 67.5% | 67.5% | 67.5% | 2.3 |
| 8096 | Shell | Duct Sealing - Inadequate Sealing - Electric furnace | IQW | SF | Retrofit | 11,926 | 11% | 1,276 | 0.32 | 20 | $450 | 100% | 100% | 100% | DUCT-18 | 26% | 73% | 44.8% | 36.9% | 36.9% | 2.6 |
| 8097 | Shell | Duct Sealing - Inadequate Sealing - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 13% | 561 | 0.24 | 20 | $288 | 174% | 100% | 100% | DUCT-19 | 50% | 78% | 48.2% | 40.8% | 40.8% | 1.4 |
| 8098 | Shell | Duct Sealing - Inadequate Sealing - Electric furnace | IQW | MF | Retrofit | 4,166 | 13% | 561 | 0.24 | 20 | $288 | 156% | 100% | 100% | DUCT-20 | 50% | 78% | 48.2% | 40.8% | 40.8% | 1.5 |
| 8099 | Shell | Duct Sealing/Insulation - Poor Sealing - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 15% | 1,813 | 0.46 | 20 | $450 | 111% | 100% | 100% | DUCT-21 | 26% | 90% | 64.1% | 59.0% | 59.0% | 3.3 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8100 | Shell | Duct Sealing/Insulation - Poor Sealing - Electric furnace | IQW | SF | Retrofit | 11,926 | 15% | 1,813 | 0.46 | 20 | $450 | 100% | 100% | 100% | DUCT-22 | 26% | 90% | 64.1% | 59.0% | 59.0% | 3.7 |
| 8101 | Shell | Duct Sealing/Insulation - Poor Sealing - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 33% | 1,394 | 0.63 | 20 | $288 | 174% | 100% | 100% | DUCT-23 | 50% | 48% | 48.7% | 48.7% | 48.7% | 3.5 |
| 8102 | Shell | Duct Sealing/Insulation - Poor Sealing - Electric furnace | IQW | MF | Retrofit | 4,166 | 33% | 1,394 | 0.63 | 20 | $288 | 100% | 100% | 100% | DUCT-24 | 50% | 48% | 38.0% | 38.0% | 38.0% | 3.9 |
| 8103 | Shell | Duct Sealing - Average Sealing - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 5% | 65 | 0.14 | 20 | $450 | 111% | 100% | 100% | DUCT-25 | 53% | 78% | 62.1% | 62.1% | 62.1% | 0.6 |
| 8104 | Shell | Duct Sealing - Average Sealing - Gas Heating | IQW | SF | Retrofit | 1,368 | 5% | 65 | 0.14 | 20 | $450 | 100% | 100% | 100% | DUCT-26 | 53% | 78% | 48.5% | 41.2% | 41.2% | 0.6 |
| 8105 | Shell | Duct Sealing - Average Sealing - Gas Heating | Efficient Products | MF | Retrofit | 530 | 26% | 136 | 0.44 | 20 | $288 | 174% | 100% | 100% | DUCT-27 | 21% | 97% | 83.0% | 80.6% | 80.6% | 1.7 |
| 8106 | Shell | Duct Sealing - Average Sealing - Gas Heating | IQW | MF | Retrofit | 530 | 26% | 136 | 0.44 | 20 | $288 | 100% | 100% | 100% | DUCT-28 | 21% | 97% | 83.0% | 80.6% | 80.6% | 1.9 |
| 8107 | Shell | Duct Sealing - Inadequate Sealing - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 7% | 91 | 0.20 | 20 | $450 | 111% | 100% | 100% | DUCT-29 | 53% | 73% | 67.5% | 67.5% | 67.5% | 0.8 |
| 8108 | Shell | Duct Sealing - Inadequate Sealing - Gas Heating | IQW | SF | Retrofit | 1,368 | 7% | 91 | 0.20 | 20 | $450 | 100% | 100% | 100% | DUCT-30 | 53% | 73% | 44.8% | 36.9% | 36.9% | 0.9 |
| 8109 | Shell | Duct Sealing - Inadequate Sealing - Gas Heating | Efficient Products | MF | Retrofit | 530 | 20% | 107 | 0.37 | 20 | $288 | 174% | 100% | 100% | DUCT-31 | 21% | 78% | 48.2% | 40.8% | 40.8% | 1.4 |
| 8110 | Shell | Duct Sealing - Inadequate Sealing - Gas Heating | IQW | MF | Retrofit | 530 | 20% | 107 | 0.37 | 20 | $288 | 100% | 100% | 100% | DUCT-32 | 21% | 78% | 48.2% | 40.8% | 40.8% | 1.6 |
| 8111 | Shell | Duct Sealing/Insulation - Poor Sealing - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 15% | 206 | 0.46 | 20 | $450 | 111% | 100% | 100% | DUCT-33 | 53% | 90% | 64.1% | 59.0% | 59.0% | 1.8 |
| 8112 | Shell | Duct Sealing/Insulation - Poor Sealing - Gas Heating | IQW | SF | Retrofit | 1,368 | 15% | 206 | 0.46 | 20 | $450 | 100% | 100% | 100% | DUCT-34 | 53% | 90% | 64.1% | 59.0% | 59.0% | 2.0 |
| 8113 | Shell | Duct Sealing/Insulation - Poor Sealing - Gas Heating | Efficient Products | MF | Retrofit | 530 | 48% | 254 | 0.94 | 20 | $288 | 174% | 100% | 100% | DUCT-35 | 21% | 48% | 48.7% | 48.7% | 48.7% | 3.6 |
| 8114 | Shell | Duct Sealing/Insulation - Poor Sealing - Gas Heating | IQW | MF | Retrofit | 530 | 48% | 254 | 0.94 | 20 | $288 | 100% | 100% | 100% | DUCT-36 | 21% | 48% | 38.0% | 38.0% | 38.0% | 4.0 |
| 8115 | Shell | Wall Insulation - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 9% | 527 | 0.04 | 20 | $1,235 | 80% | 80% | 80% | WALL-1 | 13% | 96% | 80.0% | 77.1% | 77.1% | 0.3 |
| 8116 | Shell | Wall Insulation - Heat pump | IQW | SF | Retrofit | 6,061 | 9% | 527 | 0.04 | 20 | $1,235 | 258% | 100% | 100% | WALL-2 | 13% | 96% | 80.0% | 77.1% | 77.1% | 0.1 |
| 8117 | Shell | Wall Insulation - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 13% | 337 | 0.03 | 20 | $790 | 80% | 80% | 80% | WALL-7 | 13% | 96% | 80.0% | 77.1% | 77.1% | 0.3 |
| 8118 | Shell | Wall Insulation - Heat pump | IQW | MF | Retrofit | 2,573 | 13% | 337 | 0.03 | 20 | $790 | 100% | 100% | 100% | WALL-8 | 13% | 96% | 80.0% | 77.1% | 77.1% | 0.3 |
| 8119 | Shell | Wall Insulation - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 7% | 859 | 0.04 | 20 | $1,235 | 80% | 80% | 80% | WALL-3 | 26% | 96% | 80.0% | 77.1% | 77.1% | 0.5 |
| 8120 | Shell | Wall Insulation - Electric furnace | IQW | SF | Retrofit | 11,926 | 7% | 859 | 0.04 | 20 | $1,235 | 258% | 100% | 100% | WALL-4 | 26% | 96% | 80.0% | 77.1% | 77.1% | 0.1 |
| 8121 | Shell | Wall Insulation - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 13% | 550 | 0.03 | 20 | $790 | 80% | 80% | 80% | WALL-9 | 50% | 96% | 80.0% | 77.1% | 77.1% | 0.5 |
| 8122 | Shell | Wall Insulation - Electric furnace | IQW | MF | Retrofit | 4,166 | 13% | 550 | 0.03 | 20 | $790 | 100% | 100% | 100% | WALL-10 | 50% | 96% | 80.0% | 77.1% | 77.1% | 0.4 |
| 8123 | Shell | Wall Insulation - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 3% | 43 | 0.04 | 20 | $1,235 | 80% | 80% | 80% | WALL-5 | 53% | 96% | 80.0% | 77.1% | 77.1% | 0.1 |
| 8124 | Shell | Wall Insulation - Gas Heating | IQW | SF | Retrofit | 1,368 | 3% | 43 | 0.04 | 20 | $1,235 | 258% | 100% | 100% | WALL-6 | 53% | 96% | 80.0% | 77.1% | 77.1% | 0.0 |
| 8125 | Shell | Wall Insulation - Gas Heating | Efficient Products | MF | Retrofit | 530 | 5% | 27 | 0.03 | 20 | $790 | 80% | 80% | 80% | WALL-11 | 21% | 96% | 80.0% | 77.1% | 77.1% | 0.1 |
| 8126 | Shell | Wall Insulation - Gas Heating | IQW | MF | Retrofit | 530 | 5% | 27 | 0.03 | 20 | $790 | 100% | 100% | 100% | WALL-12 | 21% | 96% | 80.0% | 77.1% | 77.1% | 0.1 |
| 8127 | Shell | Basement Sidewall Insulation - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 8% | 515 | -0.02 | 20 | $1,204 | 80% | 80% | 80% | BASEMENT-1 | 13% | 49% | 61.5% | 61.5% | 61.5% | 0.2 |
| 8128 | Shell | Basement Sidewall Insulation - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 13% | 329 | -0.01 | 20 | $1,204 | 80% | 80% | 80% | BASEMENT-2 | 13% | 33% | 44.7% | 44.7% | 44.7% | 0.1 |
| 8129 | Shell | Basement Sidewall Insulation - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 8% | 907 | -0.02 | 20 | $1,204 | 80% | 80% | 80% | BASEMENT-3 | 26% | 49% | 61.5% | 61.5% | 61.5% | 0.4 |
| 8130 | Shell | Basement Sidewall Insulation - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 14% | 580 | -0.01 | 20 | $1,204 | 80% | 80% | 80% | BASEMENT-4 | 50% | 33% | 44.7% | 44.7% | 44.7% | 0.3 |
| 8131 | Shell | Basement Sidewall Insulation - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | -2% | -26 | -0.02 | 20 | $1,204 | 80% | 80% | 80% | BASEMENT-5 | 53% | 49% | 61.5% | 61.5% | 61.5% | 0.0 |
| 8132 | Shell | Basement Sidewall Insulation - Gas Heating | Efficient Products | MF | Retrofit | 530 | -3% | -16 | -0.01 | 20 | $1,204 | 80% | 80% | 80% | BASEMENT-6 | 21% | 33% | 44.7% | 44.7% | 44.7% | 0.0 |
| 8133 | Shell | Floor Insulation Above Crawlspace - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 3% | 210 | -0.01 | 20 | $1,204 | 80% | 80% | 80% | FLOOR-1 | 13% | 12% | 76.0% | 76.0% | 76.0% | 0.1 |
| 8134 | Shell | Floor Insulation Above Crawlspace - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 5% | 134 | -0.01 | 20 | $1,204 | 80% | 80% | 80% | FLOOR-2 | 13% | 6% | 59.0% | 59.0% | 59.0% | 0.1 |
| 8135 | Shell | Floor Insulation Above Crawlspace - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 3% | 355 | 0.00 | 20 | $1,204 | 80% | 80% | 80% | FLOOR-3 | 26% | 12% | 76.0% | 76.0% | 76.0% | 0.2 |
| 8136 | Shell | Floor Insulation Above Crawlspace - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 5% | 227 | 0.00 | 20 | $1,204 | 80% | 80% | 80% | FLOOR-4 | 50% | 6% | 59.0% | 59.0% | 59.0% | 0.1 |
| 8137 | Shell | Floor Insulation Above Crawlspace - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | -2% | -21 | 0.00 | 20 | $1,204 | 80% | 80% | 80% | FLOOR-5 | 53% | 12% | 76.0% | 76.0% | 76.0% | 0.0 |
| 8138 | Shell | Floor Insulation Above Crawlspace - Gas Heating | Efficient Products | MF | Retrofit | 530 | -2% | -13 | 0.00 | 20 | $1,204 | 80% | 80% | 80% | FLOOR-6 | 21% | 6% | 59.0% | 59.0% | 59.0% | 0.0 |
| 8139 | Shell | Radiant Barrier - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 13% | 804 | 0.11 | 25 | $720 | 80% | 80% | 80% | RB-1 | 13% | 16% | 76.4% | 76.4% | 76.4% | 1.1 |
| 8140 | Shell | Radiant Barrier - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 13% | 804 | 0.11 | 25 | $720 | 100% | 80% | 80% | RB-2 | 13% | 16% | 64.3% | 48.4% | 48.4% | 1.1 |
| 8141 | Shell | Radiant Barrier - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 20% | 515 | 0.07 | 25 | $720 | 80% | 80% | 80% | RB-3 | 13% | 4% | 60.6% | 60.6% | 60.6% | 0.7 |
| 8142 | Shell | Radiant Barrier - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 20% | 515 | 0.07 | 25 | $720 | 100% | 80% | 80% | RB-4 | 13% | 4% | 63.5% | 47.6% | 47.6% | 0.7 |
| 8143 | Shell | Radiant Barrier - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 7% | 804 | 0.11 | 25 | $720 | 80% | 80% | 80% | RB-5 | 26% | 16% | 76.4% | 76.4% | 76.4% | 1.1 |
| 8144 | Shell | Radiant Barrier - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 7% | 804 | 0.11 | 25 | $720 | 100% | 80% | 80% | RB-6 | 26% | 16% | 64.3% | 48.4% | 48.4% | 1.1 |
| 8145 | Shell | Radiant Barrier - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 12% | 515 | 0.07 | 25 | $720 | 80% | 80% | 80% | RB-7 | 50% | 4% | 60.6% | 60.6% | 60.6% | 0.7 |
| 8146 | Shell | Radiant Barrier - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 12% | 515 | 0.07 | 25 | $720 | 100% | 80% | 80% | RB-8 | 50% | 4% | 63.5% | 47.6% | 47.6% | 0.7 |
| 8147 | Shell | ENERGY STAR Door - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 5% | 319 | 0.02 | 20 | $1,275 | 80% | 80% | 80% | DOOR-1 | 13% | 49% | 61.7% | 61.7% | 61.7% | 0.2 |
| 8148 | Shell | ENERGY STAR Door - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 8% | 204 | 0.01 | 20 | $1,275 | 80% | 80% | 80% | DOOR-2 | 13% | 11% | 56.8% | 56.8% | 56.8% | 0.1 |
| 8149 | Shell | ENERGY STAR Door - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 2% | 197 | 0.01 | 20 | $1,275 | 80% | 80% | 80% | DOOR-3 | 26% | 49% | 61.7% | 61.7% | 61.7% | 0.1 |
| 8150 | Shell | ENERGY STAR Door - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 3% | 126 | 0.01 | 20 | $1,275 | 80% | 80% | 80% | DOOR-4 | 50% | 11% | 56.8% | 56.8% | 56.8% | 0.1 |
| 8151 | Shell | ENERGY STAR Door - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 2% | 21 | 0.02 | 20 | $1,275 | 80% | 80% | 80% | DOOR-5 | 53% | 49% | 61.7% | 61.7% | 61.7% | 0.0 |
| 8152 | Shell | ENERGY STAR Door - Gas Heating | Efficient Products | MF | Retrofit | 530 | 3% | 14 | 0.01 | 20 | $1,275 | 80% | 80% | 80% | DOOR-6 | 21% | 11% | 56.8% | 56.8% | 56.8% | 0.0 |
| 8153 | Shell | ENERGY STAR Windows - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 5% | 329 | 0.20 | 20 | $11,300 | 80% | 80% | 80% | ES WIND-1 | 13% | 17% | 74.7% | 74.7% | 74.7% | 0.1 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8154 | Shell | ENERGY STAR Windows - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 8% | 211 | 0.13 | 20 | $7,232 | 80% | 80% | 80% | ES WIND-2 | 13% | 17% | 54.3% | 54.3% | 54.3% | 0.1 |
| 8155 | Shell | ENERGY STAR Windows - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 4% | 502 | 0.20 | 20 | $11,300 | 80% | 80% | 80% | ES WIND-3 | 26% | 17% | 74.7% | 74.7% | 74.7% | 0.1 |
| 8156 | Shell | ENERGY STAR Windows - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 8% | 322 | 0.13 | 20 | $7,232 | 80% | 80% | 80% | ES WIND-4 | 50% | 17% | 54.3% | 54.3% | 54.3% | 0.1 |
| 8157 | Shell | ENERGY STAR Windows - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 9% | 129 | 0.20 | 20 | $11,300 | 80% | 80% | 80% | ES WIND-5 | 53% | 17% | 74.7% | 74.7% | 74.7% | 0.0 |
| 8158 | Shell | ENERGY STAR Windows - Gas Heating | Efficient Products | MF | Retrofit | 530 | 16% | 83 | 0.13 | 20 | $7,232 | 80% | 80% | 80% | ES WIND-6 | 21% | 17% | 54.3% | 54.3% | 54.3% | 0.0 |
| 8159 | Shell | Smart Window Coverings - Film/Transformer - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 16% | 939 | 0.35 | 7 | $6,780 | 80% | 80% | 80% | ES WIND-1 | 13% | 18% | 74.4% | 74.4% | 74.4% | 0.1 |
| 8160 | Shell | Smart Window Coverings - Film/Transformer - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 16% | 399 | 0.23 | 7 | $4,339 | 80% | 80% | 80% | ES WIND-2 | 13% | 7% | 58.4% | 58.4% | 58.4% | 0.1 |
| 8161 | Shell | Smart Window Coverings - Film/Transformer - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 16% | 1,849 | 0.35 | 7 | $6,780 | 80% | 80% | 80% | ES WIND-3 | 26% | 18% | 74.4% | 74.4% | 74.4% | 0.1 |
| 8162 | Shell | Smart Window Coverings - Film/Transformer - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 16% | 646 | 0.23 | 7 | $4,339 | 80% | 80% | 80% | ES WIND-4 | 50% | 7% | 58.4% | 58.4% | 58.4% | 0.1 |
| 8163 | Shell | Smart Window Coverings - Film/Transformer - Gas Heating | Efficient Products | SF | Retrofit | 1,368 | 16% | 212 | 0.35 | 7 | $6,780 | 80% | 80% | 80% | ES WIND-5 | 53% | 18% | 74.4% | 74.4% | 74.4% | 0.1 |
| 8164 | Shell | Smart Window Coverings - Film/Transformer - Gas Heating | Efficient Products | MF | Retrofit | 530 | 16% | 82 | 0.23 | 7 | $4,339 | 80% | 80% | 80% | ES WIND-6 | 21% | 7% | 58.4% | 58.4% | 58.4% | 0.1 |
| 8165 | Shell | Thin Triple Windows - Heat pump | Efficient Products | SF | Retrofit | 6,061 | 37% | 2,247 | 0.67 | 40 | $12,964 | 80% | 80% | 80% | ES WIND-1 | 13% | 17% | 74.7% | 74.7% | 74.7% | 0.3 |
| 8166 | Shell | Thin Triple Windows - Heat pump | Efficient Products | MF | Retrofit | 2,573 | 56% | 1,439 | 0.43 | 40 | $8,297 | 80% | 80% | 80% | ES WIND-2 | 13% | 17% | 54.3% | 54.3% | 54.3% | 0.3 |
| 8167 | Shell | Thin Triple Windows - Electric furnace | Efficient Products | SF | Retrofit | 11,926 | 18% | 2,182 | 0.67 | 40 | $12,964 | 80% | 80% | 80% | ES WIND-3 | 26% | 17% | 74.7% | 74.7% | 74.7% | 0.3 |
| 8168 | Shell | Thin Triple Windows - Electric furnace | Efficient Products | MF | Retrofit | 4,166 | 34% | 1,397 | 0.43 | 40 | $8,297 | 80% | 80% | 80% | ES WIND-4 | 50% | 17% | 54.3% | 54.3% | 54.3% | 0.3 |
| 8169 | Shell | Thin Triple Windows - Gas heating | Efficient Products | SF | Retrofit | 1,368 | 31% | 425 | 0.67 | 40 | $12,964 | 80% | 80% | 80% | ES WIND-5 | 53% | 17% | 74.7% | 74.7% | 74.7% | 0.2 |
| 8170 | Shell | Thin Triple Windows - Gas heating | Efficient Products | MF | Retrofit | 530 | 51% | 272 | 0.43 | 40 | $8,297 | 80% | 80% | 80% | ES WIND-6 | 21% | 17% | 54.3% | 54.3% | 54.3% | 0.2 |
| 9001 | Water Heating | Heat Pump Water Heater-electric resistance heat | Efficient Products | SF | MO | 2,942 | 17% | 503 | 0.02 | 15 | $1,199 | 50% | 50% | 50% | HPWH-1 | 29% | 6% | 52.2% | 52.2% | 52.2% | 0.4 |
| 9002 | Water Heating | Heat Pump Water Heater-electric resistance heat | Efficient Products | SF | NC | 2,942 | 17% | 503 | 0.02 | 15 | $1,199 | 50% | 50% | 50% | HPWH-2 | 29% | 0% | 53.5% | 53.5% | 53.5% | 0.4 |
| 9003 | Water Heating | Heat Pump Water Heater-electric resistance heat | Efficient Products | MF | MO | 3,045 | 19% | 570 | 0.03 | 15 | $1,199 | 50% | 50% | 50% | HPWH-3 | 61% | 21% | 44.5% | 44.5% | 44.5% | 0.4 |
| 9004 | Water Heating | Heat Pump Water Heater-electric resistance heat | Efficient Products | MF | NC | 3,045 | 19% | 570 | 0.03 | 15 | $1,199 | 50% | 50% | 50% | HPWH-4 | 61% | 0% | 50.3% | 50.3% | 50.3% | 0.4 |
| 9005 | Water Heating | Heat Pump Water Heater-heat pump heat | Efficient Products | SF | MO | 2,942 | 44% | 1,301 | 0.06 | 15 | $1,199 | 50% | 50% | 50% | HPWH-5 | 5% | 6% | 52.2% | 52.2% | 52.2% | 1.0 |
| 9006 | Water Heating | Heat Pump Water Heater-heat pump heat | Efficient Products | SF | NC | 2,942 | 44% | 1,301 | 0.06 | 15 | $1,199 | 50% | 50% | 50% | HPWH-6 | 5% | 0% | 53.5% | 53.5% | 53.5% | 1.0 |
| 9007 | Water Heating | Heat Pump Water Heater-heat pump heat | Efficient Products | MF | MO | 3,045 | 45% | 1,368 | 0.06 | 15 | $1,199 | 50% | 50% | 50% | HPWH-7 | 6% | 21% | 44.5% | 44.5% | 44.5% | 1.0 |
| 9008 | Water Heating | Heat Pump Water Heater-heat pump heat | Efficient Products | MF | NC | 3,045 | 45% | 1,368 | 0.06 | 15 | $1,199 | 50% | 50% | 50% | HPWH-8 | 6% | 0% | 50.3% | 50.3% | 50.3% | 1.0 |
| 9009 | Water Heating | Heat Pump Water Heater-gas heat | Efficient Products | SF | MO | 2,942 | 71% | 2,080 | 0.10 | 15 | $1,199 | 75% | 50% | 50% | HPWH-9 | 16% | 6% | 67.6% | 52.2% | 52.2% | 1.6 |
| 9010 | Water Heating | Heat Pump Water Heater-gas heat | Efficient Products | SF | NC | 2,942 | 71% | 2,080 | 0.10 | 15 | $1,199 | 75% | 50% | 50% | HPWH-10 | 16% | 0% | 68.5% | 53.5% | 53.5% | 1.6 |
| 9011 | Water Heating | Heat Pump Water Heater-gas heat | Efficient Products | MF | MO | 3,045 | 70% | 2,147 | 0.10 | 15 | $1,199 | 75% | 50% | 50% | HPWH-11 | 13% | 21% | 55.7% | 44.5% | 44.5% | 1.6 |
| 9012 | Water Heating | Heat Pump Water Heater-gas heat | Efficient Products | MF | NC | 3,045 | 70% | 2,147 | 0.10 | 15 | $1,199 | 75% | 50% | 50% | HPWH-12 | 13% | 0% | 60.3% | 50.3% | 50.3% | 1.6 |
| 9013 | Water Heating | Smart Water Heater - Tank Controls and Sensors - electric resistance heat | Efficient Products | SF | MO | 2,942 | 15% | 441 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-1 | 29% | 6% | 77.8% | 69.5% | 69.5% | 1.9 |
| 9014 | Water Heating | Smart Water Heater - Tank Controls and Sensors - electric resistance heat | Efficient Products | SF | NC | 2,942 | 15% | 441 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-2 | 29% | 0% | 78.4% | 70.3% | 70.3% | 1.9 |
| 9015 | Water Heating | Smart Water Heater - Tank Controls and Sensors - electric resistance heat | Efficient Products | MF | MO | 3,045 | 15% | 457 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-3 | 61% | 21% | 66.2% | 57.7% | 57.7% | 2.0 |
| 9016 | Water Heating | Smart Water Heater - Tank Controls and Sensors - electric resistance heat | Efficient Products | MF | NC | 3,045 | 15% | 457 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-4 | 61% | 0% | 69.8% | 62.1% | 62.1% | 2.0 |
| 9017 | Water Heating | Smart Water Heater - Tank Controls and Sensors - heat pump heat | Efficient Products | SF | MO | 2,942 | 15% | 441 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-5 | 5% | 6% | 77.8% | 69.5% | 69.5% | 1.9 |
| 9018 | Water Heating | Smart Water Heater - Tank Controls and Sensors - heat pump heat | Efficient Products | SF | NC | 2,942 | 15% | 441 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-6 | 5% | 0% | 78.4% | 70.3% | 70.3% | 1.9 |
| 9019 | Water Heating | Smart Water Heater - Tank Controls and Sensors - heat pump heat | Efficient Products | MF | MO | 3,045 | 15% | 457 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-7 | 6% | 21% | 66.2% | 57.7% | 57.7% | 2.0 |
| 9020 | Water Heating | Smart Water Heater - Tank Controls and Sensors - heat pump heat | Efficient Products | MF | NC | 3,045 | 15% | 457 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-8 | 6% | 0% | 69.8% | 62.1% | 62.1% | 2.0 |
| 9021 | Water Heating | Smart Water Heater - Tank Controls and Sensors - gas heat | Efficient Products | SF | MO | 2,942 | 15% | 441 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-9 | 16% | 6% | 77.8% | 69.5% | 69.5% | 1.9 |
| 9022 | Water Heating | Smart Water Heater - Tank Controls and Sensors - gas heat | Efficient Products | SF | NC | 2,942 | 15% | 441 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-10 | 16% | 0% | 78.4% | 70.3% | 70.3% | 1.9 |
| 9023 | Water Heating | Smart Water Heater - Tank Controls and Sensors - gas heat | Efficient Products | MF | MO | 3,045 | 15% | 457 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-11 | 13% | 21% | 66.2% | 57.7% | 57.7% | 2.0 |
| 9024 | Water Heating | Smart Water Heater - Tank Controls and Sensors - gas heat | Efficient Products | MF | NC | 3,045 | 15% | 457 | 0.02 | 13 | $120 | 100% | 80% | 80% | HPWH-12 | 13% | 0% | 69.8% | 62.1% | 62.1% | 2.0 |
| 9025 | Water Heating | Thermostatic Restrictor Shower Valve | Efficient Products | SF | Retrofit | 2,942 | 2% | 65 | 0.00 | 10 | $30 | 80% | 80% | 80% | TRSV-1 | 106% | 14% | 65.9% | 65.9% | 65.9% | 0.9 |
| 9026 | Water Heating | Thermostatic Restrictor Shower Valve | Efficient Products | SF | NC | 2,942 | 2% | 65 | 0.00 | 10 | $30 | 80% | 80% | 80% | TRSV-2 | 106% | 0% | 70.3% | 70.3% | 70.3% | 0.9 |
| 9027 | Water Heating | Thermostatic Restrictor Shower Valve | Efficient Products | MF | Retrofit | 3,045 | 3% | 93 | 0.00 | 10 | $30 | 100% | 80% | 80% | TRSV-3 | 98% | 5% | 68.3% | 60.3% | 60.3% | 1.3 |
| 9028 | Water Heating | Thermostatic Restrictor Shower Valve | Efficient Products | MF | NC | 3,045 | 3% | 93 | 0.00 | 10 | $30 | 100% | 80% | 80% | TRSV-4 | 98% | 0% | 69.8% | 62.1% | 62.1% | 1.3 |
| 9029 | Water Heating | Water Heater Timer | Efficient Products | SF | Retrofit | 2,942 | 5% | 147 | 0.02 | 2 | $60 | 80% | 80% | 80% | WHT-1 | 50% | 0% | 70.2% | 70.2% | 70.2% | 0.3 |
| 9030 | Water Heating | Water Heater Timer | Efficient Products | SF | NC | 2,942 | 5% | 147 | 0.02 | 2 | $60 | 80% | 80% | 80% | WHT-2 | 50% | 0% | 70.3% | 70.3% | 70.3% | 0.3 |
| 9031 | Water Heating | Water Heater Timer | Efficient Products | MF | Retrofit | 3,045 | 5% | 152 | 0.02 | 2 | $60 | 80% | 80% | 80% | WHT-3 | 79% | 1% | 61.8% | 61.8% | 61.8% | 0.3 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9032 | Water Heating | Water Heater Timer | Efficient Products | MF | NC | 3,045 | 5% | 152 | 0.02 | 2 | $60 | 80% | 80% | 80% | WHT-4 | 79% | 0% | 62.1% | 62.1% | 62.1% | 0.3 |
| 9033 | Water Heating | Drain water Heat Recovery | Efficient Products | SF | Retrofit | 2,942 | 14% | 422 | 0.04 | 30 | $742 | 80% | 80% | 80% | DWHR-1 | 50% | 1% | 70.1% | 70.1% | 70.1% | 0.5 |
| 9034 | Water Heating | Drain water Heat Recovery | Efficient Products | SF | NC | 2,942 | 14% | 422 | 0.04 | 30 | $742 | 80% | 80% | 80% | DWHR-2 | 50% | 0% | 70.3% | 70.3% | 70.3% | 0.5 |
| 9035 | Water Heating | Drain water Heat Recovery | Efficient Products | MF | Retrofit | 3,045 | 14% | 437 | 0.05 | 30 | $742 | 80% | 80% | 80% | DWHR-3 | 79% | 1% | 61.8% | 61.8% | 61.8% | 0.6 |
| 9036 | Water Heating | Drain water Heat Recovery | Efficient Products | MF | NC | 3,045 | 14% | 437 | 0.05 | 30 | $742 | 80% | 80% | 80% | DWHR-4 | 79% | 0% | 62.1% | 62.1% | 62.1% | 0.6 |
| 9037 | Water Heating | Shower Timer | Efficient Products | SF | Retrofit | 2,942 | 0% | 13 | 0.00 | 2 | $5 | 80% | 80% | 80% | ST-1 | 106% | 5% | 68.9% | 68.9% | 68.9% | 0.2 |
| 9038 | Water Heating | Shower Timer | Efficient Products | SF | NC | 2,942 | 0% | 13 | 0.00 | 2 | $5 | 80% | 80% | 80% | ST-2 | 106% | 0% | 70.3% | 70.3% | 70.3% | 0.5 |
| 9039 | Water Heating | Shower Timer | Efficient Products | MF | Retrofit | 3,045 | 0% | 13 | 0.00 | 2 | $5 | 80% | 80% | 80% | ST-3 | 98% | 5% | 60.3% | 60.3% | 60.3% | 0.5 |
| 9040 | Water Heating | Shower Timer | Efficient Products | MF | NC | 3,045 | 0% | 13 | 0.00 | 2 | $5 | 80% | 80% | 80% | ST-4 | 98% | 0% | 62.1% | 62.1% | 62.1% | 0.5 |
| 9041 | Water Heating | Low Flow Showerhead 1.5 gpm | Efficient Products | SF | Retrofit | 2,942 | 12% | 339 | 0.03 | 10 | $5 | 100% | 100% | 100% | LFSH-1 | 106% | 17% | 75.5% | 75.5% | 75.5% | 30.2 |
| 9042 | Water Heating | Low Flow Showerhead 1.5 gpm | School Education | SF | Retrofit | 2,942 | 5% | 135 | 0.01 | 10 | $5 | 100% | 100% | 100% | LFSH-1 | 106% | 17% | 75.5% | 75.5% | 75.5% | 12.0 |
| 9043 | Water Heating | Low Flow Showerhead 1.5 gpm | Efficient Products | SF | Retrofit | 2,942 | 12% | 339 | 0.03 | 10 | $5 | 100% | 100% | 100% | LFSH-2 | 106% | 17% | 62.5% | 62.5% | 62.5% | 30.2 |
| 9044 | Water Heating | Low Flow Showerhead 1.5 gpm | School Education | SF | Retrofit | 2,942 | 5% | 135 | 0.01 | 10 | $5 | 100% | 100% | 100% | LFSH-2 | 106% | 17% | 62.5% | 62.5% | 62.5% | 12.0 |
| 9045 | Water Heating | Low Flow Showerhead 1.5 gpm | IQW | SF | Retrofit | 2,942 | 12% | 339 | 0.03 | 10 | $19 | 100% | 100% | 100% | LFSH-2 | 106% | 17% | 62.5% | 62.5% | 62.5% | 7.3 |
| 9046 | Water Heating | Low Flow Showerhead 1.5 gpm | Efficient Products | SF | NC | 2,942 | 12% | 339 | 0.03 | 10 | $5 | 100% | 100% | 100% | LFSH-3 | 106% | 0% | 78.4% | 78.4% | 78.4% | 30.2 |
| 9047 | Water Heating | Low Flow Showerhead 1.5 gpm | Efficient Products | MF | Retrofit | 3,045 | 11% | 339 | 0.04 | 10 | $5 | 100% | 100% | 100% | LFSH-4 | 98% | 17% | 64.2% | 64.2% | 64.2% | 31.8 |
| 9048 | Water Heating | Low Flow Showerhead 1.5 gpm | School Education | MF | Retrofit | 3,045 | 4% | 135 | 0.02 | 10 | $5 | 100% | 100% | 100% | LFSH-4 | 98% | 17% | 64.2% | 64.2% | 64.2% | 12.6 |
| 9049 | Water Heating | Low Flow Showerhead 1.5 gpm | Multifamily | MF | Retrofit | 3,045 | 10% | 313 | 0.04 | 10 | $19 | 100% | 35% | 35% | LFSH-4 | 98% | 17% | 64.2% | 29.7% | 29.7% | 20.4 |
| 9050 | Water Heating | Low Flow Showerhead 1.5 gpm | Efficient Products | MF | Retrofit | 3,045 | 11% | 339 | 0.04 | 10 | $5 | 100% | 100% | 100% | LFSH-5 | 98% | 17% | 65.0% | 65.0% | 65.0% | 31.8 |
| 9051 | Water Heating | Low Flow Showerhead 1.5 gpm | School Education | MF | Retrofit | 3,045 | 4% | 135 | 0.02 | 10 | $5 | 100% | 100% | 100% | LFSH-5 | 98% | 17% | 65.0% | 65.0% | 65.0% | 12.6 |
| 9052 | Water Heating | Low Flow Showerhead 1.5 gpm | Multifamily | MF | Retrofit | 3,045 | 10% | 313 | 0.04 | 10 | $19 | 100% | 100% | 100% | LFSH-5 | 98% | 17% | 65.0% | 65.0% | 65.0% | 7.1 |
| 9053 | Water Heating | Low Flow Showerhead 1.5 gpm | IQW | MF | Retrofit | 3,045 | 11% | 339 | 0.04 | 10 | $19 | 100% | 100% | 100% | LFSH-5 | 98% | 17% | 65.0% | 65.0% | 65.0% | 7.7 |
| 9054 | Water Heating | Low Flow Showerhead 1.5 gpm | Efficient Products | MF | NC | 3,045 | 11% | 339 | 0.04 | 10 | $5 | 100% | 100% | 100% | LFSH-6 | 98% | 0% | 69.8% | 69.8% | 69.8% | 31.8 |
| 9055 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Efficient Products | SF | Retrofit | 2,942 | 6% | 177 | 0.03 | 10 | $2 | 100% | 100% | 100% | KITCH-1 | 50% | 20% | 74.7% | 74.7% | 74.7% | 45.0 |
| 9056 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | School Education | SF | Retrofit | 2,942 | 3% | 102 | 0.02 | 10 | $2 | 100% | 100% | 100% | KITCH-1 | 50% | 20% | 74.7% | 74.7% | 74.7% | 26.0 |
| 9057 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Efficient Products | SF | Retrofit | 2,942 | 6% | 177 | 0.03 | 10 | $2 | 100% | 100% | 100% | KITCH-2 | 50% | 20% | 61.2% | 61.2% | 61.2% | 45.0 |
| 9058 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | School Education | SF | Retrofit | 2,942 | 3% | 102 | 0.02 | 10 | $2 | 100% | 100% | 100% | KITCH-2 | 50% | 20% | 61.2% | 61.2% | 61.2% | 26.0 |
| 9059 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | IQW | SF | Retrofit | 2,942 | 6% | 177 | 0.03 | 10 | $2 | 100% | 100% | 100% | KITCH-2 | 50% | 20% | 61.2% | 61.2% | 61.2% | 45.0 |
| 9060 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Efficient Products | SF | NC | 2,942 | 6% | 177 | 0.03 | 10 | $2 | 100% | 100% | 100% | KITCH-3 | 50% | 0% | 78.4% | 78.4% | 78.4% | 45.0 |
| 9061 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Efficient Products | MF | Retrofit | 3,045 | 6% | 177 | 0.04 | 10 | $2 | 100% | 100% | 100% | KITCH-4 | 79% | 6% | 68.1% | 68.1% | 68.1% | 49.0 |
| 9062 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | School Education | MF | Retrofit | 3,045 | 3% | 102 | 0.02 | 10 | $2 | 100% | 100% | 100% | KITCH-4 | 79% | 6% | 68.1% | 68.1% | 68.1% | 28.3 |
| 9063 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Multifamily | MF | Retrofit | 3,045 | 4% | 123 | 0.03 | 10 | $2 | 100% | 100% | 100% | KITCH-4 | 79% | 6% | 68.1% | 68.1% | 68.1% | 34.0 |
| 9064 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Efficient Products | MF | Retrofit | 3,045 | 6% | 177 | 0.04 | 10 | $2 | 100% | 100% | 100% | KITCH-5 | 79% | 6% | 68.9% | 68.9% | 68.9% | 49.0 |
| 9065 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | School Education | MF | Retrofit | 3,045 | 3% | 102 | 0.02 | 10 | $2 | 100% | 100% | 100% | KITCH-5 | 79% | 6% | 68.9% | 68.9% | 68.9% | 28.3 |
| 9066 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Multifamily | MF | Retrofit | 3,045 | 4% | 123 | 0.03 | 10 | $2 | 100% | 100% | 100% | KITCH-5 | 79% | 6% | 68.9% | 68.9% | 68.9% | 34.0 |
| 9067 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | IQW | MF | Retrofit | 3,045 | 6% | 177 | 0.04 | 10 | $2 | 100% | 100% | 100% | KITCH-5 | 79% | 6% | 68.9% | 68.9% | 68.9% | 49.0 |
| 9068 | Water Heating | Kitchen Faucet Aerator 1.5 gpm | Efficient Products | MF | NC | 3,045 | 6% | 177 | 0.04 | 10 | $2 | 100% | 100% | 100% | KITCH-6 | 79% | 0% | 69.8% | 69.8% | 69.8% | 49.0 |
| 9069 | Water Heating | Bathroom Aerator 1.0 gpm | Efficient Products | SF | Retrofit | 2,942 | 1% | 33 | 0.05 | 10 | $2 | 100% | 100% | 100% | BATH-1 | 88% | 20% | 74.7% | 74.7% | 74.7% | 29.5 |
| 9070 | Water Heating | Bathroom Aerator 1.0 gpm | School Education | SF | Retrofit | 2,942 | 0% | 13 | 0.02 | 10 | $2 | 100% | 100% | 100% | BATH-1 | 88% | 20% | 74.7% | 74.7% | 74.7% | 11.8 |
| 9071 | Water Heating | Bathroom Aerator 1.0 gpm | Efficient Products | SF | Retrofit | 2,942 | 1% | 33 | 0.05 | 10 | $2 | 100% | 100% | 100% | BATH-2 | 88% | 20% | 61.2% | 61.2% | 61.2% | 29.5 |
| 9072 | Water Heating | Bathroom Aerator 1.0 gpm | School Education | SF | Retrofit | 2,942 | 0% | 13 | 0.02 | 10 | $2 | 100% | 100% | 100% | BATH-2 | 88% | 20% | 61.2% | 61.2% | 61.2% | 11.8 |
| 9073 | Water Heating | Bathroom Aerator 1.0 gpm | IQW | SF | Retrofit | 2,942 | 1% | 33 | 0.05 | 10 | $2 | 100% | 100% | 100% | BATH-2 | 88% | 20% | 61.2% | 61.2% | 61.2% | 29.5 |
| 9074 | Water Heating | Bathroom Aerator 1.0 gpm | Efficient Products | SF | NC | 2,942 | 1% | 33 | 0.05 | 10 | $2 | 100% | 100% | 100% | BATH-3 | 88% | 0% | 78.4% | 78.4% | 78.4% | 29.5 |
| 9075 | Water Heating | Bathroom Aerator 1.0 gpm | Efficient Products | MF | Retrofit | 3,045 | 1% | 33 | 0.03 | 10 | $2 | 100% | 100% | 100% | BATH-4 | 81% | 6% | 68.1% | 68.1% | 68.1% | 21.3 |
| 9076 | Water Heating | Bathroom Aerator 1.0 gpm | School Education | MF | Retrofit | 3,045 | 0% | 13 | 0.01 | 10 | $2 | 100% | 100% | 100% | BATH-4 | 81% | 6% | 68.1% | 68.1% | 68.1% | 8.5 |
| 9077 | Water Heating | Bathroom Aerator 1.0 gpm | Multifamily | MF | Retrofit | 3,045 | 1% | 33 | 0.03 | 10 | $2 | 100% | 100% | 100% | BATH-4 | 81% | 6% | 68.1% | 68.1% | 68.1% | 21.0 |
| 9078 | Water Heating | Bathroom Aerator 1.0 gpm | Efficient Products | MF | Retrofit | 3,045 | 1% | 33 | 0.03 | 10 | $2 | 100% | 100% | 100% | BATH-5 | 81% | 6% | 68.9% | 68.9% | 68.9% | 21.3 |
| 9079 | Water Heating | Bathroom Aerator 1.0 gpm | School Education | MF | Retrofit | 3,045 | 0% | 13 | 0.01 | 10 | $2 | 100% | 100% | 100% | BATH-5 | 81% | 6% | 68.9% | 68.9% | 68.9% | 8.5 |
| 9080 | Water Heating | Bathroom Aerator 1.0 gpm | Multifamily | MF | Retrofit | 3,045 | 1% | 33 | 0.03 | 10 | $2 | 100% | 100% | 100% | BATH-5 | 81% | 6% | 68.9% | 68.9% | 68.9% | 21.0 |
| 9081 | Water Heating | Bathroom Aerator 1.0 gpm | IQW | MF | Retrofit | 3,045 | 1% | 33 | 0.03 | 10 | $2 | 100% | 100% | 100% | BATH-5 | 81% | 6% | 68.9% | 68.9% | 68.9% | 21.3 |
| 9082 | Water Heating | Bathroom Aerator 1.0 gpm | Efficient Products | MF | NC | 3,045 | 1% | 33 | 0.03 | 10 | $2 | 100% | 100% | 100% | BATH-6 | 81% | 0% | 69.8% | 69.8% | 69.8% | 21.3 |
| 9083 | Water Heating | Pipe Wrap | Efficient Products | SF | Retrofit | 2,942 | 1% | 42 | 0.00 | 15 | $9 | 100% | 35% | 35% | WRAP-1 | 50% | 10% | 77.2% | 38.7% | 38.7% | 7.4 |
| 9084 | Water Heating | Pipe Wrap | School Education | SF | Retrofit | 2,942 | 1% | 22 | 0.00 | 15 | $9 | 100% | 100% | 100% | WRAP-1 | 50% | 10% | 77.2% | 77.2% | 77.2% | 1.4 |
| 9085 | Water Heating | Pipe Wrap | School Education | SF | Retrofit | 2,942 | 1% | 22 | 0.00 | 15 | $9 | 100% | 100% | 100% | WRAP-2 | 50% | 10% | 65.1% | 65.1% | 65.1% | 1.4 |
| 9086 | Water Heating | Pipe Wrap | IQW | SF | Retrofit | 2,942 | 1% | 22 | 0.00 | 15 | $9 | 100% | 100% | 100% | WRAP-2 | 50% | 10% | 65.1% | 65.1% | 65.1% | 1.4 |
| 9087 | Water Heating | Pipe Wrap | Efficient Products | SF | Retrofit | 2,942 | 1% | 42 | 0.00 | 15 | $9 | 100% | 35% | 35% | WRAP-2 | 79% | 5% | 66.7% | 37.3% | 37.3% | 7.3 |
| 9088 | Water Heating | Pipe Wrap | Efficient Products | MF | Retrofit | 3,045 | 1% | 42 | 0.00 | 15 | $9 | 100% | 35% | 35% | WRAP-3 | 79% | 5% | 68.3% | 37.6% | 37.6% | 7.3 |
| 9089 | Water Heating | Pipe Wrap | School Education | MF | Retrofit | 3,045 | 1% | 22 | 0.00 | 15 | $9 | 100% | 100% | 100% | WRAP-3 | 79% | 5% | 68.3% | 68.3% | 68.3% | 1.4 |
| 9090 | Water Heating | Pipe Wrap | School Education | MF | Retrofit | 3,045 | 1% | 22 | 0.00 | 15 | $9 | 100% | 100% | 100% | WRAP-4 | 79% | 5% | 69.0% | 69.0% | 69.0% | 1.4 |
| 9091 | Water Heating | Pipe Wrap | IQW | MF | Retrofit | 3,045 | 1% | 22 | 0.00 | 15 | $9 | 100% | 100% | 100% | WRAP-4 | 79% | 5% | 69.0% | 69.0% | 69.0% | 1.4 |
| 9092 | Water Heating | Pipe Wrap | Efficient Products | MF | Retrofit | 3,045 | 1% | 42 | 0.00 | 15 | $9 | 100% | 35% | 35% | WRAP-4 | 79% | 5% | 69.0% | 40.5% | 40.5% | 7.3 |
| 9093 | Water Heating | Water Heater Temperature Setback | School Education | SF | Retrofit | 2,942 | 3% | 83 | 0.01 | 2 | $10 | 100% | 100% | 100% | WHTS-1 | 50% | 24% | 73.6% | 73.6% | 73.6% | 0.9 |
| 9094 | Water Heating | Water Heater Temperature Setback | School Education | SF | Retrofit | 2,942 | 3% | 83 | 0.01 | 2 | $10 | 100% | 100% | 100% | WHTS-2 | 50% | 24% | 59.5% | 59.5% | 59.5% | 0.9 |

**Appendix B: Residential Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Home Type | Replacement Type | Base Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9095 | Water Heating | Water Heater Temperature Setback | IQW | SF | Retrofit | 2,942 | 3% | 83 | 0.01 | 2 | $10 | 100% | 100% | 100% | WHTS-2 | 50% | 24% | 59.5% | 59.5% | 59.5% | 0.9 |
| 9096 | Water Heating | Water Heater Temperature Setback | School Education | MF | Retrofit | 3,045 | 3% | 83 | 0.01 | 2 | $10 | 100% | 100% | 100% | WHTS-3 | 79% | 6% | 68.1% | 68.1% | 68.1% | 0.9 |
| 9097 | Water Heating | Water Heater Temperature Setback | School Education | MF | Retrofit | 3,045 | 3% | 83 | 0.01 | 2 | $10 | 100% | 100% | 100% | WHTS-4 | 79% | 6% | 68.9% | 68.9% | 68.9% | 0.9 |
| 9098 | Water Heating | Water Heater Temperature Setback | IQW | MF | Retrofit | 3,045 | 3% | 83 | 0.01 | 2 | $10 | 100% | 100% | 100% | WHTS-4 | 79% | 6% | 68.9% | 68.9% | 68.9% | 0.9 |

# Appendix C. C&I Sector Measure Detail

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Assembly | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 2 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Assembly | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 3 | CompressedAir | AODD Pump Controls | Biz-Custom | Assembly | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 4 | CompressedAir | Compressed Air - Custom | Biz-Custom | Assembly | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 5 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Assembly | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 6 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Assembly | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.5 |
| 7 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Assembly | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 8 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Assembly | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 9 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Assembly | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 9.0 |
| 10 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Assembly | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.4 |
| 11 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Assembly | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 8.1 |
| 12 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Assembly | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 17.0 |
| 13 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Assembly | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.3 |
| 14 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Assembly | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 58.5% | 42.3% | 42.3% | 5.3 |
| 15 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 922 | 922 | 6% | 57 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 20% | 20% | 83.4% | 68.5% | 68.5% | 2.1 |
| 16 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 922 | 922 | 13% | 118 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 20% | 20% | 83.4% | 46.9% | 46.9% | 4.4 |
| 17 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 922 | 922 | 28% | 260 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 20% | 20% | 83.4% | 65.5% | 65.5% | 9.6 |
| 18 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 922 | 922 | 42% | 386 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 20% | 20% | 83.4% | 69.9% | 69.9% | 14.2 |
| 19 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 986 | 986 | 6% | 57 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 20% | 20% | 83.4% | 83.4% | 83.4% | 2.1 |
| 20 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 986 | 986 | 12% | 121 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 20% | 20% | 83.4% | 83.4% | 83.4% | 4.5 |
| 21 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 986 | 986 | 20% | 200 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 20% | 20% | 83.4% | 83.4% | 83.4% | 7.4 |
| 22 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 986 | 986 | 46% | 451 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 20% | 20% | 83.4% | 83.4% | 83.4% | 16.6 |
| 23 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Assembly | Retro | 937 | 937 | 7% | 66 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 39% | 50% | 83.4% | 80.1% | 80.1% | 11.8 |
| 24 | Cooling | Air Side Economizer | Biz-Custom | Assembly | Retro | 922 | 922 | 20% | 184 | 0.00 | 10 | $84 | 50% | 18% | 18% | 4 | 39% | 20% | 56.4% | 44.4% | 44.4% | 3.8 |
| 25 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Assembly | Retro | 937 | 937 | 9% | 85 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 39% | 20% | 44.0% | 36.0% | 36.0% | 1.0 |
| 26 | Cooling | HVAC Occupancy Controls | Biz-Custom | Assembly | ROB | 2,900 | 2,900 | 20% | 580 | 0.00 | 15 | $537 | 75% | 9% | 9% | 6 | 39% | 20% | 63.2% | 36.0% | 36.0% | 11.3 |
| 27 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 803 | 803 | 13% | 100 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 29% | 20% | 83.4% | 83.4% | 83.4% | 3.7 |
| 28 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 803 | 803 | 18% | 142 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 29% | 20% | 83.4% | 36.9% | 36.9% | 5.2 |
| 29 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Assembly | ROB | 803 | 803 | 22% | 178 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 29% | 20% | 83.4% | 41.9% | 41.9% | 6.6 |
| 30 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Assembly | ROB | 803 | 803 | 33% | 268 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 29% | 20% | 83.4% | 44.5% | 44.5% | 9.9 |
| 31 | Cooling | Smart Thermostat | Biz-Prescriptive | Assembly | ROB | 803 | 803 | 14% | 114 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 29% | 12% | 38.4% | 30.9% | 30.9% | 2.1 |
| 32 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Assembly | ROB | 945 | 945 | 8% | 80 | 0.00 | 8 | $84 | 75% | 42% | 42% | 9 | 0% | 20% | 66.3% | 47.0% | 47.0% | 2.4 |
| 33 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Assembly | ROB | 1,036 | 1,036 | 7% | 75 | 0.00 | 8 | $84 | 75% | 42% | 42% | 10 | 0% | 20% | 65.5% | 46.1% | 46.1% | 2.3 |
| 34 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Assembly | ROB | 1,184 | 1,184 | 10% | 113 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 0% | 20% | 83.4% | 56.7% | 56.7% | 3.4 |
| 35 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Assembly | ROB | 821 | 821 | 6% | 46 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 32% | 15% | 83.4% | 32.6% | 32.6% | 2.9 |
| 36 | Cooling | Chiller Tune-up | Biz-Custom | Assembly | Retro | 937 | 937 | 7% | 66 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 32% | 50% | 83.4% | 80.1% | 80.1% | 11.8 |
| 37 | Cooling | HVAC/Chiller Custom | Biz-Custom | Assembly | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.4 |
| 38 | Cooling | Window Film | Biz-Custom | Assembly | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 47.5% | 47.5% | 11.9 |
| 39 | Cooling | Triple Pane Windows | Biz-Custom | Assembly | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 48.2% | 36.0% | 36.0% | 22.0 |
| 40 | Cooling | Energy Recovery Ventilator | Biz-Custom | Assembly | Retro | 986 | 986 | 34% | 334 | 0.00 | 15 | $1,500 | 2% | 2% | 2% | 16 | 100% | 2% | 31.4% | 22.6% | 22.6% | 13.3 |
| 41 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 3% | 96 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 37% | 20% | 83.4% | 60.0% | 60.0% | 1.9 |
| 42 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 8% | 230 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 37% | 20% | 44.0% | 36.0% | 36.0% | 3.9 |
| 43 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 11% | 332 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 37% | 20% | 44.0% | 36.0% | 36.0% | 5.5 |
| 44 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 16% | 482 | 0.00 | 16 | $507 | 75% | 10% | 10% | 1 | 37% | 20% | 65.3% | 37.4% | 37.4% | 8.4 |
| 45 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 22% | 642 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 37% | 20% | 44.0% | 36.0% | 36.0% | 1.7 |
| 46 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 26% | 772 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 37% | 20% | 44.0% | 36.0% | 36.0% | 2.0 |
| 47 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 31% | 925 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 37% | 20% | 44.0% | 36.0% | 36.0% | 2.4 |
| 48 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 46% | 1,372 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 37% | 20% | 44.0% | 36.0% | 36.0% | 3.1 |
| 49 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Assembly | ROB | 3,550 | 3,550 | 10% | 352 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 25% | 20% | 83.4% | 78.9% | 78.9% | 20.6 |
| 50 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Assembly | ROB | 3,550 | 3,550 | 15% | 531 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 25% | 20% | 83.4% | 76.7% | 76.7% | 23.3 |
| 51 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Assembly | ROB | 3,681 | 3,681 | 12% | 442 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 25% | 20% | 83.4% | 78.2% | 78.2% | 33.2 |
| 52 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Assembly | ROB | 3,681 | 3,681 | 17% | 625 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 25% | 20% | 83.4% | 76.1% | 76.1% | 37.0 |
| 53 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 3,249 | 3,249 | 28% | 912 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 25% | 20% | 44.0% | 36.0% | 36.0% | 3.5 |
| 54 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 3,249 | 3,249 | 32% | 1,042 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 25% | 20% | 44.0% | 36.0% | 36.0% | 3.8 |
| 55 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 3,368 | 3,368 | 39% | 1,314 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 25% | 20% | 44.0% | 36.0% | 36.0% | 4.3 |
| 56 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Assembly | ROB | 3,368 | 3,368 | 52% | 1,761 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 25% | 20% | 44.0% | 36.0% | 36.0% | 5.0 |
| 57 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Assembly | ROB | 2,712 | 2,712 | 8% | 214 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 25% | 2% | 83.4% | 46.9% | 46.9% | 8.9 |
| 58 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Assembly | ROB | 3,776 | 3,776 | 8% | 303 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 25% | 20% | 83.4% | 76.7% | 76.7% | 25.9 |
| 59 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Assembly | ROB | 3,776 | 3,776 | 14% | 516 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 25% | 20% | 83.4% | 72.5% | 72.5% | 30.9 |
| 60 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 3,681 | 3,681 | 36% | 1,344 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 25% | 20% | 61.0% | 36.0% | 36.0% | 6.6 |
| 61 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 3,681 | 3,681 | 40% | 1,474 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 25% | 20% | 62.1% | 36.0% | 36.0% | 6.9 |
| 62 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 3,681 | 3,681 | 44% | 1,627 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 25% | 20% | 63.1% | 36.0% | 36.0% | 7.2 |
| 63 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Assembly | ROB | 3,681 | 3,681 | 56% | 2,074 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 25% | 20% | 83.4% | 37.8% | 37.8% | 8.0 |
| 64 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Assembly | ROB | 2,979 | 2,979 | 16% | 482 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 13% | 20% | 83.4% | 57.4% | 57.4% | 12.0 |
| 65 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Assembly | ROB | 3,325 | 3,325 | 2% | 77 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 0% | 10% | 70.4% | 60.6% | 60.6% | 1.8 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 66 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Assembly | ROB | 3,860 | 3,860 | 10% | 367 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 0% | 10% | 83.4% | 76.9% | 76.9% | 8.9 |
| 67 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Assembly | ROB | 3,597 | 3,597 | 5% | 190 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 0% | 10% | 83.4% | 71.9% | 71.9% | 4.5 |
| 68 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Assembly | ROB | 3,027 | 3,027 | 67% | 2,027 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 0% | 75.5% | 57.8% | 57.8% | 2.2 |
| 69 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Assembly | Retro | 3,027 | 3,027 | 2% | 61 | 0.00 | 20 | $60 | 50% | 8% | 8% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.3 |
| 70 | HotWater | Faucet Aerator | Biz-Prescriptive | Assembly | Retro | 389 | 389 | 32% | 126 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 10.0 |
| 71 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Assembly | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 21.8 |
| 72 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Assembly | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.6% | 45.9% | 45.9% | 3.6 |
| 73 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Assembly | Retro | 80 | 80 | 45% | 36 | 0.00 | 15 | $3 | 100% | 100% | 100% | 1 | 56% | 38% | 85.0% | 85.0% | 85.0% | 9.7 |
| 74 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Assembly | Retro | 181 | 181 | 50% | 91 | 0.00 | 15 | $70 | 100% | 43% | 43% | 1 | 56% | 38% | 85.0% | 50.2% | 50.2% | 2.5 |
| 75 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Assembly | Retro | 181 | 181 | 50% | 91 | 0.00 | 15 | $70 | 100% | 79% | 79% | 1 | 56% | 38% | 85.0% | 72.2% | 72.2% | 1.3 |
| 76 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Assembly | Retro | 181 | 181 | 74% | 135 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 6% | 38% | 56.4% | 47.4% | 47.4% | 0.7 |
| 77 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Assembly | Retro | 1,687 | 1,687 | 68% | 1,147 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 2% | 19% | 85.0% | 72.9% | 72.9% | 6.2 |
| 78 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Assembly | Retro | 1,687 | 1,687 | 66% | 1,119 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 2% | 19% | 85.0% | 72.6% | 72.6% | 6.1 |
| 79 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Assembly | Retro | 359 | 359 | 61% | 218 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 2% | 19% | 85.0% | 85.0% | 85.0% | 2.4 |
| 80 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Assembly | Retro | 359 | 359 | 59% | 211 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 2% | 19% | 85.0% | 85.0% | 85.0% | 2.3 |
| 81 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Assembly | ROB | 150 | 150 | 86% | 128 | 0.00 | 10 | $1 | 100% | 100% | 100% | 5 | 4% | 13% | 85.0% | 85.0% | 85.0% | 88.2 |
| 82 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Assembly | Retro | 124 | 124 | 68% | 84 | 0.00 | 15 | $27 | 100% | 37% | 37% | 6 | 31% | 13% | 85.0% | 69.2% | 69.2% | 6.9 |
| 83 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Assembly | ROB | 113 | 113 | 81% | 92 | 0.00 | 10 | $1 | 100% | 100% | 100% | 6 | 31% | 13% | 85.0% | 85.0% | 85.0% | 62.9 |
| 84 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Assembly | Retro | 67 | 67 | 100% | 67 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 56% | 0% | 85.0% | 81.7% | 81.7% | 43.1 |
| 85 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Assembly | Retro | 305 | 305 | 30% | 91 | 0.00 | 10 | $65 | 50% | 20% | 20% | 8 | 95% | 10% | 40.5% | 29.9% | 29.9% | 2.7 |
| 86 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Assembly | Retro | 390 | 390 | 30% | 117 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 65.4% | 65.4% | 5.2 |
| 87 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Assembly | Retro | 174 | 174 | 44% | 77 | 0.00 | 10 | $75 | 50% | 26% | 26% | 8 | 95% | 10% | 39.9% | 31.2% | 31.2% | 2.4 |
| 88 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Assembly | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 75% | 18% | 18% | 8 | 95% | 10% | 71.5% | 37.1% | 37.1% | 4.2 |
| 89 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Assembly | Retro | 1 | 1 | 49% | 1 | 0.00 | 15 | $1 | 75% | 42% | 42% | 8 | 95% | 10% | 68.3% | 40.0% | 40.0% | 2.3 |
| 90 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Assembly | Retro | 174 | 174 | 65% | 113 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 65% | 10% | 85.0% | 34.7% | 34.7% | 4.9 |
| 91 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Assembly | Retro | 69 | 69 | 43% | 29 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 92 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Assembly | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 79.8% | 79.8% | 11.5 |
| 93 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Assembly | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 46% | 46% | 1 | 12% | 44% | 60.8% | 55.2% | 55.2% | 1.6 |
| 94 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Assembly | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 95 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Assembly | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 3 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.4 |
| 96 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Assembly | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 97 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Assembly | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 25% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.6 |
| 98 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Assembly | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.7 |
| 99 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Assembly | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 100 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Assembly | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 8 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.4 |
| 101 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Assembly | Retro | 181 | 181 | 69% | 125 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 52.7% | 52.7% | 0.4 |
| 102 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 103 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 104 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Assembly | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 105 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Assembly | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 45% | 10% | 85.0% | 66.0% | 66.0% | 3.3 |
| 106 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Assembly | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,180 | 100% | 34% | 34% | 3 | 31% | 10% | 85.0% | 69.9% | 69.9% | 8.8 |
| 107 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Assembly | Retro | 262 | 262 | 83% | 217 | 0.00 | 10 | $483 | 25% | 4% | 4% | 4 | 5% | 10% | 37.0% | 25.1% | 25.1% | 10.2 |
| 108 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Assembly | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 0% | 2% | 31.4% | 17.2% | 17.2% | 3.6 |
| 109 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Assembly | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 8.0 |
| 110 | Motors | Cogged V-Belt | Biz-Custom | Assembly | Retro | 17,237 | 17,237 | 3% | 534 | 0.00 | 15 | $384 | 75% | 11% | 11% | 1 | 50% | 10% | 66.9% | 40.6% | 40.6% | 8.5 |
| 111 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Assembly | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 66.4% | 66.4% | 8.6 |
| 112 | Motors | Power Drive Systems | Biz-Custom | Assembly | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 66.3% | 66.3% | 8.0 |
| 113 | Motors | Switch Reluctance Motors | Biz-Custom | Assembly | Retro | 33,406 | 33,406 | 31% | 10,222 | 0.00 | 15 | $869 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.8 |
| 114 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Assembly | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.1 |
| 115 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Assembly | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% | | | 1 | 30% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 116 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Assembly | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.8 |
| 117 | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Assembly | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.1 |
| 118 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Assembly | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 36.6 |
| 119 | Office_PC | Energy Star Server | Biz-Custom | Assembly | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.7% | 59.7% | 4.4 |
| 120 | Office_PC | Server Virtualization | Biz-Custom | Assembly | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.1 |
| 121 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Assembly | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.4% | 51.4% | 7.3 |
| 122 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Assembly | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.8 |
| 123 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Assembly | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.4% | 77.4% | 7.0 |
| 124 | Office_PC | Energy Star Laptop | Biz-Custom | Assembly | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% | | | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 125 | Office_PC | Energy Star Monitor | Biz-Custom | Assembly | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% | | | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 126 | Refrigeration | Strip Curtains | Biz-Prescriptive | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 4 | $0 | 0% | 0% | | 1 | 11% | 30% | 79.2% | 79.2% | 79.2% | 0.0 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 127 | Refrigeration | Bare Suction Line | Biz-Custom | Assembly | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.6% | 72.6% | 7.0 |
| 128 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Assembly | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 25% | 5% | 5% | 3 | 7% | 25% | 47.5% | 39.9% | 39.9% | 4.9 |
| 129 | Refrigeration | Saturated Suction Controls | Biz-Custom | Assembly | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.6% | 28.1% | 28.1% | 12.8 |
| 130 | Refrigeration | Compressor Retrofit | Biz-Custom | Assembly | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 25% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| 131 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Assembly | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 7% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| 132 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Assembly | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 7% | 25% | 79.2% | 71.9% | 71.9% | 2.5 |
| 133 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Assembly | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 9% | 25% | 47.5% | 40.0% | 40.0% | 4.9 |
| 134 | Refrigeration | Refrigeration Economizer | Biz-Custom | Assembly | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 35% | 10% | 79.2% | 69.2% | 69.2% | 3.3 |
| 135 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Assembly | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 12% | 25% | 79.2% | 79.2% | 79.2% | 1.2 |
| 136 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Assembly | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 9% | 50% | 79.2% | 75.9% | 75.9% | 3.3 |
| 137 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Assembly | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 3% | 25% | 47.5% | 40.0% | 40.0% | 6.7 |
| 138 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Assembly | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 2% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| 139 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Assembly | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 2% | 2% | 79.2% | 72.7% | 72.7% | 5.2 |
| 140 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Assembly | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 12% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 141 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Assembly | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 12% | 54% | 67.8% | 63.2% | 63.2% | 1.8 |
| 142 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Assembly | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 4% | 25% | 79.2% | 79.2% | 79.2% | 4.7 |
| 143 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Assembly | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 4% | 50% | 79.2% | 77.8% | 77.8% | 7.8 |
| 144 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Assembly | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 4% | 25% | 79.2% | 50.9% | 50.9% | 6.7 |
| 145 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Assembly | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 4% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 146 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Assembly | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 4% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 147 | Refrigeration | Refrigeration - Custom | Biz-Custom | Assembly | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.2% | 69.2% | 3.3 |
| 148 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Assembly | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 149 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Assembly | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 4% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 150 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Assembly | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 2% | 30% | 51.0% | 45.6% | 45.6% | 2.3 |
| 151 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Assembly | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 7% | 66% | 79.2% | 77.7% | 77.7% | 24.1 |
| 152 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Assembly | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 7% | 13% | 79.2% | 75.2% | 75.2% | 18.9 |
| 153 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Assembly | Retro | 1,698 | 1,698 | 20% | 340 | 0.00 | 15 | $227 | 100% | 12% | 12% | 1 | 100% | 17% | 83.4% | 42.5% | 42.5% | 8.7 |
| 154 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Assembly | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 29% | 29% | 2 | 100% | 17% | 83.4% | 66.3% | 66.3% | 8.8 |
| 155 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Assembly | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 73.0% | 73.0% | 7.5 |
| 156 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% | | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 157 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Assembly | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 73.0% | 73.0% | 7.5 |
| 158 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Assembly | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 73.0% | 73.0% | 6.4 |
| 159 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Assembly | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 73.0% | 73.0% | 6.4 |
| 160 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Assembly | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 59.6% | 36.0% | 36.0% | 21.2 |
| 161 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Assembly | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 72.1% | 72.1% | 5.7 |
| 162 | Behavioral | COM Competitions | Biz-Custom | Assembly | Retro | 53 | 53 | 2% | 1 | 0.00 | 2 | $0 | 100% | 48% | 48% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 3.7 |
| 163 | Behavioral | Business Energy Reports | Biz-Custom | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 100% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 164 | Behavioral | Building Benchmarking | Biz-Custom | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 77% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 165 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Assembly | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 7% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 166 | Behavioral | BEIMS | Biz-Custom | Assembly | Retro | 20 | 20 | 5% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.4 |
| 167 | Behavioral | Building Operator Certification | Biz-Custom | Assembly | Retro | 10 | 10 | 3% | 0 | 0.00 | 3 | $0 | 23% | 23% | 23% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.9 |
| 168 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Education | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 169 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Education | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 170 | CompressedAir | AODD Pump Controls | Biz-Custom | Education | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 171 | CompressedAir | Compressed Air - Custom | Biz-Custom | Education | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 172 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Education | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 173 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Education | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.9 |
| 174 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Education | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 3.0 |
| 175 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Education | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.5 |
| 176 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Education | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 9.3 |
| 177 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Education | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 17.3 |
| 178 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Education | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 8.6 |
| 179 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Education | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 17.9 |
| 180 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Education | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.5 |
| 181 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Education | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 75% | 14% | 14% | 6 | 3% | 16% | 71.0% | 42.3% | 42.3% | 5.5 |
| 182 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Education | ROB | 899 | 899 | 6% | 55 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 24% | 20% | 83.4% | 68.7% | 68.7% | 2.0 |
| 183 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Education | ROB | 899 | 899 | 13% | 116 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 24% | 20% | 83.4% | 47.2% | 47.2% | 4.3 |
| 184 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Education | ROB | 899 | 899 | 28% | 254 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 24% | 20% | 83.4% | 65.7% | 65.7% | 9.4 |
| 185 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Education | ROB | 899 | 899 | 42% | 377 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 24% | 20% | 83.4% | 70.1% | 70.1% | 13.9 |
| 186 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Education | ROB | 962 | 962 | 6% | 56 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 24% | 20% | 83.4% | 83.4% | 83.4% | 2.1 |
| 187 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Education | ROB | 962 | 962 | 12% | 118 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 24% | 20% | 83.4% | 83.4% | 83.4% | 4.4 |
| 188 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Education | ROB | 962 | 962 | 20% | 195 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 24% | 20% | 83.4% | 83.4% | 83.4% | 7.2 |
| 189 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Education | ROB | 962 | 962 | 46% | 440 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 24% | 20% | 83.4% | 83.4% | 83.4% | 16.3 |
| 190 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Education | Retro | 914 | 914 | 7% | 64 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 49% | 50% | 83.4% | 80.1% | 80.1% | 11.4 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 191 | Cooling | Air Side Economizer | Biz-Custom | Education | Retro | 899 | 899 | 20% | 180 | 0.00 | 10 | $84 | 50% | 17% | 17% | 4 | 49% | 20% | 55.7% | 43.8% | 43.8% | 3.4 |
| 192 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Education | Retro | 914 | 914 | 12% | 107 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 49% | 20% | 44.0% | 36.0% | 36.0% | 1.2 |
| 193 | Cooling | HVAC Occupancy Controls | Biz-Custom | Education | ROB | 1,113 | 1,113 | 20% | 223 | 0.00 | 15 | $537 | 3% | 3% | 3% | 6 | 49% | 20% | 44.0% | 36.0% | 36.0% | 4.6 |
| 194 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Education | ROB | 783 | 783 | 13% | 98 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 3% | 20% | 83.4% | 83.4% | 83.4% | 3.6 |
| 195 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Education | ROB | 783 | 783 | 18% | 138 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 3% | 20% | 83.4% | 37.4% | 37.4% | 5.1 |
| 196 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Education | ROB | 783 | 783 | 22% | 174 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 3% | 20% | 83.4% | 42.3% | 42.3% | 6.4 |
| 197 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Education | ROB | 783 | 783 | 33% | 261 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 3% | 20% | 83.4% | 44.8% | 44.8% | 9.7 |
| 198 | Cooling | Smart Thermostat | Biz-Prescriptive | Education | ROB | 783 | 783 | 14% | 111 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 3% | 12% | 38.4% | 30.9% | 30.9% | 2.1 |
| 199 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Education | ROB | 921 | 921 | 8% | 78 | 0.00 | 8 | $84 | 75% | 42% | 42% | 9 | 0% | 20% | 66.5% | 47.2% | 47.2% | 2.3 |
| 200 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Education | ROB | 1,011 | 1,011 | 7% | 73 | 0.00 | 8 | $84 | 75% | 42% | 42% | 10 | 0% | 20% | 65.7% | 46.3% | 46.3% | 2.2 |
| 201 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Education | ROB | 1,154 | 1,154 | 10% | 110 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 0% | 20% | 83.4% | 57.2% | 57.2% | 3.3 |
| 202 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Education | ROB | 800 | 800 | 6% | 45 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 49% | 15% | 83.4% | 32.9% | 32.9% | 2.8 |
| 203 | Cooling | Chiller Tune-up | Biz-Custom | Education | Retro | 914 | 914 | 7% | 64 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 49% | 50% | 83.4% | 80.1% | 80.1% | 11.4 |
| 204 | Cooling | HVAC/Chiller Custom | Biz-Custom | Education | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.0 |
| 205 | Cooling | Window Film | Biz-Custom | Education | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 47.8% | 47.8% | 11.6 |
| 206 | Cooling | Triple Pane Windows | Biz-Custom | Education | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 49.0% | 36.0% | 36.0% | 21.5 |
| 207 | Cooling | Energy Recovery Ventilator | Biz-Custom | Education | Retro | 962 | 962 | 15% | 148 | 0.00 | 15 | $1,500 | 1% | 1% | 1% | 16 | 100% | 2% | 31.4% | 22.6% | 22.6% | 23.4 |
| 208 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 3% | 88 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 4% | 20% | 83.4% | 58.0% | 58.0% | 1.8 |
| 209 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 8% | 208 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 4% | 20% | 44.0% | 36.0% | 36.0% | 3.7 |
| 210 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 11% | 299 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 4% | 20% | 44.0% | 36.0% | 36.0% | 5.2 |
| 211 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 17% | 438 | 0.00 | 16 | $507 | 75% | 10% | 10% | 1 | 4% | 20% | 64.0% | 36.0% | 36.0% | 8.0 |
| 212 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 22% | 572 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 4% | 20% | 44.0% | 36.0% | 36.0% | 1.6 |
| 213 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 26% | 688 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 4% | 20% | 44.0% | 36.0% | 36.0% | 1.9 |
| 214 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 31% | 823 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 4% | 20% | 44.0% | 36.0% | 36.0% | 2.2 |
| 215 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 46% | 1,218 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 4% | 20% | 44.0% | 36.0% | 36.0% | 2.9 |
| 216 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Education | ROB | 3,149 | 3,149 | 10% | 317 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 41% | 20% | 83.4% | 78.5% | 78.5% | 20.3 |
| 217 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Education | ROB | 3,149 | 3,149 | 15% | 477 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 41% | 20% | 83.4% | 76.2% | 76.2% | 22.9 |
| 218 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Education | ROB | 3,267 | 3,267 | 12% | 403 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 41% | 20% | 83.4% | 77.8% | 77.8% | 32.7 |
| 219 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Education | ROB | 3,267 | 3,267 | 17% | 566 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 41% | 20% | 83.4% | 75.6% | 75.6% | 36.3 |
| 220 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Education | ROB | 2,881 | 2,881 | 28% | 815 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 41% | 20% | 44.0% | 36.0% | 36.0% | 3.3 |
| 221 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Education | ROB | 2,881 | 2,881 | 32% | 930 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 41% | 20% | 44.0% | 36.0% | 36.0% | 3.6 |
| 222 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Education | ROB | 2,996 | 2,996 | 39% | 1,181 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 41% | 20% | 44.0% | 36.0% | 36.0% | 4.1 |
| 223 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Education | ROB | 2,996 | 2,996 | 53% | 1,576 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 41% | 20% | 44.0% | 36.0% | 36.0% | 4.8 |
| 224 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Education | ROB | 2,409 | 2,409 | 9% | 209 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 41% | 2% | 83.4% | 46.1% | 46.1% | 8.8 |
| 225 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Education | ROB | 3,359 | 3,359 | 8% | 276 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 41% | 20% | 83.4% | 76.2% | 76.2% | 25.6 |
| 226 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Education | ROB | 3,359 | 3,359 | 14% | 467 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 41% | 20% | 83.4% | 71.9% | 71.9% | 30.4 |
| 227 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Education | ROB | 3,267 | 3,267 | 37% | 1,201 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 41% | 20% | 58.9% | 36.0% | 36.0% | 6.4 |
| 228 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Education | ROB | 3,267 | 3,267 | 40% | 1,316 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 41% | 20% | 60.1% | 36.0% | 36.0% | 6.7 |
| 229 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Education | ROB | 3,267 | 3,267 | 44% | 1,451 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 41% | 20% | 61.4% | 36.0% | 36.0% | 7.0 |
| 230 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Education | ROB | 3,267 | 3,267 | 57% | 1,846 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 41% | 20% | 83.4% | 36.0% | 36.0% | 7.7 |
| 231 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Education | ROB | 2,638 | 2,638 | 17% | 438 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 13% | 20% | 83.4% | 55.1% | 55.1% | 11.5 |
| 232 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Education | ROB | 2,939 | 2,939 | 3% | 75 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 0% | 10% | 69.9% | 59.3% | 59.3% | 1.8 |
| 233 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Education | ROB | 3,432 | 3,432 | 10% | 358 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 0% | 10% | 83.4% | 76.5% | 76.5% | 8.8 |
| 234 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Education | ROB | 3,185 | 3,185 | 6% | 186 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 0% | 10% | 83.4% | 71.4% | 71.4% | 4.5 |
| 235 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Education | ROB | 5,042 | 5,042 | 67% | 3,377 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 9% | 75.5% | 68.0% | 68.0% | 3.6 |
| 236 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Education | Retro | 5,042 | 5,042 | 2% | 101 | 0.00 | 20 | $60 | 100% | 13% | 13% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.2 |
| 237 | HotWater | Faucet Aerator | Biz-Prescriptive | Education | Retro | 467 | 467 | 32% | 151 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 12.8 |
| 238 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Education | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 21.1 |
| 239 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Education | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 61.4% | 47.9% | 47.9% | 3.5 |
| 240 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Education | Retro | 116 | 116 | 45% | 52 | 0.00 | 15 | $3 | 100% | 100% | 100% | 1 | 77% | 38% | 85.0% | 85.0% | 85.0% | 13.9 |
| 241 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Education | Retro | 262 | 262 | 50% | 131 | 0.00 | 15 | $70 | 100% | 43% | 43% | 1 | 77% | 38% | 85.0% | 59.8% | 59.8% | 3.5 |
| 242 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Education | Retro | 262 | 262 | 50% | 131 | 0.00 | 15 | $70 | 100% | 79% | 79% | 1 | 77% | 38% | 85.0% | 76.3% | 76.3% | 1.9 |
| 243 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Education | Retro | 262 | 262 | 74% | 195 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 9% | 38% | 56.4% | 50.0% | 50.0% | 0.9 |
| 244 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Education | Retro | 2,440 | 2,440 | 68% | 1,660 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 1% | 19% | 85.0% | 76.8% | 76.8% | 8.9 |
| 245 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Education | Retro | 2,440 | 2,440 | 66% | 1,619 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 1% | 19% | 85.0% | 76.6% | 76.6% | 8.7 |
| 246 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Education | Retro | 520 | 520 | 61% | 316 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 1% | 19% | 85.0% | 85.0% | 85.0% | 3.4 |
| 247 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Education | Retro | 520 | 520 | 59% | 305 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 1% | 19% | 85.0% | 85.0% | 85.0% | 3.3 |
| 248 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Education | ROB | 229 | 229 | 86% | 197 | 0.00 | 6 | $1 | 100% | 100% | 100% | 5 | 2% | 13% | 85.0% | 85.0% | 85.0% | 85.1 |
| 249 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Education | Retro | 180 | 180 | 68% | 121 | 0.00 | 15 | $27 | 100% | 37% | 37% | 6 | 11% | 13% | 85.0% | 74.2% | 74.2% | 9.8 |
| 250 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Education | ROB | 173 | 173 | 81% | 140 | 0.00 | 6 | $1 | 100% | 100% | 100% | 6 | 11% | 13% | 85.0% | 85.0% | 85.0% | 60.7 |
| 251 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Education | Retro | 97 | 97 | 100% | 97 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 77% | 0% | 85.0% | 82.7% | 82.7% | 61.6 |
| 252 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Education | Retro | 440 | 440 | 30% | 132 | 0.00 | 10 | $65 | 50% | 20% | 20% | 8 | 95% | 10% | 55.5% | 37.8% | 37.8% | 3.6 |
| 253 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Education | Retro | 564 | 564 | 30% | 169 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 69.5% | 69.5% | 6.2 |
| 254 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Education | Retro | 252 | 252 | 44% | 111 | 0.00 | 10 | $75 | 75% | 26% | 26% | 8 | 95% | 10% | 71.7% | 39.4% | 39.4% | 3.4 |

AES Indiana


**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **255** | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Education | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 50% | 18% | 18% | 8 | 95% | 10% | 55.0% | 37.1% | 37.1% | 4.1 |
| **256** | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Education | Retro | 3 | 3 | 49% | 1 | 0.00 | 15 | $0 | 100% | 63% | 63% | 8 | 95% | 10% | 85.0% | 75.7% | 75.7% | 3.7 |
| **257** | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Education | Retro | 337 | 337 | 65% | 219 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 87% | 10% | 85.0% | 53.3% | 53.3% | 8.1 |
| **258** | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Education | Retro | 66 | 66 | 43% | 28 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| **259** | InteriorLighting | Lighting - Custom | Biz-Custom Light | Education | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 79.3% | 79.3% | 9.9 |
| **260** | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Education | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 46% | 46% | 1 | 12% | 44% | 71.7% | 55.2% | 55.2% | 1.7 |
| **261** | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Education | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| **262** | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Education | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 3 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.6 |
| **263** | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Education | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| **264** | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Education | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 50% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 4.0 |
| **265** | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Education | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 3.0 |
| **266** | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Education | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| **267** | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Education | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 8 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.6 |
| **268** | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Education | Retro | 262 | 262 | 69% | 181 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 53.6% | 53.6% | 0.7 |
| **269** | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Education | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% |  | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| **270** | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Education | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% |  | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| **271** | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Education | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| **272** | Miscellaneous | Miscellaneous Custom | Biz-Custom | Education | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 0% | 10% | 85.0% | 65.5% | 65.5% | 3.3 |
| **273** | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Education | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,181 | 100% | 34% | 34% | 3 | 42% | 10% | 85.0% | 69.9% | 69.9% | 9.1 |
| **274** | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Education | Retro | 2,093 | 2,093 | 83% | 1,737 | 0.00 | 10 | $483 | 100% | 29% | 29% | 4 | 5% | 10% | 85.0% | 70.0% | 70.0% | 7.9 |
| **275** | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Education | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 0% | 2% | 31.4% | 17.2% | 17.2% | 3.6 |
| **276** | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Education | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 7.9 |
| **277** | Motors | Cogged V-Belt | Biz-Custom | Education | Retro | 17,237 | 17,237 | 3% | 534 | 0.00 | 15 | $384 | 75% | 11% | 11% | 1 | 50% | 10% | 66.9% | 40.6% | 40.6% | 8.3 |
| **278** | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Education | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 66.3% | 66.3% | 8.4 |
| **279** | Motors | Power Drive Systems | Biz-Custom | Education | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 66.3% | 66.3% | 7.8 |
| **280** | Motors | Switch Reluctance Motors | Biz-Custom | Education | Retro | 33,406 | 33,406 | 31% | 10,222 | 0.00 | 15 | $869 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.6 |
| **281** | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Education | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.0 |
| **282** | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Education | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% |  |  | 1 | 30% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| **283** | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Education | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.7 |
| **284** | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Education | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.0 |
| **285** | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Education | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 36.1 |
| **286** | Office_PC | Energy Star Server | Biz-Custom | Education | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.5% | 59.5% | 4.3 |
| **287** | Office_PC | Server Virtualization | Biz-Custom | Education | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.0 |
| **288** | Office_PC | High Efficiency CRAC unit | Biz-Custom | Education | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.1% | 51.1% | 7.2 |
| **289** | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Education | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.8 |
| **290** | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Education | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.3% | 77.3% | 6.9 |
| **291** | Office_PC | Energy Star Laptop | Biz-Custom | Education | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% |  |  | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| **292** | Office_PC | Energy Star Monitor | Biz-Custom | Education | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% |  |  | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| **293** | Refrigeration | Strip Curtains | Biz-Prescriptive | Education | Retro | 0 | 0 | 0% | 0 | 0.00 | 4 | $0 | 0% | 0% |  | 1 | 11% | 30% | 79.2% | 79.2% | 79.2% | 0.0 |
| **294** | Refrigeration | Bare Suction Line | Biz-Custom | Education | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.6% | 72.6% | 6.9 |
| **295** | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Education | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 5% | 5% | 5% | 3 | 7% | 25% | 47.5% | 39.9% | 39.9% | 4.8 |
| **296** | Refrigeration | Saturated Suction Controls | Biz-Custom | Education | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.6% | 28.1% | 28.1% | 12.8 |
| **297** | Refrigeration | Compressor Retrofit | Biz-Custom | Education | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 25% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| **298** | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Education | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 7% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| **299** | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Education | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 7% | 25% | 79.2% | 71.9% | 71.9% | 2.5 |
| **300** | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Education | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 9% | 25% | 47.5% | 40.0% | 40.0% | 4.8 |
| **301** | Refrigeration | Refrigeration Economizer | Biz-Custom | Education | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 35% | 10% | 79.2% | 69.3% | 69.3% | 3.3 |
| **302** | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Education | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 12% | 75% | 82.5% | 80.0% | 80.0% | 1.2 |
| **303** | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Education | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 9% | 50% | 79.2% | 75.9% | 75.9% | 3.2 |
| **304** | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Education | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 3% | 25% | 47.5% | 40.0% | 40.0% | 6.6 |
| **305** | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Education | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 2% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| **306** | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Education | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 2% | 2% | 79.2% | 72.7% | 72.7% | 5.2 |
| **307** | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Education | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 12% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| **308** | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Education | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 12% | 54% | 67.8% | 63.2% | 63.2% | 1.8 |
| **309** | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Education | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 4% | 75% | 82.5% | 80.0% | 80.0% | 4.7 |
| **310** | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Education | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 4% | 50% | 79.2% | 77.8% | 77.8% | 7.7 |
| **311** | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Education | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 4% | 25% | 79.2% | 50.9% | 50.9% | 6.6 |
| **312** | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Education | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 4% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| **313** | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Education | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 4% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| **314** | Refrigeration | Refrigeration - Custom | Biz-Custom | Education | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.3% | 69.3% | 3.3 |
| **315** | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Education | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 316 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Education | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 4% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 317 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Education | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 3% | 30% | 51.0% | 45.6% | 45.6% | 2.2 |
| 318 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Education | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 7% | 66% | 79.2% | 77.7% | 77.7% | 24.0 |
| 319 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Education | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 7% | 13% | 79.2% | 75.2% | 75.2% | 18.9 |
| 320 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Education | Retro | 2,223 | 2,223 | 20% | 445 | 0.00 | 15 | $227 | 100% | 16% | 16% | 1 | 100% | 24% | 83.4% | 47.1% | 47.1% | 8.1 |
| 321 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Education | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 24% | 83.4% | 66.4% | 66.4% | 8.4 |
| 322 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Education | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 73.0% | 73.0% | 7.5 |
| 323 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Education | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% | | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 324 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Education | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 73.0% | 73.0% | 7.5 |
| 325 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Education | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 73.0% | 73.0% | 6.4 |
| 326 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Education | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 73.0% | 73.0% | 6.4 |
| 327 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Education | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 59.3% | 36.0% | 36.0% | 21.1 |
| 328 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Education | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 72.1% | 72.1% | 5.7 |
| 329 | Behavioral | COM Competitions | Biz-Custom | Education | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 48% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 330 | Behavioral | Business Energy Reports | Biz-Custom | Education | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 100% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 331 | Behavioral | Building Benchmarking | Biz-Custom | Education | Retro | 83 | 83 | 1% | 1 | 0.00 | 2 | $0 | 77% | 77% | 77% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.4 |
| 332 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Education | Retro | 33 | 33 | 3% | 1 | 0.00 | 5 | $0 | 50% | 7% | 7% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 8.4 |
| 333 | Behavioral | BEIMS | Biz-Custom | Education | Retro | 43 | 43 | 2% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.4 |
| 334 | Behavioral | Building Operator Certification | Biz-Custom | Education | Retro | 41 | 41 | 3% | 1 | 0.00 | 3 | $0 | 97% | 97% | 97% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.9 |
| 335 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Food Sales | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 336 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Food Sales | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 337 | CompressedAir | AODD Pump Controls | Biz-Custom | Food Sales | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 338 | CompressedAir | Compressed Air - Custom | Biz-Custom | Food Sales | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 339 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Food Sales | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 340 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Food Sales | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.5 |
| 341 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Food Sales | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 342 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Food Sales | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 343 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Food Sales | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 9.0 |
| 344 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Food Sales | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.4 |
| 345 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Food Sales | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 8.1 |
| 346 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Food Sales | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 17.0 |
| 347 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Food Sales | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.2 |
| 348 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Food Sales | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 58.5% | 42.3% | 42.3% | 5.2 |
| 349 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 1,132 | 1,132 | 6% | 70 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 17% | 20% | 83.4% | 69.0% | 69.0% | 2.2 |
| 350 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 1,132 | 1,132 | 13% | 146 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 17% | 20% | 83.4% | 47.6% | 47.6% | 4.5 |
| 351 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 1,132 | 1,132 | 28% | 320 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 17% | 20% | 83.4% | 66.1% | 66.1% | 9.9 |
| 352 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 1,132 | 1,132 | 42% | 474 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 17% | 20% | 83.4% | 70.3% | 70.3% | 14.7 |
| 353 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 1,212 | 1,212 | 6% | 70 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 17% | 20% | 83.4% | 83.4% | 83.4% | 2.2 |
| 354 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 1,212 | 1,212 | 12% | 149 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 17% | 20% | 83.4% | 83.4% | 83.4% | 4.6 |
| 355 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 1,212 | 1,212 | 20% | 246 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 17% | 20% | 83.4% | 83.4% | 83.4% | 7.6 |
| 356 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 1,212 | 1,212 | 46% | 554 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 17% | 20% | 83.4% | 83.4% | 83.4% | 17.2 |
| 357 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Food Sales | Retro | 1,151 | 1,151 | 7% | 81 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 34% | 50% | 83.4% | 80.2% | 80.2% | 12.1 |
| 358 | Cooling | Air Side Economizer | Biz-Custom | Food Sales | Retro | 1,132 | 1,132 | 20% | 226 | 0.00 | 10 | $84 | 75% | 22% | 22% | 4 | 34% | 20% | 70.4% | 48.9% | 48.9% | 3.5 |
| 359 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Food Sales | Retro | 1,151 | 1,151 | 6% | 68 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 34% | 20% | 44.0% | 36.0% | 36.0% | 0.8 |
| 360 | Cooling | HVAC Occupancy Controls | Biz-Custom | Food Sales | ROB | 2,900 | 2,900 | 20% | 580 | 0.00 | 15 | $537 | 75% | 9% | 9% | 6 | 34% | 20% | 62.6% | 36.0% | 36.0% | 11.0 |
| 361 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 987 | 987 | 13% | 123 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 31% | 20% | 83.4% | 83.4% | 83.4% | 3.8 |
| 362 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 987 | 987 | 18% | 174 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 31% | 20% | 83.4% | 38.0% | 38.0% | 5.4 |
| 363 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 987 | 987 | 22% | 219 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 31% | 20% | 83.4% | 42.8% | 42.8% | 6.8 |
| 364 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 987 | 987 | 33% | 329 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 31% | 20% | 83.4% | 45.3% | 45.3% | 10.2 |
| 365 | Cooling | Smart Thermostat | Biz-Prescriptive | Food Sales | ROB | 987 | 987 | 14% | 140 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 31% | 12% | 40.2% | 32.4% | 32.4% | 2.3 |
| 366 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Food Sales | ROB | 1,161 | 1,161 | 8% | 98 | 0.00 | 8 | $84 | 100% | 42% | 42% | 9 | 34% | 20% | 83.4% | 47.7% | 47.7% | 2.5 |
| 367 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Food Sales | ROB | 1,273 | 1,273 | 7% | 92 | 0.00 | 8 | $84 | 75% | 42% | 42% | 10 | 34% | 20% | 66.2% | 46.9% | 46.9% | 2.3 |
| 368 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Food Sales | ROB | 1,454 | 1,454 | 10% | 138 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 34% | 20% | 83.4% | 58.2% | 58.2% | 3.5 |
| 369 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Food Sales | ROB | 1,008 | 1,008 | 6% | 57 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 0% | 15% | 83.4% | 32.9% | 32.9% | 2.9 |
| 370 | Cooling | Chiller Tune-up | Biz-Custom | Food Sales | Retro | 1,151 | 1,151 | 7% | 81 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 0% | 50% | 83.4% | 80.2% | 80.2% | 12.1 |
| 371 | Cooling | HVAC/Chiller Custom | Biz-Custom | Food Sales | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.1 |
| 372 | Cooling | Window Film | Biz-Custom | Food Sales | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 46.7% | 46.7% | 11.7 |
| 373 | Cooling | Triple Pane Windows | Biz-Custom | Food Sales | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 47.2% | 36.0% | 36.0% | 21.7 |
| 374 | Cooling | Energy Recovery Ventilator | Biz-Custom | Food Sales | Retro | 1,212 | 1,212 | 8% | 96 | 0.00 | 15 | $1,500 | 1% | 1% | 1% | 16 | 100% | 2% | 31.4% | 22.6% | 22.6% | 14.0 |
| 375 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 4% | 99 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 36% | 20% | 83.4% | 57.3% | 57.3% | 1.9 |
| 376 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 8% | 227 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 36% | 20% | 44.0% | 36.0% | 36.0% | 3.8 |
| 377 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 12% | 326 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 36% | 20% | 44.0% | 36.0% | 36.0% | 5.4 |
| 378 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 17% | 486 | 0.00 | 16 | $507 | 75% | 10% | 10% | 1 | 36% | 20% | 63.7% | 36.0% | 36.0% | 8.4 |
| 379 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 22% | 612 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 36% | 20% | 44.0% | 36.0% | 36.0% | 1.7 |
| 380 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 26% | 733 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 36% | 20% | 44.0% | 36.0% | 36.0% | 2.0 |
| 381 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 31% | 875 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 36% | 20% | 44.0% | 36.0% | 36.0% | 2.3 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 382 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 46% | 1,289 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 36% | 20% | 44.0% | 36.0% | 36.0% | 3.0 |
| 383 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Food Sales | ROB | 3,331 | 3,331 | 10% | 346 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 20% | 20% | 83.4% | 77.8% | 77.8% | 20.5 |
| 384 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Food Sales | ROB | 3,331 | 3,331 | 16% | 517 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 20% | 20% | 83.4% | 75.2% | 75.2% | 23.2 |
| 385 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Food Sales | ROB | 3,460 | 3,460 | 13% | 452 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 20% | 20% | 83.4% | 77.0% | 77.0% | 33.3 |
| 386 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Food Sales | ROB | 3,460 | 3,460 | 18% | 624 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 20% | 20% | 83.4% | 74.6% | 74.6% | 36.9 |
| 387 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 3,043 | 3,043 | 29% | 875 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 20% | 20% | 44.0% | 36.0% | 36.0% | 3.4 |
| 388 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 3,043 | 3,043 | 33% | 996 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 20% | 20% | 44.0% | 36.0% | 36.0% | 3.7 |
| 389 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 3,189 | 3,189 | 40% | 1,283 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 20% | 20% | 44.0% | 36.0% | 36.0% | 4.2 |
| 390 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Food Sales | ROB | 3,189 | 3,189 | 53% | 1,697 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 20% | 20% | 44.0% | 36.0% | 36.0% | 4.9 |
| 391 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Food Sales | ROB | 2,558 | 2,558 | 10% | 263 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 20% | 2% | 83.4% | 45.8% | 45.8% | 9.4 |
| 392 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Food Sales | ROB | 3,576 | 3,576 | 9% | 309 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 20% | 20% | 83.4% | 75.1% | 75.1% | 26.0 |
| 393 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Food Sales | ROB | 3,576 | 3,576 | 14% | 515 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 20% | 20% | 83.4% | 71.0% | 71.0% | 30.9 |
| 394 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 3,460 | 3,460 | 37% | 1,291 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 20% | 20% | 56.6% | 36.0% | 36.0% | 6.5 |
| 395 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 3,460 | 3,460 | 41% | 1,412 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 20% | 20% | 58.0% | 36.0% | 36.0% | 6.8 |
| 396 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 3,460 | 3,460 | 45% | 1,554 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 20% | 20% | 59.5% | 36.0% | 36.0% | 7.1 |
| 397 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Food Sales | ROB | 3,460 | 3,460 | 57% | 1,968 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 20% | 20% | 83.4% | 36.0% | 36.0% | 7.8 |
| 398 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Food Sales | ROB | 2,781 | 2,781 | 17% | 486 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 14% | 20% | 83.4% | 54.4% | 54.4% | 12.0 |
| 399 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Food Sales | ROB | 3,085 | 3,085 | 3% | 95 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 3% | 10% | 69.6% | 58.5% | 58.5% | 1.9 |
| 400 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Food Sales | ROB | 3,646 | 3,646 | 12% | 451 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 3% | 10% | 83.4% | 76.3% | 76.3% | 9.3 |
| 401 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Food Sales | ROB | 3,357 | 3,357 | 7% | 234 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 3% | 10% | 83.4% | 71.2% | 71.2% | 4.8 |
| 402 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Food Sales | ROB | 4,687 | 4,687 | 67% | 3,139 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 0% | 75.5% | 64.2% | 64.2% | 3.3 |
| 403 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Food Sales | Retro | 4,687 | 4,687 | 2% | 94 | 0.00 | 20 | $60 | 100% | 12% | 12% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.1 |
| 404 | HotWater | Faucet Aerator | Biz-Prescriptive | Food Sales | Retro | 284 | 284 | 32% | 92 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 5.0 |
| 405 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Food Sales | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 20.5 |
| 406 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Food Sales | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.4% | 45.6% | 45.6% | 3.4 |
| 407 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Food Sales | Retro | 197 | 197 | 45% | 88 | 0.00 | 9 | $3 | 100% | 100% | 100% | 1 | 80% | 38% | 85.0% | 85.0% | 85.0% | 13.1 |
| 408 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Food Sales | Retro | 445 | 445 | 50% | 223 | 0.00 | 9 | $70 | 100% | 43% | 43% | 1 | 80% | 38% | 85.0% | 68.8% | 68.8% | 3.3 |
| 409 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Food Sales | Retro | 445 | 445 | 50% | 223 | 0.00 | 9 | $70 | 100% | 79% | 79% | 1 | 80% | 38% | 85.0% | 79.3% | 79.3% | 1.8 |
| 410 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Food Sales | Retro | 445 | 445 | 74% | 331 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 9% | 38% | 56.4% | 50.2% | 50.2% | 1.4 |
| 411 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Food Sales | Retro | 4,147 | 4,147 | 68% | 2,821 | 0.00 | 9 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 79.6% | 79.6% | 8.4 |
| 412 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Food Sales | Retro | 4,147 | 4,147 | 66% | 2,751 | 0.00 | 9 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 79.4% | 79.4% | 8.2 |
| 413 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Food Sales | Retro | 883 | 883 | 61% | 537 | 0.00 | 9 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.2 |
| 414 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Food Sales | Retro | 883 | 883 | 59% | 519 | 0.00 | 9 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.1 |
| 415 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Food Sales | ROB | 308 | 308 | 86% | 264 | 0.00 | 4 | $1 | 100% | 100% | 100% | 5 | 1% | 13% | 85.0% | 85.0% | 85.0% | 70.7 |
| 416 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Food Sales | Retro | 306 | 306 | 68% | 206 | 0.00 | 9 | $27 | 100% | 37% | 37% | 6 | 10% | 13% | 85.0% | 78.0% | 78.0% | 9.2 |
| 417 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Food Sales | ROB | 233 | 233 | 81% | 188 | 0.00 | 4 | $1 | 100% | 100% | 100% | 6 | 10% | 13% | 85.0% | 85.0% | 85.0% | 50.4 |
| 418 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Food Sales | Retro | 164 | 164 | 100% | 164 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 80% | 0% | 85.0% | 83.5% | 83.5% | 84.9 |
| 419 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Food Sales | Retro | 749 | 749 | 30% | 225 | 0.00 | 10 | $65 | 100% | 20% | 20% | 8 | 95% | 10% | 85.0% | 55.5% | 55.5% | 5.6 |
| 420 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Food Sales | Retro | 959 | 959 | 30% | 288 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 73.5% | 73.5% | 7.4 |
| 421 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Food Sales | Retro | 428 | 428 | 44% | 188 | 0.00 | 10 | $75 | 100% | 26% | 26% | 8 | 95% | 10% | 85.0% | 55.7% | 55.7% | 4.6 |
| 422 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Food Sales | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 50% | 18% | 18% | 8 | 95% | 10% | 55.0% | 37.1% | 37.1% | 4.2 |
| 423 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Food Sales | Retro | 4 | 4 | 49% | 2 | 0.00 | 15 | $1 | 100% | 42% | 42% | 8 | 95% | 10% | 85.0% | 66.9% | 66.9% | 4.4 |
| 424 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Food Sales | Retro | 428 | 428 | 65% | 278 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 89% | 10% | 85.0% | 60.8% | 60.8% | 9.6 |
| 425 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Food Sales | Retro | 64 | 64 | 43% | 28 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 426 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Food Sales | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 79.0% | 79.0% | 9.2 |
| 427 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Food Sales | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 46% | 46% | 1 | 12% | 44% | 71.7% | 55.2% | 55.2% | 1.7 |
| 428 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Food Sales | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| 429 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Food Sales | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 3 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.6 |
| 430 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Food Sales | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| 431 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Food Sales | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 50% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.9 |
| 432 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Food Sales | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.9 |
| 433 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Food Sales | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| 434 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Food Sales | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 8 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.6 |
| 435 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Food Sales | Retro | 445 | 445 | 69% | 307 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 55.2% | 55.2% | 1.1 |
| 436 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 437 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 438 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Food Sales | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 439 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Food Sales | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 37% | 10% | 85.0% | 64.7% | 64.7% | 3.3 |
| 440 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Food Sales | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,182 | 100% | 34% | 34% | 3 | 13% | 10% | 85.0% | 69.8% | 69.8% | 8.8 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 441 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Food Sales | Retro | 3,819 | 3,819 | 83% | 3,170 | 0.00 | 10 | $483 | 100% | 53% | 53% | 4 | 5% | 10% | 85.0% | 78.9% | 78.9% | 6.1 |
| 442 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Food Sales | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 0% | 2% | 31.4% | 17.2% | 17.2% | 3.7 |
| 443 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Food Sales | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 8.0 |
| 444 | Motors | Cogged V-Belt | Biz-Custom | Food Sales | Retro | 19,471 | 19,471 | 3% | 604 | 0.00 | 15 | $384 | 100% | 13% | 13% | 1 | 50% | 10% | 83.4% | 42.6% | 42.6% | 8.0 |
| 445 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Food Sales | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 66.1% | 66.1% | 8.5 |
| 446 | Motors | Power Drive Systems | Biz-Custom | Food Sales | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 65.9% | 65.9% | 7.5 |
| 447 | Motors | Switch Reluctance Motors | Biz-Custom | Food Sales | Retro | 37,735 | 37,735 | 31% | 11,547 | 0.00 | 15 | $981 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.6 |
| 448 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Food Sales | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.1 |
| 449 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Food Sales | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% | | | 1 | 30% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 450 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Food Sales | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.8 |
| 451 | Office_NonPC | Plug Load  Occupancy Sensor | Biz-Custom | Food Sales | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.1 |
| 452 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Food Sales | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 36.4 |
| 453 | Office_PC | Energy Star Server | Biz-Custom | Food Sales | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.8% | 59.8% | 4.4 |
| 454 | Office_PC | Server Virtualization | Biz-Custom | Food Sales | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.1 |
| 455 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Food Sales | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.4% | 51.4% | 7.2 |
| 456 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Food Sales | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.8 |
| 457 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Food Sales | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.4% | 77.4% | 6.9 |
| 458 | Office_PC | Energy Star Laptop | Biz-Custom | Food Sales | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% | | | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 459 | Office_PC | Energy Star Monitor | Biz-Custom | Food Sales | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% | | | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 460 | Refrigeration | Strip Curtains | Biz-Prescriptive | Food Sales | Retro | 412 | 412 | 50% | 206 | 0.00 | 4 | $10 | 100% | 59% | 59% | 1 | 16% | 30% | 79.2% | 77.8% | 77.8% | 6.6 |
| 461 | Refrigeration | Bare Suction Line | Biz-Custom | Food Sales | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 1% | 50% | 79.2% | 72.7% | 72.7% | 6.9 |
| 462 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Food Sales | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 5% | 5% | 5% | 3 | 11% | 25% | 47.5% | 39.9% | 39.9% | 4.8 |
| 463 | Refrigeration | Saturated Suction Controls | Biz-Custom | Food Sales | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 68.0% | 28.8% | 28.8% | 12.8 |
| 464 | Refrigeration | Compressor Retrofit | Biz-Custom | Food Sales | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 37% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| 465 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Food Sales | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 10% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 466 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Food Sales | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 10% | 25% | 79.2% | 72.1% | 72.1% | 2.5 |
| 467 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Food Sales | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 14% | 25% | 47.5% | 40.0% | 40.0% | 4.8 |
| 468 | Refrigeration | Refrigeration Economizer | Biz-Custom | Food Sales | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 52% | 10% | 79.2% | 69.9% | 69.9% | 3.3 |
| 469 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Food Sales | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 8% | 75% | 82.5% | 80.0% | 80.0% | 1.2 |
| 470 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Food Sales | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 6% | 50% | 79.2% | 76.0% | 76.0% | 3.2 |
| 471 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Food Sales | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 2% | 25% | 47.5% | 40.0% | 40.0% | 6.6 |
| 472 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Food Sales | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 1% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 473 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Food Sales | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 1% | 2% | 79.2% | 72.8% | 72.8% | 5.2 |
| 474 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Food Sales | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 8% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 475 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Food Sales | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 8% | 54% | 67.8% | 63.2% | 63.2% | 1.8 |
| 476 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Food Sales | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 3% | 75% | 82.5% | 80.0% | 80.0% | 4.7 |
| 477 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Food Sales | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 3% | 50% | 79.2% | 77.9% | 77.9% | 7.7 |
| 478 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Food Sales | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 3% | 25% | 79.2% | 51.7% | 51.7% | 6.6 |
| 479 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Food Sales | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 3% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 480 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Food Sales | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 3% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 481 | Refrigeration | Refrigeration - Custom | Biz-Custom | Food Sales | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.9% | 69.9% | 3.3 |
| 482 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Food Sales | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 483 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Food Sales | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 0% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 484 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Food Sales | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 0% | 30% | 51.0% | 45.6% | 45.6% | 2.2 |
| 485 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Food Sales | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 5% | 66% | 79.2% | 77.8% | 77.8% | 24.0 |
| 486 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Food Sales | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 5% | 13% | 79.2% | 75.4% | 75.4% | 18.9 |
| 487 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Food Sales | Retro | 2,658 | 2,658 | 20% | 532 | 0.00 | 15 | $227 | 100% | 19% | 19% | 1 | 100% | 22% | 83.4% | 59.6% | 59.6% | 11.4 |
| 488 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Food Sales | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 22% | 83.4% | 66.4% | 66.4% | 8.5 |
| 489 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Food Sales | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 72.9% | 72.9% | 7.6 |
| 490 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% | | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 491 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Food Sales | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 72.9% | 72.9% | 7.6 |
| 492 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Food Sales | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 72.9% | 72.9% | 6.5 |
| 493 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Food Sales | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 72.9% | 72.9% | 6.5 |
| 494 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Food Sales | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 58.9% | 36.0% | 36.0% | 21.2 |
| 495 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Food Sales | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 72.0% | 72.0% | 5.7 |
| 496 | Behavioral | COM Competitions | Biz-Custom | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 48% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 497 | Behavioral | Business Energy Reports | Biz-Custom | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 100% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 498 | Behavioral | Building Benchmarking | Biz-Custom | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 77% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 499 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Food Sales | Retro | 0 | 0 | 0% | 0 | 0.00 | 5 | $0 | 0% | | 7% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 500 | Behavioral | BEIMS | Biz-Custom | Food Sales | Retro | 20 | 20 | 5% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.4 |
| 501 | Behavioral | Building Operator Certification | Biz-Custom | Food Sales | Retro | 10 | 10 | 2% | 0 | 0.00 | 3 | $0 | 23% | 23% | 23% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.9 |
| 502 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Food Service | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 503 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Food Service | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 504 | CompressedAir | AODD Pump Controls | Biz-Custom | Food Service | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 505 | CompressedAir | Compressed Air - Custom | Biz-Custom | Food Service | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 506 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Food Service | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 507 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Food Service | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.5 |
| 508 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Food Service | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 509 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Food Service | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 510 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Food Service | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 9.0 |
| 511 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Food Service | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.4 |
| 512 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Food Service | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 8.1 |
| 513 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Food Service | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 17.0 |
| 514 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Food Service | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.3 |
| 515 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Food Service | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 58.5% | 42.3% | 42.3% | 5.3 |
| 516 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 1,252 | 1,252 | 6% | 77 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 18% | 20% | 83.4% | 69.9% | 69.9% | 2.3 |
| 517 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 1,252 | 1,252 | 13% | 161 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 18% | 20% | 83.4% | 50.6% | 50.6% | 4.7 |
| 518 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 1,252 | 1,252 | 28% | 354 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 18% | 20% | 83.4% | 67.3% | 67.3% | 10.3 |
| 519 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 1,252 | 1,252 | 42% | 525 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 18% | 20% | 83.4% | 71.1% | 71.1% | 15.4 |
| 520 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 1,340 | 1,340 | 6% | 78 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 18% | 20% | 83.4% | 83.4% | 83.4% | 2.3 |
| 521 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 1,340 | 1,340 | 12% | 165 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 18% | 20% | 83.4% | 83.4% | 83.4% | 4.8 |
| 522 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 1,340 | 1,340 | 20% | 272 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 18% | 20% | 83.4% | 83.4% | 83.4% | 8.0 |
| 523 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 1,340 | 1,340 | 46% | 613 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 18% | 20% | 83.4% | 83.4% | 83.4% | 17.9 |
| 524 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Food Service | Retro | 1,273 | 1,273 | 7% | 89 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 36% | 50% | 83.4% | 80.5% | 80.5% | 12.8 |
| 525 | Cooling | Air Side Economizer | Biz-Custom | Food Service | Retro | 1,252 | 1,252 | 20% | 250 | 0.00 | 10 | $84 | 75% | 24% | 24% | 4 | 36% | 20% | 71.2% | 53.1% | 53.1% | 3.8 |
| 526 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Food Service | Retro | 1,273 | 1,273 | 2% | 26 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 36% | 20% | 44.0% | 36.0% | 36.0% | 0.3 |
| 527 | Cooling | HVAC Occupancy Controls | Biz-Custom | Food Service | ROB | 2,900 | 2,900 | 20% | 580 | 0.00 | 15 | $537 | 75% | 9% | 9% | 6 | 36% | 20% | 63.0% | 36.0% | 36.0% | 11.3 |
| 528 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 1,091 | 1,091 | 13% | 136 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 28% | 20% | 83.4% | 83.4% | 83.4% | 4.0 |
| 529 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 1,091 | 1,091 | 18% | 193 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 28% | 20% | 83.4% | 40.2% | 40.2% | 5.6 |
| 530 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Food Service | ROB | 1,091 | 1,091 | 22% | 242 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 28% | 20% | 83.4% | 44.5% | 44.5% | 7.1 |
| 531 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Food Service | ROB | 1,091 | 1,091 | 33% | 364 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 28% | 20% | 83.4% | 46.8% | 46.8% | 10.6 |
| 532 | Cooling | Smart Thermostat | Biz-Prescriptive | Food Service | ROB | 1,091 | 1,091 | 14% | 155 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 28% | 12% | 42.2% | 33.7% | 33.7% | 2.4 |
| 533 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Food Service | ROB | 1,284 | 1,284 | 8% | 109 | 0.00 | 8 | $84 | 100% | 42% | 42% | 9 | 0% | 20% | 83.4% | 51.0% | 51.0% | 2.6 |
| 534 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Food Service | ROB | 1,408 | 1,408 | 7% | 102 | 0.00 | 8 | $84 | 100% | 42% | 42% | 10 | 0% | 20% | 83.4% | 49.0% | 49.0% | 2.4 |
| 535 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Food Service | ROB | 1,608 | 1,608 | 10% | 153 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 0% | 20% | 83.4% | 60.6% | 60.6% | 3.7 |
| 536 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Food Service | ROB | 1,115 | 1,115 | 6% | 63 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 36% | 15% | 83.4% | 34.1% | 34.1% | 3.0 |
| 537 | Cooling | Chiller Tune-up | Biz-Custom | Food Service | Retro | 1,273 | 1,273 | 7% | 89 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 36% | 50% | 83.4% | 80.5% | 80.5% | 12.8 |
| 538 | Cooling | HVAC/Chiller Custom | Biz-Custom | Food Service | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.4 |
| 539 | Cooling | Window Film | Biz-Custom | Food Service | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 47.2% | 47.2% | 11.9 |
| 540 | Cooling | Triple Pane Windows | Biz-Custom | Food Service | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 47.7% | 36.0% | 36.0% | 22.0 |
| 541 | Cooling | Energy Recovery Ventilator | Biz-Custom | Food Service | Retro | 1,340 | 1,340 | 0% | 0 | 0.00 | 15 | $1,500 | 0% | | 0% | 16 | 100% | 2% | 83.4% | 83.4% | 83.4% | 0.0 |
| 542 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 4% | 99 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 34% | 20% | 83.4% | 59.3% | 59.3% | 1.9 |
| 543 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 8% | 222 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 34% | 20% | 44.0% | 36.0% | 36.0% | 3.8 |
| 544 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 12% | 319 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 34% | 20% | 44.0% | 36.0% | 36.0% | 5.4 |
| 545 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 18% | 484 | 0.00 | 16 | $507 | 75% | 10% | 10% | 1 | 34% | 20% | 64.7% | 36.3% | 36.3% | 8.4 |
| 546 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 22% | 587 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 34% | 20% | 44.0% | 36.0% | 36.0% | 1.7 |
| 547 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 27% | 701 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 34% | 20% | 44.0% | 36.0% | 36.0% | 1.9 |
| 548 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 32% | 835 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 34% | 20% | 44.0% | 36.0% | 36.0% | 2.2 |
| 549 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 47% | 1,223 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 34% | 20% | 44.0% | 36.0% | 36.0% | 2.9 |
| 550 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Food Service | ROB | 3,157 | 3,157 | 11% | 339 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 22% | 20% | 83.4% | 78.5% | 78.5% | 20.5 |
| 551 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Food Service | ROB | 3,157 | 3,157 | 16% | 503 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 22% | 20% | 83.4% | 76.1% | 76.1% | 23.1 |
| 552 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Food Service | ROB | 3,283 | 3,283 | 14% | 453 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 22% | 20% | 83.4% | 77.8% | 77.8% | 33.3 |
| 553 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Food Service | ROB | 3,283 | 3,283 | 19% | 617 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 22% | 20% | 83.4% | 75.6% | 75.6% | 36.9 |
| 554 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 2,881 | 2,881 | 29% | 842 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 22% | 20% | 44.0% | 36.0% | 36.0% | 3.4 |
| 555 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 2,881 | 2,881 | 33% | 956 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 22% | 20% | 44.0% | 36.0% | 36.0% | 3.6 |
| 556 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 3,042 | 3,042 | 41% | 1,250 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 22% | 20% | 44.0% | 36.0% | 36.0% | 4.2 |
| 557 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Food Service | ROB | 3,042 | 3,042 | 54% | 1,638 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 22% | 20% | 44.0% | 36.0% | 36.0% | 4.9 |
| 558 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Food Service | ROB | 2,433 | 2,433 | 12% | 291 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 22% | 2% | 83.4% | 47.9% | 47.9% | 9.8 |
| 559 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Food Service | ROB | 3,412 | 3,412 | 9% | 310 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 22% | 20% | 83.4% | 76.2% | 76.2% | 26.0 |
| 560 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Food Service | ROB | 3,412 | 3,412 | 15% | 510 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 22% | 20% | 83.4% | 71.9% | 71.9% | 30.9 |
| 561 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 3,283 | 3,283 | 38% | 1,244 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 22% | 20% | 58.8% | 36.0% | 36.0% | 6.5 |
| 562 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 3,283 | 3,283 | 41% | 1,358 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 22% | 20% | 60.0% | 36.0% | 36.0% | 6.7 |
| 563 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 3,283 | 3,283 | 45% | 1,492 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 22% | 20% | 61.2% | 36.0% | 36.0% | 7.0 |
| 564 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Food Service | ROB | 3,283 | 3,283 | 57% | 1,880 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 22% | 20% | 83.4% | 36.0% | 36.0% | 7.7 |
| 565 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Food Service | ROB | 2,626 | 2,626 | 18% | 484 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 22% | 20% | 83.4% | 56.3% | 56.3% | 12.0 |
| 566 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Food Service | ROB | 2,901 | 2,901 | 4% | 105 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 0% | 10% | 70.9% | 61.9% | 61.9% | 2.0 |
| 567 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Food Service | ROB | 3,472 | 3,472 | 14% | 499 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 0% | 10% | 83.4% | 77.2% | 77.2% | 9.7 |
| 568 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Food Service | ROB | 3,169 | 3,169 | 8% | 259 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 0% | 10% | 83.4% | 72.2% | 72.2% | 4.9 |
| 569 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Food Service | ROB | 5,521 | 5,521 | 67% | 3,698 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 31% | 75.5% | 66.0% | 66.0% | 4.1 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 570 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Food Service | Retro | 5,521 | 5,521 | 2% | 110 | 0.00 | 20 | $60 | 100% | 15% | 15% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.4 |
| 571 | HotWater | Faucet Aerator | Biz-Prescriptive | Food Service | Retro | 973 | 973 | 32% | 315 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 17.1 |
| 572 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Food Service | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| 573 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Food Service | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.3% | 45.6% | 45.6% | 3.7 |
| 574 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Food Service | Retro | 206 | 206 | 45% | 92 | 0.00 | 9 | $3 | 100% | 100% | 100% | 1 | 52% | 38% | 85.0% | 85.0% | 85.0% | 14.2 |
| 575 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Food Service | Retro | 467 | 467 | 50% | 234 | 0.00 | 9 | $70 | 100% | 43% | 43% | 1 | 52% | 38% | 85.0% | 69.8% | 69.8% | 3.6 |
| 576 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Food Service | Retro | 467 | 467 | 50% | 234 | 0.00 | 9 | $70 | 100% | 79% | 79% | 1 | 52% | 38% | 85.0% | 79.6% | 79.6% | 2.0 |
| 577 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Food Service | Retro | 467 | 467 | 74% | 347 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 6% | 38% | 56.4% | 50.2% | 50.2% | 1.4 |
| 578 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Food Service | Retro | 4,346 | 4,346 | 68% | 2,957 | 0.00 | 9 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 79.9% | 79.9% | 9.1 |
| 579 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Food Service | Retro | 4,346 | 4,346 | 66% | 2,883 | 0.00 | 9 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 79.8% | 79.8% | 8.9 |
| 580 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Food Service | Retro | 926 | 926 | 61% | 563 | 0.00 | 9 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.5 |
| 581 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Food Service | Retro | 926 | 926 | 59% | 543 | 0.00 | 9 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.3 |
| 582 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Food Service | ROB | 415 | 415 | 86% | 356 | 0.00 | 4 | $1 | 100% | 100% | 100% | 5 | 4% | 13% | 85.0% | 85.0% | 85.0% | 87.6 |
| 583 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Food Service | Retro | 320 | 320 | 68% | 216 | 0.00 | 9 | $27 | 100% | 37% | 37% | 6 | 38% | 13% | 85.0% | 78.4% | 78.4% | 10.0 |
| 584 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Food Service | ROB | 314 | 314 | 81% | 254 | 0.00 | 4 | $1 | 100% | 100% | 100% | 6 | 38% | 13% | 85.0% | 85.0% | 85.0% | 62.4 |
| 585 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Food Service | Retro | 172 | 172 | 100% | 172 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 52% | 0% | 85.0% | 83.6% | 83.6% | 91.5 |
| 586 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Food Service | Retro | 785 | 785 | 30% | 235 | 0.00 | 10 | $65 | 100% | 20% | 20% | 8 | 95% | 10% | 85.0% | 57.0% | 57.0% | 5.9 |
| 587 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Food Service | Retro | 1,005 | 1,005 | 30% | 301 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 73.6% | 73.6% | 7.3 |
| 588 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Food Service | Retro | 448 | 448 | 44% | 197 | 0.00 | 10 | $75 | 100% | 26% | 26% | 8 | 95% | 10% | 85.0% | 58.0% | 58.0% | 5.0 |
| 589 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Food Service | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 75% | 18% | 18% | 8 | 95% | 10% | 71.5% | 37.1% | 37.1% | 4.2 |
| 590 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Food Service | Retro | 4 | 4 | 49% | 2 | 0.00 | 15 | $1 | 100% | 42% | 42% | 8 | 95% | 10% | 85.0% | 68.0% | 68.0% | 4.8 |
| 591 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Food Service | Retro | 448 | 448 | 65% | 291 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 58% | 10% | 85.0% | 62.7% | 62.7% | 10.4 |
| 592 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Food Service | Retro | 66 | 66 | 43% | 28 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 593 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Food Service | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 79.1% | 79.1% | 9.5 |
| 594 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Food Service | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 46% | 46% | 1 | 12% | 44% | 60.8% | 55.2% | 55.2% | 1.6 |
| 595 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Food Service | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 596 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Food Service | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 3 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.4 |
| 597 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Food Service | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 598 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Food Service | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 25% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.7 |
| 599 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Food Service | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.7 |
| 600 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Food Service | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 601 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Food Service | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 8 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.4 |
| 602 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Food Service | Retro | 467 | 467 | 69% | 322 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 55.2% | 55.2% | 1.1 |
| 603 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Food Service | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% |  | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 604 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Food Service | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% |  | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 605 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Food Service | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 606 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Food Service | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 30% | 10% | 85.0% | 64.5% | 64.5% | 3.3 |
| 607 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Food Service | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,183 | 100% | 34% | 34% | 3 | 18% | 10% | 85.0% | 69.8% | 69.8% | 8.8 |
| 608 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Food Service | Retro | 1,909 | 1,909 | 83% | 1,585 | 0.00 | 10 | $483 | 100% | 26% | 26% | 4 | 5% | 10% | 85.0% | 64.5% | 64.5% | 6.1 |
| 609 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Food Service | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 0% | 2% | 31.4% | 17.2% | 17.2% | 3.6 |
| 610 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Food Service | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 8.0 |
| 611 | Motors | Cogged V-Belt | Biz-Custom | Food Service | Retro | 17,237 | 17,237 | 3% | 534 | 0.00 | 15 | $384 | 75% | 11% | 11% | 1 | 50% | 10% | 66.9% | 40.6% | 40.6% | 8.5 |
| 612 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Food Service | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 66.7% | 66.7% | 8.5 |
| 613 | Motors | Power Drive Systems | Biz-Custom | Food Service | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 66.3% | 66.3% | 8.0 |
| 614 | Motors | Switch Reluctance Motors | Biz-Custom | Food Service | Retro | 33,406 | 33,406 | 31% | 10,222 | 0.00 | 15 | $869 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.8 |
| 615 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Food Service | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.1 |
| 616 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Food Service | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% |  |  | 1 | 30% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 617 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Food Service | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.7 |
| 618 | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Food Service | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.0 |
| 619 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Food Service | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 36.2 |
| 620 | Office_PC | Energy Star Server | Biz-Custom | Food Service | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.8% | 59.8% | 4.3 |
| 621 | Office_PC | Server Virtualization | Biz-Custom | Food Service | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.0 |
| 622 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Food Service | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.4% | 51.4% | 7.2 |
| 623 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Food Service | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.8 |
| 624 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Food Service | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.4% | 77.4% | 6.9 |
| 625 | Office_PC | Energy Star Laptop | Biz-Custom | Food Service | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% |  |  | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 626 | Office_PC | Energy Star Monitor | Biz-Custom | Food Service | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% |  |  | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 627 | Refrigeration | Strip Curtains | Biz-Prescriptive | Food Service | Retro | 88 | 88 | 50% | 44 | 0.00 | 4 | $10 | 75% | 59% | 59% | 1 | 6% | 30% | 75.2% | 73.2% | 73.2% | 1.4 |
| 628 | Refrigeration | Bare Suction Line | Biz-Custom | Food Service | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.6% | 72.6% | 7.0 |
| 629 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Food Service | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 25% | 5% | 5% | 3 | 4% | 25% | 47.5% | 39.9% | 39.9% | 4.9 |
| 630 | Refrigeration | Saturated Suction Controls | Biz-Custom | Food Service | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.5% | 28.1% | 28.1% | 12.8 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 631 | Refrigeration | Compressor Retrofit | Biz-Custom | Food Service | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 13% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| 632 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Food Service | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 4% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| 633 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Food Service | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 4% | 25% | 79.2% | 71.9% | 71.9% | 2.5 |
| 634 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Food Service | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 5% | 25% | 47.5% | 40.0% | 40.0% | 4.9 |
| 635 | Refrigeration | Refrigeration Economizer | Biz-Custom | Food Service | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 18% | 10% | 79.2% | 69.2% | 69.2% | 3.3 |
| 636 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Food Service | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 18% | 75% | 82.5% | 80.0% | 80.0% | 1.2 |
| 637 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Food Service | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 13% | 50% | 79.2% | 75.9% | 75.9% | 3.3 |
| 638 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Food Service | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 5% | 25% | 47.5% | 40.0% | 40.0% | 6.7 |
| 639 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Food Service | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 3% | 80% | 86.0% | 84.0% | 84.0% | 22.1 |
| 640 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Food Service | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 3% | 2% | 79.2% | 72.7% | 72.7% | 5.2 |
| 641 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Food Service | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 18% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 642 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Food Service | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 18% | 54% | 67.8% | 63.2% | 63.2% | 1.8 |
| 643 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Food Service | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 6% | 75% | 82.5% | 80.0% | 80.0% | 4.7 |
| 644 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Food Service | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 6% | 50% | 79.2% | 77.8% | 77.8% | 7.7 |
| 645 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Food Service | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 6% | 25% | 79.2% | 50.8% | 50.8% | 6.7 |
| 646 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Food Service | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 6% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 647 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Food Service | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 6% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 648 | Refrigeration | Refrigeration - Custom | Biz-Custom | Food Service | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.2% | 69.2% | 3.3 |
| 649 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Food Service | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 650 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Food Service | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 4% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 651 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Food Service | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 0% | 30% | 51.0% | 45.6% | 45.6% | 2.3 |
| 652 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Food Service | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 11% | 66% | 79.2% | 77.7% | 77.7% | 24.1 |
| 653 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Food Service | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 11% | 13% | 79.2% | 75.2% | 75.2% | 18.9 |
| 654 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Food Service | Retro | 2,669 | 2,669 | 20% | 534 | 0.00 | 15 | $227 | 100% | 19% | 19% | 1 | 100% | 18% | 83.4% | 50.1% | 50.1% | 7.1 |
| 655 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Food Service | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 18% | 83.4% | 66.4% | 66.4% | 8.6 |
| 656 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Food Service | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 72.9% | 72.9% | 7.5 |
| 657 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Food Service | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% | | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 658 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Food Service | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 72.9% | 72.9% | 7.5 |
| 659 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Food Service | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 72.9% | 72.9% | 6.4 |
| 660 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Food Service | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 72.9% | 72.9% | 6.4 |
| 661 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Food Service | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 58.8% | 36.0% | 36.0% | 21.1 |
| 662 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Food Service | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 71.9% | 71.9% | 5.7 |
| 663 | Behavioral | COM Competitions | Biz-Custom | Food Service | Retro | 53 | 53 | 2% | 1 | 0.00 | 2 | $0 | 100% | 48% | 48% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 3.7 |
| 664 | Behavioral | Business Energy Reports | Biz-Custom | Food Service | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 100% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 665 | Behavioral | Building Benchmarking | Biz-Custom | Food Service | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 77% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 666 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Food Service | Retro | 0 | 0 | 0% | 0 | 0.00 | 5 | $0 | 0% | | 7% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 667 | Behavioral | BEIMS | Biz-Custom | Food Service | Retro | 20 | 20 | 5% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.4 |
| 668 | Behavioral | Building Operator Certification | Biz-Custom | Food Service | Retro | 40 | 40 | 3% | 1 | 0.00 | 3 | $0 | 95% | 95% | 95% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.9 |
| 669 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Health | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 670 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Health | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 671 | CompressedAir | AODD Pump Controls | Biz-Custom | Health | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 672 | CompressedAir | Compressed Air - Custom | Biz-Custom | Health | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 673 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Health | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 674 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Health | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.5 |
| 675 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Health | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 676 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Health | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 677 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Health | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 9.0 |
| 678 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Health | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.4 |
| 679 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Health | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 8.1 |
| 680 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Health | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 16.9 |
| 681 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Health | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.2 |
| 682 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Health | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 58.5% | 42.3% | 42.3% | 5.2 |
| 683 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Health | ROB | 2,226 | 2,226 | 6% | 137 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 25% | 20% | 83.4% | 72.9% | 72.9% | 2.7 |
| 684 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Health | ROB | 2,226 | 2,226 | 13% | 286 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 25% | 20% | 83.4% | 61.5% | 61.5% | 5.7 |
| 685 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Health | ROB | 2,226 | 2,226 | 28% | 628 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 25% | 20% | 83.4% | 71.1% | 71.1% | 12.5 |
| 686 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Health | ROB | 2,226 | 2,226 | 42% | 933 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 25% | 20% | 83.4% | 73.9% | 73.9% | 18.5 |
| 687 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Health | ROB | 2,382 | 2,382 | 6% | 138 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 2.7 |
| 688 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Health | ROB | 2,382 | 2,382 | 12% | 293 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 5.8 |
| 689 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Health | ROB | 2,382 | 2,382 | 20% | 483 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 9.6 |
| 690 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Health | ROB | 2,382 | 2,382 | 46% | 1,089 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 21.6 |
| 691 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Health | Retro | 2,263 | 2,263 | 7% | 158 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 50% | 50% | 83.4% | 81.5% | 81.5% | 15.5 |
| 692 | Cooling | Air Side Economizer | Biz-Custom | Health | Retro | 2,226 | 2,226 | 20% | 445 | 0.00 | 10 | $84 | 100% | 42% | 42% | 4 | 50% | 20% | 83.4% | 68.9% | 68.9% | 3.7 |
| 693 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Health | Retro | 2,263 | 2,263 | 0% | 0 | 0.00 | 10 | $98 | 0% | | 26% | 5 | 50% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 694 | Cooling | HVAC Occupancy Controls | Biz-Custom | Health | ROB | 1,150 | 1,150 | 20% | 230 | 0.00 | 15 | $537 | 75% | 3% | 3% | 6 | 50% | 20% | 51.5% | 36.0% | 36.0% | 24.4 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 695 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Health | ROB | 1,940 | 1,940 | 13% | 242 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 0% | 20% | 83.4% | 83.4% | 83.4% | 4.8 |
| 696 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Health | ROB | 1,940 | 1,940 | 18% | 342 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 0% | 20% | 83.4% | 47.1% | 47.1% | 6.8 |
| 697 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Health | ROB | 1,940 | 1,940 | 22% | 431 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 0% | 20% | 83.4% | 53.7% | 53.7% | 8.5 |
| 698 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Health | ROB | 1,940 | 1,940 | 33% | 647 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 0% | 20% | 83.4% | 57.8% | 57.8% | 12.8 |
| 699 | Cooling | Smart Thermostat | Biz-Prescriptive | Health | ROB | 1,940 | 1,940 | 14% | 275 | 0.00 | 11 | $175 | 75% | 26% | 26% | 8 | 0% | 12% | 66.7% | 43.6% | 43.6% | 3.3 |
| 700 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Health | ROB | 2,282 | 2,282 | 8% | 193 | 0.00 | 8 | $84 | 100% | 42% | 42% | 9 | 0% | 20% | 83.4% | 62.1% | 62.1% | 3.2 |
| 701 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Health | ROB | 2,503 | 2,503 | 7% | 182 | 0.00 | 8 | $84 | 100% | 42% | 42% | 10 | 0% | 20% | 83.4% | 60.7% | 60.7% | 3.0 |
| 702 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Health | ROB | 2,858 | 2,858 | 10% | 272 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 0% | 20% | 83.4% | 67.0% | 67.0% | 4.5 |
| 703 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Health | ROB | 1,982 | 1,982 | 6% | 111 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 50% | 15% | 83.4% | 42.1% | 42.1% | 3.5 |
| 704 | Cooling | Chiller Tune-up | Biz-Custom | Health | Retro | 2,263 | 2,263 | 7% | 158 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 50% | 50% | 83.4% | 81.5% | 81.5% | 15.5 |
| 705 | Cooling | HVAC/Chiller Custom | Biz-Custom | Health | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.3 |
| 706 | Cooling | Window Film | Biz-Custom | Health | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 47.7% | 47.7% | 11.9 |
| 707 | Cooling | Triple Pane Windows | Biz-Custom | Health | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 48.8% | 36.0% | 36.0% | 21.9 |
| 708 | Cooling | Energy Recovery Ventilator | Biz-Custom | Health | Retro | 2,382 | 2,382 | 42% | 1,003 | 0.00 | 15 | $1,500 | 100% | 5% | 5% | 16 | 100% | 2% | 83.4% | 31.4% | 31.4% | 19.8 |
| 709 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 4% | 146 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 0% | 20% | 83.4% | 66.4% | 66.4% | 2.3 |
| 710 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 9% | 307 | 0.00 | 16 | $442 | 50% | 11% | 11% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 4.5 |
| 711 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 13% | 439 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 0% | 20% | 46.4% | 36.0% | 36.0% | 6.4 |
| 712 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 21% | 694 | 0.00 | 16 | $507 | 100% | 10% | 10% | 1 | 0% | 20% | 83.4% | 44.5% | 44.5% | 10.2 |
| 713 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 23% | 768 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 1.9 |
| 714 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 28% | 908 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 2.2 |
| 715 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 33% | 1,073 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 2.6 |
| 716 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 47% | 1,549 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 3.4 |
| 717 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Health | ROB | 3,991 | 3,991 | 12% | 467 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 29% | 20% | 83.4% | 80.2% | 80.2% | 21.6 |
| 718 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Health | ROB | 3,991 | 3,991 | 17% | 680 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 29% | 20% | 83.4% | 78.6% | 78.6% | 24.6 |
| 719 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Health | ROB | 4,164 | 4,164 | 16% | 662 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 29% | 20% | 83.4% | 79.8% | 79.8% | 35.9 |
| 720 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Health | ROB | 4,164 | 4,164 | 21% | 871 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 29% | 20% | 83.4% | 78.3% | 78.3% | 40.0 |
| 721 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Health | ROB | 3,628 | 3,628 | 31% | 1,111 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 29% | 20% | 44.0% | 36.0% | 36.0% | 3.8 |
| 722 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Health | ROB | 3,628 | 3,628 | 34% | 1,251 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 29% | 20% | 44.0% | 36.0% | 36.0% | 4.1 |
| 723 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Health | ROB | 3,914 | 3,914 | 43% | 1,702 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 29% | 20% | 44.0% | 36.0% | 36.0% | 4.9 |
| 724 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Health | ROB | 3,914 | 3,914 | 56% | 2,178 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 2 | 29% | 20% | 62.8% | 36.0% | 36.0% | 5.7 |
| 725 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Health | ROB | 3,108 | 3,108 | 17% | 517 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 29% | 2% | 83.4% | 62.2% | 62.2% | 12.5 |
| 726 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Health | ROB | 4,393 | 4,393 | 10% | 453 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 29% | 20% | 83.4% | 78.7% | 78.7% | 27.8 |
| 727 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Health | ROB | 4,393 | 4,393 | 16% | 720 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 29% | 20% | 83.4% | 75.1% | 75.1% | 33.5 |
| 728 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Health | ROB | 4,164 | 4,164 | 40% | 1,647 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 29% | 20% | 65.8% | 39.3% | 39.3% | 7.1 |
| 729 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Health | ROB | 4,164 | 4,164 | 43% | 1,787 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 29% | 20% | 83.4% | 40.2% | 40.2% | 7.4 |
| 730 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Health | ROB | 4,164 | 4,164 | 47% | 1,952 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 29% | 20% | 83.4% | 41.2% | 41.2% | 7.7 |
| 731 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Health | ROB | 4,164 | 4,164 | 58% | 2,429 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 29% | 20% | 83.4% | 43.2% | 43.2% | 8.6 |
| 732 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Health | ROB | 3,285 | 3,285 | 21% | 694 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 43% | 20% | 83.4% | 64.7% | 64.7% | 14.6 |
| 733 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Health | ROB | 3,583 | 3,583 | 5% | 186 | 0.00 | 8 | $84 | 100% | 48% | 48% | 5 | 0% | 10% | 83.4% | 68.7% | 68.7% | 2.5 |
| 734 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Health | ROB | 4,445 | 4,445 | 20% | 886 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 0% | 10% | 83.4% | 79.7% | 79.7% | 12.2 |
| 735 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Health | ROB | 3,962 | 3,962 | 12% | 460 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 0% | 10% | 83.4% | 76.1% | 76.1% | 6.2 |
| 736 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Health | ROB | 6,995 | 6,995 | 67% | 4,684 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 33% | 75.5% | 68.4% | 68.4% | 5.2 |
| 737 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Health | Retro | 6,995 | 6,995 | 2% | 140 | 0.00 | 20 | $60 | 100% | 19% | 19% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.4 |
| 738 | HotWater | Faucet Aerator | Biz-Prescriptive | Health | Retro | 2,017 | 2,017 | 33% | 657 | 0.00 | 10 | $14 | 100% | 57% | 57% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 34.0 |
| 739 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Health | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 22.2 |
| 740 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Health | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.4% | 45.6% | 45.6% | 3.7 |
| 741 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Health | Retro | 225 | 225 | 45% | 101 | 0.00 | 9 | $3 | 100% | 100% | 100% | 1 | 70% | 38% | 85.0% | 85.0% | 85.0% | 13.4 |
| 742 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Health | Retro | 509 | 509 | 50% | 255 | 0.00 | 9 | $70 | 100% | 43% | 43% | 1 | 70% | 38% | 85.0% | 69.5% | 69.5% | 3.4 |
| 743 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Health | Retro | 509 | 509 | 50% | 255 | 0.00 | 9 | $70 | 100% | 79% | 79% | 1 | 70% | 38% | 85.0% | 79.5% | 79.5% | 1.8 |
| 744 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Health | Retro | 509 | 509 | 74% | 378 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 8% | 38% | 56.4% | 50.2% | 50.2% | 1.6 |
| 745 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Health | Retro | 4,737 | 4,737 | 68% | 3,223 | 0.00 | 9 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 79.8% | 79.8% | 8.6 |
| 746 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Health | Retro | 4,737 | 4,737 | 66% | 3,143 | 0.00 | 9 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 79.6% | 79.6% | 8.4 |
| 747 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Health | Retro | 1,009 | 1,009 | 61% | 613 | 0.00 | 9 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.3 |
| 748 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Health | Retro | 1,009 | 1,009 | 59% | 592 | 0.00 | 9 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.2 |
| 749 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Health | ROB | 385 | 385 | 86% | 331 | 0.00 | 3 | $1 | 100% | 100% | 100% | 5 | 3% | 13% | 85.0% | 85.0% | 85.0% | 57.0 |
| 750 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Health | Retro | 349 | 349 | 68% | 236 | 0.00 | 9 | $27 | 100% | 37% | 37% | 6 | 18% | 13% | 85.0% | 78.3% | 78.3% | 9.4 |
| 751 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Health | ROB | 291 | 291 | 81% | 236 | 0.00 | 3 | $1 | 100% | 100% | 100% | 6 | 18% | 13% | 85.0% | 85.0% | 85.0% | 40.6 |
| 752 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Health | Retro | 187 | 187 | 100% | 187 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 70% | 0% | 85.0% | 83.5% | 83.5% | 86.4 |
| 753 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Health | Retro | 855 | 855 | 30% | 257 | 0.00 | 10 | $65 | 100% | 20% | 20% | 8 | 95% | 10% | 85.0% | 60.3% | 60.3% | 6.6 |
| 754 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Health | Retro | 1,095 | 1,095 | 30% | 329 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 74.7% | 74.7% | 8.2 |
| 755 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Health | Retro | 489 | 489 | 44% | 215 | 0.00 | 10 | $75 | 100% | 26% | 26% | 8 | 95% | 10% | 85.0% | 57.3% | 57.3% | 4.7 |
| 756 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Health | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 75% | 18% | 18% | 8 | 95% | 10% | 71.5% | 37.1% | 37.1% | 4.3 |
| 757 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Health | Retro | 4 | 4 | 49% | 2 | 0.00 | 15 | $0 | 100% | 63% | 63% | 8 | 95% | 10% | 85.0% | 77.8% | 77.8% | 4.5 |

AES Indiana


**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 758 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Health | Retro | 489 | 489 | 65% | 318 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 79% | 10% | 85.0% | 62.2% | 62.2% | 9.8 |
| 759 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Health | Retro | 70 | 70 | 43% | 30 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 760 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Health | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 78.4% | 78.4% | 8.2 |
| 761 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Health | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 46% | 46% | 1 | 12% | 44% | 60.8% | 55.2% | 55.2% | 1.6 |
| 762 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Health | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 763 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Health | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 3 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.5 |
| 764 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Health | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 765 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Health | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 25% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.7 |
| 766 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Health | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.8 |
| 767 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Health | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 768 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Health | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 8 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.5 |
| 769 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Health | Retro | 509 | 509 | 69% | 351 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 55.2% | 55.2% | 1.3 |
| 770 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Health | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 771 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Health | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 772 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Health | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 773 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Health | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 0% | 10% | 85.0% | 64.4% | 64.4% | 3.3 |
| 774 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Health | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,184 | 100% | 34% | 34% | 3 | 28% | 10% | 85.0% | 69.8% | 69.8% | 8.7 |
| 775 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Health | Retro | 1,909 | 1,909 | 83% | 1,585 | 0.00 | 10 | $483 | 100% | 26% | 26% | 4 | 5% | 10% | 85.0% | 64.4% | 64.4% | 6.2 |
| 776 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Health | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 2% | 2% | 31.4% | 17.2% | 17.2% | 3.7 |
| 777 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Health | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 8.1 |
| 778 | Motors | Cogged V-Belt | Biz-Custom | Health | Retro | 17,237 | 17,237 | 3% | 534 | 0.00 | 15 | $384 | 75% | 11% | 11% | 1 | 50% | 10% | 66.8% | 40.3% | 40.3% | 8.5 |
| 779 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Health | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 66.1% | 66.1% | 8.5 |
| 780 | Motors | Power Drive Systems | Biz-Custom | Health | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 66.2% | 66.2% | 8.0 |
| 781 | Motors | Switch Reluctance Motors | Biz-Custom | Health | Retro | 33,406 | 33,406 | 31% | 10,222 | 0.00 | 15 | $869 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.7 |
| 782 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Health | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.2 |
| 783 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Health | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% | | | 1 | 5% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 784 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Health | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.9 |
| 785 | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Health | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.2 |
| 786 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Health | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 37.1 |
| 787 | Office_PC | Energy Star Server | Biz-Custom | Health | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.8% | 59.8% | 4.5 |
| 788 | Office_PC | Server Virtualization | Biz-Custom | Health | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.2 |
| 789 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Health | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.4% | 51.4% | 7.4 |
| 790 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Health | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.9 |
| 791 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Health | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.4% | 77.4% | 7.1 |
| 792 | Office_PC | Energy Star Laptop | Biz-Custom | Health | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% | | | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 793 | Office_PC | Energy Star Monitor | Biz-Custom | Health | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% | | | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 794 | Refrigeration | Strip Curtains | Biz-Prescriptive | Health | Retro | 0 | 0 | 0% | 0 | 0.00 | 4 | $0 | 0% | 0% | | 1 | 5% | 30% | 79.2% | 79.2% | 79.2% | 0.0 |
| 795 | Refrigeration | Bare Suction Line | Biz-Custom | Health | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.7% | 72.7% | 7.0 |
| 796 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Health | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 25% | 5% | 5% | 3 | 4% | 25% | 47.5% | 39.9% | 39.9% | 4.9 |
| 797 | Refrigeration | Saturated Suction Controls | Biz-Custom | Health | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.8% | 28.2% | 28.2% | 12.8 |
| 798 | Refrigeration | Compressor Retrofit | Biz-Custom | Health | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 12% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| 799 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Health | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 3% | 80% | 86.0% | 84.0% | 84.0% | 22.2 |
| 800 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Health | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 3% | 25% | 79.2% | 72.0% | 72.0% | 2.5 |
| 801 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Health | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 5% | 25% | 47.5% | 40.0% | 40.0% | 4.9 |
| 802 | Refrigeration | Refrigeration Economizer | Biz-Custom | Health | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 17% | 10% | 79.2% | 69.3% | 69.3% | 3.3 |
| 803 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Health | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 18% | 25% | 79.2% | 79.2% | 79.2% | 1.2 |
| 804 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Health | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 13% | 50% | 79.2% | 76.0% | 76.0% | 3.3 |
| 805 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Health | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 5% | 25% | 47.5% | 40.0% | 40.0% | 6.7 |
| 806 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Health | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 3% | 80% | 86.0% | 84.0% | 84.0% | 22.2 |
| 807 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Health | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 3% | 2% | 79.2% | 72.7% | 72.7% | 5.3 |
| 808 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Health | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 17% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 809 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Health | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 17% | 54% | 67.8% | 63.2% | 63.2% | 1.8 |
| 810 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Health | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 6% | 25% | 79.2% | 79.2% | 79.2% | 4.8 |
| 811 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Health | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 6% | 50% | 79.2% | 77.8% | 77.8% | 7.8 |
| 812 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Health | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 6% | 25% | 79.2% | 51.0% | 51.0% | 6.7 |
| 813 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Health | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 6% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 814 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Health | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 6% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 815 | Refrigeration | Refrigeration - Custom | Biz-Custom | Health | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.3% | 69.3% | 3.3 |
| 816 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Health | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 817 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Health | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 5% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 818 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Health | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 3% | 30% | 51.0% | 45.6% | 45.6% | 2.3 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 819 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Health | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 11% | 66% | 79.2% | 77.7% | 77.7% | 24.2 |
| 820 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Health | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 11% | 13% | 79.2% | 75.2% | 75.2% | 19.0 |
| 821 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Health | Retro | 2,639 | 2,639 | 20% | 528 | 0.00 | 15 | $227 | 100% | 19% | 19% | 1 | 100% | 36% | 83.4% | 53.7% | 53.7% | 8.7 |
| 822 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Health | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 36% | 83.4% | 66.3% | 66.3% | 8.6 |
| 823 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Health | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 72.8% | 72.8% | 7.6 |
| 824 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Health | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% |  | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 825 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Health | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 72.8% | 72.8% | 7.6 |
| 826 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Health | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 72.8% | 72.8% | 6.5 |
| 827 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Health | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 72.8% | 72.8% | 6.5 |
| 828 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Health | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 58.8% | 36.0% | 36.0% | 21.4 |
| 829 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Health | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 71.9% | 71.9% | 5.8 |
| 830 | Behavioral | COM Competitions | Biz-Custom | Health | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% |  | 48% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 831 | Behavioral | Business Energy Reports | Biz-Custom | Health | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% |  | 100% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 832 | Behavioral | Building Benchmarking | Biz-Custom | Health | Retro | 114 | 114 | 1% | 1 | 0.00 | 2 | $0 | 77% | 77% | 77% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.5 |
| 833 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Health | Retro | 33 | 33 | 3% | 1 | 0.00 | 5 | $0 | 50% | 7% | 7% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 8.7 |
| 834 | Behavioral | BEIMS | Biz-Custom | Health | Retro | 20 | 20 | 5% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.5 |
| 835 | Behavioral | Building Operator Certification | Biz-Custom | Health | Retro | 20 | 20 | 3% | 0 | 0.00 | 3 | $0 | 46% | 46% | 46% | 1 | 100% | 2% | 90.0% | 90.0% | 90.0% | 0.9 |
| 836 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Lodging | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 837 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Lodging | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 838 | CompressedAir | AODD Pump Controls | Biz-Custom | Lodging | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 839 | CompressedAir | Compressed Air - Custom | Biz-Custom | Lodging | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 840 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Lodging | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 841 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Lodging | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.6 |
| 842 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Lodging | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 843 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Lodging | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 844 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Lodging | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 9.1 |
| 845 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Lodging | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.6 |
| 846 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Lodging | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 8.2 |
| 847 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Lodging | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 17.2 |
| 848 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Lodging | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.3 |
| 849 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Lodging | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 58.5% | 42.3% | 42.3% | 5.3 |
| 850 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 1,401 | 1,401 | 6% | 86 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 23% | 20% | 83.4% | 70.9% | 70.9% | 2.3 |
| 851 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 1,401 | 1,401 | 13% | 180 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 23% | 20% | 83.4% | 54.3% | 54.3% | 4.8 |
| 852 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 1,401 | 1,401 | 28% | 396 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 23% | 20% | 83.4% | 68.6% | 68.6% | 10.6 |
| 853 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 1,401 | 1,401 | 42% | 587 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 23% | 20% | 83.4% | 72.0% | 72.0% | 15.7 |
| 854 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 1,500 | 1,500 | 6% | 87 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 23% | 20% | 83.4% | 83.4% | 83.4% | 2.3 |
| 855 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 1,500 | 1,500 | 12% | 185 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 23% | 20% | 83.4% | 83.4% | 83.4% | 4.9 |
| 856 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 1,500 | 1,500 | 20% | 304 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 23% | 20% | 83.4% | 83.4% | 83.4% | 8.1 |
| 857 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 1,500 | 1,500 | 46% | 686 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 23% | 20% | 83.4% | 83.4% | 83.4% | 18.3 |
| 858 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Lodging | Retro | 1,425 | 1,425 | 7% | 100 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 45% | 50% | 83.4% | 80.8% | 80.8% | 13.0 |
| 859 | Cooling | Air Side Economizer | Biz-Custom | Lodging | Retro | 1,401 | 1,401 | 20% | 280 | 0.00 | 10 | $84 | 75% | 27% | 27% | 4 | 45% | 20% | 72.0% | 57.4% | 57.4% | 3.6 |
| 860 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Lodging | Retro | 1,425 | 1,425 | 0% | 0 | 0.00 | 10 | $98 | 0% |  | 26% | 5 | 45% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 861 | Cooling | HVAC Occupancy Controls | Biz-Custom | Lodging | ROB | 9,967 | 9,967 | 20% | 1,993 | 0.00 | 15 | $537 | 100% | 30% | 30% | 6 | 45% | 20% | 83.4% | 65.1% | 65.1% | 9.2 |
| 862 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 1,221 | 1,221 | 13% | 153 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 0% | 20% | 83.4% | 83.4% | 83.4% | 4.1 |
| 863 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 1,221 | 1,221 | 18% | 215 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 0% | 20% | 83.4% | 42.5% | 42.5% | 5.8 |
| 864 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Lodging | ROB | 1,221 | 1,221 | 22% | 271 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 0% | 20% | 83.4% | 46.4% | 46.4% | 7.2 |
| 865 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Lodging | ROB | 1,221 | 1,221 | 33% | 407 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 0% | 20% | 83.4% | 49.4% | 49.4% | 10.9 |
| 866 | Cooling | Smart Thermostat | Biz-Prescriptive | Lodging | ROB | 1,221 | 1,221 | 14% | 173 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 0% | 12% | 44.3% | 36.0% | 36.0% | 2.5 |
| 867 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Lodging | ROB | 1,437 | 1,437 | 8% | 122 | 0.00 | 8 | $84 | 100% | 42% | 42% | 9 | 15% | 20% | 83.4% | 54.7% | 54.7% | 2.7 |
| 868 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Lodging | ROB | 1,576 | 1,576 | 7% | 114 | 0.00 | 8 | $84 | 100% | 42% | 42% | 10 | 15% | 20% | 83.4% | 52.9% | 52.9% | 2.5 |
| 869 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Lodging | ROB | 1,800 | 1,800 | 10% | 171 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 15% | 20% | 83.4% | 62.9% | 62.9% | 3.7 |
| 870 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Lodging | ROB | 1,248 | 1,248 | 6% | 70 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 39% | 15% | 83.4% | 36.9% | 36.9% | 3.1 |
| 871 | Cooling | Chiller Tune-up | Biz-Custom | Lodging | Retro | 1,425 | 1,425 | 7% | 100 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 39% | 50% | 83.4% | 80.8% | 80.8% | 13.0 |
| 872 | Cooling | HVAC/Chiller Custom | Biz-Custom | Lodging | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.2 |
| 873 | Cooling | Window Film | Biz-Custom | Lodging | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 48.1% | 48.1% | 11.8 |
| 874 | Cooling | Triple Pane Windows | Biz-Custom | Lodging | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 49.3% | 36.0% | 36.0% | 21.8 |
| 875 | Cooling | Energy Recovery Ventilator | Biz-Custom | Lodging | Retro | 1,500 | 1,500 | 0% | 0 | 0.00 | 15 | $1,500 | 0% |  | 0% | 16 | 100% | 2% | 83.4% | 83.4% | 83.4% | 0.0 |
| 876 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 4% | 116 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 0% | 20% | 83.4% | 66.2% | 66.2% | 2.0 |
| 877 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 8% | 263 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 4.1 |
| 878 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 12% | 378 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 0% | 20% | 46.5% | 36.0% | 36.0% | 5.8 |
| 879 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 18% | 568 | 0.00 | 16 | $507 | 75% | 10% | 10% | 1 | 0% | 20% | 69.2% | 44.2% | 44.2% | 9.1 |
| 880 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 22% | 702 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 1.8 |
| 881 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 27% | 840 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 2.1 |
| 882 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 32% | 1,000 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 2.5 |
| 883 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 46% | 1,469 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 0% | 20% | 44.0% | 36.0% | 36.0% | 3.3 |
| 884 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Lodging | ROB | 3,795 | 3,795 | 11% | 401 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 30% | 20% | 83.4% | 80.5% | 80.5% | 21.0 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 885 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Lodging | ROB | 3,795 | 3,795 | 16% | 597 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 30% | 20% | 83.4% | 79.1% | 79.1% | 23.8 |
| 886 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Lodging | ROB | 3,944 | 3,944 | 13% | 530 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 30% | 20% | 83.4% | 80.1% | 80.1% | 34.2 |
| 887 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Lodging | ROB | 3,944 | 3,944 | 18% | 727 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 30% | 20% | 83.4% | 78.7% | 78.7% | 38.1 |
| 888 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 3,465 | 3,465 | 29% | 1,005 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 30% | 20% | 44.0% | 36.0% | 36.0% | 3.6 |
| 889 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 3,465 | 3,465 | 33% | 1,142 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 30% | 20% | 44.0% | 36.0% | 36.0% | 3.9 |
| 890 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 3,645 | 3,645 | 41% | 1,483 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 30% | 20% | 44.0% | 36.0% | 36.0% | 4.5 |
| 891 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Lodging | ROB | 3,645 | 3,645 | 54% | 1,952 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 30% | 20% | 46.0% | 36.0% | 36.0% | 5.3 |
| 892 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Lodging | ROB | 2,920 | 2,920 | 11% | 326 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 30% | 2% | 83.4% | 60.3% | 60.3% | 10.2 |
| 893 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Lodging | ROB | 4,089 | 4,089 | 9% | 363 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 30% | 20% | 83.4% | 79.2% | 79.2% | 26.6 |
| 894 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Lodging | ROB | 4,089 | 4,089 | 15% | 600 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 30% | 20% | 83.4% | 75.9% | 75.9% | 31.9 |
| 895 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 3,944 | 3,944 | 38% | 1,484 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 30% | 20% | 66.9% | 41.0% | 41.0% | 6.8 |
| 896 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 3,944 | 3,944 | 41% | 1,621 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 30% | 20% | 67.4% | 41.8% | 41.8% | 7.1 |
| 897 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 3,944 | 3,944 | 45% | 1,782 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 30% | 20% | 83.4% | 42.7% | 42.7% | 7.4 |
| 898 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Lodging | ROB | 3,944 | 3,944 | 57% | 2,251 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 30% | 20% | 83.4% | 44.4% | 44.4% | 8.2 |
| 899 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Lodging | ROB | 3,162 | 3,162 | 18% | 568 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 25% | 20% | 83.4% | 64.4% | 64.4% | 13.0 |
| 900 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Lodging | ROB | 3,500 | 3,500 | 3% | 117 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 5% | 10% | 74.0% | 68.0% | 68.0% | 2.0 |
| 901 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Lodging | ROB | 4,164 | 4,164 | 13% | 558 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 5% | 10% | 83.4% | 79.4% | 79.4% | 10.0 |
| 902 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Lodging | ROB | 3,817 | 3,817 | 8% | 290 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 5% | 10% | 83.4% | 75.6% | 75.6% | 5.1 |
| 903 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Lodging | ROB | 6,347 | 6,347 | 67% | 4,250 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 33% | 75.5% | 67.5% | 67.5% | 4.5 |
| 904 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Lodging | Retro | 6,347 | 6,347 | 2% | 127 | 0.00 | 20 | $60 | 100% | 17% | 17% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.2 |
| 905 | HotWater | Faucet Aerator | Biz-Prescriptive | Lodging | Retro | 117 | 117 | 32% | 38 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 4.4 |
| 906 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Lodging | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 21.0 |
| 907 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Lodging | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.4% | 45.6% | 45.6% | 3.5 |
| 908 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Lodging | Retro | 229 | 229 | 45% | 103 | 0.00 | 8 | $3 | 100% | 100% | 100% | 1 | 42% | 38% | 85.0% | 85.0% | 85.0% | 13.5 |
| 909 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Lodging | Retro | 519 | 519 | 50% | 260 | 0.00 | 8 | $70 | 100% | 43% | 43% | 1 | 42% | 38% | 85.0% | 70.9% | 70.9% | 3.4 |
| 910 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Lodging | Retro | 519 | 519 | 50% | 260 | 0.00 | 8 | $70 | 100% | 79% | 79% | 1 | 42% | 38% | 85.0% | 80.0% | 80.0% | 1.9 |
| 911 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Lodging | Retro | 519 | 519 | 74% | 386 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 5% | 38% | 56.4% | 50.2% | 50.2% | 1.6 |
| 912 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Lodging | Retro | 4,832 | 4,832 | 68% | 3,288 | 0.00 | 8 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 80.2% | 80.2% | 8.7 |
| 913 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Lodging | Retro | 4,832 | 4,832 | 66% | 3,206 | 0.00 | 8 | $330 | 100% | 45% | 45% | 3 | 0% | 19% | 85.0% | 80.1% | 80.1% | 8.5 |
| 914 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Lodging | Retro | 1,029 | 1,029 | 61% | 626 | 0.00 | 8 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.3 |
| 915 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Lodging | Retro | 1,029 | 1,029 | 59% | 604 | 0.00 | 8 | $75 | 100% | 100% | 100% | 4 | 0% | 19% | 85.0% | 85.0% | 85.0% | 3.2 |
| 916 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Lodging | ROB | 68 | 68 | 86% | 58 | 0.00 | 3 | $1 | 100% | 100% | 100% | 5 | 8% | 13% | 85.0% | 85.0% | 85.0% | 34.6 |
| 917 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Lodging | Retro | 356 | 356 | 68% | 241 | 0.00 | 8 | $27 | 100% | 37% | 37% | 6 | 45% | 13% | 85.0% | 78.8% | 78.8% | 9.5 |
| 918 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Lodging | ROB | 51 | 51 | 81% | 42 | 0.00 | 3 | $1 | 100% | 100% | 100% | 6 | 45% | 13% | 85.0% | 85.0% | 85.0% | 24.7 |
| 919 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Lodging | Retro | 191 | 191 | 100% | 191 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 42% | 0% | 85.0% | 83.7% | 83.7% | 95.8 |
| 920 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Lodging | Retro | 872 | 872 | 30% | 262 | 0.00 | 10 | $65 | 100% | 20% | 20% | 8 | 95% | 10% | 85.0% | 61.0% | 61.0% | 6.5 |
| 921 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Lodging | Retro | 1,117 | 1,117 | 30% | 335 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 74.9% | 74.9% | 8.2 |
| 922 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Lodging | Retro | 498 | 498 | 44% | 219 | 0.00 | 10 | $75 | 100% | 26% | 26% | 8 | 95% | 10% | 85.0% | 60.6% | 60.6% | 5.2 |
| 923 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Lodging | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 75% | 18% | 18% | 8 | 95% | 10% | 71.5% | 37.1% | 37.1% | 4.2 |
| 924 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Lodging | Retro | 4 | 4 | 49% | 2 | 0.00 | 15 | $1 | 100% | 42% | 42% | 8 | 95% | 10% | 85.0% | 69.2% | 69.2% | 5.0 |
| 925 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Lodging | Retro | 498 | 498 | 65% | 324 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 47% | 10% | 85.0% | 64.4% | 64.4% | 10.9 |
| 926 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Lodging | Retro | 67 | 67 | 43% | 29 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 927 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Lodging | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 78.9% | 78.9% | 8.9 |
| 928 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Lodging | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 46% | 46% | 1 | 12% | 44% | 71.7% | 55.2% | 55.2% | 1.6 |
| 929 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Lodging | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 930 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Lodging | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 3 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.5 |
| 931 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Lodging | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 932 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Lodging | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 50% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.9 |
| 933 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Lodging | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.8 |
| 934 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Lodging | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 935 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Lodging | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 8 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.5 |
| 936 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Lodging | Retro | 519 | 519 | 69% | 358 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 55.2% | 55.2% | 1.3 |
| 937 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Lodging | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 938 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Lodging | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 939 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Lodging | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 940 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Lodging | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 41% | 10% | 85.0% | 65.5% | 65.5% | 3.3 |
| 941 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Lodging | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,185 | 100% | 34% | 34% | 3 | 25% | 10% | 85.0% | 69.8% | 69.8% | 8.8 |
| 942 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Lodging | Retro | 262 | 262 | 83% | 217 | 0.00 | 10 | $483 | 4% | 4% | 4% | 4 | 5% | 10% | 37.0% | 23.9% | 23.9% | 5.9 |
| 943 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Lodging | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 2% | 2% | 31.4% | 17.2% | 17.2% | 3.6 |
| 944 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Lodging | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 8.0 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 945 | Motors | Cogged V-Belt | Biz-Custom | Lodging | Retro | 29,207 | 29,207 | 3% | 905 | 0.00 | 15 | $384 | 100% | 19% | 19% | 1 | 50% | 10% | 83.4% | 50.1% | 50.1% | 6.9 |
| 946 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Lodging | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 66.2% | 66.2% | 8.5 |
| 947 | Motors | Power Drive Systems | Biz-Custom | Lodging | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 64.6% | 64.6% | 6.5 |
| 948 | Motors | Switch Reluctance Motors | Biz-Custom | Lodging | Retro | 56,602 | 56,602 | 31% | 17,320 | 0.00 | 15 | $1,472 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.7 |
| 949 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Lodging | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.1 |
| 950 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Lodging | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% | | | 1 | 5% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 951 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Lodging | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.8 |
| 952 | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Lodging | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.1 |
| 953 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Lodging | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 36.5 |
| 954 | Office_PC | Energy Star Server | Biz-Custom | Lodging | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.8% | 59.8% | 4.4 |
| 955 | Office_PC | Server Virtualization | Biz-Custom | Lodging | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.1 |
| 956 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Lodging | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.4% | 51.4% | 7.3 |
| 957 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Lodging | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.8 |
| 958 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Lodging | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.4% | 77.4% | 6.9 |
| 959 | Office_PC | Energy Star Laptop | Biz-Custom | Lodging | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% | | | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 960 | Office_PC | Energy Star Monitor | Biz-Custom | Lodging | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% | | | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 961 | Refrigeration | Strip Curtains | Biz-Prescriptive | Lodging | Retro | 0 | 0 | 0% | 0 | 0.00 | 4 | $0 | 0% | 0% | | 1 | 11% | 30% | 79.2% | 79.2% | 79.2% | 0.0 |
| 962 | Refrigeration | Bare Suction Line | Biz-Custom | Lodging | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.6% | 72.6% | 6.9 |
| 963 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Lodging | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 5% | 5% | 5% | 3 | 7% | 25% | 47.5% | 39.9% | 39.9% | 4.8 |
| 964 | Refrigeration | Saturated Suction Controls | Biz-Custom | Lodging | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.6% | 28.1% | 28.1% | 12.8 |
| 965 | Refrigeration | Compressor Retrofit | Biz-Custom | Lodging | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 24% | 25% | 47.5% | 39.9% | 39.9% | 12.8 |
| 966 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Lodging | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 7% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 967 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Lodging | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 7% | 25% | 79.2% | 71.9% | 71.9% | 2.5 |
| 968 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Lodging | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 9% | 25% | 47.5% | 40.0% | 40.0% | 4.8 |
| 969 | Refrigeration | Refrigeration Economizer | Biz-Custom | Lodging | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 34% | 10% | 79.2% | 69.2% | 69.2% | 3.3 |
| 970 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Lodging | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 11% | 25% | 79.2% | 79.2% | 79.2% | 1.2 |
| 971 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Lodging | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 8% | 50% | 79.2% | 75.9% | 75.9% | 3.2 |
| 972 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Lodging | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 3% | 25% | 47.5% | 40.0% | 40.0% | 6.6 |
| 973 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Lodging | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 2% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 974 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Lodging | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 2% | 2% | 79.2% | 72.7% | 72.7% | 5.2 |
| 975 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Lodging | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 11% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 976 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Lodging | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 11% | 54% | 67.8% | 63.2% | 63.2% | 1.7 |
| 977 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Lodging | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 4% | 25% | 79.2% | 79.2% | 79.2% | 4.7 |
| 978 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Lodging | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 4% | 50% | 79.2% | 77.8% | 77.8% | 7.7 |
| 979 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Lodging | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 4% | 25% | 79.2% | 50.9% | 50.9% | 6.6 |
| 980 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Lodging | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 4% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 981 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Lodging | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 4% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 982 | Refrigeration | Refrigeration - Custom | Biz-Custom | Lodging | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.2% | 69.2% | 3.3 |
| 983 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Lodging | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 984 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Lodging | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 6% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 985 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Lodging | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 4% | 30% | 51.0% | 45.6% | 45.6% | 2.2 |
| 986 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Lodging | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 7% | 66% | 79.2% | 77.7% | 77.7% | 24.0 |
| 987 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Lodging | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 7% | 13% | 79.2% | 75.2% | 75.2% | 18.9 |
| 988 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Lodging | Retro | 2,639 | 2,639 | 20% | 528 | 0.00 | 15 | $227 | 100% | 19% | 19% | 1 | 100% | 23% | 83.4% | 53.9% | 53.9% | 8.6 |
| 989 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Lodging | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 23% | 83.4% | 66.4% | 66.4% | 8.5 |
| 990 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Lodging | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 15% | 20% | 83.4% | 73.0% | 73.0% | 7.5 |
| 991 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Lodging | Retro | 7,167 | 7,167 | 19% | 1,382 | 0.00 | 15 | $260 | 100% | 77% | 77% | 2 | 85% | 20% | 83.4% | 76.2% | 76.2% | 2.6 |
| 992 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Lodging | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 73.0% | 73.0% | 7.5 |
| 993 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Lodging | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 73.0% | 73.0% | 6.4 |
| 994 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Lodging | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 73.0% | 73.0% | 6.4 |
| 995 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Lodging | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 59.3% | 36.0% | 36.0% | 21.1 |
| 996 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Lodging | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 72.1% | 72.1% | 5.7 |
| 997 | Behavioral | COM Competitions | Biz-Custom | Lodging | Retro | 53 | 53 | 2% | 1 | 0.00 | 2 | $0 | 100% | 48% | 48% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 3.7 |
| 998 | Behavioral | Business Energy Reports | Biz-Custom | Lodging | Retro | 313 | 313 | 0% | 1 | 0.00 | 2 | $0 | 100% | 100% | 100% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.4 |
| 999 | Behavioral | Building Benchmarking | Biz-Custom | Lodging | Retro | 263 | 263 | 0% | 1 | 0.00 | 2 | $0 | 77% | 77% | 77% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.4 |
| 1000 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Lodging | Retro | 0 | 0 | 0% | 0 | 0.00 | 5 | $0 | 0% | | 7% | 1 | 100% | 0% | 90.0% | 90.0% | 90.0% | 0.0 |
| 1001 | Behavioral | BEIMS | Biz-Custom | Lodging | Retro | 20 | 20 | 5% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 50.0% | 50.0% | 50.0% | 0.4 |
| 1002 | Behavioral | Building Operator Certification | Biz-Custom | Lodging | Retro | 12 | 12 | 3% | 0 | 0.00 | 3 | $0 | 29% | 29% | 29% | 1 | 100% | 2% | 50.0% | 50.0% | 50.0% | 0.9 |
| 1003 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Retail | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 1004 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Retail | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 1005 | CompressedAir | AODD Pump Controls | Biz-Custom | Retail | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 1006 | CompressedAir | Compressed Air - Custom | Biz-Custom | Retail | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 1007 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Retail | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1008 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Retail | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.3 |
| 1009 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Retail | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.8 |
| 1010 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Retail | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 1011 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Retail | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 71.0% | 71.0% | 8.8 |
| 1012 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Retail | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.0 |
| 1013 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Retail | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 75.0% | 75.0% | 7.9 |
| 1014 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Retail | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.2% | 45.6% | 45.6% | 16.5 |
| 1015 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Retail | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.7% | 75.7% | 5.1 |
| 1016 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Retail | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 58.5% | 42.3% | 42.3% | 5.1 |
| 1017 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 831 | 831 | 6% | 51 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 14% | 20% | 83.4% | 67.7% | 67.7% | 2.0 |
| 1018 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 831 | 831 | 13% | 107 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 14% | 20% | 83.4% | 45.8% | 45.8% | 4.3 |
| 1019 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 831 | 831 | 28% | 235 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 14% | 20% | 83.4% | 64.4% | 64.4% | 9.4 |
| 1020 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 831 | 831 | 42% | 348 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 14% | 20% | 83.4% | 69.2% | 69.2% | 14.0 |
| 1021 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Retail | ROB | 889 | 889 | 6% | 51 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 14% | 20% | 83.4% | 83.4% | 83.4% | 2.1 |
| 1022 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Retail | ROB | 889 | 889 | 12% | 109 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 14% | 20% | 83.4% | 83.4% | 83.4% | 4.4 |
| 1023 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Retail | ROB | 889 | 889 | 20% | 180 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 14% | 20% | 83.4% | 83.4% | 83.4% | 7.2 |
| 1024 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Retail | ROB | 889 | 889 | 46% | 407 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 14% | 20% | 83.4% | 83.4% | 83.4% | 16.3 |
| 1025 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Retail | Retro | 845 | 845 | 7% | 59 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 29% | 50% | 83.4% | 79.8% | 79.8% | 11.5 |
| 1026 | Cooling | Air Side Economizer | Biz-Custom | Retail | Retro | 831 | 831 | 20% | 166 | 0.00 | 10 | $84 | 50% | 16% | 16% | 4 | 29% | 20% | 53.5% | 42.1% | 42.1% | 3.8 |
| 1027 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Retail | Retro | 845 | 845 | 13% | 106 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 29% | 20% | 44.0% | 36.0% | 36.0% | 1.3 |
| 1028 | Cooling | HVAC Occupancy Controls | Biz-Custom | Retail | ROB | 2,900 | 2,900 | 20% | 580 | 0.00 | 15 | $537 | 75% | 9% | 9% | 6 | 29% | 20% | 63.0% | 36.0% | 36.0% | 11.3 |
| 1029 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Retail | ROB | 724 | 724 | 13% | 91 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 24% | 20% | 83.4% | 83.4% | 83.4% | 3.6 |
| 1030 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Retail | ROB | 724 | 724 | 18% | 128 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 24% | 20% | 83.4% | 36.0% | 36.0% | 5.1 |
| 1031 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Retail | ROB | 724 | 724 | 22% | 161 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 24% | 20% | 83.4% | 40.4% | 40.4% | 6.5 |
| 1032 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Retail | ROB | 724 | 724 | 33% | 241 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 24% | 20% | 83.4% | 43.2% | 43.2% | 9.7 |
| 1033 | Cooling | Smart Thermostat | Biz-Prescriptive | Retail | ROB | 724 | 724 | 14% | 103 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 24% | 12% | 38.4% | 29.6% | 29.6% | 2.1 |
| 1034 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Retail | ROB | 852 | 852 | 8% | 72 | 0.00 | 8 | $84 | 75% | 42% | 42% | 9 | 14% | 20% | 65.3% | 45.8% | 45.8% | 2.3 |
| 1035 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Retail | ROB | 935 | 935 | 7% | 68 | 0.00 | 8 | $84 | 75% | 42% | 42% | 10 | 14% | 20% | 64.4% | 44.8% | 44.8% | 2.2 |
| 1036 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Retail | ROB | 1,067 | 1,067 | 10% | 102 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 14% | 20% | 83.4% | 54.5% | 54.5% | 3.3 |
| 1037 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Retail | ROB | 740 | 740 | 6% | 42 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 33% | 15% | 83.4% | 32.0% | 32.0% | 2.8 |
| 1038 | Cooling | Chiller Tune-up | Biz-Custom | Retail | Retro | 845 | 845 | 7% | 59 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 33% | 50% | 83.4% | 79.8% | 79.8% | 11.5 |
| 1039 | Cooling | HVAC/Chiller Custom | Biz-Custom | Retail | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.4 |
| 1040 | Cooling | Window Film | Biz-Custom | Retail | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 47.2% | 47.2% | 12.0 |
| 1041 | Cooling | Triple Pane Windows | Biz-Custom | Retail | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 47.7% | 36.0% | 36.0% | 22.0 |
| 1042 | Cooling | Energy Recovery Ventilator | Biz-Custom | Retail | Retro | 889 | 889 | 17% | 156 | 0.00 | 15 | $1,500 | 1% | 1% | 1% | 16 | 100% | 2% | 31.4% | 22.6% | 22.6% | 6.7 |
| 1043 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 3% | 78 | 0.00 | 16 | $87 | 75% | 57% | 57% | 1 | 35% | 20% | 66.3% | 56.0% | 56.0% | 1.7 |
| 1044 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 8% | 183 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 35% | 20% | 44.0% | 36.0% | 36.0% | 3.5 |
| 1045 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 11% | 263 | 0.00 | 16 | $507 | 25% | 10% | 10% | 1 | 35% | 20% | 44.0% | 36.0% | 36.0% | 4.9 |
| 1046 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 17% | 388 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 35% | 20% | 45.6% | 36.0% | 36.0% | 7.6 |
| 1047 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 22% | 501 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 35% | 20% | 44.0% | 36.0% | 36.0% | 1.5 |
| 1048 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 26% | 601 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 35% | 20% | 44.0% | 36.0% | 36.0% | 1.8 |
| 1049 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 31% | 718 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 35% | 20% | 44.0% | 36.0% | 36.0% | 2.0 |
| 1050 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 46% | 1,061 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 35% | 20% | 44.0% | 36.0% | 36.0% | 2.7 |
| 1051 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Retail | ROB | 2,744 | 2,744 | 10% | 279 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 21% | 20% | 83.4% | 78.3% | 78.3% | 20.0 |
| 1052 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Retail | ROB | 2,744 | 2,744 | 15% | 419 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 21% | 20% | 83.4% | 75.7% | 75.7% | 22.4 |
| 1053 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Retail | ROB | 2,847 | 2,847 | 13% | 358 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 21% | 20% | 83.4% | 77.5% | 77.5% | 32.2 |
| 1054 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Retail | ROB | 2,847 | 2,847 | 18% | 500 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 21% | 20% | 83.4% | 75.1% | 75.1% | 35.4 |
| 1055 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 2,509 | 2,509 | 28% | 713 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 21% | 20% | 44.0% | 36.0% | 36.0% | 3.2 |
| 1056 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 2,509 | 2,509 | 32% | 814 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 21% | 20% | 44.0% | 36.0% | 36.0% | 3.4 |
| 1057 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 2,616 | 2,616 | 40% | 1,038 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 21% | 20% | 44.0% | 36.0% | 36.0% | 3.8 |
| 1058 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Retail | ROB | 2,616 | 2,616 | 53% | 1,381 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 21% | 20% | 44.0% | 36.0% | 36.0% | 4.5 |
| 1059 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Retail | ROB | 2,102 | 2,102 | 9% | 193 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 21% | 2% | 83.4% | 45.3% | 45.3% | 8.6 |
| 1060 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Retail | ROB | 2,933 | 2,933 | 8% | 245 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 21% | 20% | 83.4% | 75.8% | 75.8% | 25.2 |
| 1061 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Retail | ROB | 2,933 | 2,933 | 14% | 413 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 21% | 20% | 83.4% | 71.5% | 71.5% | 29.7 |
| 1062 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Retail | ROB | 2,847 | 2,847 | 37% | 1,052 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 21% | 20% | 57.1% | 36.0% | 36.0% | 6.1 |
| 1063 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Retail | ROB | 2,847 | 2,847 | 40% | 1,152 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 21% | 20% | 58.3% | 36.0% | 36.0% | 6.4 |
| 1064 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Retail | ROB | 2,847 | 2,847 | 45% | 1,270 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 21% | 20% | 59.6% | 36.0% | 36.0% | 6.7 |
| 1065 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Retail | ROB | 2,847 | 2,847 | 57% | 1,613 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 21% | 20% | 62.2% | 36.0% | 36.0% | 7.3 |
| 1066 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Retail | ROB | 2,296 | 2,296 | 17% | 388 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 14% | 20% | 83.4% | 52.6% | 52.6% | 10.8 |
| 1067 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Retail | ROB | 2,554 | 2,554 | 3% | 69 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 3% | 10% | 69.5% | 58.0% | 58.0% | 1.7 |
| 1068 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Retail | ROB | 2,994 | 2,994 | 11% | 331 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 3% | 10% | 83.4% | 76.2% | 76.2% | 8.6 |
| 1069 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Retail | ROB | 2,772 | 2,772 | 6% | 172 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 3% | 10% | 83.4% | 71.1% | 71.1% | 4.4 |
| 1070 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Retail | ROB | 4,687 | 4,687 | 67% | 3,139 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 23% | 75.5% | 64.1% | 64.1% | 3.4 |
| 1071 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Retail | Retro | 4,687 | 4,687 | 2% | 94 | 0.00 | 20 | $60 | 100% | 12% | 12% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.2 |
| 1072 | HotWater | Faucet Aerator | Biz-Prescriptive | Retail | Retro | 284 | 284 | 32% | 92 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 5.1 |
| 1073 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Retail | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 21.2 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1074 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Retail | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.3% | 45.6% | 45.6% | 3.5 |
| 1075 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Retail | Retro | 153 | 153 | 45% | 68 | 0.00 | 12 | $3 | 100% | 100% | 100% | 1 | 68% | 38% | 85.0% | 85.0% | 85.0% | 13.9 |
| 1076 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Retail | Retro | 346 | 346 | 50% | 173 | 0.00 | 12 | $70 | 100% | 43% | 43% | 1 | 68% | 38% | 85.0% | 65.3% | 65.3% | 3.5 |
| 1077 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Retail | Retro | 346 | 346 | 50% | 173 | 0.00 | 12 | $70 | 100% | 79% | 79% | 1 | 68% | 38% | 85.0% | 78.1% | 78.1% | 1.9 |
| 1078 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Retail | Retro | 346 | 346 | 74% | 257 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 8% | 38% | 56.4% | 50.2% | 50.2% | 1.1 |
| 1079 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Retail | Retro | 3,225 | 3,225 | 68% | 2,194 | 0.00 | 12 | $330 | 100% | 45% | 45% | 3 | 1% | 19% | 85.0% | 78.4% | 78.4% | 8.9 |
| 1080 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Retail | Retro | 3,225 | 3,225 | 66% | 2,140 | 0.00 | 12 | $330 | 100% | 45% | 45% | 3 | 1% | 19% | 85.0% | 78.3% | 78.3% | 8.7 |
| 1081 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Retail | Retro | 687 | 687 | 61% | 417 | 0.00 | 12 | $75 | 100% | 100% | 100% | 4 | 1% | 19% | 85.0% | 85.0% | 85.0% | 3.4 |
| 1082 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Retail | Retro | 687 | 687 | 59% | 403 | 0.00 | 12 | $75 | 100% | 100% | 100% | 4 | 1% | 19% | 85.0% | 85.0% | 85.0% | 3.3 |
| 1083 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Retail | ROB | 257 | 257 | 86% | 221 | 0.00 | 5 | $1 | 100% | 100% | 100% | 5 | 3% | 13% | 85.0% | 85.0% | 85.0% | 77.5 |
| 1084 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Retail | Retro | 238 | 238 | 68% | 161 | 0.00 | 12 | $27 | 100% | 37% | 37% | 6 | 19% | 13% | 85.0% | 76.3% | 76.3% | 9.7 |
| 1085 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Retail | ROB | 194 | 194 | 81% | 157 | 0.00 | 5 | $1 | 100% | 100% | 100% | 6 | 19% | 13% | 85.0% | 85.0% | 85.0% | 55.2 |
| 1086 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Retail | Retro | 128 | 128 | 100% | 128 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 68% | 0% | 85.0% | 83.1% | 83.1% | 72.0 |
| 1087 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Retail | Retro | 582 | 582 | 30% | 175 | 0.00 | 10 | $65 | 75% | 20% | 20% | 8 | 95% | 10% | 74.6% | 44.8% | 44.8% | 4.4 |
| 1088 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Retail | Retro | 746 | 746 | 30% | 224 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 71.0% | 71.0% | 6.2 |
| 1089 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Retail | Retro | 333 | 333 | 44% | 146 | 0.00 | 10 | $75 | 100% | 26% | 26% | 8 | 95% | 10% | 85.0% | 47.3% | 47.3% | 3.9 |
| 1090 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Retail | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 50% | 18% | 18% | 8 | 95% | 10% | 55.0% | 37.1% | 37.1% | 4.1 |
| 1091 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Retail | Retro | 3 | 3 | 49% | 1 | 0.00 | 15 | $1 | 100% | 42% | 42% | 8 | 95% | 10% | 85.0% | 63.0% | 63.0% | 3.8 |
| 1092 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Retail | Retro | 333 | 333 | 65% | 216 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 77% | 10% | 85.0% | 53.5% | 53.5% | 8.2 |
| 1093 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Retail | Retro | 67 | 67 | 43% | 29 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 1094 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Retail | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 79.4% | 79.4% | 10.1 |
| 1095 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Retail | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 46% | 46% | 1 | 12% | 44% | 60.8% | 55.2% | 55.2% | 1.6 |
| 1096 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Retail | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 1097 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Retail | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 3 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.4 |
| 1098 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Retail | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 1099 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Retail | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 25% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.6 |
| 1100 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Retail | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.7 |
| 1101 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Retail | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.0 |
| 1102 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Retail | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 50% | 30% | 30% | 8 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.4 |
| 1103 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Retail | Retro | 346 | 346 | 69% | 239 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 55.2% | 55.2% | 0.8 |
| 1104 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Retail | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 1105 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Retail | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 1106 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Retail | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 1107 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Retail | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 41% | 10% | 85.0% | 64.1% | 64.1% | 3.3 |
| 1108 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Retail | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,186 | 100% | 33% | 33% | 3 | 0% | 10% | 85.0% | 69.2% | 69.2% | 8.8 |
| 1109 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Retail | Retro | 1,909 | 1,909 | 83% | 1,585 | 0.00 | 10 | $483 | 100% | 26% | 26% | 4 | 5% | 10% | 85.0% | 66.4% | 66.4% | 6.9 |
| 1110 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Retail | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 0% | 2% | 31.4% | 17.2% | 17.2% | 3.6 |
| 1111 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Retail | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 7.9 |
| 1112 | Motors | Cogged V-Belt | Biz-Custom | Retail | Retro | 14,670 | 14,670 | 3% | 455 | 0.00 | 15 | $384 | 75% | 9% | 9% | 1 | 50% | 10% | 65.5% | 37.6% | 37.6% | 9.1 |
| 1113 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Retail | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 67.2% | 67.2% | 8.5 |
| 1114 | Motors | Power Drive Systems | Biz-Custom | Retail | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 66.9% | 66.9% | 8.6 |
| 1115 | Motors | Switch Reluctance Motors | Biz-Custom | Retail | Retro | 28,430 | 28,430 | 31% | 8,700 | 0.00 | 15 | $739 | 100% | 100% | 100% | 2 | 100% | 1% | 83.4% | 83.4% | 83.4% | 5.7 |
| 1116 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Retail | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.0 |
| 1117 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Retail | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% | | | 1 | 30% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 1118 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Retail | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.8 |
| 1119 | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Retail | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.1 |
| 1120 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Retail | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.6% | 83.6% | 36.3 |
| 1121 | Office_PC | Energy Star Server | Biz-Custom | Retail | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 59.8% | 59.8% | 4.3 |
| 1122 | Office_PC | Server Virtualization | Biz-Custom | Retail | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.1 |
| 1123 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Retail | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 51.4% | 51.4% | 7.2 |
| 1124 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Retail | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.8 |
| 1125 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Retail | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.4% | 77.4% | 6.9 |
| 1126 | Office_PC | Energy Star Laptop | Biz-Custom | Retail | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% | | | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 1127 | Office_PC | Energy Star Monitor | Biz-Custom | Retail | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% | | | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 1128 | Refrigeration | Strip Curtains | Biz-Prescriptive | Retail | Retro | 0 | 0 | 0% | 0 | 0.00 | 4 | $0 | 0% | 0% | | 1 | 6% | 30% | 79.2% | 79.2% | 79.2% | 0.0 |
| 1129 | Refrigeration | Bare Suction Line | Biz-Custom | Retail | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.6% | 72.6% | 6.9 |
| 1130 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Retail | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 5% | 5% | 5% | 3 | 4% | 25% | 47.5% | 39.9% | 39.9% | 4.8 |
| 1131 | Refrigeration | Saturated Suction Controls | Biz-Custom | Retail | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.6% | 28.1% | 28.1% | 12.8 |
| 1132 | Refrigeration | Compressor Retrofit | Biz-Custom | Retail | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 13% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| 1133 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Retail | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 4% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 1134 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Retail | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 4% | 25% | 79.2% | 71.9% | 71.9% | 2.5 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1135 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Retail | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 5% | 25% | 47.5% | 40.0% | 40.0% | 4.8 |
| 1136 | Refrigeration | Refrigeration Economizer | Biz-Custom | Retail | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 18% | 10% | 79.2% | 69.2% | 69.2% | 3.3 |
| 1137 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Retail | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 18% | 75% | 82.5% | 80.0% | 80.0% | 1.2 |
| 1138 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Retail | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 13% | 50% | 79.2% | 75.9% | 75.9% | 3.2 |
| 1139 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Retail | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 5% | 25% | 47.5% | 40.0% | 40.0% | 6.6 |
| 1140 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Retail | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 3% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 1141 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Retail | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 3% | 2% | 79.2% | 72.7% | 72.7% | 5.2 |
| 1142 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Retail | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 17% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 1143 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Retail | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 17% | 54% | 67.8% | 63.2% | 63.2% | 1.7 |
| 1144 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Retail | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 6% | 75% | 82.5% | 80.0% | 80.0% | 4.7 |
| 1145 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Retail | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 6% | 50% | 79.2% | 77.8% | 77.8% | 7.7 |
| 1146 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Retail | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 6% | 25% | 79.2% | 50.9% | 50.9% | 6.6 |
| 1147 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Retail | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 6% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 1148 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Retail | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 6% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 1149 | Refrigeration | Refrigeration - Custom | Biz-Custom | Retail | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.2% | 69.2% | 3.3 |
| 1150 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Retail | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 1151 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Retail | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 2% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 1152 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Retail | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 4% | 30% | 51.0% | 45.6% | 45.6% | 2.2 |
| 1153 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Retail | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 11% | 66% | 79.2% | 77.7% | 77.7% | 24.0 |
| 1154 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Retail | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 11% | 13% | 79.2% | 75.2% | 75.2% | 18.9 |
| 1155 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Retail | Retro | 2,798 | 2,798 | 20% | 560 | 0.00 | 15 | $227 | 100% | 20% | 20% | 1 | 100% | 18% | 83.4% | 58.5% | 58.5% | 9.9 |
| 1156 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Retail | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 18% | 83.4% | 66.4% | 66.4% | 8.6 |
| 1157 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Retail | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 72.8% | 72.8% | 7.5 |
| 1158 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Retail | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% |  | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 1159 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Retail | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 72.8% | 72.8% | 7.5 |
| 1160 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Retail | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 72.8% | 72.8% | 6.4 |
| 1161 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Retail | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 72.8% | 72.8% | 6.4 |
| 1162 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Retail | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 58.6% | 36.0% | 36.0% | 21.0 |
| 1163 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Retail | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 71.9% | 71.9% | 5.7 |
| 1164 | Behavioral | COM Competitions | Biz-Custom | Retail | Retro | 53 | 53 | 2% | 1 | 0.00 | 2 | $0 | 100% | 48% | 48% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 3.7 |
| 1165 | Behavioral | Business Energy Reports | Biz-Custom | Retail | Retro | 313 | 313 | 0% | 1 | 0.00 | 2 | $0 | 100% | 100% | 100% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 0.4 |
| 1166 | Behavioral | Building Benchmarking | Biz-Custom | Retail | Retro | 97 | 97 | 1% | 1 | 0.00 | 2 | $0 | 77% | 77% | 77% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 0.4 |
| 1167 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Retail | Retro | 0 | 0 | 0% | 0 | 0.00 | 5 | $0 | 0% |  | 7% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 0.0 |
| 1168 | Behavioral | BEIMS | Biz-Custom | Retail | Retro | 20 | 20 | 5% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 50.0% | 50.0% | 50.0% | 0.4 |
| 1169 | Behavioral | Building Operator Certification | Biz-Custom | Retail | Retro | 14 | 14 | 3% | 0 | 0.00 | 3 | $0 | 33% | 33% | 33% | 1 | 100% | 2% | 50.0% | 50.0% | 50.0% | 0.9 |
| 1170 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Office | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 1171 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Office | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 1172 | CompressedAir | AODD Pump Controls | Biz-Custom | Office | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 1173 | CompressedAir | Compressed Air - Custom | Biz-Custom | Office | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 1174 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Office | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 1175 | Cooking | Commercial Combination Oven  (Electric) | Biz-Prescriptive | Office | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.5 |
| 1176 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Office | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 1177 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Office | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 1178 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Office | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 70.6% | 70.6% | 9.0 |
| 1179 | Cooking | Dishwasher  Low Temp Door (Energy Star) | Biz-Prescriptive | Office | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.5 |
| 1180 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Office | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 74.9% | 74.9% | 8.2 |
| 1181 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Office | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.1% | 45.1% | 45.1% | 17.1 |
| 1182 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Office | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.6% | 75.6% | 5.3 |
| 1183 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Office | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 57.8% | 41.7% | 41.7% | 5.3 |
| 1184 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Office | ROB | 1,406 | 1,406 | 6% | 87 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 26% | 20% | 83.4% | 71.5% | 71.5% | 2.3 |
| 1185 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Office | ROB | 1,406 | 1,406 | 13% | 181 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 26% | 20% | 83.4% | 56.5% | 56.5% | 4.8 |
| 1186 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Office | ROB | 1,406 | 1,406 | 28% | 397 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 26% | 20% | 83.4% | 69.3% | 69.3% | 10.6 |
| 1187 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Office | ROB | 1,406 | 1,406 | 42% | 589 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 26% | 20% | 83.4% | 72.5% | 72.5% | 15.8 |
| 1188 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Office | ROB | 1,505 | 1,505 | 6% | 87 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 26% | 20% | 83.4% | 83.4% | 83.4% | 2.3 |
| 1189 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Office | ROB | 1,505 | 1,505 | 12% | 185 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 26% | 20% | 83.4% | 83.4% | 83.4% | 5.0 |
| 1190 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Office | ROB | 1,505 | 1,505 | 20% | 305 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 26% | 20% | 83.4% | 83.4% | 83.4% | 8.2 |
| 1191 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Office | ROB | 1,505 | 1,505 | 46% | 688 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 26% | 20% | 83.4% | 83.4% | 83.4% | 18.4 |
| 1192 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Office | Retro | 1,430 | 1,430 | 7% | 100 | 0.00 | 3 | $5 | 100% | 50% | 50% | 3 | 51% | 50% | 83.4% | 81.0% | 81.0% | 13.1 |
| 1193 | Cooling | Air Side Economizer | Biz-Custom | Office | Retro | 1,406 | 1,406 | 20% | 281 | 0.00 | 10 | $84 | 75% | 27% | 27% | 4 | 51% | 20% | 72.1% | 57.6% | 57.6% | 3.7 |
| 1194 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Office | Retro | 1,430 | 1,430 | 2% | 23 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 51% | 20% | 44.0% | 36.0% | 36.0% | 0.3 |
| 1195 | Cooling | HVAC Occupancy Controls | Biz-Custom | Office | ROB | 2,900 | 2,900 | 20% | 580 | 0.00 | 15 | $537 | 75% | 9% | 9% | 6 | 51% | 20% | 64.3% | 36.0% | 36.0% | 11.2 |
| 1196 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Office | ROB | 1,225 | 1,225 | 13% | 153 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 8% | 20% | 83.4% | 83.4% | 83.4% | 4.1 |
| 1197 | Cooling | Air Conditioner -  17 SEER (<5 Tons) | Biz-Prescriptive | Office | ROB | 1,225 | 1,225 | 18% | 216 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 8% | 20% | 83.4% | 43.9% | 43.9% | 5.8 |
| 1198 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Office | ROB | 1,225 | 1,225 | 22% | 272 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 8% | 20% | 83.4% | 47.5% | 47.5% | 7.3 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1199 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Office | ROB | 1,225 | 1,225 | 33% | 408 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 8% | 20% | 83.4% | 51.9% | 51.9% | 10.9 |
| 1200 | Cooling | Smart Thermostat | Biz-Prescriptive | Office | ROB | 1,225 | 1,225 | 14% | 174 | 0.00 | 11 | $175 | 50% | 26% | 26% | 8 | 8% | 12% | 45.1% | 37.2% | 37.2% | 2.5 |
| 1201 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Office | ROB | 1,442 | 1,442 | 8% | 122 | 0.00 | 8 | $84 | 100% | 42% | 42% | 9 | 7% | 20% | 83.4% | 56.7% | 56.7% | 2.7 |
| 1202 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Office | ROB | 1,581 | 1,581 | 7% | 115 | 0.00 | 8 | $84 | 100% | 42% | 42% | 10 | 7% | 20% | 83.4% | 55.0% | 55.0% | 2.5 |
| 1203 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Office | ROB | 1,806 | 1,806 | 10% | 172 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 7% | 20% | 83.4% | 64.0% | 64.0% | 3.8 |
| 1204 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Office | ROB | 1,252 | 1,252 | 6% | 70 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 35% | 15% | 83.4% | 38.9% | 38.9% | 3.1 |
| 1205 | Cooling | Chiller Tune-up | Biz-Custom | Office | Retro | 1,430 | 1,430 | 7% | 100 | 0.00 | 3 | $5 | 100% | 50% | 50% | 13 | 35% | 50% | 83.4% | 81.0% | 81.0% | 13.1 |
| 1206 | Cooling | HVAC/Chiller Custom | Biz-Custom | Office | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.3 |
| 1207 | Cooling | Window Film | Biz-Custom | Office | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 50.6% | 50.6% | 11.8 |
| 1208 | Cooling | Triple Pane Windows | Biz-Custom | Office | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 51.7% | 36.0% | 36.0% | 21.8 |
| 1209 | Cooling | Energy Recovery Ventilator | Biz-Custom | Office | Retro | 1,505 | 1,505 | 63% | 952 | 0.00 | 15 | $1,500 | 100% | 5% | 5% | 16 | 100% | 2% | 83.4% | 38.1% | 38.1% | 30.8 |
| 1210 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 4% | 111 | 0.00 | 16 | $87 | 100% | 57% | 57% | 1 | 8% | 20% | 83.4% | 59.7% | 59.7% | 2.0 |
| 1211 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 8% | 248 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 8% | 20% | 44.0% | 36.0% | 36.0% | 4.0 |
| 1212 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 12% | 356 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 8% | 20% | 44.0% | 36.0% | 36.0% | 5.7 |
| 1213 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 18% | 540 | 0.00 | 16 | $507 | 75% | 10% | 10% | 1 | 8% | 20% | 65.0% | 37.0% | 37.0% | 8.9 |
| 1214 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 22% | 654 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 8% | 20% | 44.0% | 36.0% | 36.0% | 1.8 |
| 1215 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 27% | 781 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 8% | 20% | 44.0% | 36.0% | 36.0% | 2.1 |
| 1216 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 32% | 929 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 8% | 20% | 44.0% | 36.0% | 36.0% | 2.4 |
| 1217 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 47% | 1,360 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 8% | 20% | 44.0% | 36.0% | 36.0% | 3.1 |
| 1218 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Office | ROB | 3,512 | 3,512 | 11% | 378 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 27% | 20% | 83.4% | 78.2% | 78.2% | 20.9 |
| 1219 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Office | ROB | 3,512 | 3,512 | 16% | 560 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 27% | 20% | 83.4% | 75.7% | 75.7% | 23.6 |
| 1220 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Office | ROB | 3,653 | 3,653 | 14% | 506 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 27% | 20% | 83.4% | 77.5% | 77.5% | 34.0 |
| 1221 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Office | ROB | 3,653 | 3,653 | 19% | 688 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 27% | 20% | 83.4% | 75.2% | 75.2% | 37.8 |
| 1222 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Office | ROB | 3,204 | 3,204 | 29% | 938 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 27% | 20% | 44.0% | 36.0% | 36.0% | 3.5 |
| 1223 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Office | ROB | 3,204 | 3,204 | 33% | 1,064 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 27% | 20% | 44.0% | 36.0% | 36.0% | 3.8 |
| 1224 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Office | ROB | 3,385 | 3,385 | 41% | 1,393 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 27% | 20% | 44.0% | 36.0% | 36.0% | 4.4 |
| 1225 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Office | ROB | 3,385 | 3,385 | 54% | 1,825 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 27% | 20% | 44.0% | 36.0% | 36.0% | 5.2 |
| 1226 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Office | ROB | 2,708 | 2,708 | 12% | 327 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 27% | 2% | 83.4% | 48.0% | 48.0% | 10.3 |
| 1227 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Office | ROB | 3,797 | 3,797 | 9% | 346 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 27% | 20% | 83.4% | 75.8% | 75.8% | 26.5 |
| 1228 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Office | ROB | 3,797 | 3,797 | 15% | 569 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 27% | 20% | 83.4% | 71.6% | 71.6% | 31.7 |
| 1229 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Office | ROB | 3,653 | 3,653 | 38% | 1,386 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 27% | 20% | 58.4% | 36.0% | 36.0% | 6.7 |
| 1230 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Office | ROB | 3,653 | 3,653 | 41% | 1,512 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 27% | 20% | 59.7% | 36.0% | 36.0% | 7.0 |
| 1231 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Office | ROB | 3,653 | 3,653 | 45% | 1,661 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 27% | 20% | 61.0% | 36.0% | 36.0% | 7.3 |
| 1232 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Office | ROB | 3,653 | 3,653 | 57% | 2,092 | 0.00 | 25 | $2,576 | 100% | 14% | 14% | 3 | 27% | 20% | 83.4% | 36.0% | 36.0% | 8.1 |
| 1233 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Office | ROB | 2,921 | 2,921 | 18% | 540 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 28% | 20% | 83.4% | 57.0% | 57.0% | 12.7 |
| 1234 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Office | ROB | 3,225 | 3,225 | 4% | 117 | 0.00 | 8 | $84 | 75% | 48% | 48% | 5 | 3% | 10% | 70.9% | 61.8% | 61.8% | 2.1 |
| 1235 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Office | ROB | 3,863 | 3,863 | 14% | 560 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 3% | 10% | 83.4% | 77.2% | 77.2% | 10.1 |
| 1236 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Office | ROB | 3,525 | 3,525 | 8% | 291 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 3% | 10% | 83.4% | 72.2% | 72.2% | 5.2 |
| 1237 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Office | ROB | 4,536 | 4,536 | 67% | 3,038 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 16% | 75.5% | 63.4% | 63.4% | 3.4 |
| 1238 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Office | Retro | 4,536 | 4,536 | 2% | 91 | 0.00 | 20 | $60 | 100% | 12% | 12% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.6 |
| 1239 | HotWater | Faucet Aerator | Biz-Prescriptive | Office | Retro | 545 | 545 | 32% | 176 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 14.1 |
| 1240 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Office | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 23.3 |
| 1241 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Office | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.3% | 45.6% | 45.6% | 3.8 |
| 1242 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Office | Retro | 115 | 115 | 45% | 51 | 0.00 | 15 | $3 | 100% | 100% | 100% | 1 | 72% | 38% | 85.0% | 85.0% | 85.0% | 13.2 |
| 1243 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Office | Retro | 260 | 260 | 50% | 130 | 0.00 | 15 | $70 | 100% | 43% | 43% | 1 | 72% | 38% | 85.0% | 55.8% | 55.8% | 3.3 |
| 1244 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Office | Retro | 260 | 260 | 50% | 130 | 0.00 | 15 | $70 | 100% | 79% | 79% | 1 | 72% | 38% | 85.0% | 75.3% | 75.3% | 1.8 |
| 1245 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Office | Retro | 260 | 260 | 74% | 193 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 8% | 38% | 56.4% | 49.8% | 49.8% | 0.9 |
| 1246 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Office | Retro | 2,423 | 2,423 | 68% | 1,649 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 1% | 19% | 85.0% | 75.8% | 75.8% | 8.5 |
| 1247 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Office | Retro | 2,423 | 2,423 | 66% | 1,608 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 1% | 19% | 85.0% | 75.6% | 75.6% | 8.3 |
| 1248 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Office | Retro | 516 | 516 | 61% | 314 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 1% | 19% | 85.0% | 85.0% | 85.0% | 3.2 |
| 1249 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Office | Retro | 516 | 516 | 59% | 303 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 1% | 19% | 85.0% | 85.0% | 85.0% | 3.1 |
| 1250 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Office | ROB | 283 | 283 | 86% | 243 | 0.00 | 7 | $1 | 100% | 100% | 100% | 5 | 2% | 13% | 85.0% | 85.0% | 85.0% | 103.3 |
| 1251 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Office | Retro | 179 | 179 | 68% | 121 | 0.00 | 15 | $27 | 100% | 37% | 37% | 6 | 17% | 13% | 85.0% | 72.9% | 72.9% | 9.3 |
| 1252 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Office | ROB | 214 | 214 | 81% | 173 | 0.00 | 7 | $1 | 100% | 100% | 100% | 6 | 17% | 13% | 85.0% | 85.0% | 85.0% | 73.6 |
| 1253 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Office | Retro | 96 | 96 | 100% | 96 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 72% | 0% | 85.0% | 82.4% | 82.4% | 58.7 |
| 1254 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Office | Retro | 438 | 438 | 30% | 131 | 0.00 | 10 | $65 | 75% | 20% | 20% | 8 | 95% | 10% | 71.3% | 37.3% | 37.3% | 3.8 |
| 1255 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Office | Retro | 560 | 560 | 30% | 168 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 68.0% | 68.0% | 6.2 |
| 1256 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Office | Retro | 250 | 250 | 44% | 110 | 0.00 | 10 | $75 | 75% | 26% | 26% | 8 | 95% | 10% | 70.2% | 37.3% | 37.3% | 3.2 |
| 1257 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Office | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 75% | 18% | 18% | 8 | 95% | 10% | 71.5% | 37.1% | 37.1% | 4.3 |
| 1258 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Office | Retro | 5 | 5 | 49% | 2 | 0.00 | 15 | $1 | 100% | 42% | 42% | 8 | 95% | 10% | 85.0% | 70.0% | 70.0% | 5.3 |
| 1259 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Office | Retro | 589 | 589 | 65% | 383 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 81% | 10% | 85.0% | 65.3% | 65.3% | 11.4 |
| 1260 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Office | Retro | 70 | 70 | 43% | 30 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.8 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1261 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Office | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 78.1% | 78.1% | 7.9 |
| 1262 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Office | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 46% | 46% | 1 | 12% | 44% | 71.7% | 55.2% | 55.2% | 1.6 |
| 1263 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Office | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 1264 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Office | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 3 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.5 |
| 1265 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Office | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 1266 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Office | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 50% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 3.8 |
| 1267 | ExteriorLighting | LED parking garage fixture (existing W<250) | Biz-Prescriptive Light | Office | Retro | 1,742 | 1,742 | 66% | 1,154 | 0.00 | 6 | $248 | 75% | 32% | 32% | 6 | 11% | 44% | 78.8% | 67.1% | 67.1% | 2.8 |
| 1268 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W≥250) | Biz-Prescriptive Light | Office | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 7 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.1 |
| 1269 | ExteriorLighting | LED Mogul-base HID Lamp Replacing Exterior HID (existing W<250) | Biz-Prescriptive Light | Office | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 8 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.5 |
| 1270 | ExteriorLighting | Bi-Level Lighting Fixture – Garages | Biz-Prescriptive Light | Office | Retro | 260 | 260 | 69% | 179 | 0.00 | 10 | $274 | 29% | 29% | 29% | 9 | 11% | 44% | 60.8% | 53.6% | 53.6% | 0.7 |
| 1271 | ExteriorLighting | LED fuel pump canopy fixture (existing W<250) | Biz-Prescriptive Light | Office | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 10 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 1272 | ExteriorLighting | LED fuel pump canopy fixture (existing W≥250) | Biz-Prescriptive Light | Office | Retro | 0 | 0 | 0% | 0 | 0.00 | 12 | $0 | 0% | 0% | | 11 | 0% | 44% | 85.0% | 85.0% | 85.0% | 0.0 |
| 1273 | Miscellaneous | Vending Machine Controller - Non-Refrigerated | Biz-Prescriptive | Office | Retro | 385 | 385 | 61% | 237 | 0.00 | 5 | $233 | 17% | 17% | 17% | 1 | 5% | 30% | 51.0% | 44.0% | 44.0% | 1.0 |
| 1274 | Miscellaneous | Miscellaneous Custom | Biz-Custom | Office | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 2 | 32% | 10% | 85.0% | 63.4% | 63.4% | 3.3 |
| 1275 | Miscellaneous | Kitchen Exhaust Hood Demand Ventilation Control System | Biz-Custom | Office | ROB | 9,932 | 9,932 | 50% | 4,966 | 0.00 | 20 | $1,187 | 100% | 33% | 33% | 3 | 31% | 10% | 85.0% | 69.2% | 69.2% | 8.8 |
| 1276 | Miscellaneous | High Efficiency Hand Dryers | Biz-Custom | Office | Retro | 262 | 262 | 83% | 217 | 0.00 | 10 | $483 | 25% | 4% | 4% | 4 | 5% | 10% | 37.0% | 23.9% | 23.9% | 8.4 |
| 1277 | Miscellaneous | Ozone Commercial Laundry | Biz-Custom | Office | Retro | 2,984 | 2,984 | 25% | 746 | 0.00 | 10 | $20,310 | 0% | 0% | 0% | 5 | 3% | 2% | 31.4% | 17.2% | 17.2% | 3.7 |
| 1278 | Miscellaneous | ENERGY STAR Uninterrupted Power Supply | Biz-Custom | Office | ROB | 3,096 | 3,096 | 3% | 85 | 0.00 | 15 | $59 | 75% | 12% | 12% | 6 | 20% | 70% | 79.0% | 76.0% | 76.0% | 8.2 |
| 1279 | Motors | Cogged V-Belt | Biz-Custom | Office | Retro | 9,092 | 9,092 | 3% | 282 | 0.00 | 15 | $384 | 50% | 6% | 6% | 1 | 50% | 10% | 42.5% | 30.6% | 30.6% | 11.6 |
| 1280 | Motors | Pump and Fan Variable Frequency Drive Controls (Pumps) | Biz-Custom | Office | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 10% | 83.4% | 65.4% | 65.4% | 8.6 |
| 1281 | Motors | Power Drive Systems | Biz-Custom | Office | Retro | 4 | 4 | 23% | 1 | 0.00 | 15 | $0 | 100% | 31% | 31% | 2 | 100% | 10% | 83.4% | 68.2% | 68.2% | 11.0 |
| 1282 | Motors | Switch Reluctance Motors | Biz-Custom | Office | Retro | 17,620 | 17,620 | 31% | 5,392 | 0.00 | 15 | $528 | 100% | 87% | 87% | 2 | 100% | 1% | 83.4% | 81.5% | 81.5% | 5.7 |
| 1283 | Motors | Escalators Motor Efficiency Controllers | Biz-Custom | Office | Retro | 7,500 | 7,500 | 20% | 1,500 | 0.00 | 10 | $5,000 | 2% | 2% | 2% | 3 | 0% | 10% | 37.0% | 28.0% | 28.0% | 7.2 |
| 1284 | Office_NonPC | Energy Star Printer/Copier/Fax | Biz-Custom | Office | ROB | 551 | 551 | 40% | 223 | 0.00 | 6 | $0 | 0% | | | 1 | 30% | 90% | 93.0% | 92.0% | 92.0% | 0.0 |
| 1285 | Office_NonPC | Smart Power Strip – Commercial Use | Biz-Custom | Office | Retro | 1,086 | 1,086 | 10% | 109 | 0.00 | 7 | $50 | 25% | 17% | 17% | 2 | 35% | 15% | 40.5% | 36.1% | 36.1% | 2.8 |
| 1286 | Office_NonPC | Plug Load Occupancy Sensor | Biz-Custom | Office | Retro | 1,126 | 1,126 | 15% | 169 | 0.00 | 8 | $70 | 50% | 19% | 19% | 2 | 35% | 15% | 57.7% | 38.8% | 38.8% | 3.1 |
| 1287 | Office_PC | Electrically Commutated Plug Fans in data centers | Biz-Custom | Office | Retro | 86,783 | 86,783 | 18% | 15,778 | 0.00 | 15 | $480 | 100% | 50% | 50% | 1 | 65% | 20% | 85.0% | 83.5% | 83.5% | 36.7 |
| 1288 | Office_PC | Energy Star Server | Biz-Custom | Office | ROB | 1,621 | 1,621 | 23% | 368 | 0.00 | 8 | $118 | 100% | 25% | 25% | 1 | 65% | 25% | 85.0% | 58.1% | 58.1% | 4.4 |
| 1289 | Office_PC | Server Virtualization | Biz-Custom | Office | Retro | 2 | 2 | 45% | 1 | 0.00 | 8 | $0 | 100% | 50% | 50% | 1 | 65% | 25% | 85.0% | 75.5% | 75.5% | 3.1 |
| 1290 | Office_PC | High Efficiency CRAC unit | Biz-Custom | Office | ROB | 541 | 541 | 30% | 162 | 0.00 | 15 | $63 | 100% | 21% | 21% | 2 | 65% | 20% | 85.0% | 49.1% | 49.1% | 7.3 |
| 1291 | Office_PC | Computer Room Air Conditioner Economizer | Biz-Custom | Office | Retro | 418 | 418 | 86% | 358 | 0.00 | 15 | $82 | 100% | 35% | 35% | 2 | 65% | 20% | 85.0% | 66.6% | 66.6% | 4.9 |
| 1292 | Office_PC | Data Center Hot/Cold Aisle Configuration | Biz-Custom | Office | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 3% | 10% | 85.0% | 77.0% | 77.0% | 7.0 |
| 1293 | Office_PC | Energy Star Laptop | Biz-Custom | Office | ROB | 126 | 126 | 33% | 41 | 0.00 | 4 | $0 | 0% | | | 4 | 11% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 1294 | Office_PC | Energy Star Monitor | Biz-Custom | Office | ROB | 72 | 72 | 21% | 15 | 0.00 | 4 | $0 | 0% | | | 5 | 25% | 85% | 89.5% | 88.0% | 88.0% | 0.0 |
| 1295 | Refrigeration | Strip Curtains | Biz-Prescriptive | Office | Retro | 0 | 0 | 0% | 0 | 0.00 | 4 | $0 | 0% | 0% | | 1 | 10% | 30% | 79.2% | 79.2% | 79.2% | 0.0 |
| 1296 | Refrigeration | Bare Suction Line | Biz-Custom | Office | Retro | 23 | 23 | 93% | 21 | 0.00 | 15 | $4 | 100% | 42% | 42% | 2 | 0% | 50% | 79.2% | 72.6% | 72.6% | 6.9 |
| 1297 | Refrigeration | Floating Head Pressure Controls | Biz-Custom | Office | Retro | 1,112 | 1,112 | 25% | 278 | 0.00 | 15 | $431 | 5% | 5% | 5% | 3 | 7% | 25% | 47.5% | 39.9% | 39.9% | 4.8 |
| 1298 | Refrigeration | Saturated Suction Controls | Biz-Custom | Office | Retro | 831 | 831 | 50% | 416 | 0.00 | 15 | $559 | 75% | 6% | 6% | 4 | 2% | 10% | 66.6% | 28.1% | 28.1% | 12.8 |
| 1299 | Refrigeration | Compressor Retrofit | Biz-Custom | Office | Retro | 813 | 813 | 20% | 163 | 0.00 | 15 | $477 | 25% | 3% | 3% | 5 | 22% | 25% | 47.5% | 39.9% | 39.9% | 12.9 |
| 1300 | Refrigeration | Electronically Commutated (EC) Walk-In Evaporator Fan Motor | Biz-Prescriptive | Office | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 6 | 6% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 1301 | Refrigeration | Evaporator Fan Motor Controls | Biz-Prescriptive | Office | Retro | 1,912 | 1,912 | 25% | 478 | 0.00 | 13 | $162 | 100% | 62% | 62% | 7 | 6% | 25% | 79.2% | 71.9% | 71.9% | 2.5 |
| 1302 | Refrigeration | Variable Speed Condenser Fan | Biz-Custom | Office | Retro | 2,960 | 2,960 | 50% | 1,480 | 0.00 | 15 | $1,170 | 25% | 10% | 10% | 8 | 8% | 25% | 47.5% | 40.0% | 40.0% | 4.8 |
| 1303 | Refrigeration | Refrigeration Economizer | Biz-Custom | Office | Retro | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 9 | 31% | 10% | 79.2% | 69.2% | 69.2% | 3.3 |
| 1304 | Refrigeration | Anti-Sweat Heater Controls MT | Biz-Prescriptive | Office | Retro | 579 | 579 | 59% | 338 | 0.00 | 10 | $100 | 100% | 100% | 100% | 10 | 20% | 25% | 79.2% | 79.2% | 79.2% | 1.2 |
| 1305 | Refrigeration | Auto Door Closer, Cooler | Biz-Prescriptive | Office | Retro | 471,500 | 471,500 | 0% | 943 | 0.00 | 8 | $157 | 100% | 70% | 70% | 11 | 15% | 50% | 79.2% | 75.9% | 75.9% | 3.2 |
| 1306 | Refrigeration | Display Case Door Retrofit, Medium Temp | Biz-Custom | Office | Retro | 1,584 | 1,584 | 36% | 578 | 0.00 | 12 | $686 | 25% | 7% | 7% | 11 | 6% | 25% | 47.5% | 40.0% | 40.0% | 6.6 |
| 1307 | Refrigeration | Electronically Commutated (EC) Reach-In Evaporator Fan Motor | Biz-Prescriptive | Office | Retro | 2,440 | 2,440 | 65% | 1,586 | 0.00 | 15 | $305 | 100% | 13% | 13% | 12 | 3% | 80% | 86.0% | 84.0% | 84.0% | 22.0 |
| 1308 | Refrigeration | Q-Sync Motor for Walk-In and Reach-in Evaporator Fan Motor | Biz-Custom | Office | Retro | 1,911 | 1,911 | 26% | 504 | 0.00 | 10 | $96 | 100% | 42% | 42% | 12 | 3% | 2% | 79.2% | 72.7% | 72.7% | 5.2 |
| 1309 | Refrigeration | Energy Star Reach-In Refrigerator, Glass Doors | Biz-Prescriptive | Office | ROB | 2,140 | 2,140 | 29% | 629 | 0.00 | 12 | $1,239 | 6% | 6% | 6% | 13 | 19% | 54% | 67.8% | 63.2% | 63.2% | 4.2 |
| 1310 | Refrigeration | Energy Star Reach-In Refrigerator, Solid Doors | Biz-Prescriptive | Office | ROB | 1,410 | 1,410 | 20% | 281 | 0.00 | 12 | $1,211 | 6% | 6% | 6% | 14 | 19% | 54% | 67.8% | 63.2% | 63.2% | 1.7 |
| 1311 | Refrigeration | Anti-Sweat Heater Controls LT | Biz-Prescriptive | Office | Retro | 2,016 | 2,016 | 68% | 1,361 | 0.00 | 10 | $100 | 100% | 100% | 100% | 15 | 7% | 25% | 79.2% | 79.2% | 79.2% | 4.7 |
| 1312 | Refrigeration | Auto Door Closer, Freezer | Biz-Prescriptive | Office | Retro | 419,455 | 419,455 | 1% | 2,307 | 0.00 | 8 | $157 | 100% | 70% | 70% | 16 | 7% | 50% | 79.2% | 77.8% | 77.8% | 7.7 |
| 1313 | Refrigeration | Display Case Door Retrofit, Low Temp | Biz-Custom | Office | Retro | 2,922 | 2,922 | 50% | 1,453 | 0.00 | 12 | $686 | 100% | 17% | 17% | 16 | 7% | 25% | 79.2% | 50.9% | 50.9% | 6.6 |
| 1314 | Refrigeration | Energy Star Reach-In Freezer, Glass Doors | Biz-Prescriptive | Office | ROB | 6,374 | 6,374 | 20% | 1,275 | 0.00 | 12 | $1,651 | 28% | 28% | 28% | 17 | 7% | 54% | 67.8% | 63.2% | 63.2% | 1.3 |
| 1315 | Refrigeration | Energy Star Reach-In Freezer, Solid Doors | Biz-Prescriptive | Office | ROB | 4,522 | 4,522 | 7% | 305 | 0.00 | 12 | $1,521 | 13% | 13% | 13% | 18 | 7% | 54% | 67.8% | 63.2% | 63.2% | 0.7 |
| 1316 | Refrigeration | Refrigeration - Custom | Biz-Custom | Office | ROB | 7 | 7 | 2% | 0 | 0.00 | 10 | $0 | 100% | 50% | 50% | 19 | 90% | 25% | 79.2% | 69.2% | 69.2% | 3.3 |
| 1317 | Refrigeration | Retro-commissioning_Refrigerator Optimization | Biz-Custom RCx | Office | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 20 | 90% | 25% | 79.2% | 76.5% | 76.5% | 1.5 |
| 1318 | Refrigeration | Energy Star Ice Machine | Biz-Prescriptive | Office | ROB | 6,993 | 6,993 | 10% | 721 | 0.00 | 15 | $1,426 | 25% | 18% | 18% | 21 | 9% | 44% | 60.8% | 55.1% | 55.1% | 1.5 |
| 1319 | Refrigeration | Vending Machine Controller - Refrigerated | Biz-Prescriptive | Office | Retro | 1,586 | 1,586 | 34% | 537 | 0.00 | 5 | $245 | 25% | 16% | 16% | 22 | 9% | 30% | 51.0% | 45.6% | 45.6% | 2.2 |
| 1320 | Refrigeration | LED Refrigerated Display Case Lighting Average 6W/LF | Biz-Prescriptive | Office | Retro | 273 | 273 | 89% | 243 | 0.00 | 9 | $11 | 100% | 45% | 45% | 23 | 12% | 66% | 79.2% | 77.7% | 77.7% | 24.0 |
| 1321 | Refrigeration | LED Refrigerated Display Case Lighting Controls | Biz-Prescriptive | Office | Retro | 522 | 522 | 27% | 141 | 0.00 | 10 | $14 | 100% | 30% | 30% | 24 | 12% | 13% | 79.2% | 75.2% | 75.2% | 18.9 |
| 1322 | Ventilation | Demand Controlled Ventilation | Biz-Custom | Office | Retro | 2,644 | 2,644 | 20% | 529 | 0.00 | 15 | $227 | 100% | 19% | 19% | 1 | 100% | 48% | 83.4% | 58.6% | 58.6% | 5.7 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1323 | Ventilation | Pump and Fan Variable Frequency Drive Controls (Fans) | Biz-Prescriptive | Office | Retro | 1,902 | 1,902 | 38% | 731 | 0.00 | 15 | $200 | 100% | 30% | 30% | 2 | 100% | 48% | 83.4% | 65.9% | 65.9% | 8.5 |
| 1324 | WholeBldg_HVAC | HVAC - Energy Management System | Biz-Custom RCx | Office | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 1 | 100% | 20% | 83.4% | 72.8% | 72.8% | 7.6 |
| 1325 | WholeBldg_HVAC | Guest room energy management system | Biz-Prescriptive | Office | Retro | 0 | 0 | 0% | 0 | 0.00 | 15 | $260 | 0% | | 77% | 2 | 100% | 20% | 83.4% | 83.4% | 83.4% | 0.0 |
| 1326 | WholeBldg_HVAC | Retro-commissioning_Bld Optimization | Biz-Custom RCx | Office | Retro | 7 | 7 | 15% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 3 | 100% | 0% | 83.4% | 72.8% | 72.8% | 7.6 |
| 1327 | WholeBuilding | WholeBlg - Com RET | Biz-Custom | Office | Retro | 7 | 7 | 15% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 0% | 83.4% | 72.8% | 72.8% | 6.5 |
| 1328 | WholeBuilding | WholeBlg - Custom (Other) | Biz-Custom | Office | Retro | 5 | 5 | 20% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 2 | 100% | 0% | 83.4% | 72.8% | 72.8% | 6.5 |
| 1329 | WholeBuilding | Power Distribution Equipment Upgrades (Transformers) | Biz-Custom | Office | Retro | 1,150 | 1,150 | 1% | 6 | 0.00 | 30 | $8 | 75% | 4% | 4% | 3 | 100% | 20% | 58.3% | 36.0% | 36.0% | 21.3 |
| 1330 | WholeBldg_NC | WholeBlg - Com NC | Biz-Custom | Office | NC | 4 | 4 | 25% | 1 | 0.00 | 12 | $0 | 100% | 50% | 50% | 1 | 100% | 60% | 83.4% | 71.8% | 71.8% | 5.8 |
| 1331 | Behavioral | COM Competitions | Biz-Custom | Office | Retro | 53 | 53 | 2% | 1 | 0.00 | 2 | $0 | 100% | 48% | 48% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 3.8 |
| 1332 | Behavioral | Business Energy Reports | Biz-Custom | Office | Retro | 0 | 0 | 0% | 0 | 0.00 | 2 | $0 | 0% | | 100% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 0.0 |
| 1333 | Behavioral | Building Benchmarking | Biz-Custom | Office | Retro | 114 | 114 | 1% | 1 | 0.00 | 2 | $0 | 77% | 77% | 77% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 0.5 |
| 1334 | Behavioral | Strategic Energy Management | Biz-Custom SEM | Office | Retro | 33 | 33 | 3% | 1 | 0.00 | 5 | $0 | 50% | 7% | 7% | 1 | 100% | 0% | 50.0% | 50.0% | 50.0% | 8.6 |
| 1335 | Behavioral | BEIMS | Biz-Custom | Office | Retro | 29 | 29 | 4% | 1 | 0.00 | 2 | $0 | 39% | 39% | 39% | 1 | 100% | 2% | 50.0% | 50.0% | 50.0% | 0.5 |
| 1336 | Behavioral | Building Operator Certification | Biz-Custom | Office | Retro | 16 | 16 | 3% | 0 | 0.00 | 3 | $0 | 37% | 37% | 37% | 1 | 100% | 2% | 50.0% | 50.0% | 50.0% | 0.9 |
| 1337 | CompressedAir | Efficient Air Compressors (VSD) | Biz-Prescriptive | Warehouse | ROB | 1,583 | 1,583 | 21% | 329 | 0.00 | 13 | $127 | 100% | 47% | 47% | 1 | 100% | 33% | 83.4% | 69.0% | 69.0% | 5.2 |
| 1338 | CompressedAir | Efficient Air Nozzles | Biz-Prescriptive | Warehouse | Retro | 1,480 | 1,480 | 50% | 740 | 0.00 | 15 | $50 | 100% | 40% | 40% | 2 | 35% | 33% | 83.4% | 78.4% | 78.4% | 22.7 |
| 1339 | CompressedAir | AODD Pump Controls | Biz-Custom | Warehouse | Retro | 103,919 | 103,919 | 35% | 36,372 | 0.00 | 10 | $1,150 | 100% | 50% | 50% | 3 | 10% | 33% | 83.4% | 81.4% | 81.4% | 28.9 |
| 1340 | CompressedAir | Compressed Air - Custom | Biz-Custom | Warehouse | Retro | 5 | 5 | 20% | 1 | 0.00 | 10 | $0 | 100% | 38% | 38% | 4 | 50% | 33% | 83.4% | 69.6% | 69.6% | 5.7 |
| 1341 | CompressedAir | Retro-commissioning_Compressed Air Optimization | Biz-Custom RCx | Warehouse | Retro | 3 | 3 | 30% | 1 | 0.00 | 5 | $0 | 100% | 80% | 80% | 5 | 50% | 33% | 83.4% | 78.1% | 78.1% | 1.5 |
| 1342 | Cooking | Commercial Combination Oven (Electric) | Biz-Prescriptive | Warehouse | ROB | 38,561 | 38,561 | 48% | 18,432 | 0.00 | 12 | $16,884 | 50% | 6% | 6% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 10.5 |
| 1343 | Cooking | Commercial Electric Convection Oven | Biz-Prescriptive | Warehouse | ROB | 12,193 | 12,193 | 15% | 1,879 | 0.00 | 12 | $1,706 | 50% | 23% | 23% | 1 | 18% | 53% | 67.1% | 62.4% | 62.4% | 2.9 |
| 1344 | Cooking | Commercial Electric Griddle | Biz-Prescriptive | Warehouse | ROB | 17,056 | 17,056 | 15% | 2,596 | 0.00 | 12 | $3,604 | 25% | 22% | 22% | 2 | 14% | 17% | 41.9% | 33.6% | 33.6% | 1.4 |
| 1345 | Cooking | Commercial Electric Steam Cooker | Biz-Prescriptive | Warehouse | ROB | 19,549 | 19,549 | 67% | 13,162 | 0.00 | 12 | $3,300 | 100% | 27% | 27% | 3 | 6% | 45% | 79.2% | 70.6% | 70.6% | 9.0 |
| 1346 | Cooking | Dishwasher Low Temp Door (Energy Star) | Biz-Prescriptive | Warehouse | ROB | 39,306 | 39,306 | 44% | 17,369 | 0.00 | 15 | $662 | 100% | 76% | 76% | 4 | 26% | 61% | 79.2% | 78.5% | 78.5% | 16.5 |
| 1347 | Cooking | Dishwasher High Temp Door (Energy Star) | Biz-Prescriptive | Warehouse | ROB | 26,901 | 26,901 | 32% | 8,586 | 0.00 | 15 | $995 | 100% | 50% | 50% | 4 | 26% | 61% | 79.2% | 74.9% | 74.9% | 8.2 |
| 1348 | Cooking | Energy efficient electric fryer | Biz-Prescriptive | Warehouse | ROB | 18,955 | 18,955 | 17% | 3,274 | 0.00 | 12 | $1,500 | 75% | 5% | 5% | 5 | 27% | 24% | 72.1% | 45.1% | 45.1% | 17.1 |
| 1349 | Cooking | Insulated Holding Cabinets (Full Size) | Biz-Custom | Warehouse | ROB | 13,697 | 13,697 | 68% | 9,314 | 0.00 | 12 | $1,200 | 100% | 62% | 62% | 6 | 3% | 16% | 79.2% | 75.6% | 75.6% | 5.3 |
| 1350 | Cooking | Insulated Holding Cabinets (Half-Size) | Biz-Custom | Warehouse | ROB | 4,383 | 4,383 | 60% | 2,630 | 0.00 | 12 | $1,500 | 50% | 14% | 14% | 6 | 3% | 16% | 57.8% | 41.7% | 41.7% | 5.3 |
| 1351 | Cooling | Air Conditioner - 13 IEER (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 357 | 357 | 6% | 22 | 0.00 | 15 | $63 | 100% | 79% | 79% | 1 | 25% | 20% | 83.4% | 64.4% | 64.4% | 1.8 |
| 1352 | Cooling | Air Conditioner - 14 IEER (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 357 | 357 | 13% | 46 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 25% | 20% | 83.4% | 41.3% | 41.3% | 3.8 |
| 1353 | Cooling | Air Conditioner - 17 IEER (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 357 | 357 | 28% | 101 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 25% | 20% | 83.4% | 59.6% | 59.6% | 8.3 |
| 1354 | Cooling | Air Conditioner - 21 IEER (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 357 | 357 | 42% | 150 | 0.00 | 15 | $127 | 100% | 39% | 39% | 1 | 25% | 20% | 83.4% | 66.3% | 66.3% | 12.3 |
| 1355 | Cooling | Air Conditioner - 12.1 IEER (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 382 | 382 | 6% | 22 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 1.8 |
| 1356 | Cooling | Air Conditioner - 13 IEER (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 382 | 382 | 12% | 47 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 3.9 |
| 1357 | Cooling | Air Conditioner - 14.3 IEER (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 382 | 382 | 20% | 77 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 6.4 |
| 1358 | Cooling | Air Conditioner - 21 IEER (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 382 | 382 | 46% | 175 | 0.00 | 15 | $50 | 100% | 100% | 100% | 2 | 25% | 20% | 83.4% | 83.4% | 83.4% | 14.3 |
| 1359 | Cooling | Comprehensive Rooftop Unit Quality Maintenance (AC Tune-up) | Biz-Custom | Warehouse | Retro | 363 | 363 | 7% | 25 | 0.00 | 3 | $5 | 100% | 38% | 38% | 3 | 50% | 50% | 83.4% | 77.7% | 77.7% | 13.1 |
| 1360 | Cooling | Air Side Economizer | Biz-Custom | Warehouse | Retro | 357 | 357 | 20% | 71 | 0.00 | 10 | $84 | 7% | 7% | 7% | 4 | 50% | 20% | 44.0% | 36.0% | 36.0% | 3.4 |
| 1361 | Cooling | Advanced Rooftop Controls | Biz-Prescriptive | Warehouse | Retro | 363 | 363 | 2% | 6 | 0.00 | 10 | $98 | 26% | 26% | 26% | 5 | 50% | 20% | 44.0% | 36.0% | 36.0% | 0.1 |
| 1362 | Cooling | HVAC Occupancy Controls | Biz-Custom | Warehouse | ROB | 426 | 426 | 20% | 85 | 0.00 | 15 | $537 | 1% | 1% | 1% | 6 | 50% | 20% | 44.0% | 36.0% | 36.0% | 4.6 |
| 1363 | Cooling | Air Conditioner - 16 SEER (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 311 | 311 | 13% | 39 | 0.00 | 15 | $50 | 100% | 100% | 100% | 7 | 50% | 20% | 83.4% | 83.4% | 83.4% | 3.2 |
| 1364 | Cooling | Air Conditioner - 17 SEER (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 311 | 311 | 18% | 55 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 50% | 20% | 83.4% | 36.0% | 36.0% | 4.5 |
| 1365 | Cooling | Air Conditioner - 18 SEER(<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 311 | 311 | 22% | 69 | 0.00 | 15 | $206 | 100% | 24% | 24% | 7 | 50% | 20% | 83.4% | 36.0% | 36.0% | 5.7 |
| 1366 | Cooling | Air Conditioner - 21 SEER(<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 311 | 311 | 33% | 104 | 0.00 | 15 | $253 | 100% | 20% | 20% | 7 | 50% | 20% | 83.4% | 38.0% | 38.0% | 8.5 |
| 1367 | Cooling | Smart Thermostat | Biz-Prescriptive | Warehouse | ROB | 311 | 311 | 14% | 44 | 0.00 | 11 | $175 | 26% | 26% | 26% | 8 | 50% | 12% | 38.4% | 29.6% | 29.6% | 1.6 |
| 1368 | Cooling | PTAC - <7,000 Btuh - lodging | Biz-Prescriptive | Warehouse | ROB | 366 | 366 | 8% | 31 | 0.00 | 8 | $84 | 75% | 42% | 42% | 9 | 0% | 20% | 60.5% | 40.9% | 40.9% | 2.0 |
| 1369 | Cooling | PTAC - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Warehouse | ROB | 401 | 401 | 7% | 29 | 0.00 | 8 | $84 | 75% | 42% | 42% | 10 | 0% | 20% | 59.0% | 39.6% | 39.6% | 1.9 |
| 1370 | Cooling | PTAC - >15,000 Btuh - lodging | Biz-Prescriptive | Warehouse | ROB | 459 | 459 | 10% | 44 | 0.00 | 8 | $84 | 100% | 42% | 42% | 11 | 0% | 20% | 83.4% | 46.8% | 46.8% | 2.8 |
| 1371 | Cooling | Air Cooled Chiller | Biz-Prescriptive | Warehouse | ROB | 318 | 318 | 6% | 18 | 0.00 | 23 | $126 | 100% | 40% | 40% | 12 | 0% | 15% | 83.4% | 32.0% | 32.0% | 2.6 |
| 1372 | Cooling | Chiller Tune-up | Biz-Custom | Warehouse | Retro | 363 | 363 | 7% | 25 | 0.00 | 3 | $5 | 100% | 38% | 38% | 13 | 0% | 50% | 83.4% | 77.7% | 77.7% | 13.1 |
| 1373 | Cooling | HVAC/Chiller Custom | Biz-Custom | Warehouse | Retro | 5 | 5 | 20% | 1 | 0.00 | 20 | $1 | 100% | 6% | 6% | 14 | 100% | 20% | 83.4% | 36.0% | 36.0% | 28.0 |
| 1374 | Cooling | Window Film | Biz-Custom | Warehouse | Retro | 6,000 | 6,000 | 4% | 264 | 0.00 | 10 | $154 | 100% | 14% | 14% | 15 | 100% | 20% | 83.4% | 47.7% | 47.7% | 11.6 |
| 1375 | Cooling | Triple Pane Windows | Biz-Custom | Warehouse | ROB | 6,000 | 6,000 | 6% | 360 | 0.00 | 25 | $700 | 75% | 4% | 4% | 15 | 100% | 20% | 48.7% | 36.0% | 36.0% | 21.5 |
| 1376 | Cooling | Energy Recovery Ventilator | Biz-Custom | Warehouse | Retro | 382 | 382 | 0% | 0 | 0.00 | 15 | $1,500 | 0% | | 0% | 16 | 100% | 2% | 83.4% | 83.4% | 83.4% | 0.0 |
| 1377 | Heating | Heat Pump - 16 SEER (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 3% | 54 | 0.00 | 16 | $87 | 75% | 57% | 57% | 1 | 25% | 20% | 64.0% | 50.9% | 50.9% | 1.5 |
| 1378 | Heating | Heat Pump - 17 SEER (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 7% | 137 | 0.00 | 16 | $442 | 25% | 11% | 11% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 3.1 |
| 1379 | Heating | Heat Pump - 18 SEER(<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 10% | 198 | 0.00 | 16 | $507 | 25% | 10% | 10% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 4.4 |
| 1380 | Heating | Heat Pump - 21 SEER(<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 15% | 276 | 0.00 | 16 | $507 | 50% | 10% | 10% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 6.7 |
| 1381 | Heating | Geothermal HP - SEER 20.3 (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 21% | 398 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 1.4 |
| 1382 | Heating | Geothermal HP - SEER 21.5 (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 25% | 482 | 0.00 | 25 | $2,576 | 14% | 14% | 14% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 1.6 |
| 1383 | Heating | Geothermal HP - SEER 23.1 (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 31% | 580 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 1.8 |
| 1384 | Heating | Geothermal HP - SEER 29.3 (<5 Tons) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 46% | 868 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 1 | 25% | 20% | 44.0% | 36.0% | 36.0% | 2.4 |
| 1385 | Heating | Heat Pump - 14.0 IEER COP 3.6 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Warehouse | ROB | 2,249 | 2,249 | 9% | 209 | 0.00 | 16 | $100 | 100% | 50% | 50% | 2 | 13% | 20% | 83.4% | 78.0% | 78.0% | 19.5 |
| 1386 | Heating | Heat Pump - 15.0 IEER COP 3.8 (65,000-134,000 Btu/hr) | Biz-Prescriptive | Warehouse | ROB | 2,249 | 2,249 | 14% | 321 | 0.00 | 16 | $136 | 100% | 37% | 37% | 2 | 13% | 20% | 83.4% | 75.3% | 75.3% | 21.6 |
| 1387 | Heating | Heat Pump - 14.5 IEER COP 3.5 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Warehouse | ROB | 2,327 | 2,327 | 11% | 248 | 0.00 | 16 | $100 | 100% | 35% | 35% | 2 | 13% | 20% | 83.4% | 77.1% | 77.1% | 30.9 |

**Appendix C: C&I Measure Assumptions**

| Measure # | End-Use | Measure Name | Program | Building Type | Replacement Type | Base (Existing) Annual Electric | Base (Standard) Annual Electric | % Elec Savings | Per Unit Elec Savings | Per Unit Summer kW | EE EUL | Measure Cost | MAP Incentive (%) | RAP Incentive (%) | PP Incentive (%) | End Use Measure Group | Base Saturation | EE Saturation | MAP Adoption Rate | RAP Adoption Rate | PP Adoption Rate | UCT Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1388 | Heating | Heat Pump - 15.5 IEER COP 3.7 (135,000-239,000 Btu/hr) | Biz-Prescriptive | Warehouse | ROB | 2,327 | 2,327 | 16% | 364 | 0.00 | 16 | $139 | 100% | 25% | 25% | 2 | 13% | 20% | 83.4% | 74.5% | 74.5% | 33.9 |
| 1389 | Heating | Geothermal HP - SEER 20.3 (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 2,063 | 2,063 | 27% | 561 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 13% | 20% | 44.0% | 36.0% | 36.0% | 2.9 |
| 1390 | Heating | Geothermal HP - SEER 21.5 (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 2,063 | 2,063 | 31% | 645 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 13% | 20% | 44.0% | 36.0% | 36.0% | 3.2 |
| 1391 | Heating | Geothermal HP - SEER 23.1 (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 2,109 | 2,109 | 37% | 789 | 0.00 | 25 | $2,576 | 25% | 14% | 14% | 2 | 13% | 20% | 44.0% | 36.0% | 36.0% | 3.5 |
| 1392 | Heating | Geothermal HP - SEER 29.3 (5-20 Tons) | Biz-Prescriptive | Warehouse | ROB | 2,109 | 2,109 | 51% | 1,078 | 0.00 | 25 | $2,576 | 50% | 14% | 14% | 2 | 13% | 20% | 44.0% | 36.0% | 36.0% | 4.0 |
| 1393 | Heating | Variable Refrigerant Flow Heat Pump | Biz-Custom | Warehouse | ROB | 1,706 | 1,706 | 5% | 83 | 0.00 | 16 | $224 | 100% | 16% | 16% | 2 | 13% | 2% | 83.4% | 41.1% | 41.1% | 7.4 |
| 1394 | Heating | Heat Pump - 12 IEER 3.4 COP (>239,000 Btu/hr) | Biz-Prescriptive | Warehouse | ROB | 2,364 | 2,364 | 7% | 170 | 0.00 | 16 | $100 | 100% | 35% | 35% | 3 | 13% | 20% | 83.4% | 75.4% | 75.4% | 24.4 |
| 1395 | Heating | Heat Pump - 13 IEER 3.6 COP (>239,000 Btu/hr) | Biz-Prescriptive | Warehouse | ROB | 2,364 | 2,364 | 13% | 300 | 0.00 | 16 | $175 | 100% | 20% | 20% | 3 | 13% | 20% | 83.4% | 70.9% | 70.9% | 28.4 |
| 1396 | Heating | Geothermal HP - SEER 20.3 (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 2,327 | 2,327 | 35% | 825 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 13% | 20% | 54.8% | 36.0% | 36.0% | 5.8 |
| 1397 | Heating | Geothermal HP - SEER 21.5 (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 2,327 | 2,327 | 39% | 909 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 13% | 20% | 56.1% | 36.0% | 36.0% | 6.1 |
| 1398 | Heating | Geothermal HP - SEER 23.1 (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 2,327 | 2,327 | 43% | 1,007 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 13% | 20% | 57.4% | 36.0% | 36.0% | 6.3 |
| 1399 | Heating | Geothermal HP - SEER 29.3 (20+ Tons) | Biz-Prescriptive | Warehouse | ROB | 2,327 | 2,327 | 56% | 1,295 | 0.00 | 25 | $2,576 | 75% | 14% | 14% | 3 | 13% | 20% | 60.1% | 36.0% | 36.0% | 6.8 |
| 1400 | Heating | Mini Split Ductless Heat Pump Cold Climate (Tiers & sizes TBD) | Biz-Prescriptive | Warehouse | ROB | 1,899 | 1,899 | 15% | 276 | 0.00 | 16 | $224 | 100% | 16% | 16% | 4 | 50% | 20% | 83.4% | 47.4% | 47.4% | 9.6 |
| 1401 | Heating | PTHP - <7,000 Btuh - lodging | Biz-Custom | Warehouse | ROB | 2,136 | 2,136 | 1% | 30 | 0.00 | 8 | $84 | 50% | 48% | 48% | 5 | 0% | 10% | 53.2% | 51.8% | 51.8% | 1.5 |
| 1402 | Heating | PTHP - >15,000 Btuh - lodging | Biz-Prescriptive | Warehouse | ROB | 2,425 | 2,425 | 6% | 142 | 0.00 | 8 | $84 | 100% | 48% | 48% | 6 | 0% | 10% | 83.4% | 74.5% | 74.5% | 7.5 |
| 1403 | Heating | PTHP - 7,000 to 15,000 Btuh - lodging | Biz-Prescriptive | Warehouse | ROB | 2,294 | 2,294 | 3% | 74 | 0.00 | 8 | $84 | 100% | 48% | 48% | 7 | 0% | 10% | 83.4% | 69.2% | 69.2% | 3.8 |
| 1404 | HotWater | Heat Pump Water Heater | Biz-Prescriptive | Warehouse | ROB | 3,027 | 3,027 | 67% | 2,027 | 0.00 | 15 | $1,115 | 100% | 49% | 49% | 1 | 100% | 0% | 75.5% | 57.2% | 57.2% | 2.2 |
| 1405 | HotWater | Hot Water Pipe Insulation | Biz-Custom | Warehouse | Retro | 3,027 | 3,027 | 2% | 61 | 0.00 | 20 | $60 | 50% | 8% | 8% | 2 | 100% | 80% | 86.0% | 84.0% | 84.0% | 8.4 |
| 1406 | HotWater | Faucet Aerator | Biz-Prescriptive | Warehouse | Retro | 195 | 195 | 32% | 63 | 0.00 | 10 | $8 | 100% | 100% | 100% | 3 | 20% | 90% | 93.0% | 92.0% | 92.0% | 5.1 |
| 1407 | HotWater | Low Flow Pre-Rinse Sprayers | Biz-Custom | Warehouse | ROB | 18,059 | 18,059 | 54% | 9,789 | 0.00 | 5 | $75 | 100% | 100% | 100% | 4 | 20% | 80% | 86.0% | 84.0% | 84.0% | 22.3 |
| 1408 | HotWater | ENERGY STAR Commercial Washing Machines | Biz-Prescriptive | Warehouse | ROB | 1,552 | 1,552 | 43% | 671 | 0.00 | 7 | $250 | 50% | 18% | 18% | 5 | 25% | 32% | 60.5% | 45.7% | 45.7% | 3.7 |
| 1409 | InteriorLighting | LED T8 Tube Replacement | Biz-Prescriptive Light | Warehouse | Retro | 110 | 110 | 45% | 49 | 0.00 | 15 | $3 | 100% | 100% | 100% | 1 | 69% | 38% | 85.0% | 85.0% | 85.0% | 13.9 |
| 1410 | InteriorLighting | LED troffer retrofit kit, 2'X2' and 2'X4' | Biz-Prescriptive Light | Warehouse | Retro | 248 | 248 | 50% | 124 | 0.00 | 15 | $70 | 100% | 43% | 43% | 1 | 69% | 38% | 85.0% | 59.6% | 59.6% | 3.5 |
| 1411 | InteriorLighting | LED troffer, 2'X2' and 2'X4' | Biz-Prescriptive Light | Warehouse | Retro | 248 | 248 | 50% | 124 | 0.00 | 15 | $70 | 100% | 79% | 79% | 1 | 69% | 38% | 85.0% | 76.3% | 76.3% | 1.9 |
| 1412 | InteriorLighting | Bi-Level Lighting Fixture – Stairwells, Hallways | Biz-Custom Light | Warehouse | Retro | 248 | 248 | 74% | 184 | 0.00 | 10 | $274 | 29% | 29% | 29% | 2 | 8% | 38% | 56.4% | 49.5% | 49.5% | 0.8 |
| 1413 | InteriorLighting | LED high bay fixture | Biz-Prescriptive Light | Warehouse | Retro | 2,310 | 2,310 | 68% | 1,571 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 2% | 19% | 85.0% | 76.8% | 76.8% | 8.9 |
| 1414 | InteriorLighting | LED Mogul-base HID Lamp Replacing High Bay HID | Biz-Prescriptive Light | Warehouse | Retro | 2,310 | 2,310 | 66% | 1,532 | 0.00 | 15 | $330 | 100% | 45% | 45% | 3 | 2% | 19% | 85.0% | 76.5% | 76.5% | 8.7 |
| 1415 | InteriorLighting | LED low bay fixture | Biz-Prescriptive Light | Warehouse | Retro | 492 | 492 | 61% | 299 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 2% | 19% | 85.0% | 85.0% | 85.0% | 3.4 |
| 1416 | InteriorLighting | LED Mogul-base HID Lamp Replacing Low Bay HID | Biz-Prescriptive Light | Warehouse | Retro | 492 | 492 | 59% | 289 | 0.00 | 15 | $75 | 100% | 100% | 100% | 4 | 2% | 19% | 85.0% | 85.0% | 85.0% | 3.3 |
| 1417 | InteriorLighting | LED Screw-In Lamps (Directional) | Biz-Prescriptive Light | Warehouse | ROB | 352 | 352 | 86% | 302 | 0.00 | 6 | $1 | 100% | 100% | 100% | 5 | 2% | 13% | 85.0% | 85.0% | 85.0% | 107.7 |
| 1418 | InteriorLighting | LED downlight fixture | Biz-Prescriptive Light | Warehouse | Retro | 170 | 170 | 68% | 115 | 0.00 | 15 | $27 | 100% | 37% | 37% | 6 | 16% | 13% | 85.0% | 74.2% | 74.2% | 9.8 |
| 1419 | InteriorLighting | LED Screw-In Lamps (Omnidirectional & Decorative) | Biz-Prescriptive Light | Warehouse | ROB | 266 | 266 | 81% | 215 | 0.00 | 6 | $1 | 100% | 100% | 100% | 6 | 16% | 13% | 85.0% | 85.0% | 85.0% | 76.8 |
| 1420 | InteriorLighting | DeLamp Fluorescent Fixture Average Lamp Wattage 28W | Biz-Prescriptive Light | Warehouse | Retro | 91 | 91 | 100% | 91 | 0.00 | 11 | $4 | 100% | 25% | 25% | 7 | 69% | 0% | 85.0% | 82.7% | 82.7% | 61.5 |
| 1421 | InteriorLighting | Occupancy Sensors | Biz-Prescriptive Light | Warehouse | Retro | 417 | 417 | 30% | 125 | 0.00 | 10 | $65 | 50% | 20% | 20% | 8 | 95% | 10% | 52.5% | 36.3% | 36.3% | 3.3 |
| 1422 | InteriorLighting | Daylighting Controls | Biz-Prescriptive Light | Warehouse | Retro | 534 | 534 | 30% | 160 | 0.00 | 10 | $58 | 100% | 34% | 34% | 8 | 95% | 10% | 85.0% | 67.4% | 67.4% | 5.3 |
| 1423 | InteriorLighting | Dual Occupancy & Daylighting Controls | Biz-Custom Light | Warehouse | Retro | 238 | 238 | 44% | 105 | 0.00 | 10 | $75 | 75% | 26% | 26% | 8 | 95% | 10% | 71.6% | 39.3% | 39.3% | 3.4 |
| 1424 | InteriorLighting | Central Lighting Monitoring & Controls (non-networked) | Biz-Custom Light | Warehouse | Retro | 41,703 | 41,703 | 20% | 8,341 | 0.00 | 12 | $3,700 | 50% | 18% | 18% | 8 | 95% | 10% | 55.0% | 37.1% | 37.1% | 4.1 |
| 1425 | InteriorLighting | Network Lighting Controls - Wireless (WiFi) | Biz-Prescriptive Light | Warehouse | Retro | 3 | 3 | 49% | 1 | 0.00 | 15 | $1 | 100% | 42% | 42% | 8 | 95% | 10% | 85.0% | 63.4% | 63.4% | 3.8 |
| 1426 | InteriorLighting | Luminaire Level Lighting Controls w/ HVAC Control | Biz-Custom Light | Warehouse | Retro | 338 | 338 | 65% | 220 | 0.00 | 15 | $90 | 100% | 21% | 21% | 8 | 82% | 10% | 85.0% | 54.3% | 54.3% | 8.3 |
| 1427 | InteriorLighting | LED Exit Sign - 4 Watt Fixture (2 lamp) | Biz-Prescriptive Light | Warehouse | Retro | 63 | 63 | 43% | 27 | 0.00 | 5 | $33 | 31% | 31% | 31% | 9 | 1% | 75% | 82.5% | 80.0% | 80.0% | 0.7 |
| 1428 | InteriorLighting | Lighting - Custom | Biz-Custom Light | Warehouse | Retro | 4 | 4 | 25% | 1 | 0.00 | 15 | $0 | 100% | 50% | 50% | 10 | 100% | 0% | 85.0% | 79.4% | 79.4% | 10.1 |
| 1429 | ExteriorLighting | LED wallpack (existing W<250) | Biz-Prescriptive Light | Warehouse | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 46% | 46% | 1 | 12% | 44% | 71.7% | 55.2% | 55.2% | 1.7 |
| 1430 | ExteriorLighting | LED parking lot fixture (existing W≥250) | Biz-Prescriptive Light | Warehouse | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 2 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| 1431 | ExteriorLighting | LED parking lot fixture (existing W<250) | Biz-Prescriptive Light | Warehouse | Retro | 856 | 856 | 66% | 567 | 0.00 | 12 | $248 | 75% | 30% | 30% | 3 | 11% | 44% | 71.7% | 55.2% | 55.2% | 2.6 |
| 1432 | ExteriorLighting | LED outdoor pole decorative fixture (existing W≥250) | Biz-Prescriptive Light | Warehouse | Retro | 1,589 | 1,589 | 60% | 959 | 0.00 | 12 | $756 | 25% | 20% | 20% | 4 | 11% | 44% | 60.8% | 55.2% | 55.2% | 2.2 |
| 1433 | ExteriorLighting | LED parking garage fixture (existing W≥250) | Biz-Prescriptive Light | Warehouse | Retro | 3,235 | 3,235 | 60% | 1,953 | 0.00 | 6 | $756 | 50% | 13% | 13% | 5 | 11% | 44% | 60.8% | 55.2% | 55.2% | 4.0 |

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

**AES INDIANA**

aes Indiana

# 2022 Demand Side Management Market Potential Study

*November 18,*
2022

**FINAL REPORT**

*prepared by*

**GDS ASSOCIATES INC**

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

# AES INDIANA

aes Indiana

# 2022 Market Potential Study Distributed Energy Resources and Electrification

*September 2,* 2022

**FINAL REPORT**

*prepared by*

**GDS ASSOCIATES INC**

# VOLUME I *2022 MPS – DER and Electrification Report*



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# 1 Introduction

## 1.1 BACKGROUND & STUDY SCOPE

This distributed energy resource ("DER") and electrification Market Potential Study was conducted to as part of a broader effort that included an energy efficiency and demand response potential study in support of Integrated Resource Plan (IRP) and DSM planning for AES Indiana. The study included an analysis of various DER options including solar photovoltaics and combined heat and power, a study of transportation electrification, including both commercial sector and residential sector vehicles, and a building electrification analysis of the residential, commercial, and industrial sectors.

## 1.2 STUDY LIMITATIONS

This DER and Electrification Market Potential Study was developed using the best currently available data to inform the estimates of future potential. The long-term projections of these technologies remain highly uncertain as the cost-effectiveness of DER could change in future years and become a more attractive option, while electrification projections continue to evolve based on various factors such as policy decisions, manufacturer goals and consumer preferences.

## 1.3 ORGANIZATION OF REPORT

The remainder of this report is organized in seven sections as follows:

***Section 2 Distributed Energy Resources*** provides the approach to analyzing DER potential and the technical, economic and market potential for solar photovoltaics and combined heat and power.

***Section 3 Transportation Electrification*** provides the results of the analysis for commercial and residential transportation electrification.

***Section 4 Building Electrification*** provides approach and results of the building electrification analysis for the residential, commercial, and industrial sectors.

# 2 Distributed Energy Resources

The GDS Team considered distributed energy resources (DER) as sources of behind-the-meter customer-sited generation. The DER potential study followed the same method as the energy efficiency potential study in that the DER analysis reviewed the opportunity for technical, economic, and achievable potential. We used the same forecast data as used in the energy efficiency study to assess DER potential. The analysis limited resources for this potential study to technologies that are behind-the-meter and owned by the customer and did not consider market potential for supply-side resources. Specifically, this market potential assessment for DER focused on solar photovoltaic (PV) and combined heat and power (CHP) systems for the period 2023 to 2042.

## 2.1 APPROACH

The following section discusses the methods used to conduct the DER potential analysis. We detail approaches used to assess technical, economic, and achievable potential for solar PV and CHP.

### *2.1.1 Distributed Energy Resources Potential*

#### 2.1.1.1 Solar Photovoltaic Systems

Photovoltaic systems utilize solar panels, a packaged collection of photovoltaic cells, to convert sunlight into electricity. A system is constructed with multiple solar panels, a DC/AC inverter(s), a racking system to hold the panels, and electrical system interconnections. These systems are often roof-mounted and face south-west, south, and/or, south-east.

The study analyzed the potential associated with roof-mounted systems installed on residential and non-residential sector buildings. For the non-residential sector, the analysis also estimated potential for ground mounted (or covered parking) systems for a few specific business types. The analysis included battery storage as an additional configuration with each solar PV system type; however, due to the uncertainty associated with battery dispatch schedules, potential battery generation is excluded from this analysis. As noted above, this study did not explore the market potential associated utility-scale solar PV installations.

The approach to estimating technical potential required calculating the total square footage of suitable rooftop area within the AES-IN's territory and calculating solar PV system generation based on building and regional characteristics. Technical potential is computed using the following equation.

$$\boldsymbol{PV\ Technical\ Potential} = \boldsymbol{\Sigma}(\boldsymbol{Suitable\ Rooftop\ Square\ Footage}\ \times \boldsymbol{PV\ System\ Generation\ per\ Sq.Ft.})$$

The two key parameters in prior equation were estimated based on multiple data sources relevant to the AES-IN territory. Methods for defining these parameters are discussed below.

The GDS Team estimated total rooftop square footage using the forecast disaggregation analysis to characterize the residential and non-residential building stocks. The building stocks were characterized based on relevant parameters such as number of facilities, average number of floors, average premise consumption, and premise EUI. The GDS Team used these parameters to estimate the total rooftop square footage.

To estimate the fraction of the total roof area that is suitable for rooftop solar PV, the GDS Team relied on research completed by the National Renewable Energy Laboratory (NREL). NREL has developed estimates of the portion of total rooftops across the country that are suitable for solar PV based on analysis of LIDAR data. NREL criteria for suitable roof area include:

- **Contiguous rooftop area size:** Rooftops with fewer than 10 square meters of contiguous roof area excluded.

- **Rooftop orientation (tilt and azimuth):** Northeast through northwest orientation and roof pitches greater than 60 degrees excluded.
- **Shading:** Roof areas that had a minimum solar exposure of less than 80% relative to an unshaded roof were excluded.

Based on NREL's data, the GDS Team was able to apply unique suitability factors to estimate the total square footage of suitable rooftop for residential and non-residential buildings across AES-IN's territory.

The second key parameter – PV system generation – was estimated by developing standardized solar PV system configurations. These included system sizes for residential premises ranging from 3 to 20 kW (DC) and 10 to 2,000 kW (DC) for non-residential premises. Additionally, the GDS Team selected battery system sizes for each solar PV system size to dispatch energy for 2-4 hours.

The Team relied on NREL's PVWatts[1] (Version 6.1.4) and System Advisor Model (SAM)[2] tools to estimate system generation for both residential and non-residential sited systems. These tools model PV power density based on site specific data from NREL's LIDAR-based NSRDB to estimate total solar irradiance in conjunction with PV system specifications. The PV system simulations were generated based on Indianapolis, IN characteristics. The GDS Team based assumptions for PV system azimuth on rooftop orientation data sourced from Google's Project Sunroof, also based on Indianapolis, IN. The analysis assumptions are summarized in Table 2-1.

**TABLE 2-1: KEY ASSUMPTIONS IN SOLAR PV ANALYSIS**

| Parameter | Assumptions |
|---|---|
| Residential System Sizes (Nominal DC Capacity) | 3 kW, 5 kW, 7.5 kW, 10 kW, 15 kW, 20 kW |
| Non-Residential System Sizes (Nominal DC Capacity) | 10 kW, 15 kW, 20 kW, 25 kW, 50 kW, 100 kW, 250 kW, 500 kW, 1,000 kW, 2,000 kW |
| System losses | 14.1% |
| Tilt | By region |
| Azimuth: | By region |
| DC to AC size ratio | 1.2 |
| Inverter efficiency | 96% (micro-inverter) |
| Battery Round-Trip Efficiency | 85% |

Based on the simulations and resulting capacity factors for residential and non-residential buildings for the Indianapolis, we applied the state-specific capacity factor to the system size to estimate annual electricity generation. These system generation values were used to calculate total energy generation per square foot of rooftop and extrapolated based on the total suitable rooftop square footage to estimate overall all technical potential. As a final step, the GDS Team removed from the technical potential for any generation occurring from existing systems. Data on existing systems was provided directly by AES-IN.

#### 2.1.1.2 Combined Heat and Power

CHP systems generate electric power and useful thermal energy in a single integrated system. Heat that is normally wasted in conventional power generation is recovered as useful thermal energy. Due to the

1 PVWatts estimates solar PV energy production and costs. Developed by the National Renewable Energy Laboratory. (NREL) http://pvwatts.nrel.gov/

2 SAM estimates hourly solar PV energy production and costs with more detailed inputs and outputs than PVwatts. Developed by the National Renewable Energy Laboratory. (NREL) http:// https://sam.nrel.gov/

integration of both power and thermal generation, CHP systems are more efficient than separate sources for electric power generation and thermal energy production.

In most CHP applications, a heat engine creates shaft power that drives an electrical generator (fuel cells can produce electrical power directly from electrochemical reactions). The waste heat from the engine is then recovered to provide steam or hot water to meet on-site needs. By combining the thermal and electrical energy generation in one process, the total efficiency of a CHP application far exceeds that of a separate plant and boiler system. Overall, the efficiency of CHP technologies can reach 80% or more, while simple-cycle electricity generation reaches only 30% and combined cycle generation typically achieves 50%. When considering both thermal and electric energy generation, CHP requires 40% less energy input to achieve the same energy output as a separate plant and boiler system. Figure 2-1 illustrates this point.

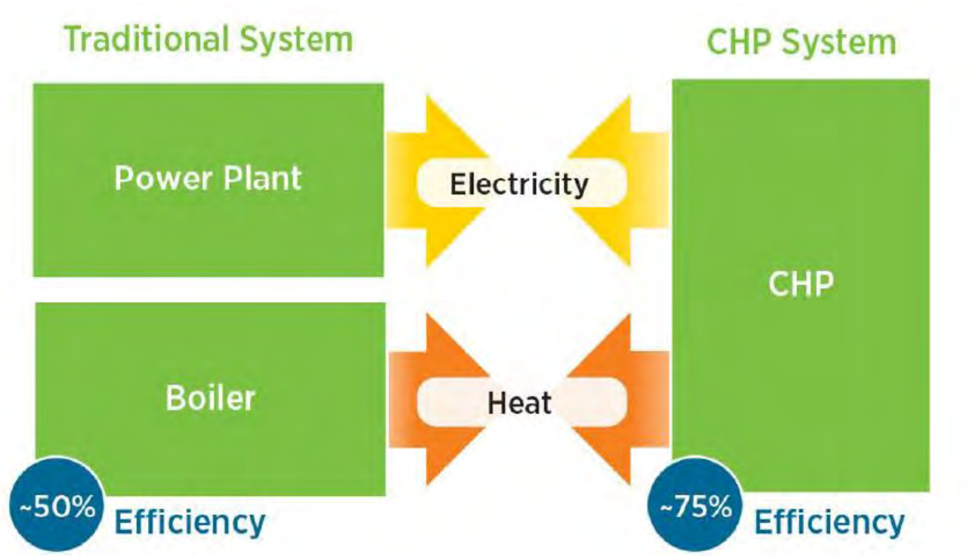


Figure courtesy of US DOE Energy Efficiency & Renewable Energy

**FIGURE 2-1: CHP ENERGY FLOW DIAGRAM**

Common technologies used in CHP applications and explored in this study include:

- Steam turbines
- Gas turbines
- Micro turbines
- Fuel Cells
- Reciprocating engines

Applications with steady demand for electricity and thermal energy are potentially good economic targets for CHP deployment. Industrial applications, particularly in industries with continuous processing and high steam requirements, are very economic and represent a large share of existing CHP capacity today. Commercial applications such as hospitals, nursing homes, laundries, and hotels with large hot water needs are well suited for CHP. Institutional applications such as colleges and schools, prisons, and residential and recreational facilities are also excellent prospects for CHP.

Selecting a specific CHP technology depends on several factors, which include but are not limited to power requirements, the duty cycle, space constraints, thermal energy needs, emission regulations, fuel availability, utility prices, and interconnection issues. Table 2-2 summarizes the CHP technologies evaluated in this study and their assumed operating parameters.

**TABLE 2-2: CHP TECHNOLOGY COMPARISON[3]**

| Parameter | Reciprocating Engine | Gas Turbine | Steam Turbine | Micro-Turbine | Fuel Cell |
|---|---|---|---|---|---|
| Size (kW) | 50-5,000 | 500-50,000 | 10-100,000 | 30-250 | 200-2,000 |
| Electric Efficiency | 28-39% | 25-40% (simple) 40-60% (combined) | 5-15% | 25-28% | 36-42% |
| Overall Efficiency | 73-79% | 64-72% | ~80% | 67-72% | 62%-67% |
| Fuels | Natural gas, biogas, propane, liquid fuels | Natural gas, biogas, propane, distillate oil | All | Natural gas, biogas, propane, distillate oil | Hydrogen, natural gas, propane |
| $NO_x$ Emissions (lb/MWh) | 0.15-2.17 | 0.55-0.68 | Function of boiler emissions | 0.14-0.17 | 0.01-0.04 |
| Uses for Heat Recovery | Hot water, low pressure steam, district heating | Direct heat, hot water-, low- or high-pressure steam, district heating | Low- or high-pressure steam, district heating | Direct heat, hot water, low pressure steam | Hot water-, low- or high-pressure steam |
| Thermal Output (Btu/kWh) | 3,000-6,100 | 3,200-5,000 | n/a | 4,800-6,300 | 1,500-3,000 |
| Useable Temp (°F) | 200-500 | 500-1,100 | n/a | 400-650 | 140-700 |

To estimate technical potential for CHP, the GDS Team first developed a screening process based on the DOE's national technical potential study of CHP resources[4] to identify probable CHP candidate premises. First, customers with less than 50,000 kWh annual consumption were removed from eligibility as a CHP candidate. Second, we considered customer loads to assess if and what CHP system type and size may be a potential match to a customer. To effectively utilize CHP, a facility must have coincident electric and thermal energy requirements for a large load factor of the year. A continuous process industry with nearly constant steam or hot water demand electric load is an excellent target, such as a chemicals manufacturer or a hospital. Facilities with intermittent electric and thermal loads are progressively less attractive as the number of hours of coincident load diminishes. We therefore screened for eligible customers based on the customer's annual kWh usage and an approximate sized CHP system based on a thermal factor.

The team calculated and applied a thermal factor to potential candidate customer loads to reflect thermal load considerations in CHP sizing. In most cases, on-site thermal energy demand is smaller than electrical demand. Thus, CHP size is usually dictated by the thermal load to achieve proper efficiencies and adequate returns on investment. The Team used power to heat ratios[5] for both the CHP technology as well as different market segments to calculate the thermal factor as shown in following equation.

[3] Combined Heat and Power Market Assessment. ICF International for the California Energy Commission, April 2010.
[4] U.S. Department of Energy. Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.
[5] Power to heat ratios were sourced from a combination of the following sources:
•U.S. Environmental Protection Agency Combined Heat and Power Partnership. Catalog of CHP Technologies, September 2017.
•U.S. Environmental Protection Agency Combined Heat and Power Partnership. Spark Spread Estimator Version 1.2
•U.S. Department of Energy. Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.

$$\textbf{Thermal Factor} = \frac{\textbf{P/H (CHP System)}}{\textbf{P/H (Customer Segment)}}$$

A thermal factor of one (1.0) would result in the CHP system capacity being equal to the electric demand of the facility. A thermal factor of less than one would indicate that the application is thermally limited, and the resulting CHP system size would be below the electric demand of the facility. A thermal factor greater than one indicates that a CHP system sized to the thermal load would produce more electricity than can be used on-site, resulting in excess power that could be exported to the grid. Following the method applied in the DOE national technical potential study, the thermal factor was multiplied by each customer's annual consumption to estimate the appropriate CHP system size. The GDS Team screened and removed any CHP technology that did not fall within +/- 15% generation of the customer's annual kWh consumption. A summary of the power to heat ratios by segment is listed in Table 2-3, as sourced from the DOE EPA CHP potential study.

**TABLE 2-3: POWER TO HEAT RATIO BY SEGMENT**

| Industrial Segment | Heat to Power Ratio | Commercial Segment | Heat to Power Ratio |
|---|---|---|---|
| Utilities | 1.29 | Education | 0.50 |
| Smelting | 0.26 | Healthcare | 0.75 |
| Food Manufacturing | 1.10 | Institutions | 0.94 |
| Transportation Manufacturing | 0.33 | Grocery | 0.62 |
| Paper Manufacturing | 2.37 | Lodging | 0.62 |
| Plastics Manufacturing | 0.31 | Office | 0.20 |
| Misc. Manufacturing | 1.34 | Retail | 0.84 |
| Agriculture | 0.25 | Warehouse | 0.68 |
| Construction | 0.25 | Misc. | 0.68 |
| Metal Manufacturing | 3.83 | | |

After applying the screening method, we reviewed which CHP systems were eligible matches for given customer sites. In cases where multiple CHP technologies were viable for a single customer site, an applicability factor was assigned for each eligible CHP technology. After assigning applicability factors, the GDS Team summed the total CHP generation across the population. The GDS Team removed from the technical potential any generation occurring from existing systems. Data on existing systems was provided directly by AES-IN.

### *2.1.2 Economic Potential*

Economic potential represents the DER generation possible given full adoption of all cost-effective DER measures. For the cost effectiveness analysis on solar PV and CHP, the GDS Team used a Total Resource Cost (TRC) hurdle of 1.0. To assess the TRC, the GDS Team relied on the same avoided energy and capacity costs used in the energy efficiency analysis. These avoided costs serve as the benefits while the costs are represented as the installation and O&M costs of the modeled solar PV and CHP measures.

#### 2.1.2.1 Solar Photovoltaic

To estimate economic potential for solar PV, we gathered pertinent data on system costs along with calculated generation benefits to use in the benefit-cost analysis, which we conducted at the system measure level. The GDS Team assessed system component costs based on data included in the National Renewable Energy Laboratory's (NREL) Q1 2020 Benchmarking report as well as public data files from Tracking the Sun[6] and compared these national cost parameters to AES-IN-specific values by using various market data provided by Energy Sage.[7] This analysis produced an estimated installation cost per watt installed, which we applied to each system size to estimate total installed cost. Additionally, the GDS Team included O&M costs that scale with system size.[8] Finally, we assumed the impact of the federal investment tax credit (ITC) to follow the existing schedule at the time of this report which equates to a 10% tax credit for commercial systems by 2024 and a 0% tax credit for residential systems by 2024.

In addition to modeling solar PV system costs, the GDS Team estimated cost impacts for solar PV systems coupled with battery storage based on analysis from NREL's Q1 2020 Benchmarking report and Lazard's Levelized Cost of Storage Analysis.[9] The GDS Team estimated an average lithium-ion battery installation cost of $1,093/kWh and $721/kWh for the residential and non-residential sectors, respectively, inclusive of the ITC. Table 2-4 provides the average solar PV installation cost by sector.

**TABLE 2-4: AVERAGE SOLAR PV INSTALLATION COST**

| Sector | System Cost ($/ DC W)[1] |
|---|---|
| Residential | $3.05 |
| Non-Residential (<100 kW) | $2.56 |
| Non-Residential (>100 kW) | $2.20 |
| Non-Residential - Tracking (<100 kW) | $3.95 |
| Non-Residential - Tracking (>100 kW) | $3.39 |

[1]Costs reflect impact of federal investment tax credit; battery systems not reflected in cost.

#### 2.1.2.2 Combined Heat and Power

To assess costs for the various CHP technologies analyzed in the potential study, the GDS Team relied on data sourced from the EPA Catalog of CHP Technologies.[10] Costs were calculated for fuel cell, gas turbine, micro turbine, reciprocating engine, and steam turbine CHP configurations at various capacity sizes. These costs reflect the inclusion of the ITC based on the existing schedule at the time of this report which equates to a 10% tax credit for CHP through 2023.

Table 2-5 summarizes detailed CHP cost considerations and assumptions utilized in the cost-effectiveness screening. These costs reflect the inclusion of the ITC based on the existing schedule at the time of this report which equates to a 10% tax credit for CHP through 2023.

[6] Feldman, D, et. al., U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020. NREL, January 2021.
[7] https://www.energysage.com/solar-panels/in/; https://www.energysage.com/solar-panels/mi/ (accessed March 2021).
[8] Feldman, D, et. al., U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020. NREL, January 2021.
[9] Ibid.
[10] U.S. Environmental Protection Agency Combined Heat and Power Partnership. Catalog of CHP Technologies, September 2017.

**TABLE 2-5: DETAILED CHP COST CONSIDERATION SUMMARY**

| Technology Type | Size (kW) | Installed System Cost ($/W) | O&M Costs ($/kWh) |
|---|---|---|---|
| **Fuel Cell** | 125 | $17.33 | $0.35 |
| | 250 | $12.42 | $0.31 |
| | 500 | $6.69 | $0.27 |
| | 750 | $6.10 | $0.27 |
| | 1000 | $5.50 | $0.26 |
| | 1250 | $4.91 | $0.26 |
| | 1500 | $4.32 | $0.26 |
| | 2000 | $3.13 | $0.26 |
| **Gas Turbine** | 750 | $3.84 | $0.09 |
| | 1000 | $3.77 | $0.09 |
| | 1250 | $3.69 | $0.09 |
| | 1500 | $3.62 | $0.09 |
| | 2000 | $3.48 | $0.09 |
| | 2500 | $3.34 | $0.09 |
| | 3000 | $3.20 | $0.09 |
| | 3500 | $3.06 | $0.09 |
| | 4000 | $2.92 | $0.09 |
| | 4500 | $2.78 | $0.09 |
| | 5000 | $2.64 | $0.09 |
| | 5500 | $2.50 | $0.09 |
| | 6000 | $2.36 | $0.08 |
| **Micro Turbine** | 50 | $3.50 | $0.05 |
| | 100 | $3.30 | $0.05 |
| | 150 | $3.10 | $0.05 |
| | 200 | $2.90 | $0.05 |

| Technology Type | Size (kW) | Installed System Cost ($/W) | O&M Costs ($/kWh) |
|---|---|---|---|
| **Reciprocating Engine** | 125 | $2.85 | $0.07 |
| | 250 | $2.81 | $0.07 |
| | 500 | $2.73 | $0.07 |
| | 750 | $2.64 | $0.07 |
| | 1000 | $2.55 | $0.06 |
| | 1250 | $2.47 | $0.06 |
| | 1500 | $2.38 | $0.06 |
| | 2000 | $2.21 | $0.06 |
| | 2500 | $2.04 | $0.05 |
| | 3000 | $1.86 | $0.05 |
| | 3000 | $1.86 | $0.05 |
| | 4000 | $1.74 | $0.05 |
| | 4500 | $1.71 | $0.05 |
| | 5000 | $1.68 | $0.04 |
| **Steam Turbine** | 500 | $4.95 | $0.18 |
| | 750 | $4.95 | $0.18 |
| | 1000 | $4.95 | $0.18 |
| | 1250 | $4.95 | $0.18 |
| | 1500 | $4.95 | $0.18 |
| | 2000 | $4.95 | $0.18 |
| | 2500 | $4.95 | $0.18 |
| | 3000 | $4.95 | $0.18 |
| | 3500 | $4.95 | $0.18 |
| | 4000 | $4.95 | $0.18 |
| | 4500 | $4.95 | $0.18 |
| | 5000 | $4.95 | $0.18 |
| | 5500 | $4.95 | $0.18 |
| | 6000 | $4.95 | $0.18 |

### *2.1.3 Market Potential*

Market potential is the amount of energy that can realistically be saved given likely future utility program intervention and various market barriers. The anticipated approach to assess achievable potential for the DER potential analysis was to follow the same logic and methods as used in the energy efficiency achievable potential analysis. However, as discussed in Section 2.2 below, market potential was not assessed as neither the solar PV nor CHP technologies passed a TRC screen of 1.0.

## 2.2 DER POTENTIAL FINDINGS

This section of the report presents the Technical, Economic, Achievable (MAP and RAP) for CHP and solar PV.

### *2.2.1 Solar Photovoltaics*

Table 2-6 summarizes the solar PV cumulative annual potential estimates for electric demand and Table 2-7 for electric energy within AES-IN's territory. The residential 2042 technical market potential for solar PV represents 46.6% of the 2042 residential sector sales forecast. Additionally, the non-residential 2042 technical market potential represents 60.7% of the 2042 non-residential sector sales forecast.

**TABLE 2-6: SUMMART OF SOLAR PV ELECTRIC DEMAND MARKET POTENTIAL**

| Year | Technical DC Capacity (MW) | Technical Peak Capacity (MW) | Economic (MW) | MAP (MW) | RAP (MW) |
|---|---|---|---|---|---|
| 2023 | 319 | 104 | 0 | 0 | 0 |
| 2027 | 1,836 | 575 | 0 | 0 | 0 |
| 2032 | 5,416 | 1,695 | 0 | 0 | 0 |
| 2042 | 6,344 | 1,985 | 0 | 0 | 0 |

**TABLE 2-7: SUMMARY OF SOLAR PV ELECTRIC ENERGY MARKET POTENTIAL**

| Year | Technical (MWh) | Economic (MWh) | MAP (MWh) | RAP (MWh) |
|---|---|---|---|---|
| 2023 | 415,268 | 0 | 0 | 0 |
| 2027 | 2,297,314 | 0 | 0 | 0 |
| 2032 | 6,767,212 | 0 | 0 | 0 |
| 2042 | 7,926,314 | 0 | 0 | 0 |

Table 2-8 summarizes the cost effectiveness results for each technology and for the TRC cost-effectiveness perspective.

**TABLE 2-8: SUMMARY OF SOLAR PV COST-EFFECTIVENESS**

| Solar PV Technologies | TRC Test Range |
|---|---|
| Residential Roof-mounted (3 – 20 kW) | 0.40 |
| Residential Roof-mounted with Batteries (3 – 20 kW) | 0.19 – 0.35 |
| Non-residential Roof mounted (10 – 50 kW) | 0.42 |
| Non-residential Roof mounted with Batteries (10 – 50 kW) | 0.31 – 0.35 |
| Non-residential Ground mounted (100 kW – 2MW) | 0.48 |
| Non-residential Ground mounted with Batteries (100 kW – 2MW) | 0.41 – 0.42 |
| Non-residential Ground mounted Tracking (100 kW – 2MW) | 0.44 |
| Non-residential Ground mounted Tracking with Batteries (10 – 50 kW) | 0.39 – 0.40 |

It is notable that no solar PV technologies pass cost-effectiveness screening under the TRC. This test is the primary cost-effectiveness criteria used to determine whether a utility sponsored program intervention is prudent. Low avoided costs serve as the primary driver behind the cost effectiveness results. At a technology level, the introduction of battery storage reduces cost effectiveness despite potential capacity benefit gains. Similarly, benefits achieved through additional generation using tracking-enabled systems are ultimately outweighed by the higher installation cost associated with the tracking technology.

It is notable while the TRC test for solar PV systems doesn't meet a 1.0 cost-effectiveness threshold, AES-IN customers install solar PV systems at their homes and businesses. Consequently, a baseline, business-as-usual (BAU) forecast was developed for integration into the IRP modeling. The BAU forecasts are based upon the:

- AES-IN customer and rooftop characterization described earlier
- Number of existing systems
- Trend of existing system installation from 2015-2020
- Willingness to participate and market adoption data collected from AES-IN customers
- Bass-diffusion curve and coefficients based upon the NREL dGen model[11] and EIA DGPV interconnection and Census data

Three adoption scenarios for BAU solar PV installations are described below for the Residential sector:

- Low; up to 6% market adoption
- Medium; up to 15% market adoption
- High; up to 29% market adoption

The BAU forecasts for system and energy (MWh-DC) are shown in Figure 2-2 and Figure 2-3, respectfully.

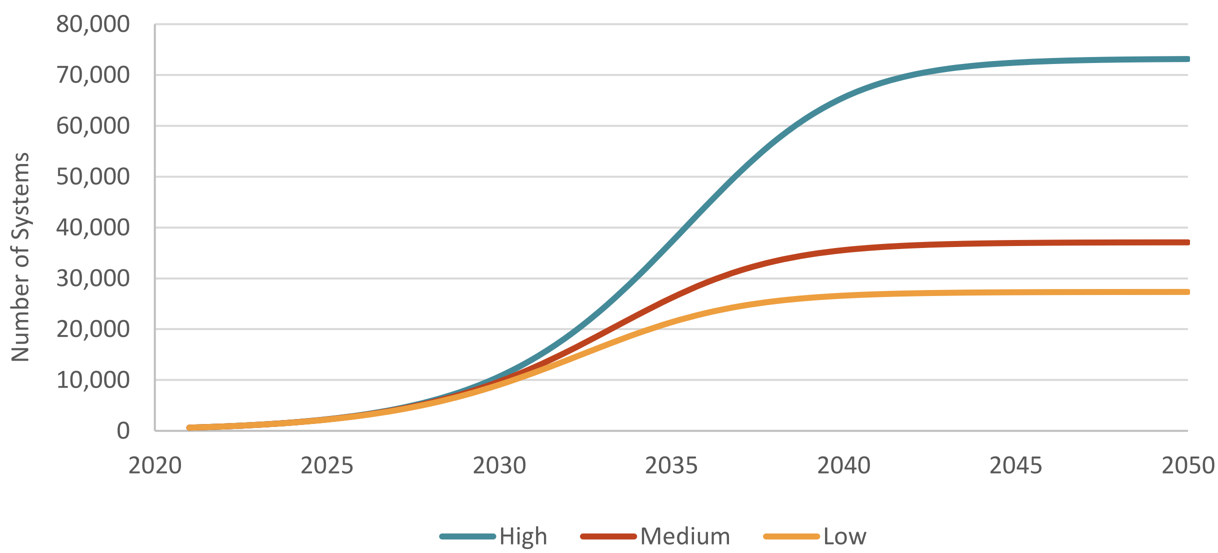


**FIGURE 2-2: RESIDENTIAL SOLAR PV SYSTEM FORECAST (BUSINESS-AS-USUAL)**

[11] https://www.nrel.gov/analysis/dgen/

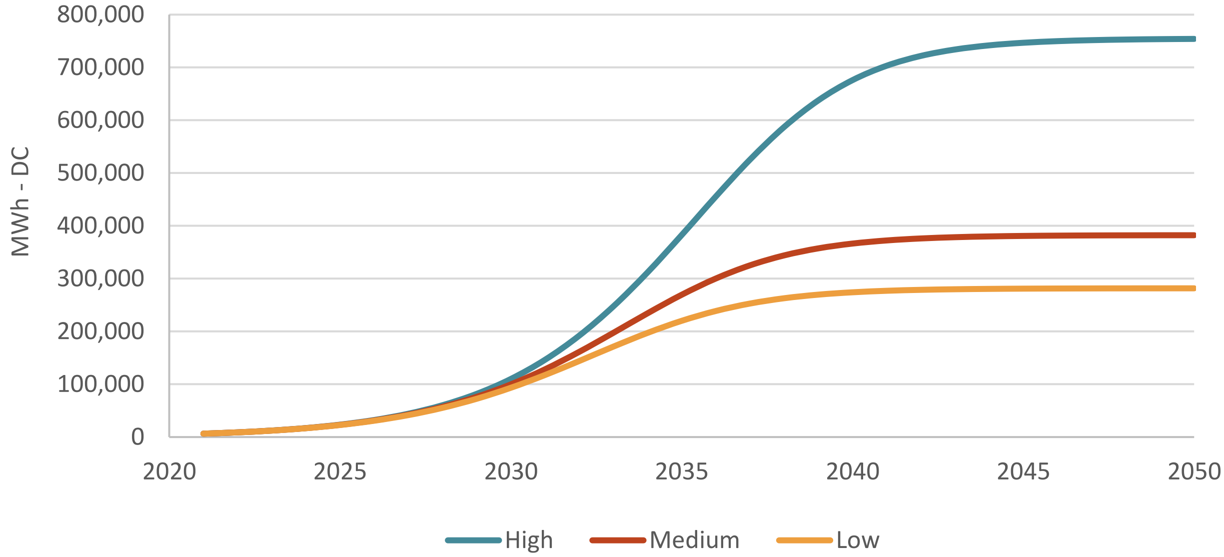


**FIGURE 2-3: RESIDENTIAL SOLAR PV SYSTEM ENERGY CONSUMPTION (MWH-DC) (BUSINESS-AS-USUAL)**

Three adoption scenarios for BAU solar PV installations are described below for the Non-residential sector:

- Low; up to 7% market adoption
- Medium; up to 19% market adoption
- High; up to 35% market adoption

The BAU forecasts for system and energy (MWh-DC) are shown in Figure 2-4 and Figure 2-5, respectfully.

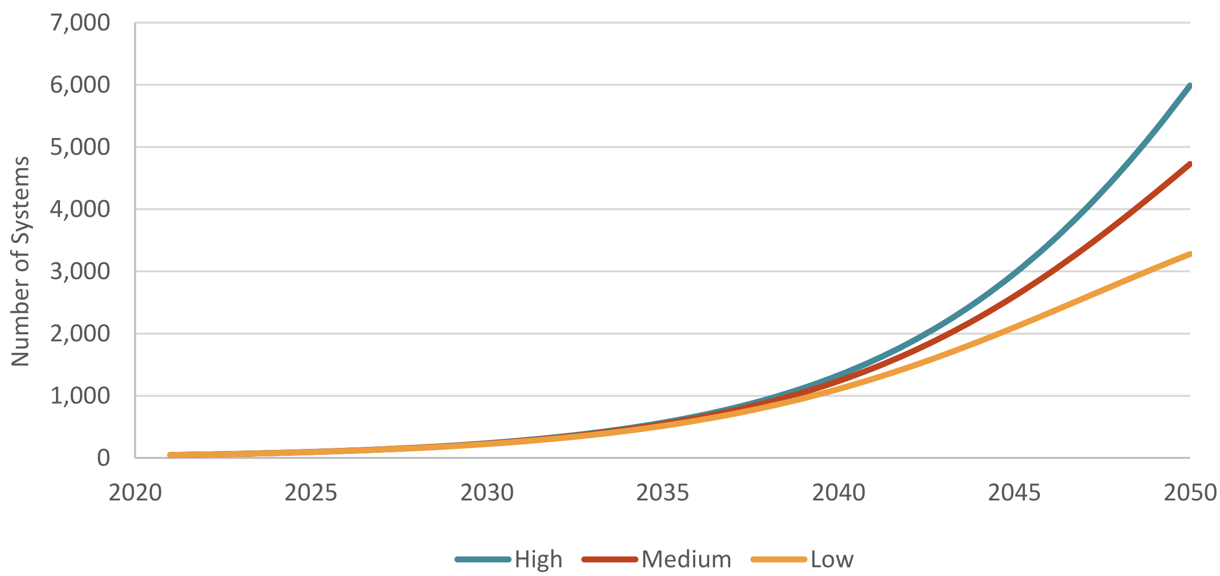


**FIGURE 2-4: NON-RESIDENTIAL SOLAR PV SYSTEM FORECAST (BUSINESS-AS-USUAL)**

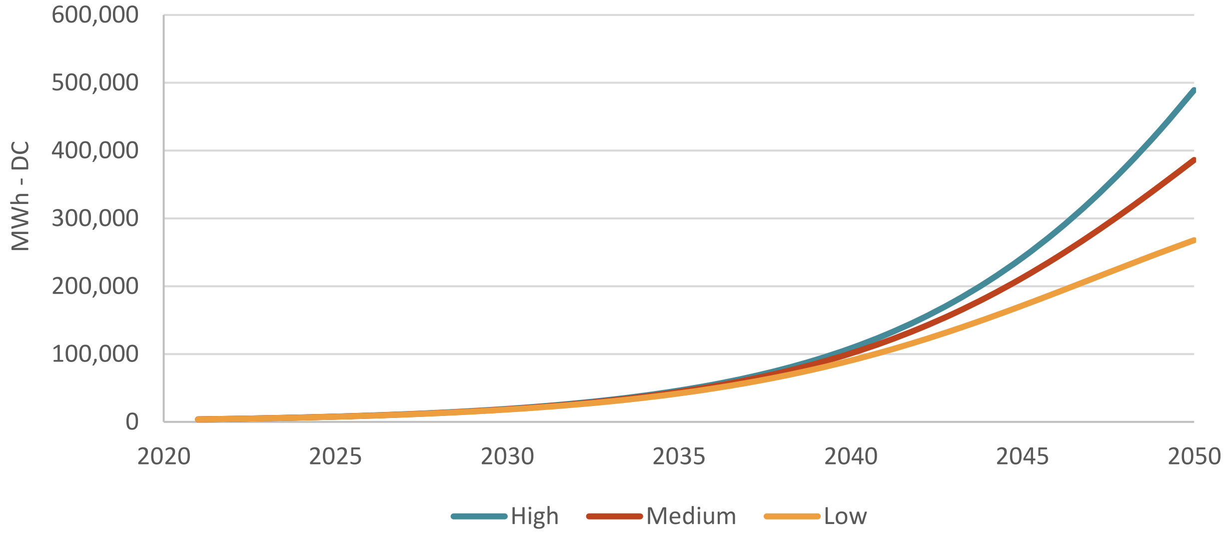


**FIGURE 2-5: NON-RESIDENTIAL SOLAR PV SYSTEM ENERGY CONSUMPTION (MWH-DC) (BUSINESS-AS-USUAL)**

### *2.2.2 Combined Heat & Power*

Table 2-9 summarizes the CHP cumulative annual potential estimates for electric demand and Table 2-10 for electric energy within AES-IN territory. 2042 technical market potential for CHP represents of the 2042 non-residential sector sales forecast.

**TABLE 2-9: SUMMARY OF CHP ELECTRIC DEMAND MARKET POTENTIAL**

| Year | Technical Peak Capacity (MW) | Economic (MW) | MAP (MW) | RAP (MW) |
|---|---|---|---|---|
| 2023 | 7 | 0 | 0 | 0 |
| 2027 | 40 | 0 | 0 | 0 |
| 2032 | 125 | 0 | 0 | 0 |
| 2042 | 150 | 0 | 0 | 0 |

**TABLE 2-10: SUMMARY OF CHP ELECTRIC MARKET POTENTIAL**

| Year | Technical (MWh) | Economic (MWh) | MAP (MWh) | RAP (MWh) |
|---|---|---|---|---|
| 2023 | 59,521 | 0 | 0 | 0 |
| 2027 | 346,669 | 0 | 0 | 0 |
| 2032 | 1,089,496 | 0 | 0 | 0 |
| 2042 | 1,308,179 | 0 | 0 | 0 |

Table 2-11 summarizes the cost effectiveness results for each technology and for the TRC cost-effectiveness perspective.

**TABLE 2-11: SUMMARY OF CHP COST-EFFECTIVENESS**

| CHP Technologies | TRC Test Range |
|---|---|
| Fuel Cell (125 – 2,000 kW) | 0.14 – 0.32 |
| Gas Turbine (750 – 6,000 kW) | 0.46 – 0.77 |
| Micro-Turbine (50 – 200 kW) | 0.26 – 0.30 |
| Reciprocating Engine (125 – 5,000 kW) | 0.32 – 0.54 |
| Steam Turbine (500 – 6,000KW) | Less than 0.1 |

It is notable that no CHP technologies pass cost-effectiveness screening under the TRC. This test is the primary cost-effectiveness criteria used to determine whether a utility sponsored program intervention is prudent. Low avoided costs serve as the primary driver behind the cost effectiveness results. However, it may be the case that certain site location conditions have important performance parameters that allow for a favorable cost-effectiveness assessment for that specific site, even if the average system and facility is not cost-effective as analyzed.

# 3 Transportation Electrification

Wide-scale adoption of EVs across the U.S. will necessitate a substantial amount of energy supply to meet the needs of consumers over time. As traditional internal combustion engine (ICE) vehicles are offset by both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), electric service providers will need to account for the expanding EV market in their resource planning efforts.[12] EVs increase the demand for electricity that regulated electric utilities like AES-IN are required to supply to customers in their service territory. The growing adoption of EVs amongst all customer classes (residential, commercial, and industrial) poses supply and demand challenges that may require increased focus towards the assessment of the transportation sector and how it effects retail electric rates.

As of December 2021, the Federal Highway Administration provides that there are over 275 million vehicles in the U.S., and roughly 6.1 million in Indiana.[13] The Department of Energy (DOE), in accordance with the National Renewable Energy Laboratory (NREL) estimates that for 2021, just over 1 million electric vehicles were registered in the U.S.[14] The annual number of EV sales has been steadily increasing over time as well. In 2010, there were just over 15,000 EVs sold in the U.S.; in 2015 that number grew to over 120,000; and in 2021, that number was up to over 600,000.[15] As of the beginning of 2022, the Environmental Protection Agency's (EPA) fuel economy report notes over 65 different makes and models of EV passenger cars are available to consumers, with new makes and models reported to hit the market year after year.

Differentiating between residential and commercial vehicles is the first step to determining the impact of new EVs in AES-IN's service territory. Residential vehicles can be typically defined as light- or medium-duty passenger vehicles or trucks used for daily commutes or recreational purposes. Commercial vehicles can be any type of vehicle used for business purposes (e.g., used for the transportation of goods or people; owned by a company or the public sector). This range of potential commercial vehicles can include light-duty passenger cars such as taxis and cop cars, all the way to vans, large trucks, and transit/school buses. Determining the number of each vehicle type takes a bottom-up approach before the energy consumption values can be approximated for AES-IN's service territory.

While EV passenger cars have a wide variety of options, the market for small delivery trucks and vans, large heavy-duty trucks (e.g., semi and tractor trailer trucks), limos, transit buses, school buses, is currently limited to a small number of makes and models, as of 2022. The adoption of these vehicles is still in its infancy. For example, car manufacturers like Tesla, Volvo, Dailmer, and BYD are still in the process of developing an EV semi-truck, with production estimates as early as Q4, 2022.[16] Additionally, regarding school buses, of the roughly 500,000 in the U.S. as of December 2021, less than 1% are electric.[17] Getting initial vehicle counts of these vehicle types is useful but forecasting out the adoption of each, and its associated energy usage has its limitations.

## 3.1 COMMERCIAL TRANSPORTATION ELECTRIFICATION

Within the market potential study, The GDS Team developed a commercial Electric Vehicle (EV) forecast for the AES-IN service territory over the 20-year resource planning period (2021-2041), to assess the potential energy and demand consumption attributed to increasing EV adoption by the commercial sector. This

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[12] For purposes of this report, "EV" will refer to both battery electric vehicles and plug-in hybrid vehicles.

[13] Federal Highway Administration, Highway Statistics Series "Highway Statistics 2020" (December 2021)

[14] U.S. Dept. of Energy, Alternative Fuels Data Center "10962-Electric Vehicle Registrations by State, 2021"

[15] U.S. Dept. of Energy, "New Plug-in Electric Vehicle Sales in the United States Nearly Doubled from 2020 to 2021"

[16] See U.S. News "Future Electric Semi Trucks" 02/18/22.

[17] See SchoolBusFleet "School Bus Statistics" Dec. 2021

analysis should be utilized as a supplement to support AES-IN's energy forecasting efforts. This analysis utilizes existing, publicly available, historical data and trends along with supplemental information supplied by AES-IN. The forecast in this report is solely a business-as-usual forecast; meaning there are no assumptions built in for utility intervention, or State or Federal policy implications throughout the planning period.

This section describes the overall methodology used to develop the commercial EV forecast. The structure of this report will be as follows:

- Characterizing the commercial EV market in AES-IN's service territory as it relates to commercial vehicle registrations, sales, and historical trends;
- Developing EV measures, segmented by measure group to determine unique energy consumption values;
- Defining EV market penetration scenarios (low, medium, and high case);
- Approach used to forecast vehicle classes and energy consumption through the 20-year resource planning period; and
- Offering concluding findings and remarks surrounding the forecasted scenarios considered, and challenges posed by future adoption of heavy-duty EVs.

### *3.1.1 Commercial EV Market Characterization*

First, to establish a forecasted value of commercial vehicles in AES-IN's service territory, an AES-IN provided baseline year of 2021 is used. Commercial vehicle types are determined, and primary data is collected for historical U.S. vehicle registrations from sources such as the U.S. Dept. of Transportation's Federal Highway Administration (FHA), and the DOE. Historical values are compared against national, state, and city population values year-over-year,[18] and number of registered vehicles in a specific State and County can be extrapolated for a single historical year. Commercial vehicle types are then grouped in segments based on characteristics.

#### 3.1.1.1 Vehicle Classification

The Federal government typically classifies vehicles based on the vehicle's Gross Vehicle Weight Rating (GVWR). Eight cohorts of vehicles are categorized ranging from Class 1 (GVWR < 6,000 lbs) to Class 8 (GVWR > 33,000 lbs. This analysis utilizes these classifications and further categorizes each based on current EV models available in the market today. Table 3-1 provides a listing of the federal commercial vehicle cohorts by GVWR.

**TABLE 3-1: FEDERAL COMMERCIAL VEHICLE COHORTS**

| Gross Vehicle Weight Rating (GWWR) (lbs) | Federal Highway Admin Vehicle Class | Federal Highway Admin GVWR Category |
|---|---|---|
| <6,000 | Class 1: <6,000 lbs | Light Duty (< 10,000 lbs) |
| 10,000 | Class 2: 6,001 - 10,000 lbs | |
| 14,000 | Class 3: 10,001 - 14,000 lbs | Medium Duty (10,001-19,500 lbs) |
| 16,000 | Class 4: 14,001 - 16,000 lbs | |
| 19,500 | Class 5: 16,001 - 19,500 lbs | Light Heavy Duty (19,001 -26,000 lbs) |
| 26,000 | Class 6: 19,501 - 26,000 lbs | |
| 33,000 | Class 7: 26,001 - 33,000 lbs | Heavy Duty (> 26,000 lbs) |
| >33,000 | Class 8: >33,000 lbs | |

[18] U.S. Census Bureau, U.S. population data, 2021

Classes 1 and 2 are typical passenger vehicle on the road today. Of the 275 million vehicles registered in the U.S. in 2020, 37% would be considered under this class. Semi and Tractor trailer trucks make up most of the Class 7 and 8 vehicles, with the FHA reporting that over 13 million registered in 2020. The amount of fuel needed to power these different Classes of vehicles varies greatly, and furthermore, the Miles Per Gallon ("MPG") of a Class 1 vehicle could dramatically differ from a Class 8 vehicle.[19] For an EV model of each class, the amount of electricity needed to supply one vehicle to travel equal distances will also greatly vary.

For purposes of this study, based on the data that was available to be collected, along with vehicle characteristics and EV models available, the federal classes discussed were further recategorized into unique segments for all commercial vehicle types. Table 3-2 shows each of the vehicle segments.

**TABLE 3-2: COMMERCIAL EV SEGMENTS**

| Segment | Class/ Additional Description |
|---|---|
| **Government Passenger Cars** | Light & Medium Duty, SUVS |
| **Government Trucks** | Light, Medium and Heavy Duty |
| **Police Cars** | Light & Medium Duty, SUVS |
| **Police Trucks** | Light, Medium and Heavy Duty |
| **Private Vehicle – Class 1** | Excluding all other segments |
| **Private Vehicle – Class 2** | Excluding all other segments |
| **Private Vehicle – Class 3 through 6** | Excluding all other segments |
| **Private Vehicle – Class 7 & 8** | Excluding all other segments |
| **School Buses** | - |
| **Transit Buses** | - |
| **Limos** | All Types |

Each segment was scaled to Marion County based on population changes year-over-year. A total count of vehicles was determined for 2021, to be used as the initial baseline for scenario development and forecasting efforts.

### *3.1.2 Technology Characterization*

Data on current makes and models of commercial EVs available in the U.S. market as of 2021 were collected and analyzed. Unique model characteristics such as Gross Vehicle Weight Rating (GVWR),[20] range, Manufacturer Suggested Retail Price (MSRP), Miles Per Gallon Equivalent (MPGe),[21] etc., were compared to models into unique commercial EV cohorts.

Based on the range and battery, miles per kWh was defined for each model, and then averaged within each vehicle cohort, if multiple products are available. The FHA publishes an annual Vehicle Miles Traveled (VMT) every year based on types of vehicles. Using the miles per kWh values, and VMT values regionalized to central States, annual kWh values are derived for each of the vehicle segments.

Along with the uniqueness of the vehicle segments, each has a useful life, which is the length of time that the individual vehicle will, on average, be replaced. The DOT, EPA and individual car manufacturers provide insight towards the useful life of different vehicle types. The values have been collected and averaged and are used in the forecast of commercial EVs. Table 3-3 provides a summary of the vehicle segments, useful life,

[19] EPA ratings for Class 1 vehicles are on average 24.2 MPG, while Class 8 vehicles can range from 2.5 to 6.5 MPG.

[20] Values provided by the DOE, Office of Energy Efficiency & Renewable Energy.

[21] EPA unit used for alternative fuel vehicles. 1 U.S. gallon of unleaded gasoline equals 33.7 kilowatt-hours of electricity based on an energy standard of 115,000 BTUs (British thermal units) per gallon of gasoline.

and number of commercial vehicles within AES-IN's service territory used in this study. The turnover and new purchase for each commercial vehicle provides the opportunity for vehicle to switch to electric from internal combustion.

**TABLE 3-3: USEFUL LIFE AND BASELINE YEAR MARKET SIZE FOR EACH VEHICLE SEGMENT**

| Segment | Estimated Vehicles in 2021 | Useful Life (years) |
|---|---|---|
| **Government Passenger Cars** | 12 | 5,416 |
| **Government Trucks** | 8 | 2,267 |
| **Police Cars** | 5 | 1,326 |
| **Police Trucks** | 5 | 284 |
| **Private Vehicle – Class 1** | 12 | 100,524 |
| **Private Vehicle – Class 2** | 12 | 10,538 |
| **Private Vehicle – Class 3 through 6** | 15 | 32,405 |
| **Private Vehicle – Class 7 & 8** | 15 | 17,170 |
| **School Buses** | 14 | 288 |
| **Transit Buses** | 14 | 2,115 |
| **Limos** | 15 | 107 |

### *3.1.3 Forecasting Scenarios and Assumptions*

Various industry sources have offered opinions and projections towards the future of the U.S. EV market. For example, the Energy Information Administration (EIA),[22] the International Energy Agency (IEA),[23] and NREL[24] all publish annual studies on potential EV penetration and adoption, with unique sales forecasts for the U.S. The characterization of the current EV market and the best estimates of future trends are based on leveraging both national and local historical data to the extent possible. Local data was used when available, such as historical values of school and transit buses in Marion County, IN.

Due to the 20-yr length of the study timeframe, and the current state of the EV market, this study uses three linear-trend scenarios of EV shares of total vehicle sales as described below:

- Low – starting at 1.7% in 2020 rising to 9.1% in 2042
- Medium – starting at 1.7% in 2020 rising to 18.2% in 2042
- High – starting at 1.7% in 2020 rising to 36.0% in 2042

A linear regression analysis is utilized for each cohort to develop a projected of new commercial vehicle purchases and replacements for each cohort within the forecasted years in the planning period. The linear regression approach is used because of its simplicity and the uncertainty of the EV market. The forecast does not include any additional market interventions by AES-IN, such as customer incentives of exceptional energy rate structures.

### *3.1.4 Commercial Transportation Electrification Results*

Figure 3-1 and Figure 3-2 show the forecasts for incremental new commercial electric vehicles and incremental energy usage for all three scenarios (low, medium, high).

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[22] U.S. Energy Information Administration, Annual Energy Outlook 2022 (AEO2022) "Light-duty vehicle sales by technology or fuel type"

[23] International Energy Agency: Global EV Outlook 2021

[24] NREL: Electrification Futures Study ("EFS"), May 2021

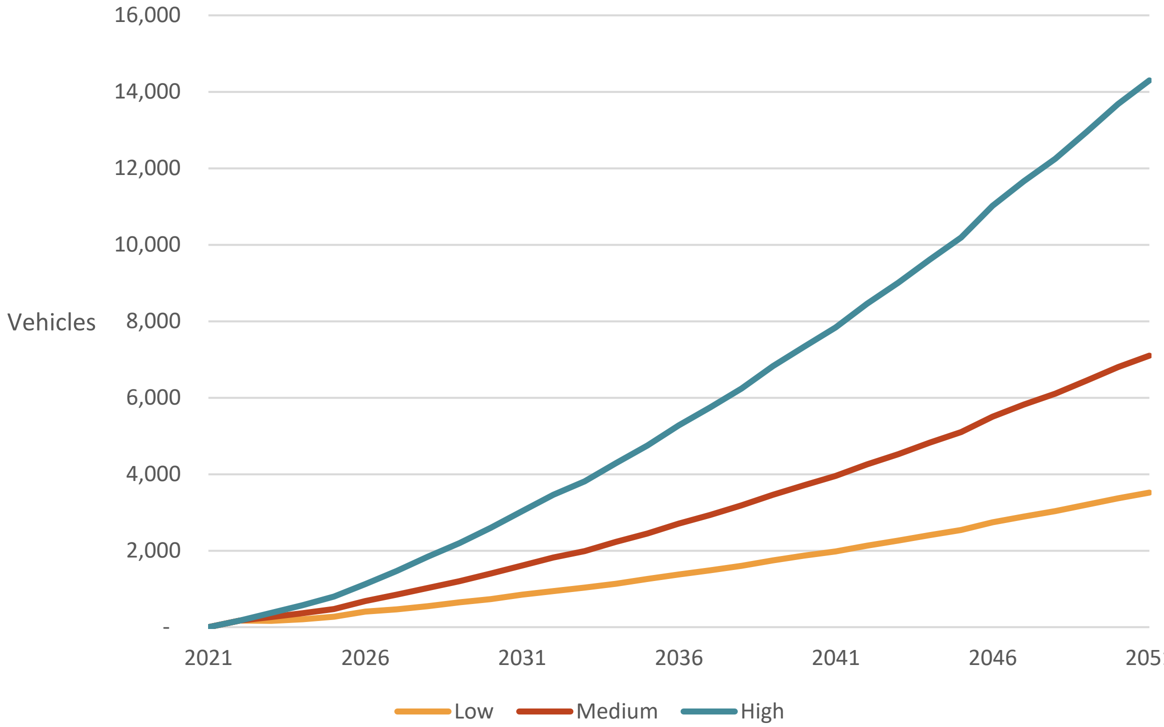


**FIGURE 3-1: INCREMENTAL NEW COMMERCIAL ELECTRIC VEHICLES**

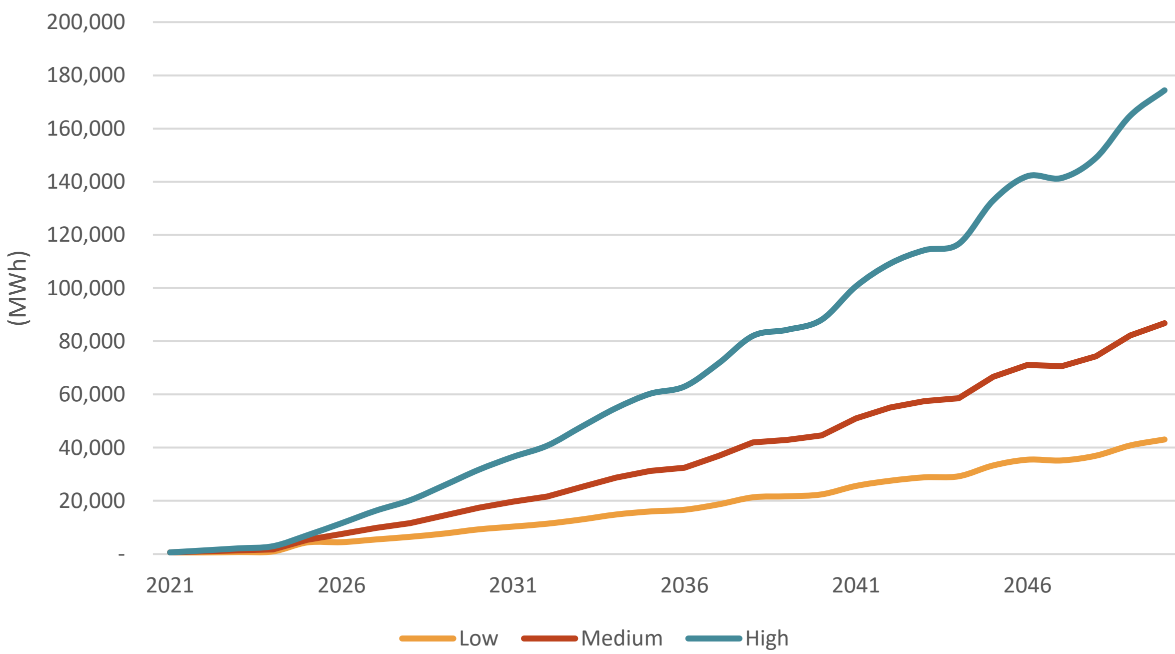


**FIGURE 3-2: INCREMENTAL ENERGY USAGE FROM NEW COMMERCIAL ELECTRIFICATION VEHICLES**

After the offset adoption of some of the larger vehicles is realized after 2024, the commercial EV's incremental energy usage takes a significant jump under all three scenarios. By 2030, under the "low scenario" the commercial EV sector will consume 7,700 MWh of energy supply. Under the high scenario, that energy supply increases to over 25,800 MWh. By 2041, incremental energy usage ranges from roughly 22k

MWh to 88k MWh between the low and high scenarios. Under all scenarios, Class 7 and 8 vehicles account for nearly 50% of all energy needs every year. The adoption of these vehicles has the most potential to influence the energy usage values of the commercial EV market. Table 3-4 shows the EV cumulative energy usage as percentage of total forecasted AES-IN non-residential energy sales through 2041 in the low and high scenarios.

**TABLE 3-4: CUMULATIVE ENERGY USAGE – NON-RESIDENTIAL EV**

| Year | Non-Residential Sales Forecast (GWh) | EV % (Low) | EV % (High) |
|---|---|---|---|
| **2022** | 8,025 | 0.01% | 0.01% |
| **2026** | 8,087 | 0.09% | 0.18% |
| **2031** | 8,080 | 0.51% | 1.48% |
| **2036** | 8,052 | 1.32% | 4.47% |
| **2041** | 8,080 | 2.57% | 9.30% |

It is notable that no commercial EV technologies pass cost-effectiveness screening under a TRC 1.0 threshold. This test is the primary cost-effectiveness criteria used to determine whether a utility sponsored program intervention is prudent. Consequently, no technical, economic, or achievable potential is estimated.

### *3.1.5 Conclusion*

As the EV market continues to develop, new EV models, technology enhancements, and overall public opinion will begin to influence the rate of EV adoption. Studies like this are a challenging exercise because they lack the ability to accurately take these factors into account with such a new and uncertain market. Electric utilities like AES-IN may need to account for the potential load on their distribution lines associated with more of their customers choosing to purchase EVs over conventional ICE vehicles. Assessing potential supply and demand needs is common practice with electric utilities although greater assessment will need to be done towards EV usage year-after-year.

Heavy-duty vehicles like tractor trailer and semi-trucks account for only 10% of all commercial vehicles in AES-IN's service territory but have the potential to account for roughly 50% of the commercial EV market's energy needs. Analysis of the adoption of these vehicles will need to be closely monitored by AES-IN as they evaluate their generation supply. Indiana is home to the second largest FedEx hub in the world and is ranked first in the U.S. in pass-through highways, with access to five major interstates. The need to supply these vehicles as more EV models are made and adopted, may result in greater EV energy usage in AES-IN's service territory relative to most other electric utilities.

Although this study utilizes forecast absent utility intervention, it is expected that federal and state policies can influence the adoption rate of EVs both on the residential and commercial level. AES-IN doesn't currently have a mandated requirement for energy efficiency, beneficial electrification, or EV adoption, but many States around the country do have these policies. Greater incentives towards adoption in these States, along with the Federal level can influence the levels of EV adoption seen in AES-IN's service territory. Thus, there remains a high level of uncertainty surrounding future deployment of commercial EVs in the AES-IN territory. This study is the result of publicly available data and trends available at the time of publication and should be used to aide AES-IN's resource planning efforts today and as more information becomes available.

## 3.2 RESIDENTIAL TRANSPORTATION ELECTRIFICATION

GDS developed a residential electric vehicle (EV) forecast for AES-IN, which includes low, base, and high scenarios for the number of residential EV's and the associated total energy consumption by the forecasted EV's. The forecasting model is based on many inputs and assumptions. This section describes the methodology, data inputs, some of which will be detailed below.

The first key input in the residential EV model is the number of AES-IN customers that make up potential EV owners. GDS utilized the most recently completed load forecast from AES-IN to input the number of residential customers on the system. The number of residential customers is essentially the number of households served by AES-IN, therefore the number of residential customers can be multiplied by the number of vehicles per household to estimate the total number of vehicles within the AES-IN service territory. The U.S. Census Bureau estimates there are 1.86 vehicles per household in the Indianapolis metropolitan area.

A second key assumption is the number of EV's currently in the AES-IN service territory. GDS utilized Indiana Bureau of Motor Vehicles (BMV) registration data and the 2021 residential consumer survey conducted for the 2021 MPS to determine the number of residential EV's served by AES-IN. Based on the data discussed above, GDS estimates that in 2021 3,575 EV's were served by AES-IN.

The final key assumption used in the EV model is the percentage of EV's that make up new vehicle sales. GDS started with publicly available data from the Energy Information Administration (EIA) and their published Annual Energy Outlook (AEO) for 2021.[25] The 2021 AEO projects that 11.7% of new vehicle sales will be EV's in the year 2050. GDS conducted broad and thorough EV industry research to understand the AEO projections and form a basis for what new vehicle sales percentage should be in alternate scenarios. The AEO estimate of 11.7% is on the low end of the current industry projections based on GDS research, so the AEO trend was closely followed for the low scenario. GDS then developed a base case and high case scenario based on the industry research. As seen in Figure 3-3 below, the various scenarios all produce a linear growth trend for EV sales as a percentage of new vehicle sales, with the Low scenario closely following the AEO projections and the Base and High scenarios representing more optimistic projections. While the High scenario may appear overly optimistic compared to the Low and Base scenarios, many auto manufacturers have stated goals for EV sales that far outpace the percentages in the High scenario.

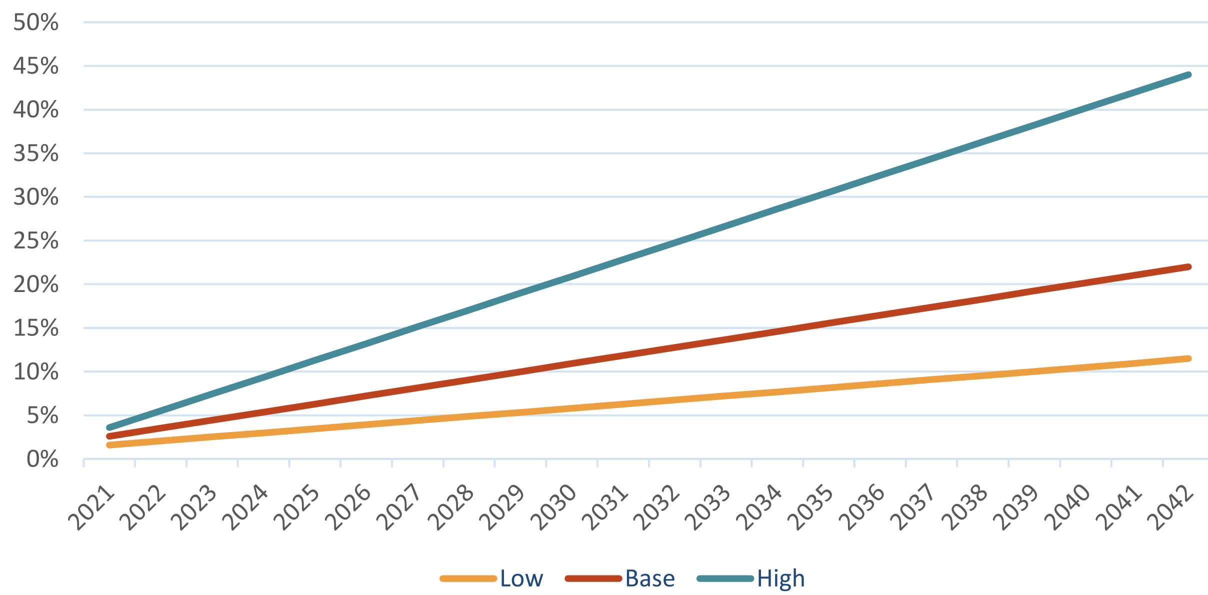


**FIGURE 3-3: EV SALES AS A PERCENTAGE OF NEW VEHICLE SALES**

Given the initial number of EV's in Indianapolis and the projected percentage of new vehicle EV sales, the cumulative number of EV's served by AES-IN can be projected annually. The projection for total number of EV's accounts for the typical "lifespan" of a vehicle as well. Figure 3-4 below shows the projections for total number of electric vehicles.

25 https://www.eia.gov/outlooks/aeo/tables_ref.php

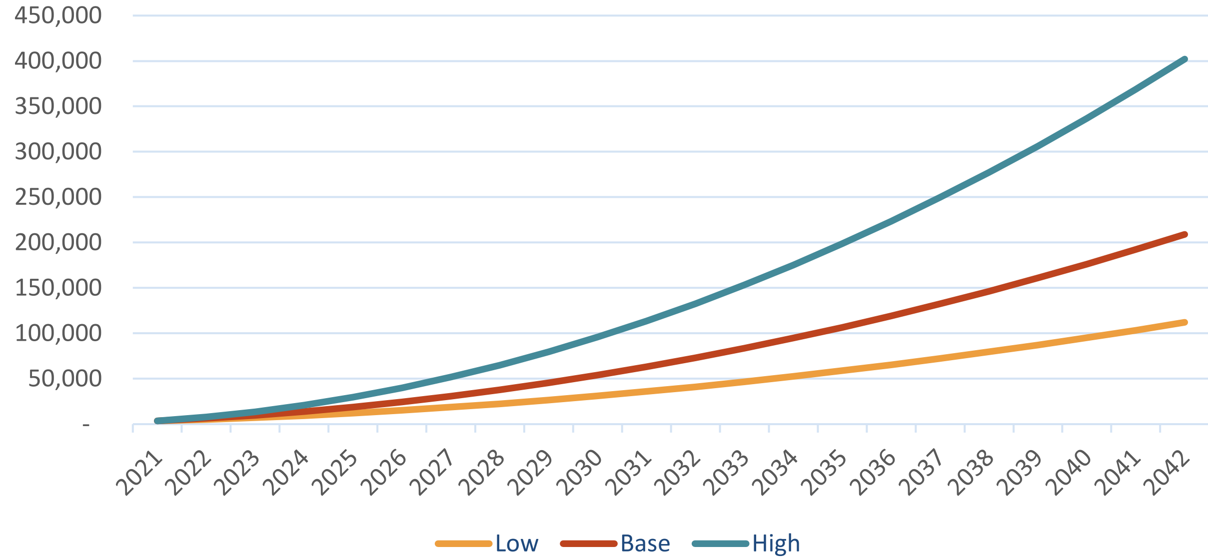


**FIGURE 3-4: TOTAL EV'S**

The total number of electric vehicles and several other inputs, including average miles driven per year and kWh per mile efficiency, are used to calculate the total energy sales attributable to the projected number of EV's on the AES-IN system. The expected average miles driven varies between scenarios, representing another layer of either optimistic or pessimistic assumptions regarding EV adoption and use. As seen below in Figure 3-5, the differences between the scenarios in expected MWh sales has increased due to the changing miles/year assumption.

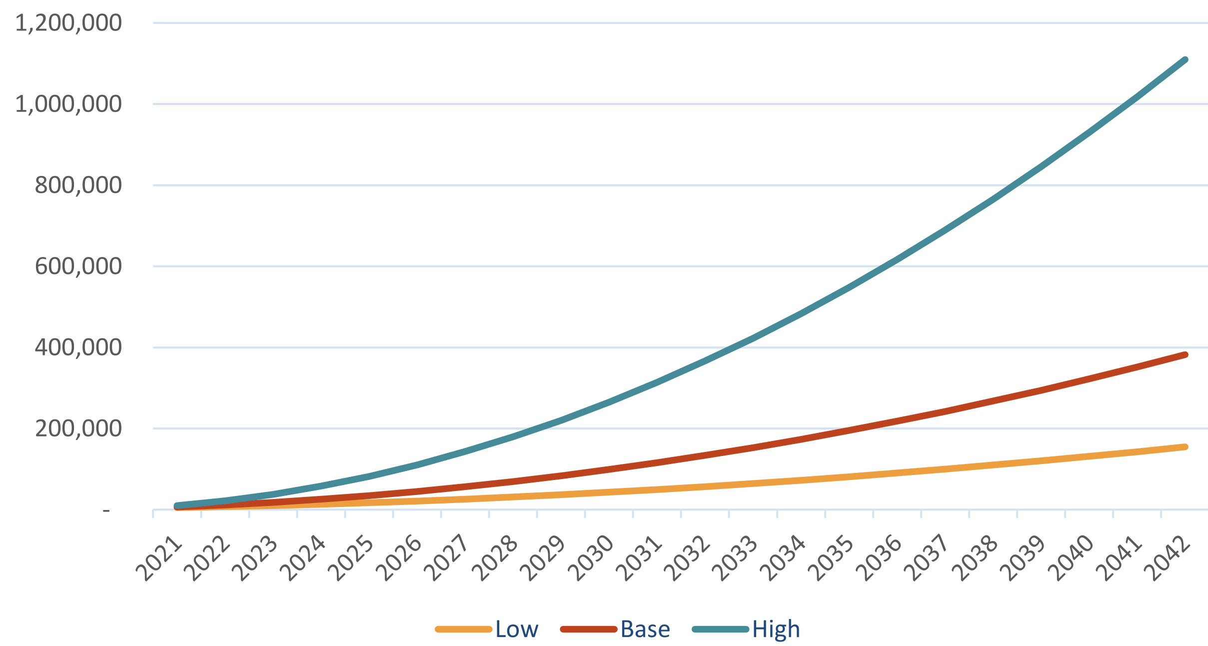


**FIGURE 3-5: MWH SALES ATTRIBUTABLE TO EV'S**

# 4 Building Electrification

This chapter describes a building electrification forecast to understand the cost-effectiveness of building electrification measures and a range of possible electrification adoption impacts on AES's base forecast of MWh sales. The forecast includes the residential, commercial, and industrial sectors.

## 4.1 OVERVIEW OF APPROACH

GDS approached the forecast of building electrification load impacts using three methods, varying by each sector. Each are summarized below. In all cases, GDS assumed that building electrification would offset natural gas consumption.

### *4.1.1 Residential Sector*

The residential building electrification forecast was developed using a bottom-up approach. In this approach, the count of single family and multifamily buildings using natural gas for space heating, water heating, cooking, and laundry had electrification measures applied to the natural gas loads. GDS first utilized AES customer data to understand the share of end-uses that utilize natural gas. Table 4-1 summarizes the share of homes currently using natural gas.

**TABLE 4-1: RESIDENTIAL USE OF NATURAL GAS BY END USE**

| Housing Type / End Use | Single Family | Multifamily | Total |
|---|---|---|---|
| Existing Customer Count | 341,467 | 121,225 | 462,692 |
| Space Heating Share | 55.25% | 22.89% | 46.8% |
| Water Heating | 49.71% | 20.97% | 42.2% |
| Gas range or stovetop | 29.48% | 14.32% | 25.5% |
| Gas oven | 24.75% | 16.41% | 22.6% |
| Gas clothes dryer | 8.31% | 5.34% | 7.5% |

GDS developed baseline technology models using assumptions from the Illinois TRM V10 for space heating and water heating natural gas consumption. GDS developed estimates of cooking equipment performance for gas ranges/stovetops and gas ovens. Gas clothes dryers were dropped from the model due to the limited share currently using natural gas. The resulting natural gas consumption was compared to reported natural gas sales by Citizens Energy Group in American Gas Association 2019 sales data. The bottom-up measure modeling estimated a total of 20,001,293 annual MMBTU of natural gas consumption, 96 percent of the 2019 Citizens Energy Group sales.

GDS applied assumptions regarding possible electrification alternatives to each end-use. These included:

- Dual-fuel and 100 percent offset HVAC heat pumps operating at a range of efficiencies from 16 SEER/8.1 HSPF to 21 SEER/9.0 HSPF, and ground-source heat pumps
- Electric resistance water heaters and heat pump water heaters
- Induction and electric resistance stovetops
- Electric resistance ovens

The technical performance of these measures developed electricity consumption estimates for each technology. GDS also applied assumptions regarding the technical feasibility for AES customers to incorporate a technology in their home.

GDS analyzed the economics of the natural gas and electrification technologies. As a starting point, customer perspectives based on equipment costs and retail rates for electricity and natural gas drove a life-cycle cost analysis and simple payback metric in which the cost of equipment, available AES incentives, and operational costs created a customer-based benefit-cost ratio. The metrics provide insight into the lifecycle cost of purchasing and operating equipment, as well as whether operational energy costs were more or less for the electrification technologies than their natural gas counterparts. Additionally, GDS developed an analysis of utility economics in which the additional revenue from electrification electricity sales was offset by wholesale energy costs and program incentives. While not used directly, this second economic analysis provides insight into utility economic thresholds for program costs or incentives. Under the Utility Cost Test (UCT) used in Indiana to gauge energy efficiency cost-effectiveness, electrification would not pass the test due to increasing energy sales. The UCT was not used in economic modeling.

The general outcome of the economic modeling found that:

- Air-source heat pumps were cost-effective for customers. Ground-source heat pumps were not due to equipment costs.
- Electric water heating was cost-effective for customers (electric resistance or heat pump).
- Electric resistance stovetops were cost-effective for customers, though induction stovetops and electric resistance ovens were not.
- For residential new construction, all end-uses could be cost-effectively electrified for customers, other than electric resistance ovens.

With the resulting cost-effectiveness results for customers, GDS then utilized a Bass diffusion curve to develop estimates of low, medium, and high scenarios for future market adoptions. For existing residential buildings, the adoption curves assumed that half of customers would adopt electrification over time. The medium adoption scenario assumed 25 percent would adopt electrification, and the low adoption scenario assumed 12.5 percent would adopt electrification. For the high scenario, the available annual equipment sales were confirmed to approach 100 percent of sales across HVAC and water heating annual unit sales but did not exceed that amount.

Finally, GDS compared the forecasted electrification electricity sales increase to NREL's 2018 Electrification Futures study reference case. The NREL study analyzed, nationally, residential electrification electricity sales. The NREL study's reference case was used as a "Business As Usual" (BAU) case from which the low, medium, and high adoption scenarios could reflect varying levels of possible program interventions.

### *4.1.2 Commercial Sector*

For the commercial building sector, GDS employed a top-down analysis. In this case, GDS began with the Citizens Energy Group 2019 commercial sector natural sales, as reported to the American Gas Association. GDS then disaggregated those sales into end-use consumption using a variety of data sources, including EIA's CBECS data for the Midwest region, USDOE's Energy Scout data, ACEEE reports, and other existing industry literature that presented estimates of commercial building natural gas consumption end-use shares. Of the possible commercial end-uses, only space heating, water heating, and cooking had data. As such, the analysis focuses on possible electrification from only those end uses. GDS acknowledges that other end uses of commercial natural gas exist, such as commercial laundry drying, gas-based cooling, or combined heat and power equipment. The electrification of those end-uses, due to the apparently low-share of commercial sector natural gas consumption, is expected to have minor impacts on overall electricity consumption. The general impact of electrifying space heating, water heating, and cooking end uses may also be representative of the impacts of electrifying the unaccounted-for end-uses and may be implicitly assumed in the forecast.

Table 4-2 describes the end-use share assumptions for each of the end-uses modeled for electrification.

**TABLE 4-2: COMMERCIAL SECTOR END-USE NATURAL GAS CONSUMPTION**

| End Use | Share |
|---|---|
| Space Heating | 60 percent |
| Water Heating | 30 percent |
| Cooking | 10 percent |

Within each end-use GDS developed a variety of technology models that captured a range of possible baseline and electrified equipment configurations. For all technologies, GDS developed the technology performance assumptions utilizing the Illinois TRM V10 for space heating and water heating. Parameters for high, low, and average use were developed to capture diversity within the commercial sector, though the sector was modeled as a whole and did not include measure permutations for different building types. For commercial cooking, GDS developed estimates of energy and cost impacts from its own research, focusing on commercial-scale professional cooking equipment.

For new construction, GDS utilized the AES commercial forecast to identify how new construction electricity load was expected to grow absent DSM programs. The aggregate growth of load absent DSM program was approximately 5.2 percent across the forecast period. GDS assumed that same growth rate for natural gas consumption, allowing that growth to occur at an equal level year-to-year to inform possible new natural gas consumption that could be electrified. New construction electrification potential was only applied to space heating and hot water loads due to the small share and high uncertainty regarding the presence of new gas cooking. Averages of the existing commercial sector measure performances were applied to these new construction loads.

GDS applied assumptions regarding possible electrification alternatives to each end-use. These included:

- Electric resistance and heat pump water heaters in distributed and central water heating configurations with higher and lower hot water consumption assumptions.
- Replacing residential-size furnaces and boilers with central or ductless heat pumps
- Replacing a boiler or furnace with rooftop or window air conditioning with ductless heat pumps
- Replacing a boiler or furnace with chillers with large VRF heat pumps and ground source heat pumps
- For HVAC systems, heating loads used configurations of average (IL TRM) loads, and then higher and lower HVAC loads to reflect more or less efficient commercial buildings

The purpose of the mix of technologies and consumption level assumptions was to understand the mix of possible energy loads and equipment configurations. GDS developed assumptions on the share of furnaces and boilers and cooling equipment using DOE's Energy Scout Data for the Indianapolis climate region. This mix provides a range of possible equipment costs and energy impacts to support the economic analysis and thermodynamic relationship of equipment type electrification impacts on utility electricity sales.

GDS analyzed the economics of the natural gas and electrification technologies. As a starting point, customer perspectives based on equipment costs and retail rates for electricity and natural gas drove a life-cycle cost analysis and simple payback metric in which the cost of equipment, available AES incentives, and operational costs created a customer-based benefit-cost ratio. The metrics provide insight into the lifecycle cost of purchasing and operating equipment, as well as whether operational energy costs were more or less for the electrification technologies than their natural gas counterparts. Additionally, GDS developed an analysis of utility economics in which the additional revenue from electrification electricity sales was offset by wholesale energy costs and program incentives. While not used directly, this second economic analysis provides insight into utility economic thresholds for program costs or incentives. Under the Utility Cost Test (UCT) used in Indiana to gauge energy efficiency cost-effectiveness, electrification would not pass the test due to increasing energy sales. The UCT was not used in economic modeling.

The general outcome of the economic modeling found that:

- Under current and forecasted retail rates, HVAC heat pumps and water heaters were not cost effective to electrify.
- Of cooking equipment, only combination ovens and steam cookers were shown to be cost effective to electrify

As a result of the economic analysis, GDS elected to provide flexibility in the potential adoption of electrification measures for the commercial sector. GDS reduced the threshold of cost-effectiveness to 0.70 and elected to assume that new construction HVAC and water heating electrification would be cost effective. This approach provides several benefits to the forecast:

- Allows for the diversity of the commercial sector to allow that cost-effective conditions may exist that could not be directly modeled with the available data.
- Accounts for commercial sector customers to that may choose to make sub-economic decisions.
- Acknowledges that some commercial sector customers in the economy are choosing to electrify despite sub-economic outcomes or that non-energy impacts may overcome energy economics.
- Allows that economic conditions, including equipment costs and relative costs of energy, may shift to favor electrification over the forecast period.

Nevertheless, GDS still found that electrification measures did not pass cost-effectiveness criteria. For HVAC, ground source heat pumps and larger commercial VRF systems remained non-cost effective when compared to natural gas options. For water heating, electric resistance water heating remained non-cost effective. For cooking, electric griddles and fryers remained not cost-effective. The outcome points to the importance of possible program interventions to encourage electrification.

To model the possible adoption of commercial sector electrification and its impact on AES electricity sales, GDS applied Bass diffusion curves based on NREL research. The scenarios all assumed that 50 percent of the commercial sector could ultimately adopt electrification. Three Bass diffusion curves were selected to model the adoption of electrification to reflect high/medium/low adoptions.

- High adoption utilized the residential sector Bass parameters, reflecting rapid adoption over time.
- Medium adoption utilized NREL's national estimate for commercial sector curves, reflecting a pace of adoption based on a national average, which may be more reflective of AES' service territory than the State as a whole.
- Low adoption utilized NREL's Indiana-specific commercial sector parameters, reflecting a slower pace to durable goods adoption.

The selection of these curves are compared to NREL's Electrification Futures Study reference case, which was used to estimate a "Business As Usual" (BAU) scenario. The High/Medium/Low adoptions envision program support and market acceptance above that of the BAU case.

### *4.1.3 Industrial Sector*

Despite challenging energy economics, the industrial sector, nationally, has exhibited some adoptions of electrification. The industrial sector differs from the residential and commercial sectors due to specialized process equipment that may consume considerable amounts of natural gas, though varies by industrial type. For example, using industrial heat pumps to provide low-grade process heat will have substantially different outcomes than replacing a gas steam boiler with an arc boiler using electricity. The specific timing and type of technology that may be adopted is highly uncertain, particularly for a specific utility service territory. Corporate decisions will be based on energy economics, possible decarbonization goals, and the timing for aging process equipment to be replaced.

GDS utilized data from NREL's Electrification Futures Study to estimate the possible impact of electrification growth in AES' industrial sector. The NREL study provides national-level estimates of industrial electrification, with NREL's reference case indicating zero industrial electrification. NREL's low and medium case envision nearly zero industrial adoptions of electrification. Only in NREL's high case does industrial electrification exhibit meaningful growth.

GDS began with AES' forecast of industrial sales across the forecast period. GDS notes that industrial electricity sales are approximately 15 percent of AES' total electricity sales, indicating that the industrial sector makes up a relatively small portion of AES' customer base, further suggesting caution at making assumptions for electrification for a specific service territory. To estimate the impact of NREL's high case for industrial electrification, GDS analyzed the NREL assumption regarding overall industrial load growth and removed the share of load growth already accounted for in AES' forecast. The remaining share was assumed to be driven by electrification. The growth occurs in the last decade of the forecast.

To model adoptions of industrial electrification and the resulting increase in electricity sales above the current forecast, GDS applied a compound annual growth rate that models the entire period's growth in industrial electrification. Three scenarios were developed to estimate the load impacts:

- A high scenario that utilizes NREL's high case
- A medium scenario that assumes two-thirds the growth of the high case occurs
- A low scenario that assumes one-third the growth of the high case occurs

These three scenarios can be compared to NREL's reference case, which serves as a "Business As Usual" (BAU) scenario. With NREL's reference case indicating that no industrial electrification would occur, the BAU case is inherently reflecting that AES' industrial sector would not adopt electrification technologies.

## 4.2 RESULTS

Below we present the results of the building electrification modeling in aggregate, by sector, and for each of the adoption scenarios. For the total across all sectors and for each sector, the results show the estimated impact of electrification and 2042 results compared to the base forecast for 2042.

### *4.2.1 All Sectors*

Table 4-3 shows the impact of additional electrification load compared to the AES base electricity sales forecast for the combined residential, commercial, and industrial sectors for selected forecast years. The 2042 electricity sales under the three electrification scenarios are compared to the base electrification forecast, which does not include any assumed electrification growth.

**TABLE 4-3: CUMULATIVE ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 8,910 | 16,954 | 52,983 | 109,200 | 163,058 | 187,904 | 1.3% |
| **Medium** | 10,709 | 22,653 | 74,905 | 181,388 | 301,705 | 347,890 | 2.4% |
| **High** | 12,727 | 29,661 | 111,370 | 329,653 | 598,830 | 654,627 | 4.4% |

The above results for additional load due to electrification show a range of 1.3 percent to 4.4 percent above the AES base forecast, which does not include electrification. As a comparison, the business-usual-case (BAU) based on NREL's Electrification Futures study Reference Case, was modeled as showing 0.9 percent growth above the base forecast by 2042. As a national model, the growth in total electric consumption does not necessarily mirror AES's forecast are not illustrative of year-on-year differences between scenarios that are specific to AES. In the BAU forecast, NREL's modeling assumes no incremental load growth due to electrification occurring for the industrial sector.

### *4.2.2 Residential Sector*

Table 4-4 presents the impact of additional electrification load compared to the AES base electricity sales forecast for the residential sector.

**TABLE 4-4: CUMULATIVE RESIDENTIAL BUILDING ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 3,786 | 7,150 | 28,233 | 60,645 | 73,712 | 75,624 | 1.2% |
| **Medium** | 3,807 | 7,322 | 32,907 | 95,698 | 140,253 | 146,732 | 2.3% |
| **High** | 3,818 | 7,410 | 35,760 | 131,534 | 254,286 | 278,720 | 4.4% |

The above results for additional load due to residential building electrification show a range of 1.2 percent to 4.4 percent above the AES base forecast, which does not include electrification. As a comparison, the business-usual-case (BAU) based on NREL's Electrification Futures study Reference Case, was modeled as showing 0.85 percent growth above the base forecast by 2042. A contributor to the residential sector results is that both single-family and multifamily buildings already exhibit relatively high shares of electric market penetration for end uses.

### *4.2.3 Commercial Sector*

Table 4-5 presents the impact of additional commercial building electrification load compared to the AES base electricity sales forecast for the commercial sector.

**TABLE 4-5: CUMULATIVE COMMERCIAL BUILDING ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 3,535 | 5,036 | 12,034 | 27,890 | 60,734 | 80,488 | 1.3% |
| **Medium** | 3,674 | 5,649 | 16,179 | 43,735 | 103,360 | 136,611 | 2.1% |
| **High** | 4,092 | 7,800 | 37,075 | 135,499 | 257,840 | 279,569 | 4.3% |

The above results for additional load due to commercial building electrification show a range of 1.25 percent to 4.3 percent above the AES base forecast, which does not include electrification. As a comparison, the business-usual-case (BAU) based on NREL's Electrification Futures study Reference Case, was modeled as showing 1.2 percent growth above the base forecast by 2042. That both the BAU case (derived from NREL) and the Low scenario result in similar load growth assumptions suggest that commercial sector electrification decision making regarding may be similar between national perspectives and AES's commercial sector.

### *4.2.4 Industrial Sector*

Table 4-6 presents the impact of additional electrification load compared to the AES base electricity sales forecast for the industrial sector.

**TABLE 4-6: CUMULATIVE INDUSTRIAL BUILDING ELECTRIFICATION SALES ABOVE BASE FORECAST, MWH**

| Scenario | 2023 | 2025 | 2030 | 2035 | 2040 | 2042 | Percent Above Base Forecast |
|---|---|---|---|---|---|---|---|
| **Low** | 1,590 | 4,769 | 12,717 | 20,664 | 28,612 | 31,791 | 1.6% |
| **Medium** | 3,227 | 9,682 | 25,819 | 41,955 | 58,092 | 64,546 | 3.3% |
| **High** | 4,817 | 14,451 | 38,535 | 62,620 | 86,704 | 96,338 | 4.9% |

The above results for additional load due to industrial sector building electrification (including processes) show a range of 1.5% to 4.4% above the AES base forecast, which does not include electrification. NREL's Reference Case informs a BAU case, which indicates no industrial electrification load growth. Note that the High scenario directly utilizes NREL's High Case to inform the AES low growth assumption. As such, the High Scenario assumes the same general mix of industry types, processes, and other drivers of NREL's High Case. The Low and Medium Scenarios are assumed as multiples of the High Case to provide a range of possible impacts, though without reflection on the decision making, thermodynamics, and technologies that may drive electrification decisions by AES's industrial customers over the next two decades.

GDS Associates, Inc.
ENGINEERS & CONSULTANTS

*prepared for*

# AES INDIANA

aes Indiana

# *2022 Market Potential Study Distributed Energy Resources and Electrification*

**FINAL REPORT**

*September 2,* 2022

*prepared by*

**GDS ASSOCIATES INC**

AES Indiana

# 2022 IRP

# Attachment 8-3

(Quanta Technology's System Reliability Assessment of AES Indiana's 2022 IRP Portfolios)

# System Reliability Assessment of AES Indiana's 2022 IRP Portfolios

***PREPARED FOR***

AES Indiana
(AES)

***DATE***

November 23, 2022

***PREPARED BY***

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- Dr. Hisham Othman

**VERSION HISTORY:**

| Version | Date | Description |
|---|---|---|
| 1 | 10/24/2022 | Initial Submission |
| 2 | 11/23/2022 | Revised document to conform with scenario and strategy names |
| | | |
| | | |

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# EXECUTIVE SUMMARY

## 1.1 Background

Quanta Technology was retained by AES US Services, LLC (AES) to provide an independent assessment, a scoring methodology and metrics for the reliability attributes of 24 resource portfolios that have been studied in its 2022 integrated resource plan (IRP). AES has evolved its IRP process to include measures of resource reliability contributions to ensure meeting its reliability and affordability obligations.

AES Indiana provides retail electric service to approximately 517,000 residential, commercial, and industrial customers in Indianapolis, as well as portions of other Central Indiana communities surrounding Marion County and owns and operates 3,634 MW of generation assets. AES is part of the Midcontinent Independent System Operator (MISO) grid and represents a small fraction of the grid's total makeup.

Electric power systems require several reliability services from installed resources to function properly and to deliver reliable and safe electricity to consumers that meets mandatory industry requirements embodied in several of the North American Electric Reliability (NERC) standards. Some of the reliability services such as reserves can be procured from the RTO while others such as voltage control have traditionally been assumed to be innately provided by the local resources. Integrating high levels of intermittent renewable resources (e.g., solar, wind) and other inverter-based resources (IBR) (e.g., energy storage) into the power grid brings a clear opportunity to realize a clean energy future. However, it also brings significant concerns about the preparedness of the electric grid to operate reliably.

A careful assessment of the essential grid services that can be provided by the various IRP portfolios is required to ensure continued safe and reliable operation of the power system in accordance with industry standards, and where applicable, the provision of additional reliability services and enforcement of interconnection standards to assure the successful implementation of the IRP objectives in a timely and affordable manner.

The 2022 IRP optimized five strategies and one "Encompass Optimization" analysis across four scenarios or future views.[1]. See Section 8 of the AES Indiana IRP 2022 IRP Report for more information on the IRP Modeling Framework including strategies and scenarios. This reliability study analyzed all 24 portfolios. A range of solar, storage, wind, energy efficiency, demand response, and gas resources are incorporated across the portfolios.

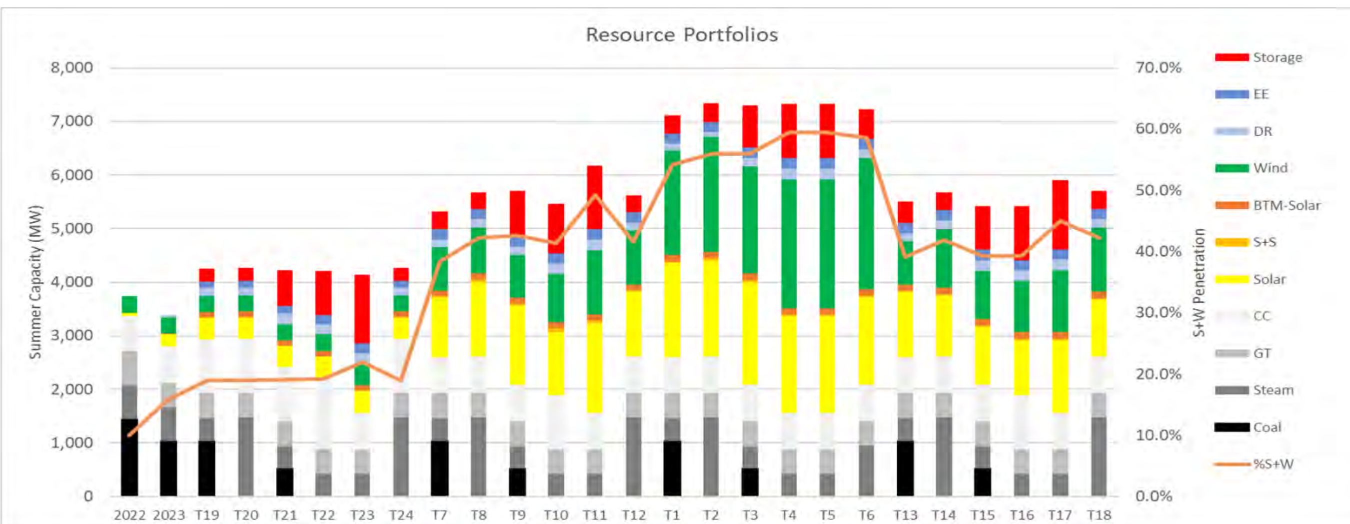
[1] Scenarios (No Environmental Action, Current Trends, Aggressive Environmental, Decarbonized Economy); Portfolios (No Early Retirement, Petersburg Conversion, One Petersburg Unit Retires, Both Petersburg Units Retire, Clean Energy Strategy, Encompass Optimization)

The report will use the following naming conventions for the five strategies and "Encompass Optimization" analysis in tables and charts where space is limited:

"No Early Retirement" = No Retire
"Petersburg Conversion" = Convert
"One Petersburg Unit Retires" = 1 Retire
"Both Petersburg units Retire" = 2 Retire
"Clean Energy Strategy" = Clean
"Encompass Optimization" analysis = Optimize

The acronym IBR used in this report means "Inverter-Based Resources".

The 24 portfolios that were analyzed in this study explored a wide range of resource strategies as exhibited in Figure ES-1 and Table E-1 where the inverter-based resources reached 7.3GWs and the renewable penetration 85% by 2042. This study focused all its analysis on the Y2031 as a midyear within the 20-year horizon and also as a year when most of the portfolio temporal changes have taken place.




| | Aggressive Environmental | | | | | |
|---|---|---|---|---|---|---|
| | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimiz |
| Dispatchable % | 43 | 42 | 42 | 38 | 38 | 39 |
| Solar&Wind % | 54 | 56 | 56 | 59 | 59 | 59 |

| | Current Trends (Ref. case) | | | | | |
|---|---|---|---|---|---|---|
| | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimiz |
| Dispatchable % | 58 | 55 | 54 | 55 | 48 | 55 |
| Solar&Wind % | 38 | 42 | 43 | 41 | 49 | 42 |

| | Decarbonized Economy | | | | | |
|---|---|---|---|---|---|---|
| | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimiz |
| Dispatchable % | 57 | 55 | 57 | 57 | 52 | 55 |
| Solar&Wind % | 39 | 42 | 39 | 39 | 45 | 42 |

| | No Environmental Action | | | | | |
|---|---|---|---|---|---|---|
| | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimiz |
| Dispatchable % | 78 | 78 | 78 | 77 | 73 | 78 |
| Solar&Wind % | 19 | 19 | 19 | 19 | 22 | 19 |

**Figure ES-1: Resource Mix in each of the Portfolios**

**Table E-1**

| | Inverter Based Resources (IBR) (GW) | Solar + Wind (% of All Resource ICAP) | Renewable Penetration (%) |
|---|---|---|---|
| 2022 | 0.4 | 10% | 8% |
| 2031 | 1.0 – 5.4 | 19% - 59% | 13 – 81% |
| 2042 | 1.1 – 7.3 | 18% - 61% | 8 – 85% |

Grid reliability and security standards require grid planners and operators to adhere to numerous performance requirements[2], including the ones abbreviated and summarized in Table ES-2.

**Table ES-2. Selected Grid Reliability and Security Requirements**

| Reliability/Security Category | Requirement / Guidance | Consequence |
|---|---|---|
| Steady-State Voltages | Voltages on138 kV and above facilities to remain within 92-105% of rated levels | Equipment insulation failure or heating and fire hazard |
| Steady-State Frequency | Maintain system frequency within -/+0.5% of 60 Hz | Affects the voltage level and magnetizing currents of transformers; Affects speed of motors; Affects power-sharing between interconnecting areas |
| Thermal Limits Pre-contingency | Electric current flows on all bulk power facilities should not exceed 100% of their normal rating limits. | Exceeding grid equipment ratings causes equipment loss of life or catastrophic failure. |
| Thermal Limits Post-contingency | Electric current flows on all bulk power facilities should not exceed 100% of emergency (SE) rating limits after any P1[3], P2-1, and P3 contingency and 100% of SE after any P4-P7 category contingencies. | Exceeding grid equipment ratings causes equipment loss of life or catastrophic failure. |
| Voltage Stability Limits Post-contingency | Voltages on 138 kV and above facilities should not exceed -10%/+5% of rated levels after any contingency of P1-P7 categories. | Exceeding grid equipment ratings leading to loss of life and failure |
| Stability Limits Post -contingency | The power system should not lose synchronism following any P1-P7 category contingency and should not drop load.<br><br>There should be an acceptable transient voltage recovery where the voltage following fault clearing shall | Cascading outages |

[2] NERC standards such as TPL-001-4, and AES's Electric Transmission Planning Criteria

[3] Contingency classification per NERC TPL-001-4 standard. P0 is intact system (N-0); P1 is single element failure (circuit, generator, transformer, shunt device); P2 is also single element failure (line section, bus, breaker); P3 is loss of a second element after a period of losing a generator (N-1-1), P4 is multiple element loss (stuck breaker), P5 is also multiple element loss (delayed fault clearing due to relay failure); P6 is a loss of single element (line, transformer, shunt) followed by a loss of another single element (N-1-1), and P7 is loss of multiple elements (common structure).

| Reliability/Security Category | Requirement / Guidance | Consequence |
|---|---|---|
| | recover to an allowable steady state condition. after 5 seconds.<br><br>Following the disturbance, the oscillations of the monitored parameters should display positive damping. The damping ratio should reach 3% or better for inter-area oscillations and 4% or better for local mode oscillations. | |
| Rate of Change of Frequency (RoCoF) | Following the loss of the largest generator, the RoCoF should not exceed 1.0Hz/s. | Reduced synchronizing torques may cause generators to trip; may exceed the speed of operation of protective equipment; may damage generators. |
| Power Quality - Harmonics | Connecting equipment should not inject harmonics in excess of allowable levels. The harmonic content of grid voltages should not exceed allowable levels. | Heating of equipment, audible noise, mis-operation of electronic devices, and deterioration of insulation in cables |
| Power Quality – Flicker (Voltage Fluctuations) | The variability of the power output of connecting equipment should not rise to a level that causes irritation to customers. | Visible irritation to customers, lost productivity, and damage to sensitive electronic equipment |
| Short Circuit Ratio | The connecting equipment power injection level should be limited to a level commensurate with the strength of the grid at the point of common coupling. | Grid voltages become very sensitive, resulting in large voltage deviations in response to renewable power fluctuations, beyond acceptable limits. This results in the malfunction of inverters' controls. Inverter manufacturers do not guarantee proper operation of equipment under these conditions.<br>It becomes difficult to energize large power transformers. |
| Protection System Operation | Short circuit currents should be high enough for proper operation of protection systems. | Protection system mis-operation resulting in equipment failure, cascading outages, and human safety concerns |

Being part of the MISO grid, AES Indiana relies on the market to provide many of the required reliability services as shown in Figure ES-2 such as the dispatch of its resources, the balancing of its energy requirements, and the control of frequency. However, some reliability services are local in nature and not procured by the markets such as frequency responsive reserves and voltage support. Other services such as blackstart and restoration are planned by AES Indiana and approved by MISO. Most of the time, the regional markets work as planned and provide the required reliability services to all participants.

However, during periods of extreme weather or emergency operation events, such as "Max Gen" events, the available resources in the market are severely restricted and thus the ability of AES Indiana to continue serving its baseload customer needs should be assessed. A careful analysis of each portfolio is prudent to ensure it has the requisite reliability attributes and can be integrated reliably into the T&D grid.

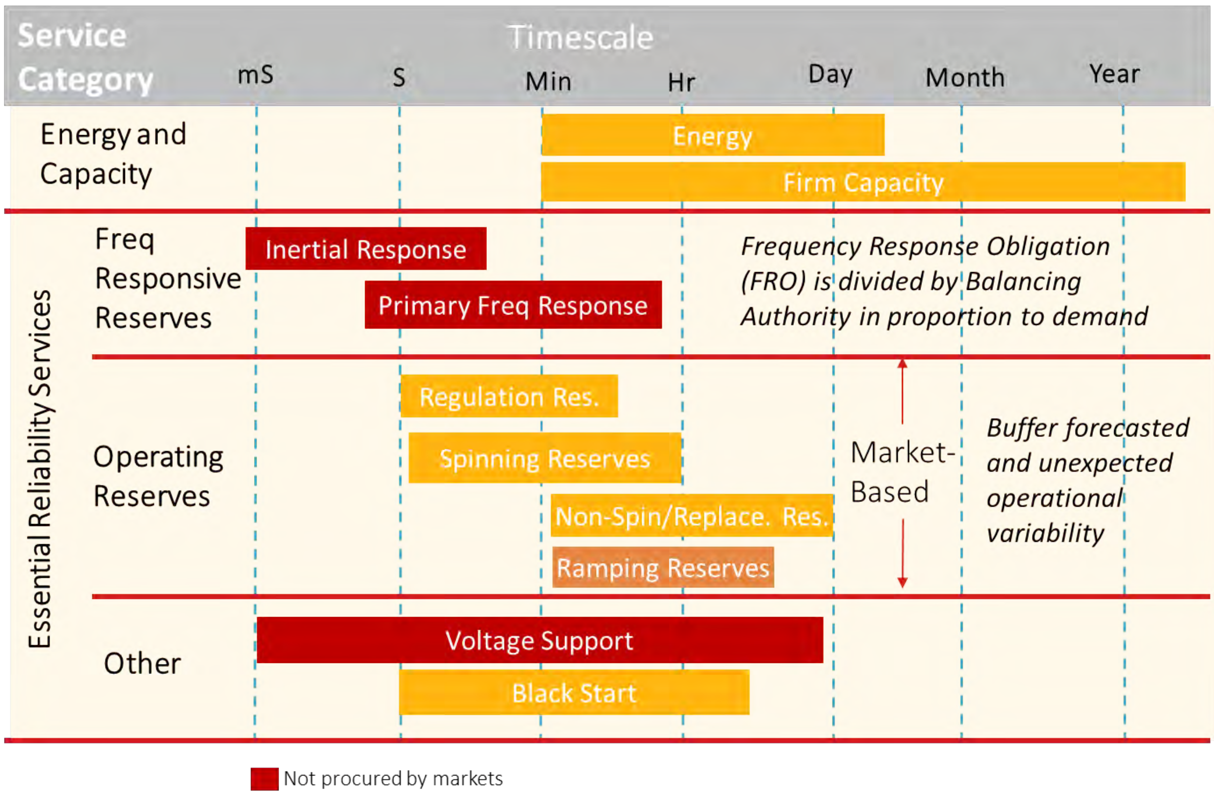



**Figure ES-2: Essential Reliability Services**

## 1.2 Study Methodology

The reliability assessment study (Figure ES-3) started by gathering and collating data characterizing the existing and planned resources along with locations, planned retirement schedules, portfolio resource additions, and transmission grid power flow and dynamic models.

The study then reviewed, refined, and augmented the initial set of reliability metrics, along with the measures that will be used to quantify the performance of each portfolio against each metric.

The study then proceeded to conduct a series of system analyses, each quantifying the performance of each of the twenty-four portfolios against each measure, and where appropriate determining the required mitigations to address any performance gaps. The nature of the study is akin to a series of analysis filters. Passing one analysis filter is not a guarantee for the ability to integrate IBRs and to operate reliably.

However, limits imposed or flagged by any analysis filter represent a reliability concern that should be mitigated.

A scoring matrix is organized along with acceptable performance thresholds to provide a quantifiable score for each reliability measure. These scores are aggregated for each metric, and eventually for each portfolio. Mitigations are quantified for each portfolio to address its reliability shortcomings.


**Figure ES-3: Reliability Study Methodology**

## 1.3 Reliability Metrics

Nine metrics have been selected to assess the reliability attributes of each portfolio, as summarized in Table ES-3.

**Table ES-3: Reliability Metrics**

| | Metric | Description | Rationale |
|---|---|---|---|
| 1 | Energy Adequacy | Resources are able to meet the energy and capacity duration requirements. Portfolio resources are able to supply the energy demand of customers during normal and emergency max gen events, and also to supply the energy needs of critical loads during islanded operation events. | Utility must have long duration resources to serve the needs of its customers during emergency and islanded operation events. |
| 2 | Operational Flexibility and Frequency Support | Ability to provide inertial energy reservoir or a sink to stabilize the system. Additionally, resources can adjust their output to provide frequency support or stabilization in response | Regional markets and/or control centers balance supply and demand under different time frames according to prevailing market construct under normal conditions, but preferable that local control |

| | | | |
|---|---|---|---|
| | | to frequency deviations with a droop of 5% or better. | centers possess the ability to maintain operation during under-frequency conditions in emergencies. |
| 3 | Short Circuit Strength Requirement | Ensure the strength of the system to enable the stable integration of all inverter-based resources (IBRs) within a portfolio. | The retirement of synchronous generators within utility footprint and replacements with increasing levels of inverter-based resources will lower the short circuit strength of the system. Resources than can operate at lower levels of short circuit ratio (SCR) and those that provide higher short circuit current provide a better future proofing without the need for expensive mitigation measures. |
| 4 | Power Quality (Flicker) | The "stiffness of the grid" affects the sensitivity of grid voltages to the intermittency of renewable resources. Ensuring the grid can deliver power quality in accordance with IEEE standards is essential. | Retirement of large thermal generation plants lower the strength of the grid and increases its susceptibility to voltage flicker due to intermittency of renewable resources, unless properly assessed and mitigated. |
| 5 | Blackstart | Ensure that resources have the ability to be started without support from the wider system or are designed to remain energized without connection to the remainder of the system, with the ability to energize a bus, supply real and reactive power, frequency and voltage control | In the event of a black out condition, utility must have a blackstart plan to restore its local electric system. The plan should demonstrate the ability to energize a cranking path to start large flexible resources with sufficient energy reservoir. |
| 6 | Dynamic VAR Support | Customer equipment driven by induction motors (e.g., air conditioning or factories) requires dynamic reactive power after a grid fault to avoid stalling. The ability of portfolio resources to provide this service depends on their closeness to the load centers. | Utility must retain resources electrically close to load centers to provide this attribute in accordance with NERC and IEEE Standards |
| 7 | Dispatchability and Automatic Generation Control | Resources should respond to directives from system operators regarding their status, output, and timing. Resources that can be ramped up and down automatically to respond immediately to changes in the system contribute more to reliability than resources which can be ramped only up or only down, and those in turn are better than ones that cannot be ramped. | Ability to control frequency is paramount to stability of the electric system and the quality of power delivered to customers. Control centers (regional or local) provide dispatch signals under normal conditions, and under emergency restoration procedures or other operational considerations. |
| 8 | Predictability and Firmness of Supply | Ability to predict/forecast the output of resources and to counteract forecast errors. | The ability to predict resource output from a day-ahead to real-time is advantageous to minimize the need for spinning reserves. In places with an active energy market, energy is scheduled with the market in the day-ahead hourly market and in the real-time 5-minute market. Deviations from these schedules have financial consequences and thus the ability to accurately forecast the output of a resource up to 38 hours ahead of time for the day- |

| | | | |
|---|---|---|---|
| | | | ahead market and 30 minutes for the real time market is advantageous. |
| 9 | Geographic Location Relative to Load (Resilience) | Ensure the ability to have redundant power evacuation or deliverability paths from resources. Preferrable to locate resources at substations with easy access to multiple high voltage paths, unrestricted fuel supply infrastructure, and close to major load centers. | Location provides economic value in the form of reduced losses, congestion, curtailment risk, and address local capacity requirements. Additionally, from a reliability perspective, resources that are interconnected to buses with multiple power evacuation paths and those close to load centers are more resilient to transmission system outages and provide better assistance in the blackstart restoration process. |

Each reliability metric is assessed using one or multiple measures as shown in Table ES-4.

**Table ES-4: Reliability Measures for Each Metric**

| | Metric | Measure |
|---|---|---|
| 1 | Energy Adequacy | Loss of Load Hours (LOLH) - normal system, 50/50 forecast |
| | | Expected Energy not Served (GWh) - normal system 50/50 forecast |
| | | max MW Short (MW) - normal system 50/50 forecast |
| | | max MW Short - loss of 50% of tie-line capacity, 50/50 forecast |
| | | max MW Short (islanded, 50/50 forecast) |
| | | max MW Short (normal system, 90/10 forecast) |
| 2 | Operational Flexibility and Frequency Support | Inertia MVA-s |
| | | Inertial Gap FFR MW (% CAP) |
| | | Primary Gap PFR MW (% CAP) |
| 3 | Short Circuit Strength | Inverter MWs passing ESCR limits (%) - Connected System |
| | | Inverter MWs passing ESCR limits (%) - Islanded System |
| | | Required Additional Synch Condensers MVA (% peak load) - Connected |
| | | Required Additional Synch Condensers MVA (% peak load) - Islanded |
| 4 | Flicker | Compliance with Flicker limits when Connected (GE Flicker Curve or IEC Flicker Meter) |
| | | Compliance with Flicker limits when islanded |
| | | Required Synchronous Condensers MVA to mitigate Flicker |
| 5 | Blackstart | Qualitative Assessment of Ability to blackstart the system |
| 6 | Dynamic VAR Support | Dynamic VAR to load Center Capability (% of Peak Load) |
| 7 | Dispatchability | Dispatchable (%CAP) |
| | | Unavoidable VER Penetration % |
| | | Increased Freq Regulation Requirements (% Peak Load) |
| | | 1-min Ramp Capability (MW) |
| | | 10-min Ramp Capability (MW) |
| 8 | Predictability and Firmness | Ramping Capability to Mitigate Forecast Errors (+Excess/-Deficit) (%VER MW) |
| 9 | Location | Average Number of Evacuation Paths |

## 1.4 Scope of Reliability Analysis

Operating a power system with high levels of inverter-based resources (IBR) requires careful analysis of the resource reliability attributes to ensure a safe and reliable system operation during normal, emergency, and islanded system conditions. This study evaluated twenty-four portfolios across nine reliability metrics involving 25 measures. The study focused on the year 2031 for all quantitative analyses because it is in the middle of 20-year horizon and because most of the portfolio temporal changes have taken place by then. Table ES-5 summarizes the reliability assessments that have been conducted in this study.

**Table ES-5: Reliability Assessments**

| | Reliability Study Area | Normal (50/50, Connected) | Max-Gen (90/10, Import Limited) | Islanded (Critical Load) |
|---|---|---|---|---|
| 1 | Energy Adequacy | X | X | X |
| 2 | Operational Flexibility and Frequency Support | X | | X |
| 3 | Short Circuit Strength Requirement | X | | X |
| 4 | Power Quality (Flicker) | X | | X |
| 5 | Blackstart | | | X |
| 6 | Dynamic VAR Deliverability | X | | |
| 7 | Dispatchability and Automatic Generation Control | X | | |
| 8 | Predictability and Firmness of Supply | X | | |
| 9 | Geographic Location Relative to Load | X | | |

This study takes the resource portfolios and associated schedules of retirements and additions from the IRP along with the standard models of the existing transmission grid and generation resources and assesses several of the mandatory reliability requirements for the year 2031. Given the dynamic nature of renewable energy developments during the 10-year horizon and the future state of the transmission grid buildout, this study provides an envelope of outcomes (and in many cases, best or optimistic outcomes) under a regime of well-coordinated or guided project development.

Prudent assumptions were made in the study. For example, operating renewable resources economically requires them to generate all the time at their maximum potential power levels as allowed by solar irradiance and wind speeds. This mode of economic operation precludes these resources from providing frequency response in the upward direction, as will be required when a generator or import is suddenly lost. Reducing the power output to enable participation in frequency response in the upward direction is very expensive. However, the speed of control of the IBRs makes them perfectly suited for participating in frequency response in the downward direction (i.e., curtailment), as will be required when a large load or export is suddenly lost.

Screening-level quantitative studies were conducted for several reliability standards, including inertial response, primary frequency response, secondary frequency response, short circuit strength, system ramping requirements, dynamic reactive support, flicker, and energy adequacy. Qualitative assessments were made for blackstart and system restoration capability. Other areas of reliability assessment are outside the scope of this study and include system protection and control interactions. Detailed system studies will be required to ascertain the reliability of the system once a portfolio is selected and the location, size, and technology of all portfolio resources are available.

## 1.5 Summary of Study Results

This study identified potential reliability gaps for each of the twenty-four IRP portfolios and has also suggested potential mitigations to these gaps. The mitigations take the form of grid-forming inverter technology, additional fast power resources such as battery storage, super capacitors, or combustion turbines, and additional synchronous condensers.

The key findings of this study are summarized in Table ES-6 for each of the performance measures under each of the nine metrics of the Current Trends/Reference Case Scenario. The results of all portfolios are summarized in the Appendix.

**Table ES-6: Study Results of the Reliability Performance of Portfolios in the Current Trends Future**

| | | Current Trends/Reference Case | | | | | |
|---|---|---|---|---|---|---|---|
| | | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize |
| **Year 2031** | | **T7** | **T8** | **T9** | **T10** | **T11** | **T12** |
| Resource Adequacy | Additional Reserve Margin Required - Summer (MW) | -210 | -373 | -101 | 47 | 61 | -318 |
| Energy Adequacy | Loss of Load Hours (LOLH) - normal system, 50/50 forecast | 0 | 0 | 11 | 39 | 64 | 0 |
| | Expected Energy not Served (GWh) - normal system 50/50 forecast | 0 | 0 | 0 | 0 | 0 | 0 |
| | max MW Short (MW) - normal system 50/50 forecast | 0 | 0 | 503 | 748 | 1029 | 0 |
| | max MW Short - loss of 50% of tieline capacity, 50/50 forecast | 0 | 0 | 614 | 798 | 1079 | 0 |
| | max MW Short (islanded, 50/50 forecast) | 0 | 0 | 663 | 847 | 1128 | 0 |
| | max MW Short (normal system, 90/10 forecast) | 621 | 600 | 1138 | 1322 | 1603 | 582 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Operational Flexibility and Frequency Support | Inertia MVA-s | 12,740 | 13,829 | 11,115 | 11,903 | 9,490 | 13,829 |
| | Inertial Gap FFR MW | 129 | 99 | 183 | 49 | 128 | 98 |
| | Primary Gap PFR MW | 298 | 326 | 0 | 0 | 0 | 325 |
| Short Circuit Strength | Inverter MWs passing ESCR limits (%) - Connected System | 100% | 100% | 100% | 100% | 100% | 100% |
| | Inverter MWs passing ESCR limits (%) - Islanded System | 100% | 100% | 49% | 53% | 10% | 100% |
| | Required Additional Synch Condensers MVA (when connected) | 0 | 0 | 0 | 0 | 0 | 0 |
| | Required Additional Synch Condensers MVA (when Islanded) | 0 | 0 | 350 | 300 | 1500 | 0 |
| Power Quality (Flicker) | Compliance with Flicker limits when connected (GE Flicker Curve or IEC Flicker Meter) | 100% | 100% | 100% | 100% | 100% | 100% |
| | Compliance with Flicker limits when Islanded | 100% | 100% | 100% | 100% | 100% | 100% |
| | Required Synchronous Condensers MVA to mitigate Flicker | 0 | 0 | 0 | 0 | 0 | 0 |
| Blackstart | Qualitative Assessment of Ability to Blackstart the system | 1 | 1 | 1 | 1 | 1 | 1 |
| Dynamic VAR Support | Dynamic VARs that can be delivered to select load centers (% of Load) at peak | 59% | 50% | 53% | 50% | 51% | 52% |
| Dispatchability and Automatic Generation Control | Dispatchable (%CAP) | 82% | 80% | 78% | 79% | 74% | 82% |
| | Unavoidable VER Penetration % | 0% | 0% | 0% | 0% | 0% | 0% |
| | Increased Freq Regulation Requirements (MW) | 39 | 48 | 49 | 45 | 66 | 47 |
| | 1-min Ramp Capability (MW) | 417 | 403 | 919 | 1,005 | 1,255 | 403 |
| | 10-min Ramp Capability (MW) | 1,159 | 1,200 | 1,621 | 1,756 | 1,915 | 1,200 |
| Predictability and Firmness | Ramping Capability to Mitigate Forecast Errors (+Excess/-Deficit) MW | 329 | 231 | 752 | 752 | 870 | 952 |
| Location | Average Number of Paths for Evacuating Power from Resources | 4.5 | 4.5 | 4.4 | 4.4 | 4.4 | 4.5 |

Quantitative assessment of each measure, except blackstart, was calculated using resource technology, size, and location within each portfolio along with resource production profiles and grid data. Blackstart, on the other hand, was deemed acceptable for all portfolios since the existing blackstart restoration plan is not impacted by the resource mix in each portfolio.

Table ES-7 summarizes potential mitigation measures to address the reliability concerns and their estimated costs.

**Table ES-7. Summary of Proposed Mitigations of Portfolios in the Current Trends Future**

| | Current Trends/Reference Case | | | | | |
|---|---|---|---|---|---|---|
| | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize |
| | **T7** | **T8** | **T9** | **T10** | **T11** | **T12** |
| Equip Stand-alone ESS with GFM inverters (MW) | **129** | **99** | **183** | **49** | **128** | **98** |
| Additional Synchronous Condensers (MVA) | **0** | **0** | **350** | **300** | **1500** | **0** |
| Additional Power Mitigations (MW)[4] | **298** | **326** | **183** | **49** | **128** | **325** |
| Increased Freq Regulation | 39 | 48 | 49 | 45 | 66 | 47 |
| Address Inertial Response Gaps | 129 | 99 | 183 | 49 | 128 | 98 |
| Address Primary Response Gaps | 298 | 326 | 0 | 0 | 0 | 325 |
| Firm up Intermittent Renewable Forecast | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| GFM Inverter Premium ($M) | $6 | $5 | $9 | $2 | $6 | $5 |
| Additional BESS ($M) | $120 | $131 | $74 | $20 | $52 | $131 |
| Additional Synchronous Condensers ($M) | $0 | $0 | $158 | $135 | $871 | $0 |
| **Estimated Cost of Mitigations ($M)** | **$127** | **$136** | **$241** | **$157** | **$929** | **$136** |

Observations and Comments:

1. Reliability concerns were identified for each portfolio, especially under emergency and islanded conditions, and mitigation measures were identified as follows:

   a. Stand-alone energy storage should have grid-forming inverters (GFM) with additional capabilities including blackstart and fast frequency response (FFR). GFM inverters are not widely used today in the US market, but the technology is available and is recommended for portfolios with high penetration of IBRs.

   b. The provision of additional fast power resources is required in each portfolio. These have been quantified for energy storge technology. However, super capacitors or combustion turbines can also provide the same function, but the size should be determined for these technologies.

   c. Specifications of equivalent short circuit ratio (SCR) of inverters not to exceed 3.5.

[4] Requires fast frequency response within 100ms. Can be in the form of battery storage, super capacitors, or appropriately upsized combustion engines or gas turbines.

d. Provision of additional synchronous condensers to increase the grid's short circuit strength ranging from 0 to 1500 MVAr.

2. This study covered several areas of reliability assessment. However, it is not exhaustive. Areas that have not been covered include the following:

   e. The study assumed that any required grid upgrades will be implemented as part of MISO interconnection process, and thus excluded the analysis of portfolio deliverability.

   f. The study assumed the IRP process produced portfolios with sufficient capacity to assure meeting the LOLE target of 0.1 days/year, and thus excluded the analysis of resource adequacy.

   g. All reliability assessments in this study applied screening level indicative analyses. Detailed system studies are essential and should be conducted to properly assess system reliability of the short-listed Portfolios.

## 1.6 Scoring Methodology and Performance Thresholds

Table ES 8 summarizes the thresholds that are used in this study to score the reliability assessment of each measure, along with the rationale for setting the threshold values. Measures that exceed the upper threshold are deemed satisfactory (Pass) and given a score of 1, while those measures below the lower threshold are deemed potentially problematic and given a score of 0. Measures in between are cautionary and given a score of ½. The scores of measures within each of the eight metrics are averaged to yield a single score for each metric. Metric scores are then added for each portfolio and compared. The maximum score of each portfolio is nine.

**Table ES 8: Scoring Thresholds**

| | Year 2031 | | 1 (Pass) | 2 (Caution) | 3 (Problem) | Rationale |
|---|---|---|---|---|---|---|
| 1 | Energy Adequacy | Loss of Load Hours (LOLH) - normal system, 50/50 forecast | <2.4 hrs | 2.4-4.8 hrs | >4.8 hrs | Expected number of hours in a year the portfolio is energy short and relies on imports (2.4hrs = 1day in 10 years) |
| | | Expected Energy not Served (GWh) - normal system 50/50 fcst | <2.4*Peak | 2.4-4.8*Peak | >4.8*Peak | The energy consumption which is not supplied due to insufficient capacity resources within portfolio to meet the demand |
| | | max MW Short (MW) - normal system 50/50 forecast | <0% | 0-10% | >10% | The maximum hourly power shortage in the portfolio that has to be supplied by imports (% of Tie-line Import Limits) |
| | | max MW Short - loss of 50% of tieline capacity, 50/50 fcst | <0% | 0-5% | >5% | The energy consumption which is not supplied due to insufficient resources and imports to meet the demand, when tieline import capacity is halved |
| | | max MW Short (islanded, 50/50 forecast) | <70% | 70-85% | >85% | Ability of Resources to serve critical loads, estimated at 15% of total load. Adding other important loads brings the total to 30% |
| | | max MW Short (normal system, 90/10 forecast) | <5% | 5-20% | >20% | Ability of portfolio resources to serve unanticipated growth in load consumption during MISO emergency max-gen events |
| 2 | Operational Flexibility and | Inertia MVA-s | >4.2 *Peak | 2.6-4.2 *Peak | <2.6 *Peak | Synchronous machine has inertia of 2-5xMVA rating. Conventional systems have inertia that exceeds 2-5x (Peak load x 1.3) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Frequency Support | Inertial Gap FFR MW (% CAP) | 0 | 0-10% of CAP | >10% of CAP | System should have enough inertial response, so gap should be 0. Inertial response of synch machine ≈ 10% of CAP |
| | | Primary Gap PFR MW (% CAP) | 0 | 0 - 2% of CAP | >2% of CAP | System should have enough primary response, so gap should be 0. Primary response of synch machine ≈ 3.3%of CAP/0.1Hz (Droop 5%) |
| 3 | Short Circuit Strength | Inverter MWs passing ESCR limits (%) - Connected System | 95% | 80-95% | 80% | Grid following inverters require short circuit strength at the point of connection to operate properly (ESCR threshold of 3.5) |
| | | Inverter MWs passing ESCR limits (%) - Islanded System | 0 | 0-20% | >20% | Grid following inverters require short circuit strength at the point of connection to operate properly (ESCR threshold of 3.5) |
| | | Required Additional Synch Condensers MVA (% peak load) | 0 | 0-500 | >500 | Portfolio should not require additional synchronous condensers. 500MVArs is a threshold |
| 4 | Flicker | Compliance with Flicker limits when connected (GE Flicker Curve or IEC Flicker Meter) | >95% | 80-95% | <80% | % of system load buses that is likely to experience flicker (>100% of Border line of irritation or Pst>1) |
| | | Compliance with Flicker limits when islanded | >80% | 50-80% | <50% | % of system load buses that is likely to experience flicker (>100% of Border line of irritation or Pst>1) |
| | | Required Synchronous Condensers MVA to mitigate Flicker | 0% | 0-500 | >500 | Size of Synchronous condensors required to mitigate flicker ( 500MVArs is a threshold) |
| 5 | Blackstart | Qualitative Assessment of Ability to Blackstart the system | Excellent | Average | Poor | System requires real and reactive power sources with sufficient rating and duration to start other resources. Higher rated resources lower the risk |
| 6 | Dynamic VAR Support | Dynamic VAR to load Center Capability (% of Peak Load) | ≥85% | 55-85% | <55% | Dynamic reactive power (DRP) should exceed 55-85% of the peak load served by the load centers. DRP requirement to prevent induction motor stalling is 2.5x the steady state reactive consumption. Assuming a PF=0.9, and Induction motors account for 50-80% of the load. |
| 7 | Dispatchability | Dispatchable (%CAP) | >60% | 50-60% | <50% | Dipatchable resource are essential for system operation |
| | | Unavoidable VER Penetration % | <60% | 60-70% | >70% | Intermittent Power Penetration above 60% is problematic when islanded |
| | | Increased Freq Regulation Requirements (% Peak Load) | <2% of peak load | 2-3% of Peak Load | >3% of peak load | Regulation of Conventional Systems ≈1% |
| | | 1-min Ramp Capability (MW) | >15% of CAP | 10-15% of CAP | <10% of CAP | 10% per minute was the norm for conventional systems. Renewable portfolios require more ramping capability |
| | | 10-min Ramp Capability (MW) | >65% of CAP | 50-65% of CAP | <50% of CAP | 10% per minute was the norm for conventional systems. But with 50% min loading, that will be 50% in 10 min. Renewable portfolios require more ramping capability |
| 8 | Predictability and Firmness | Ramping Capability to Mitigate Forecast Errors (+Excess/-Deficit) (%VER MW) | ≥ 0 | -10% - 0% of CAP | <-10% of CAP | Excess ramping capability to offset higher levels of intermittent resource output variability is desired |
| 9 | Location | Average Number of Evacuation Paths | >3 | 2-3 | <2 | More power evacuation paths increase system resilience |

The study results as summarized in **Table ES-6** are normalized following the threshold definitions and shown in Table ES-9.

**Table ES-9: Normalized Study Results**

| | | | Current Trends/Reference Case | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize |
| | **Year 2031** | | **T7** | **T8** | **T9** | **T10** | **T11** | **T12** |
| 1 | Energy Adequacy | Loss of Load Hours (LOLH) - normal system, 50/50 forecast | 1 | 1 | 0 | 0 | 0 | 1 |
| | | Expected Energy not Served (GWh) - normal system 50/50 forecast | 1 | 1 | 1 | 1 | 1 | 1 |
| | | max MW Short (MW) - normal system 50/50 forecast | 1 | 1 | 1 | 1 | 1 | 1 |
| | | max MW Short - loss of 50% of tieline capacity, 50/50 forecast | 1 | 1 | 1 | 1/2 | 0 | 1 |
| | | max MW Short (islanded, 50/50 forecast) | 1 | 1 | 1 | 1 | 1 | 1 |
| | | max MW Short (normal system, 90/10 forecast) | 1/2 | 1/2 | 0 | 0 | 0 | 1/2 |
| 2 | Operational Flexibility and Frequency Support | Inertia MVA-s | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| | | Inertial Gap FFR MW (% CAP) | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 | 1/2 |
| | | Primary Gap PFR MW (% CAP) | 0 | 0 | 1 | 1 | 1 | 0 |
| 3 | Short Circuit Strength | Inverter MWs passing ESCR limits (%) - Connected System | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Inverter MWs passing ESCR limits (%) - Islanded System | 1 | 1 | 0 | 1/2 | 0 | 1 |
| | | Required Additional Synch Condensers MVA (when connected) | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Required Additional Synch Condensers MVA (when islanded) | 1 | 1 | 1/2 | 1/2 | 0 | 1 |
| 4 | Power Quality | Compliance with Flicker limits when connected (GE Flicker Curve or IEC Flicker Meter) | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Compliance with Flicker limits when islanded | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Required Synchronous Condensers MVA to mitigate Flicker | 1 | 1 | 1 | 1 | 1 | 1 |
| 5 | Blackstart | Qualitative Assessment of Ability to Blackstart the system | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | Dynamic VAR Support | Dynamic VAR to load Center Capability (% of Peak Load) | 1 | 1 | 1 | 1 | 1 | 1 |
| 7 | Dispatchability and Automatic Generation Control | Dispatchable (%CAP) | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Unavoidable VER Penetration % | 1 | 1 | 1 | 1 | 1 | 1 |
| | | Increased Freq Regulation Requirements (% Peak Load) | 1 | 1 | 1 | 1 | 1 | 1 |
| | | 1-min Ramp Capability (MW) | 1/2 | 1/2 | 1 | 1 | 1 | 1/2 |
| | | 10-min Ramp Capability (MW) | 0 | 0 | 1/2 | 1/2 | 1/2 | 0 |
| 8 | Predictability and Firmness | Ramping Capability to Mitigate Forecast Errors (+Excess/-Deficit) (%VER MW) | 1 | 1 | 1 | 1 | 1 | 1 |
| 9 | Location | Average Number of Evacuation Paths | 1 | 1 | 1 | 1 | 1 | 1 |
| | | **Cumulative core (out of possible 9)** | **7.95** | **7.95** | **7.86** | **7.90** | **7.57** | **7.95** |

VER: Variable Energy Resources (e.g., solar, wind)

CAP: Capacity credit of all resources including existing, planned, and portfolio

## 1.7 Appendix A – Reliability Analysis Results of All Portfolios

| | | | No Environmental Action | | | | | | Current Trends (reference Case) | | | | | | Aggressive Environmental | | | | | | Decarbonized Economy | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 2031 | | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize |
| - | Resource Adequacy | Additional Reserve Margin Required - Summer (MW) | -144 | -217 | 50 | 123 | 466 | -218 | -210 | -373 | -101 | 47 | 61 | -318 | -450 | -515 | -293 | 30 | 30 | -160 | -270 | -315 | -21 | 60 | 116 | -299 |
| 1 | Energy Adequacy | Loss of Load Hours (LOLH) - normal system, 50/50 forecast | 0 | 0 | 0 | 20 | 325 | 0 | 0 | 0 | 11 | 39 | 64 | 0 | 0 | 0 | 0 | 32 | 32 | 0 | 0 | 0 | 9 | 0 | 68 | 0 |
| | | Expected Energy not Served (GWh) - normal system 50/50 fcst | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | max MW Short (MW) - normal system 50/50 forecast | 0 | 0 | 0 | 515 | 1152 | 0 | 0 | 0 | 503 | 748 | 1029 | 0 | 0 | 0 | 0 | 863 | 863 | 0 | 0 | 0 | 487 | 0 | 1033 | 0 |
| | | max MW Short - loss of 50% of tieline capacity, 50/50 fcst | 0 | 0 | 271 | 567 | 1201 | 0 | 0 | 0 | 614 | 798 | 1079 | 0 | 0 | 0 | 301 | 913 | 913 | 109 | 0 | 0 | 598 | 0 | 1082 | 0 |
| | | max MW Short (islanded, 50/50 forecast) | 0 | 0 | 394 | 616 | 1251 | 0 | 0 | 0 | 663 | 847 | 1128 | 0 | 0 | 0 | 351 | 1059 | 1059 | 328 | 0 | 0 | 647 | 0 | 1132 | 0 |
| | | max MW Short (normal system, 90/10 forecast) | 362 | 350 | 897 | 1092 | 1727 | 350 | 621 | 600 | 1138 | 1322 | 1603 | 582 | 365 | 294 | 967 | 1436 | 1436 | 905 | 613 | 542 | 1121 | 350 | 1605 | 475 |
| 2 | Operational Flexibility and Frequency Support | Inertia MVA-s | 15,153 | 16,242 | 13,528 | 14,316 | 9,490 | 16,242 | 12,740 | 13,829 | 11,115 | 11,903 | 9,490 | 13,829 | 12,740 | 13,829 | 11,115 | 9,490 | 9,490 | 11,659 | 12,740 | 13,829 | 11,115 | 11,903 | 9,490 | 13,829 |
| | | Inertial Gap FFR MW | 53 | 23 | 107 | 221 | 133 | 23 | 129 | 99 | 183 | 49 | 128 | 98 | 124 | 93 | 178 | 123 | 123 | 164 | 129 | 98 | 183 | 49 | 128 | 98 |
| | | Primary Gap PFR MW | 370 | 378 | 0 | 0 | 0 | 378 | 298 | 326 | 0 | 0 | 0 | 325 | 323 | 322 | 0 | 0 | 0 | 117 | 239 | 310 | 0 | 0 | 0 | 310 |
| 3 | Short Circuit Strength | Inverter MWs passing ESCR limits (%) - Connected System | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | | Inverter MWs passing ESCR limits (%) - Islanded System | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 49% | 53% | 10% | 100% | 30% | 28% | 8% | 6% | 6% | 8% | 100% | 100% | 55% | 55% | 15% | 100% |
| | | Required Additional Synch Condensers MVA (when Connected) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | Required Additional Synch Condensers MVA (when Islanded) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 350 | 300 | 1500 | 0 | 1250 | 1500 | 1900 | 2700 | 2700 | 2050 | 0 | 0 | 100 | 200 | 1100 | 0 |
| 4 | Power Quality (Flicker) | Compliance with Flicker limits when Connected (GE Flicker Curve or IEC Flicker Meter) | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | | Compliance with Flicker limits when Islanded | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 78% | 78% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| | | Required Synchronous Condensers MVA to mitigate Flicker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 200 | 200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | Blackstart | Qualitative Assessment of Ability to Blackstart the system | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6 | Dynamic VAR Support | Dynamic VARs that can be delivered to select load centers (% of Load) at peak | 57% | 36% | 36% | 34% | 29% | 24% | 59% | 50% | 53% | 50% | 51% | 52% | 63% | 64% | 65% | 63% | 56% | 56% | 54% | 52% | 56% | 51% | 51% | 51% |
| ## | Dispatchability and Automatic Generation Control | Dispatchable (%CAP) | 92% | 92% | 91% | 90% | 87% | 92% | 82% | 80% | 78% | 79% | 74% | 82% | 76% | 75% | 73% | 70% | 70% | 74% | 82% | 82% | 81% | 81% | 77% | 82% |
| | | Unavoidable VER Penetration % | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 5% | 5% | 4% | 0% | 0% | 0% | 0% | 0% | 0% |
| | | Increased Freq Regulation Requirements (MW) | 9 | 9 | 9 | 9 | 11 | 9 | 39 | 48 | 49 | 45 | 66 | 47 | 90 | 97 | 97 | 105 | 105 | 101 | 42 | 48 | 41 | 41 | 56 | 49 |
| | | 1-min Ramp Capability (MW) | 334 | 340 | 770 | 915 | 1,355 | 340 | 417 | 403 | 919 | 1,005 | 1,255 | 403 | 417 | 435 | 864 | 1,087 | 1,087 | 635 | 477 | 423 | 892 | 1,097 | 1,367 | 423 |
| | | 10-min Ramp Capability (MW) | 1,167 | 1,228 | 1,562 | 1,757 | 2,015 | 1,228 | 1,159 | 1,200 | 1,621 | 1,756 | 1,915 | 1,200 | 1,159 | 1,233 | 1,566 | 1,748 | 1,748 | 1,364 | 1,219 | 1,220 | 1,593 | 1,848 | 2,028 | 1,220 |
| 8.0 | Predictability and Firmness | Ramping Capability to Mitigate Forecast Errors (+Excess/-Deficit) MW | 242 | 518 | 518 | 958 | 1,098 | 1,534 | 329 | 231 | 752 | 752 | 870 | 952 | -94 | -138 | 310 | 467 | 467 | 34 | 239 | 364 | 249 | 788 | 987 | 1,147 |
| 9 | Location | Average Number of Paths for Evacuating Power from Resources | 4.8 | 4.8 | 4.6 | 4.6 | 4.4 | 4.8 | 4.5 | 4.5 | 4.4 | 4.4 | 4.4 | 4.5 | 4.6 | 4.6 | 4.6 | 4.5 | 4.5 | 4.6 | 4.5 | 4.5 | 4.4 | 4.4 | 4.4 | 4.5 |

| Year 2031 | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize | No Retire | Convert | 1 Retire | 2 Retire | Clean | Optimize |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equip Stand-alone ESS with GFM inverters (MW) | **53** | **23** | **107** | **221** | **133** | **23** | **129** | **99** | **183** | **49** | **128** | **98** | **124** | **93** | **178** | **123** | **123** | **164** | **129** | **98** | **183** | **49** | **128** | **98** |
| Additional Synchronous Condensers (MVA) | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **350** | **300** | **1500** | **0** | **1250** | **1500** | **1900** | **2700** | **2700** | **2050** | **0** | **0** | **100** | **200** | **1100** | **0** |
| Additional Power Mitigations (MW) | **370** | **378** | **0** | **0** | **0** | **378** | **298** | **326** | **0** | **0** | **0** | **325** | **323** | **322** | **0** | **0** | **0** | **117** | **239** | **310** | **0** | **0** | **0** | **310** |
| Increased Freq Regulation | 9 | 9 | 9 | 9 | 11 | 9 | 39 | 48 | 49 | 45 | 66 | 47 | 90 | 97 | 97 | 105 | 105 | 101 | 42 | 48 | 41 | 41 | 56 | 49 |
| Address Inertial Response Gaps | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Address Primary Response Gaps | 370 | 378 | 0 | 0 | 0 | 378 | 298 | 326 | 0 | 0 | 0 | 325 | 323 | 322 | 0 | 0 | 0 | 117 | 239 | 310 | 0 | 0 | 0 | 310 |
| Firm up Intermittent Renewable Forecast | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 94 | 138 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| GFM Inverter Premium ($M) | $3 | $1 | $5 | $11 | $7 | $1 | $6 | $5 | $9 | $2 | $6 | $5 | $6 | $5 | $9 | $6 | $6 | $8 | $6 | $5 | $9 | $2 | $6 | $5 |
| Additional BESS ($M) | $150 | $152 | $4 | $4 | $4 | $152 | $120 | $131 | $20 | $18 | $27 | $131 | $130 | $130 | $39 | $42 | $42 | $47 | $96 | $125 | $17 | $17 | $22 | $125 |
| Additional Synchronous Condensers ($M) | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $158 | $135 | $871 | $0 | $709 | $871 | $1,131 | $1,651 | $1,651 | $1,229 | $0 | $0 | $45 | $90 | $611 | $0 |
| Total ($M) | **$152** | **$154** | **$9** | **$15** | **$11** | **$154** | **$127** | **$136** | **$186** | **$155** | **$904** | **$136** | **$845** | **$1,006** | **$1,179** | **$1,699** | **$1,699** | **$1,284** | **$103** | **$130** | **$71** | **$109** | **$640** | **$130** |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| Installed Storage | 240 | 240 | 680 | 820 | 1,280 | 240 | 333 | 313 | 840 | 920 | 1,180 | 313 | 333 | 345 | 785 | 1,013 | 1,013 | 553 | 393 | 333 | 813 | 1,013 | 1,293 | 333 |
| Additional storage required for increased freq regul | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Assuming installed storage can also provide frequency regulation | | | | | | | | | | | | | | | | | | | | | | | | |

## 1.8 Appendix B – Cost Assumptions for Mitigation Measures

| Cost Category | Value | Units |
|---|---|---|
| GFM Inverter Premium | 50 | $/kVA |
| BESS - AC Side | 272 | $/kW |
| BESS - DC Side (<1C) | 351 | $/kWh |
| BESS Cost Premium (4C) | 50% | |
| BESS Capacity (hrs) – Frequency Response | 0.25 | |
| BESS Capacity (hrs) - Firm up Forecast | 1.00 | |
| Synchronous Condenser | 450 | $/kVA |
| Grid Headroom to Integrate Synch. Condensers | 520 | MVA |
| Grid Upgrade Cost | 200 | $/kVA |