

# California's Largest ZNE Communities:

Designing, Marketing, Building  
and Measuring Performance

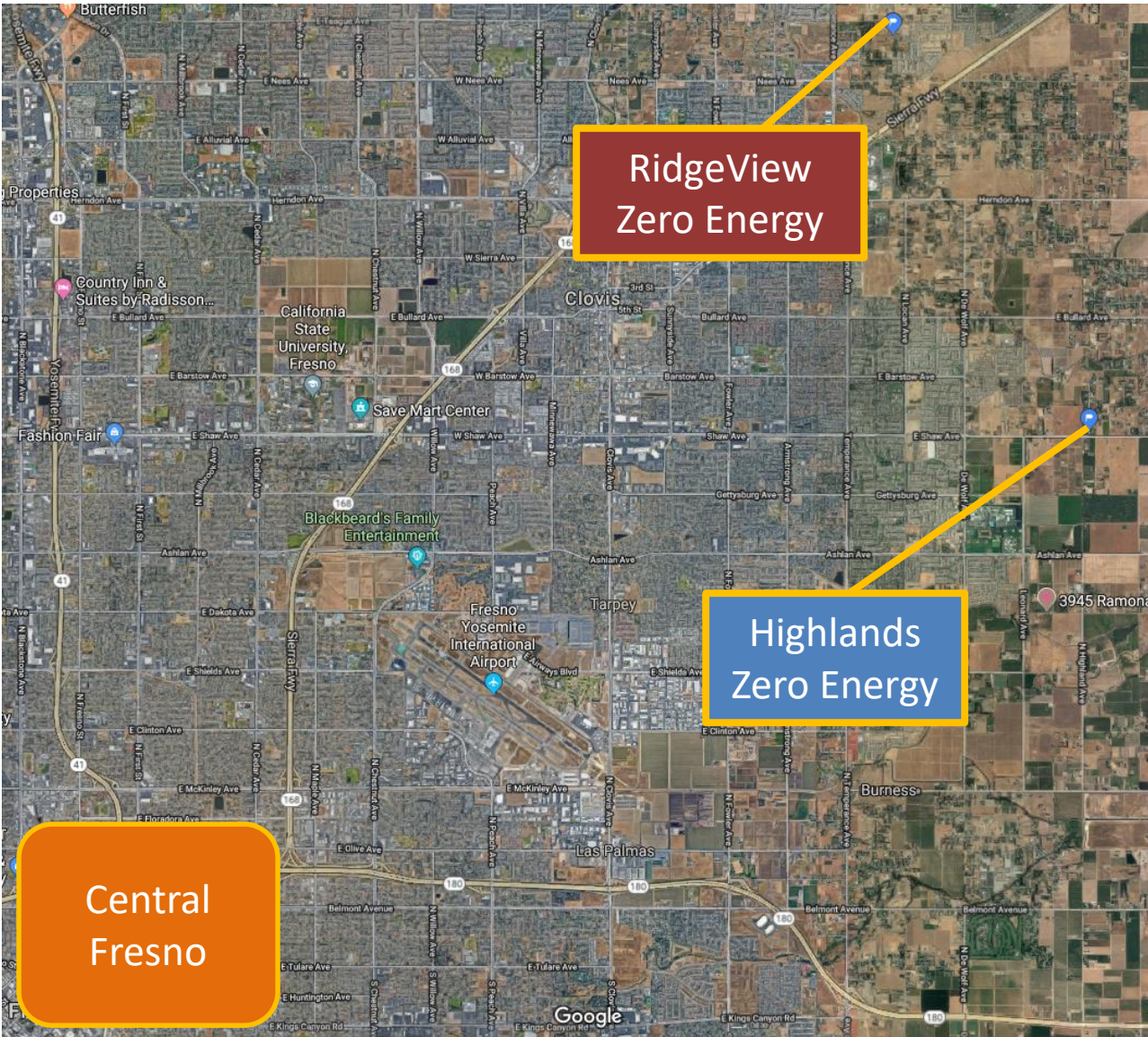
---

Garth Torvestad  
Senior Technical Consultant  
gtorvestad@consol.org  
916-426-8382

# Overview

- CEC EPIC-funded “Demonstration Project”
  - Show production builders that ZNE can be done at scale
  - Overcome remaining obstacles to adoption of ZNE through repetition, research and analysis
  - Collect data to improve models and understanding
- Largest single-family ZNE communities in CA
  - Highlands (45 homes)
  - RidgeView (58 homes)
- 20+ homes currently in the construction pipeline
- CEC project ends in March 2020

# Project Locations



RidgeView  
Zero Energy

Highlands  
Zero Energy

Central  
Fresno

# DeYoung Properties

- 3-generation builder in Fresno/Clovis
- Build between 50-100 homes/year
- 3 of 5 active subdivisions are ZNE
- Use “Zero Energy” for marketing



# DeYoung Properties

- Mid-market builder:
  - Entry-level
  - Move-up
- Leader in EE/ZNE for 10+ years
- First ZNE subdivision “Envision”
- At least 50% single story product



# Project Team

- California Homebuilding Foundation
- DeYoung Properties
- ConSol
- Opinion Dynamics
- Energy Solutions
- UC Davis
- And many more.....



California  
**Homebuilding**  
Foundation®

Scholarship | Research | Education

# Approach to ZNE

- 2x6 Walls w/ Advanced Framing (R-21 + R4)
- Unvented Attic with R-38 Owens Corning Boxed Netting
- Rheem 3.5 EF Heat Pump Water Heater
- Lennox XP-20 Variable Capacity Heat Pump HVAC
- Dual-pane Low-e Argon Fill Windows
- CURB Circuit-Level Energy Management System (also used for data collection)
- Tesla Rooftop PV (sized on source basis)
- 100% LED Lighting
- Electric Oven
- Electric Heat Pump Clothes Dryer
- Induction Cooktop (option)
- Battery Storage (option)
- Gas Cooktop (standard)
- Gas Fireplace (option)

# Research and Analysis Topics

1. **Ground-up floor plan redesigns for ZNE**
2. Consumer preference and market for ZNE
3. Obstacles to full electrification
4. Most cost effective approaches to ZNE
5. Data collection for comparison to CBECC models
6. Ventilation strategies and IAQ measurements



# Architectural Redesign for ZNE

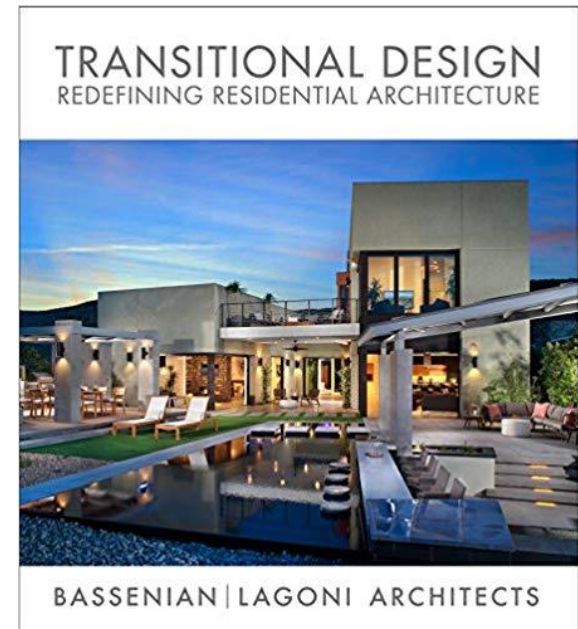
- Objectives:
  - Design “next-gen” DeYoung ZNE homes from the ground-up
  - Consider energy impacts of layout and design from the outset
  - Attempt to reconcile energy with consumer preferences and construction costs
- Two all-new floor plans:
  - 1800 sq. ft. (Plan 1)
  - 2100 sq. ft. (Plan 2)
- Project team (energy nerds) +
- DeYoung +
- Bassenian Lagoni Architects



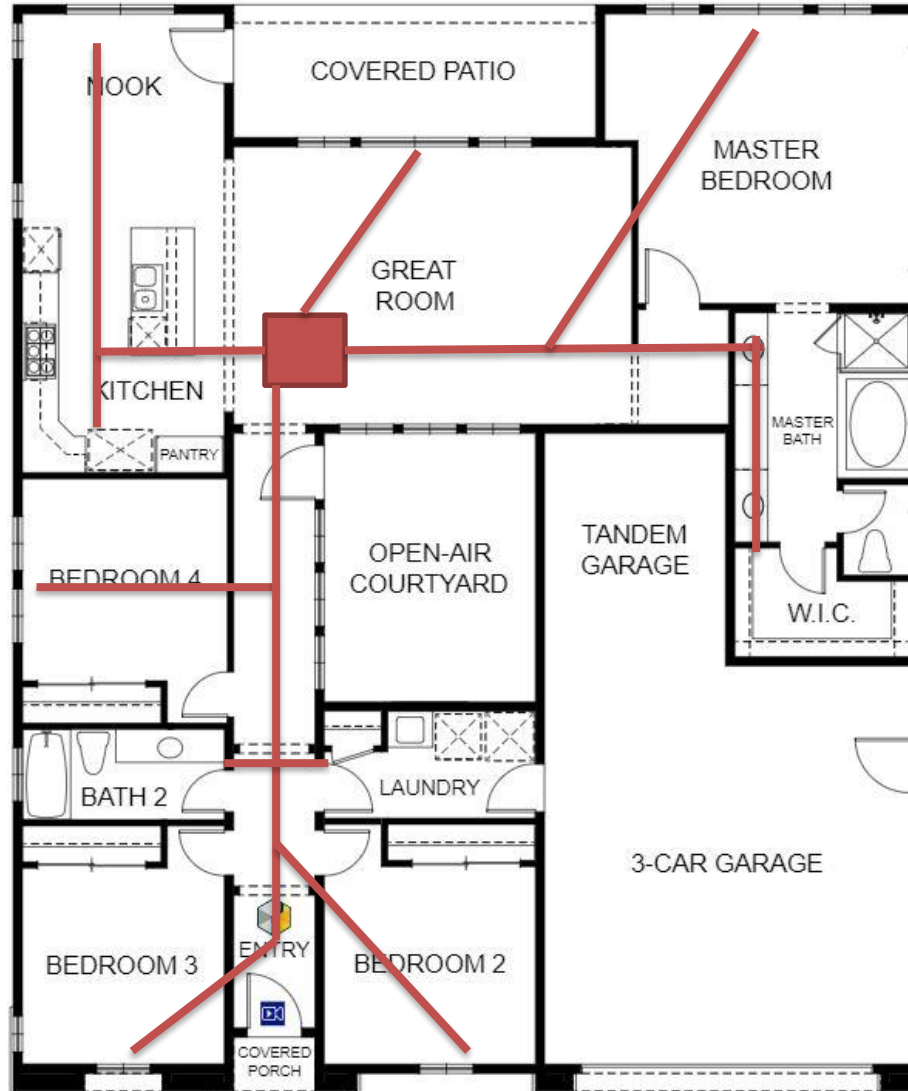
# Architectural Redesign for ZNE

- Limitations and Preferences:

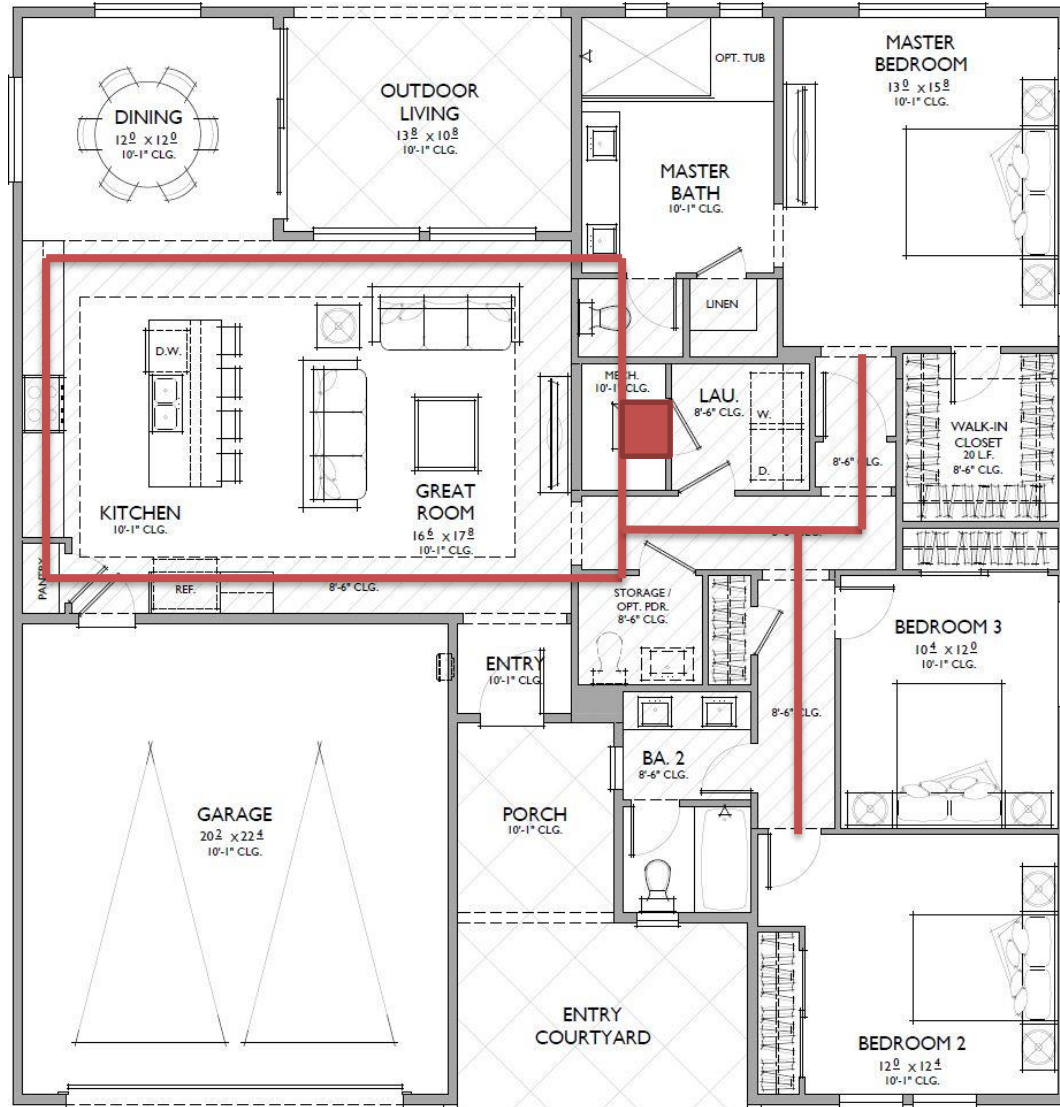
- Slab construction (no crawlspace)
- Single story
- Garage in front
- 50% max lot coverage
- Side/Front/Back setbacks
- Must enter into great room
- Great room must open to backyard
- Can be built on any axis
- Simple roof design to control costs
- Roof layout varies depending on style (Tuscan, Modern, Italianate, etc.)
- Move secondary bedrooms (kids) closer to master bedroom
- Avoid kids bedroom facing the street



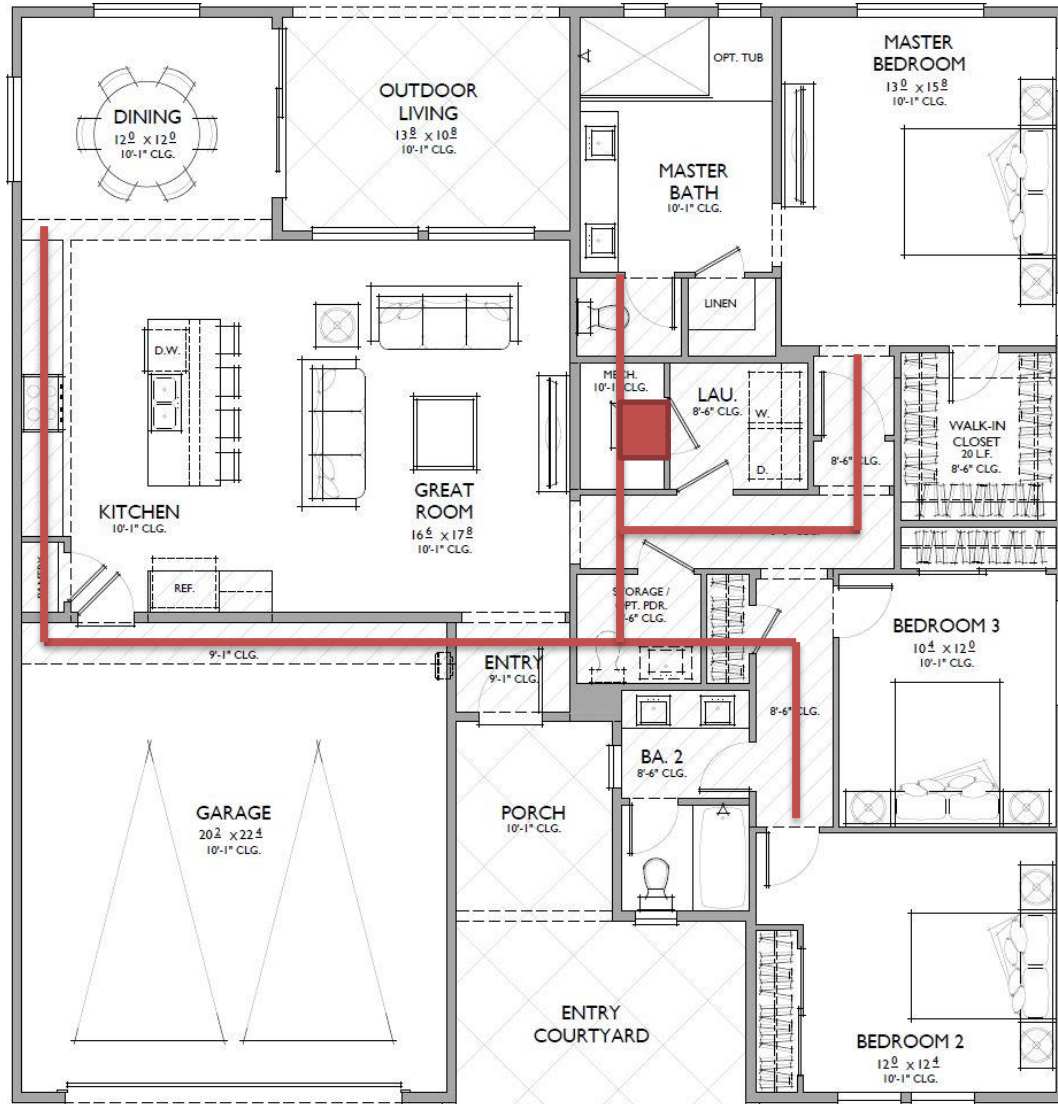
# Best Selling Floor Plan—Current Ducts in UVA, Conventional Duct Layout



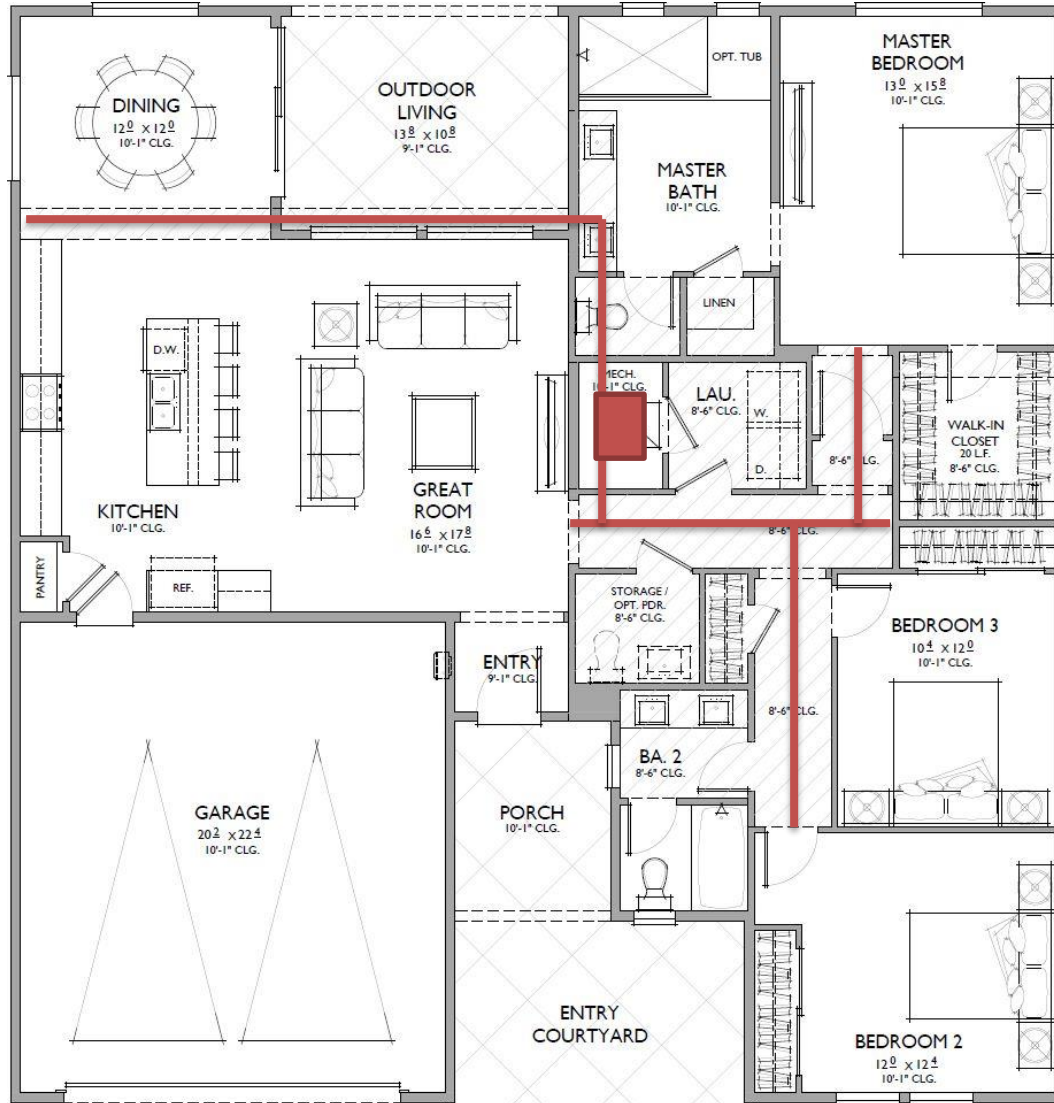
# Redesign Plan 1(a)—Compact Design, Ducts in Conditioned Space, Dropped Ceiling



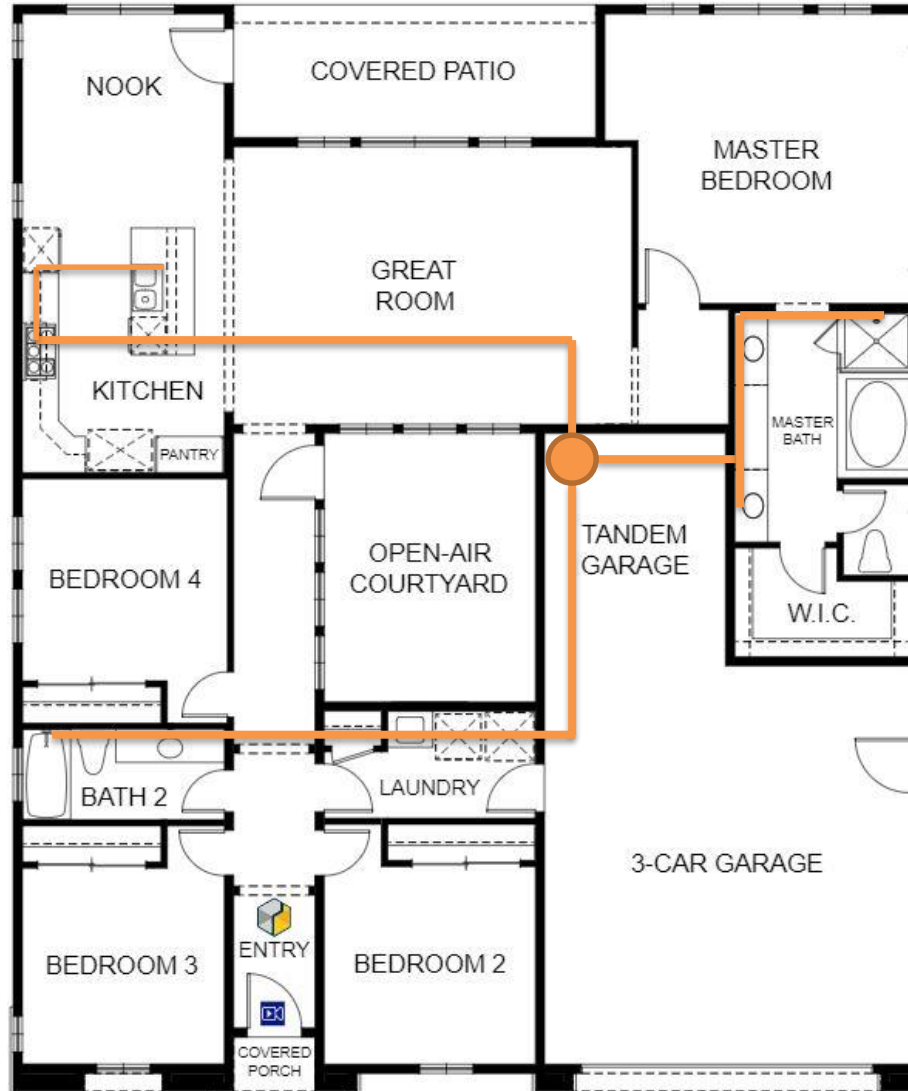
# Redesign Plan 1(b)—Compact Design, Ducts in Conditioned Space, Dropped Ceiling



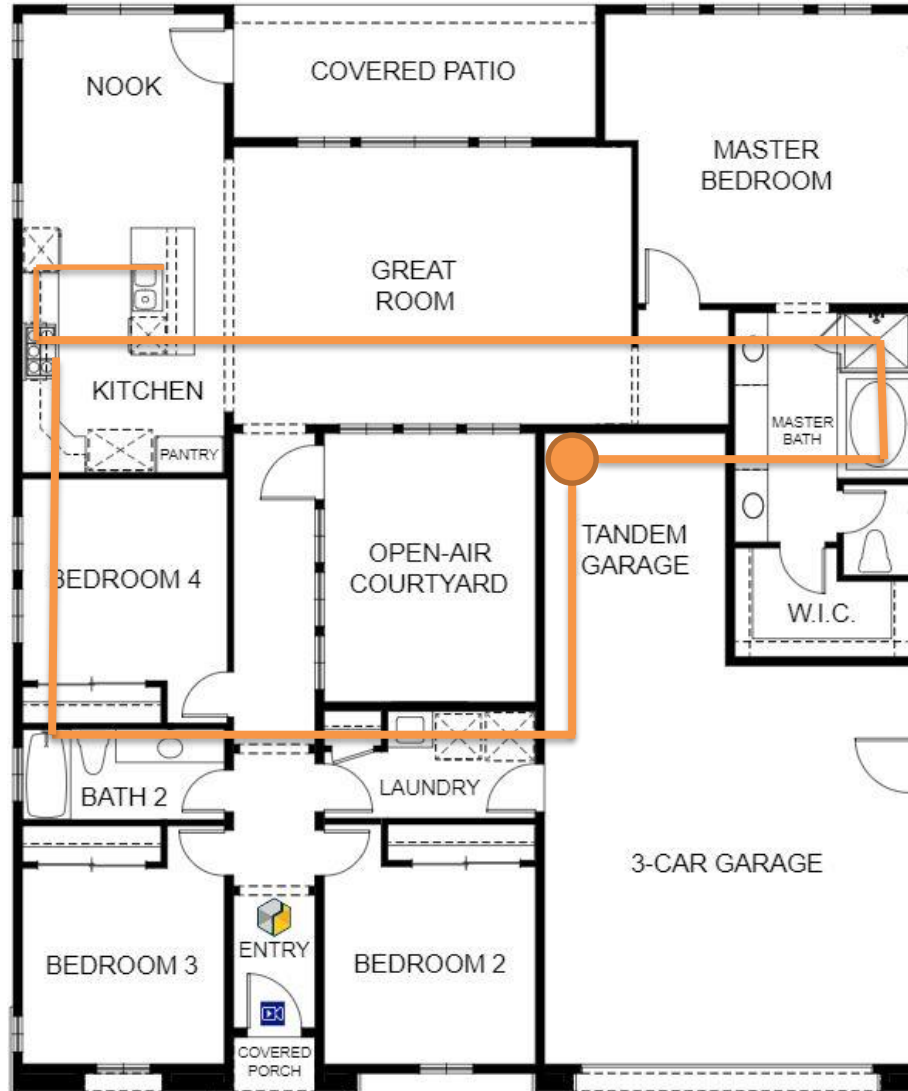
# Redesign Plan 1(c)—Compact Design, Ducts in Conditioned Space, Dropped Ceiling



# Best Selling Floor Plan—Current Pipes in Attic/Slab, WH in Garage

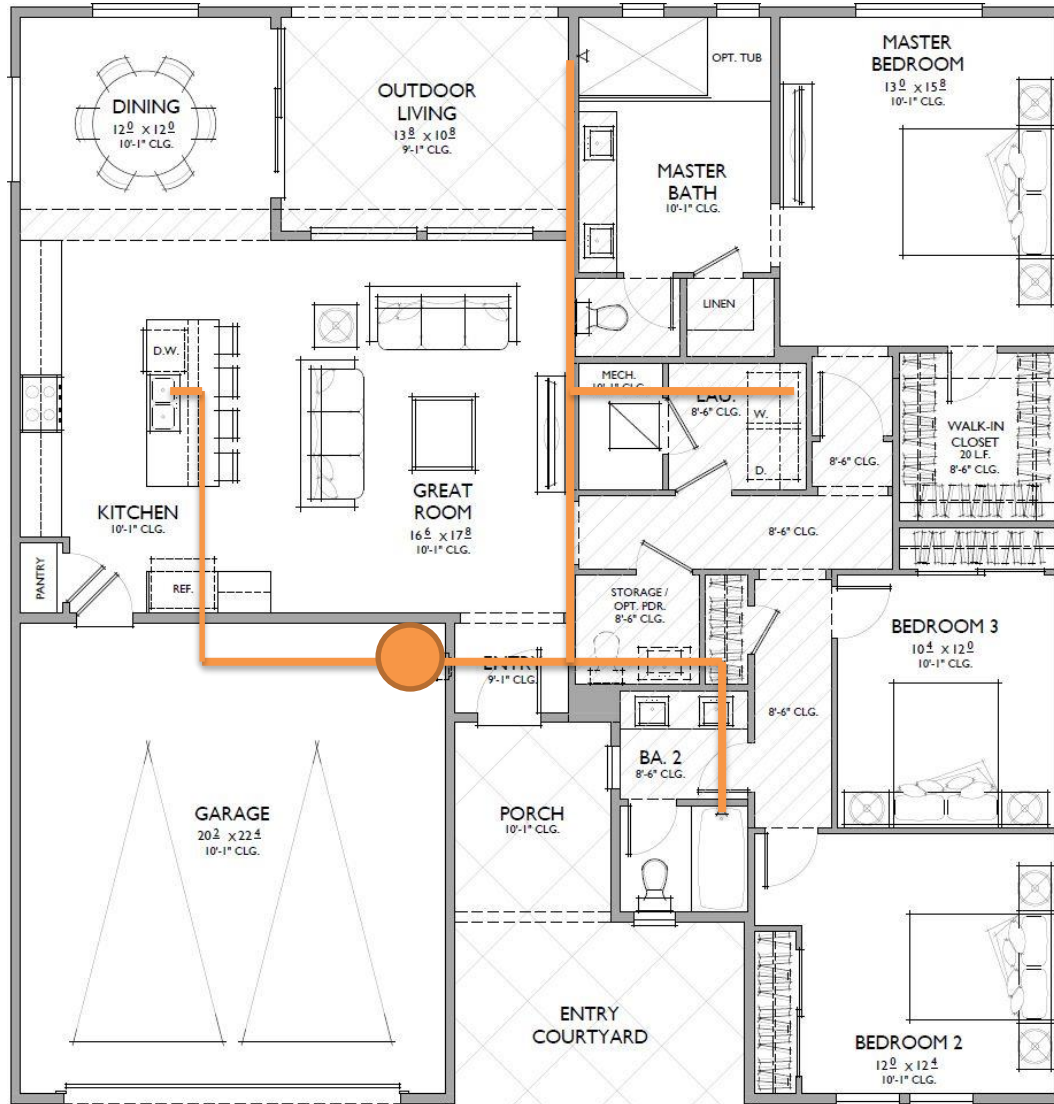


# Best Selling Floor Plan—Current Pipes in Attic/Slab, WH in Garage, Recirc



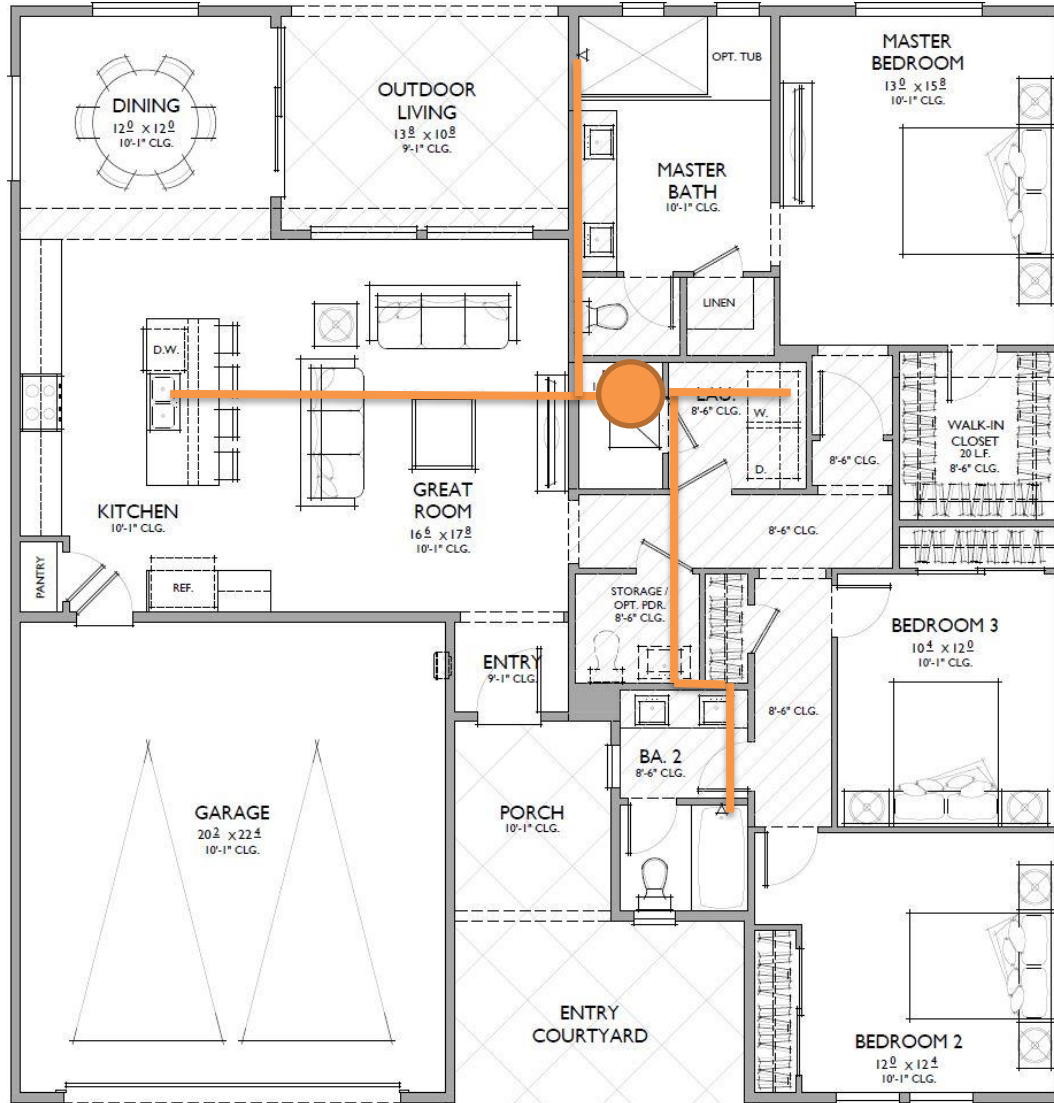


# Architectural Redesign for ZNE—Plan 1 Plumbing Layout (Draft)—WH in Garage



# Architectural Redesign for ZNE—Plan 1

## Plumbing Layout (Draft)—WH in Mech Closet



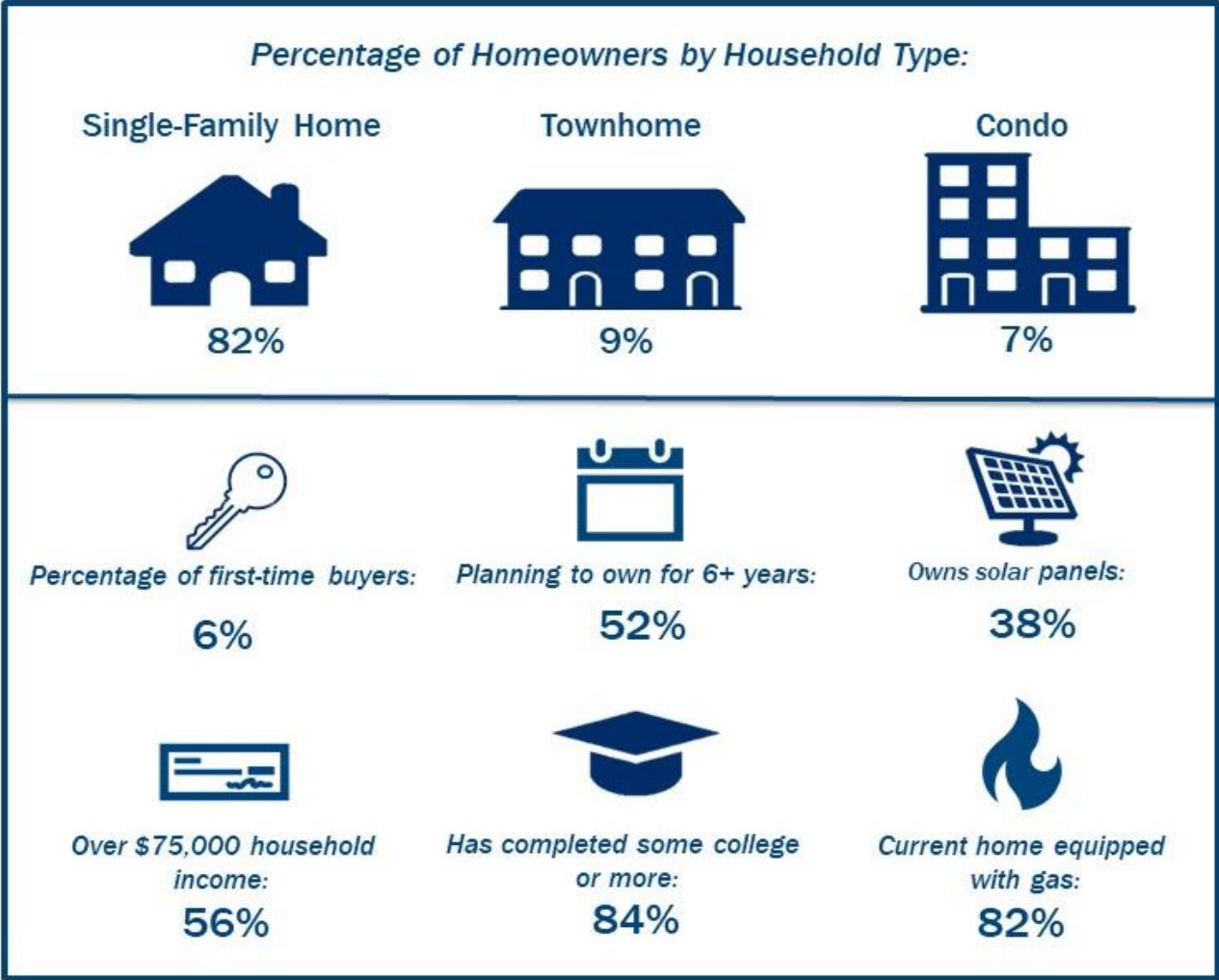
# Research and Analysis Topics

1. Ground-up floor plan redesigns for ZNE
2. **Consumer preference and market for ZNE**
3. **Obstacles to full electrification**
4. Most cost effective approaches to ZNE
5. Data collection for comparison to CBECC models
6. Ventilation strategies and IAQ measurements

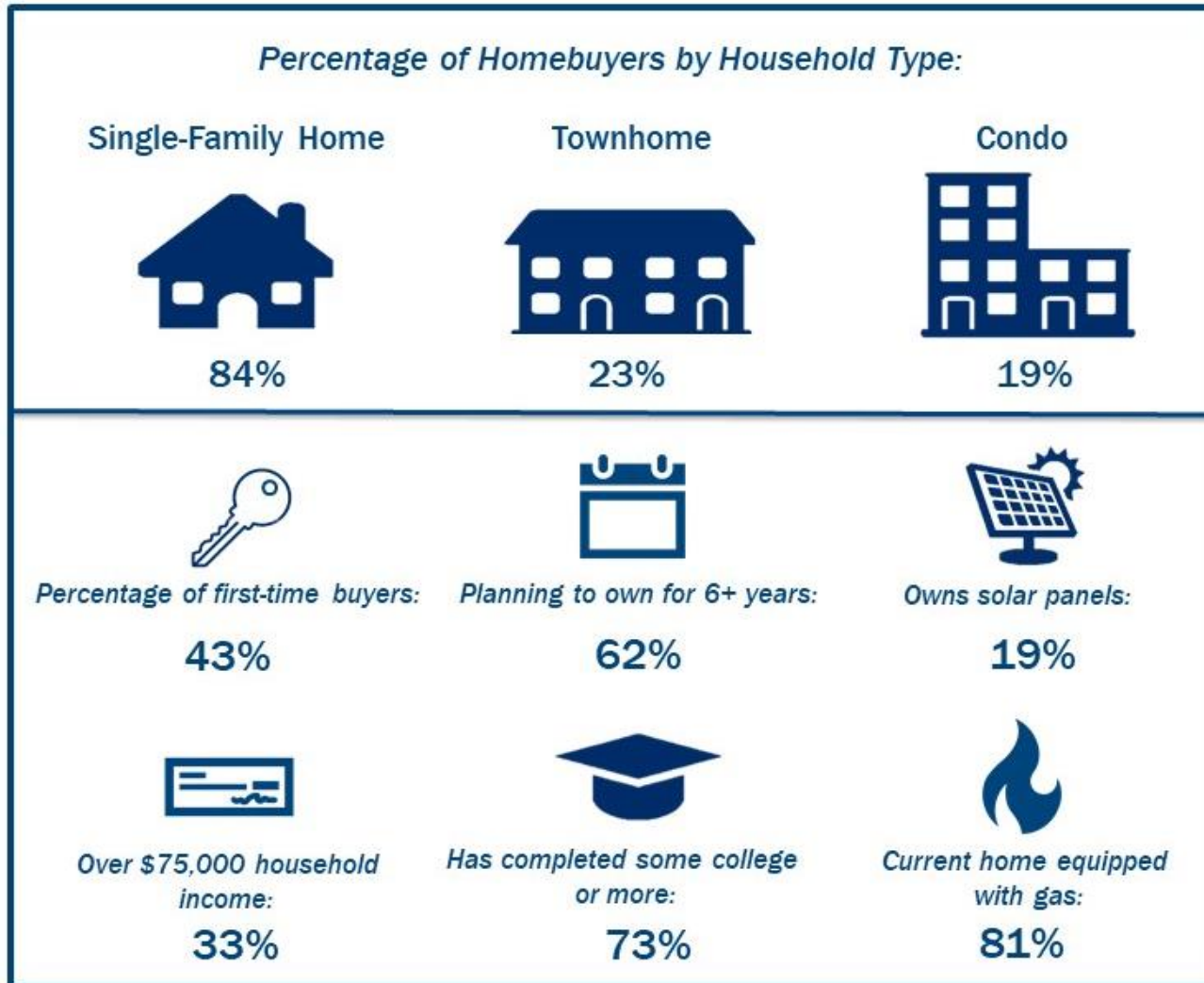
# Consumer Surveys

| Respondent Group | Number of Completes | Percent of Total Respondents |
|------------------|---------------------|------------------------------|
| Homeowners       | 120                 | 24%                          |
| Homebuyers       | 380                 | 76%                          |
| Total            | 500                 | 100%                         |

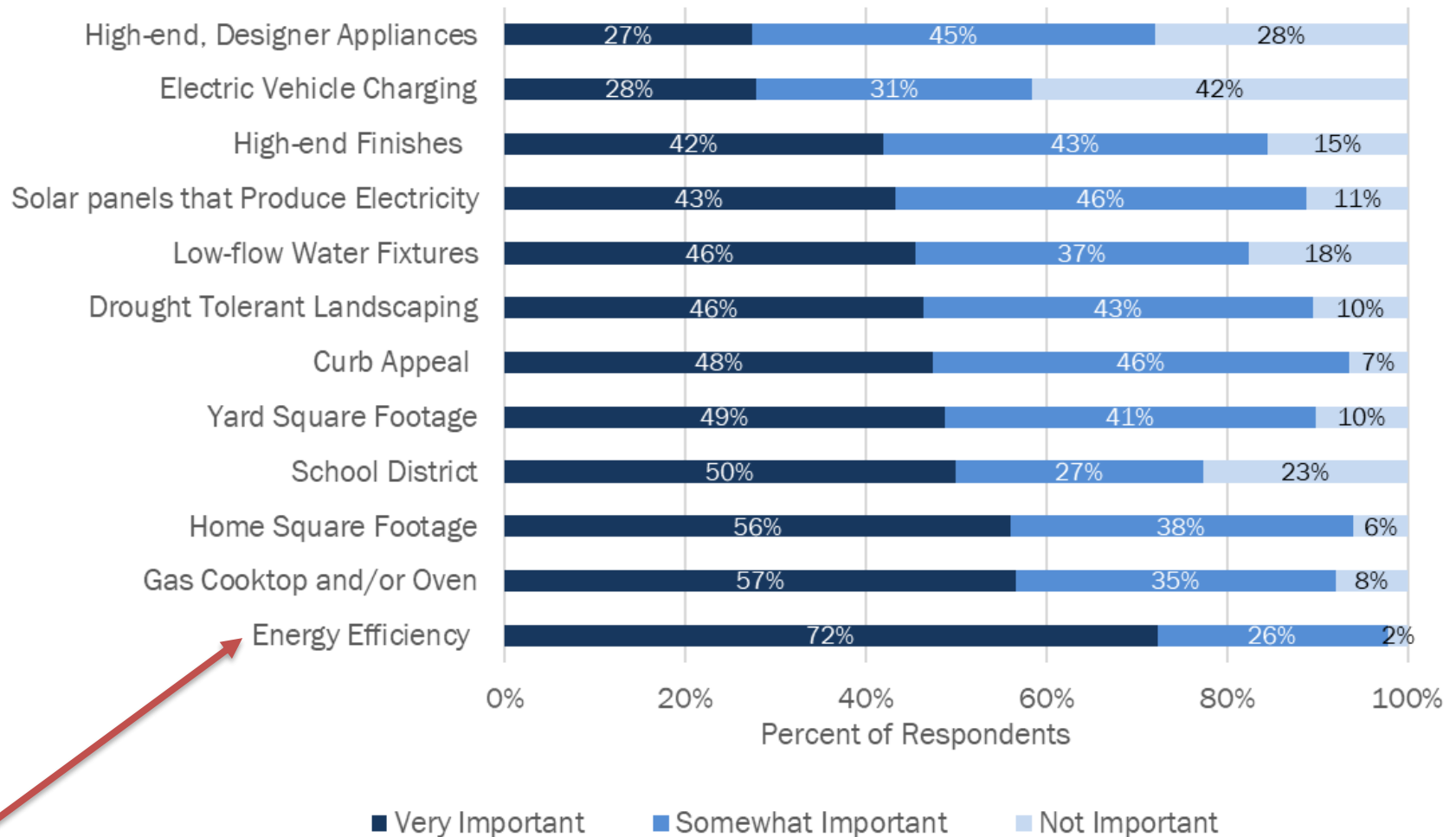
# Consumer Surveys—Recent Buyers



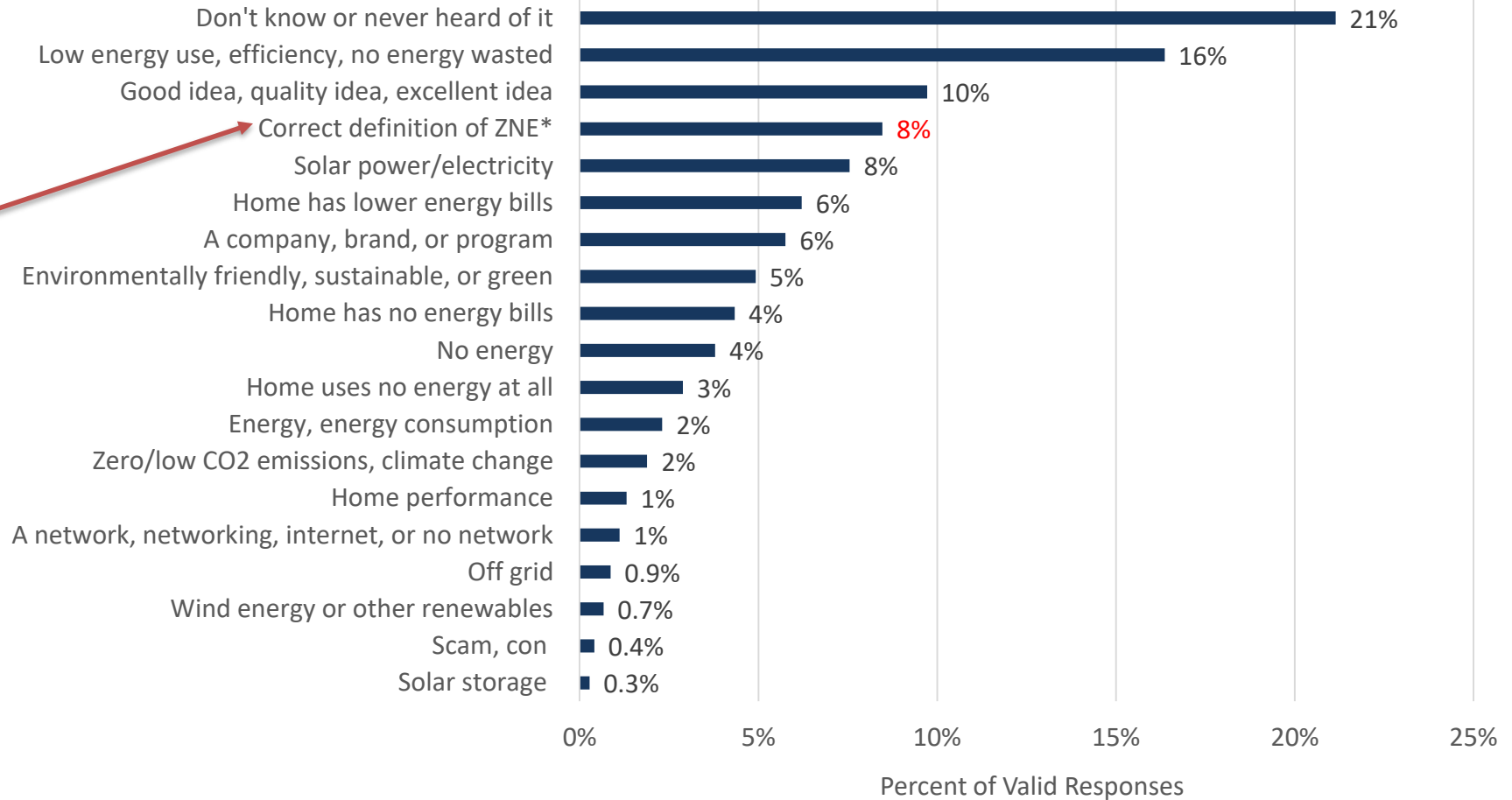
# Consumer Surveys—Home Shoppers



# Consumer Survey— How Important is each Feature?

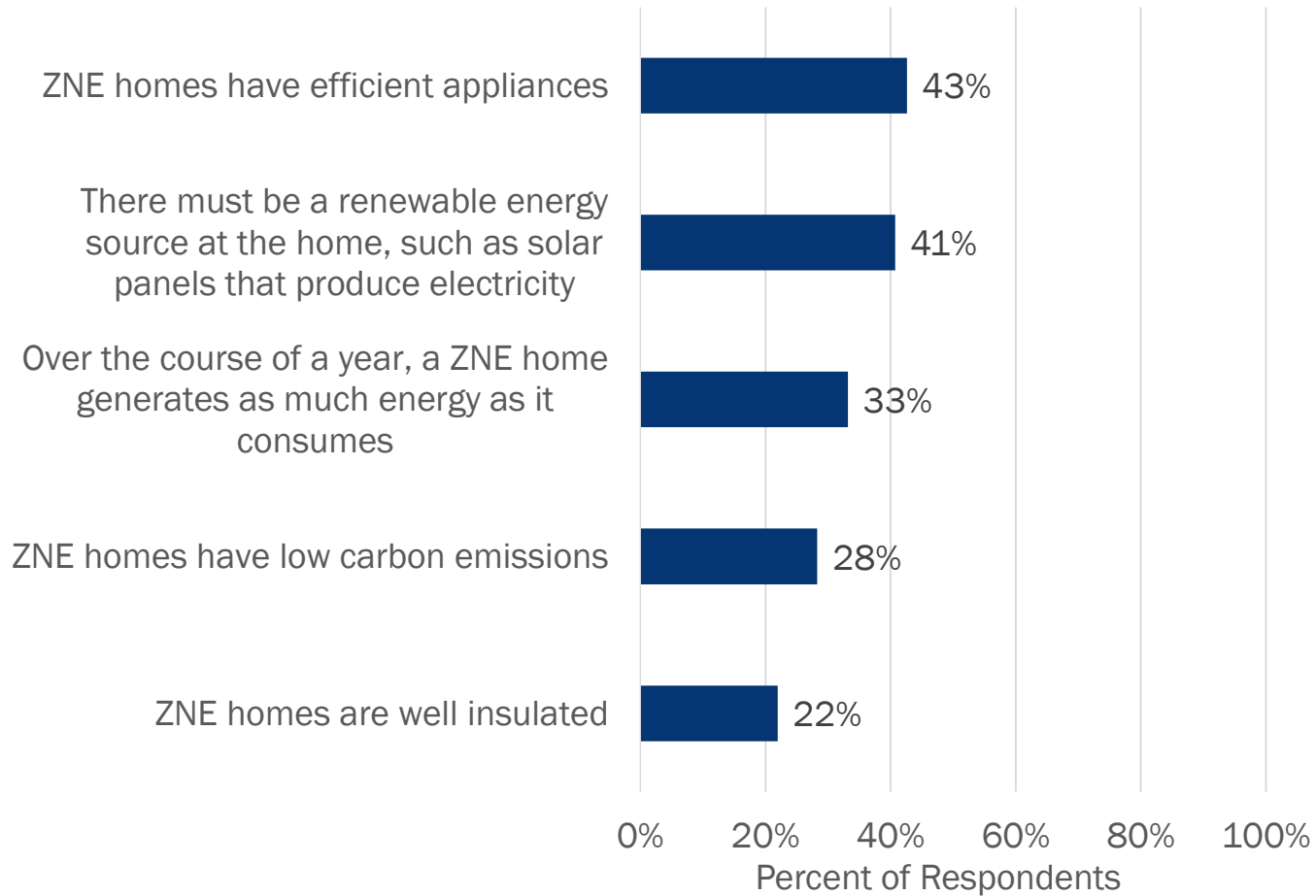


# Consumer Survey— What is Zero Net Energy?

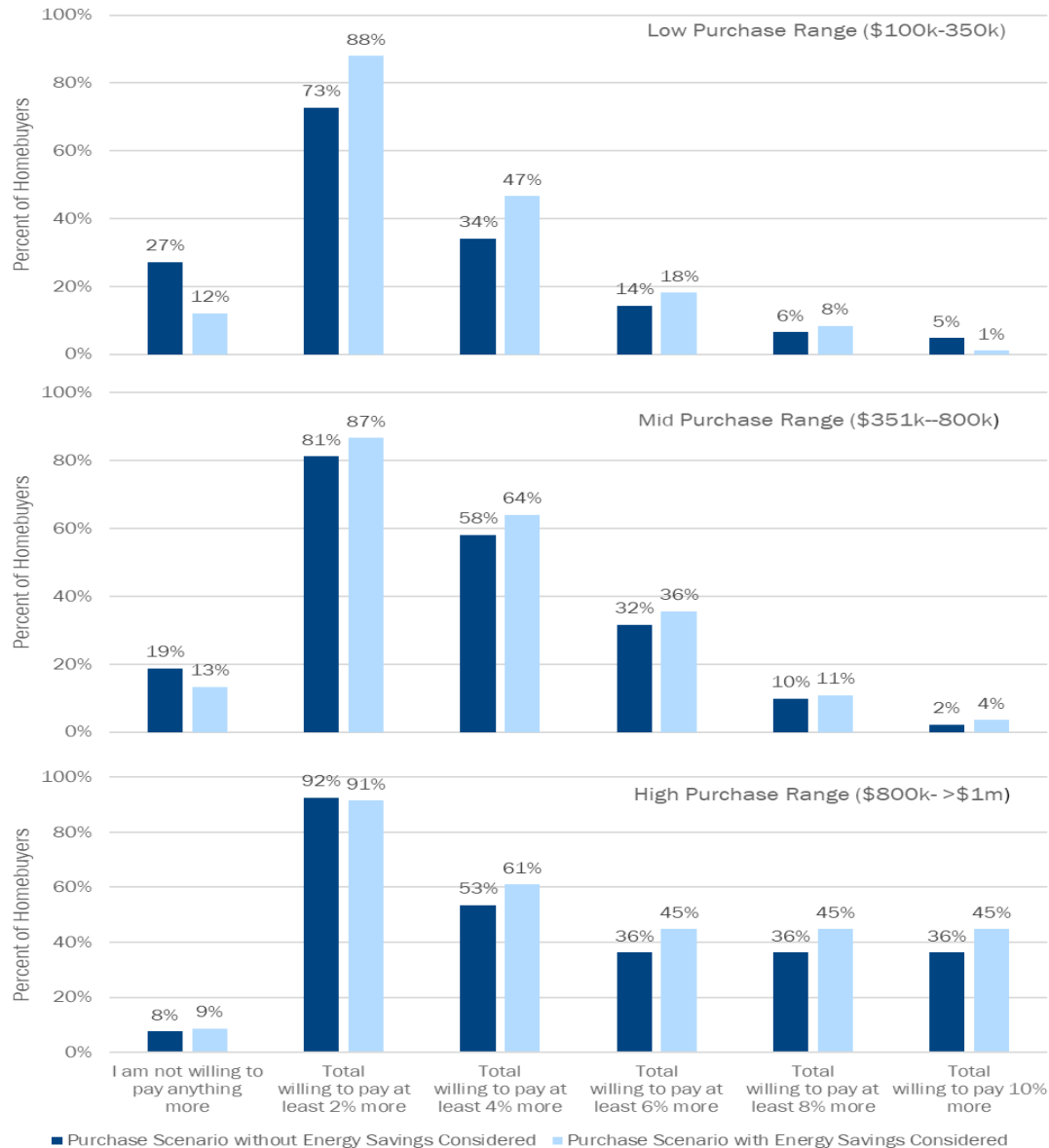




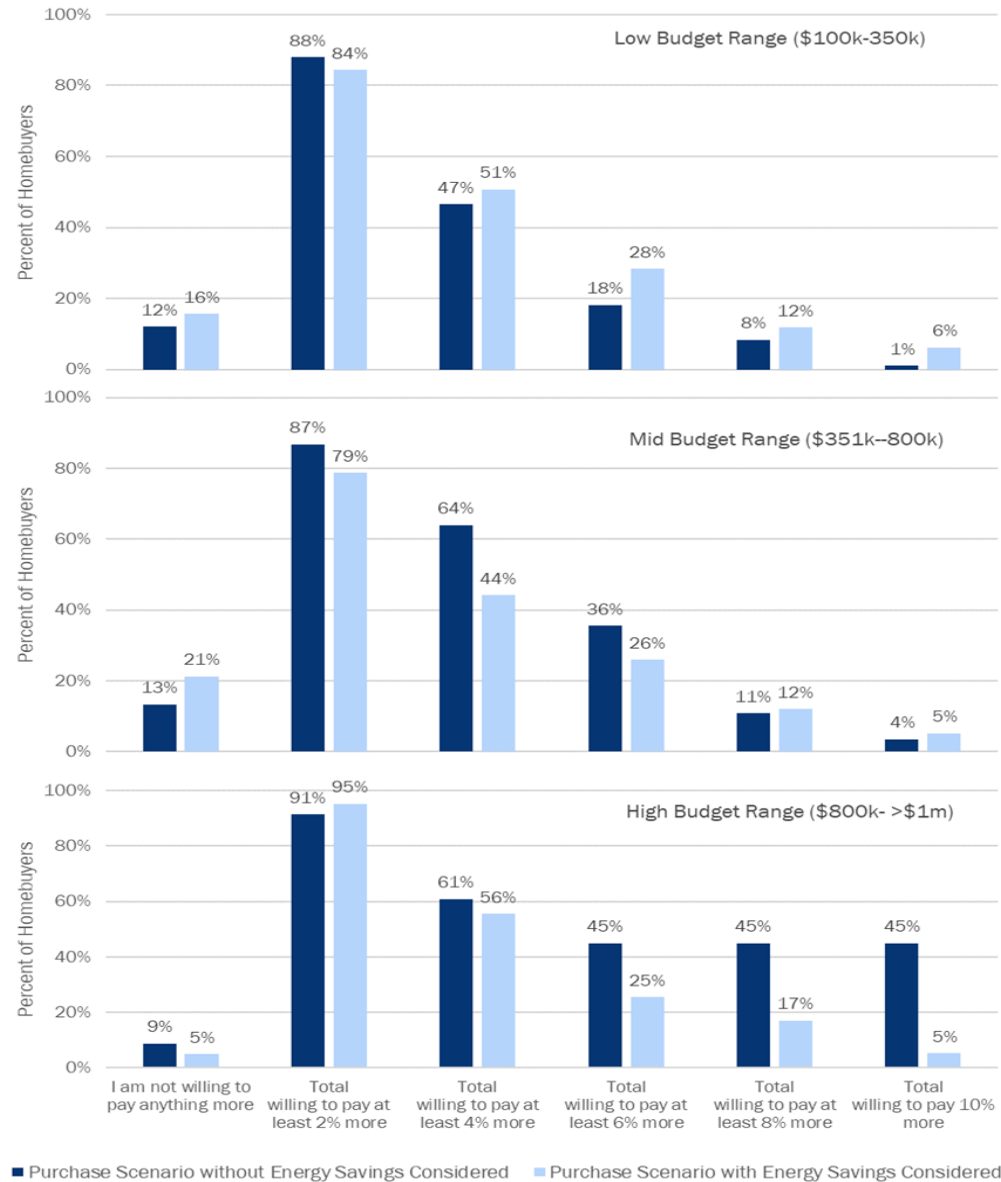
# Heard of ZNE—but what does it mean?



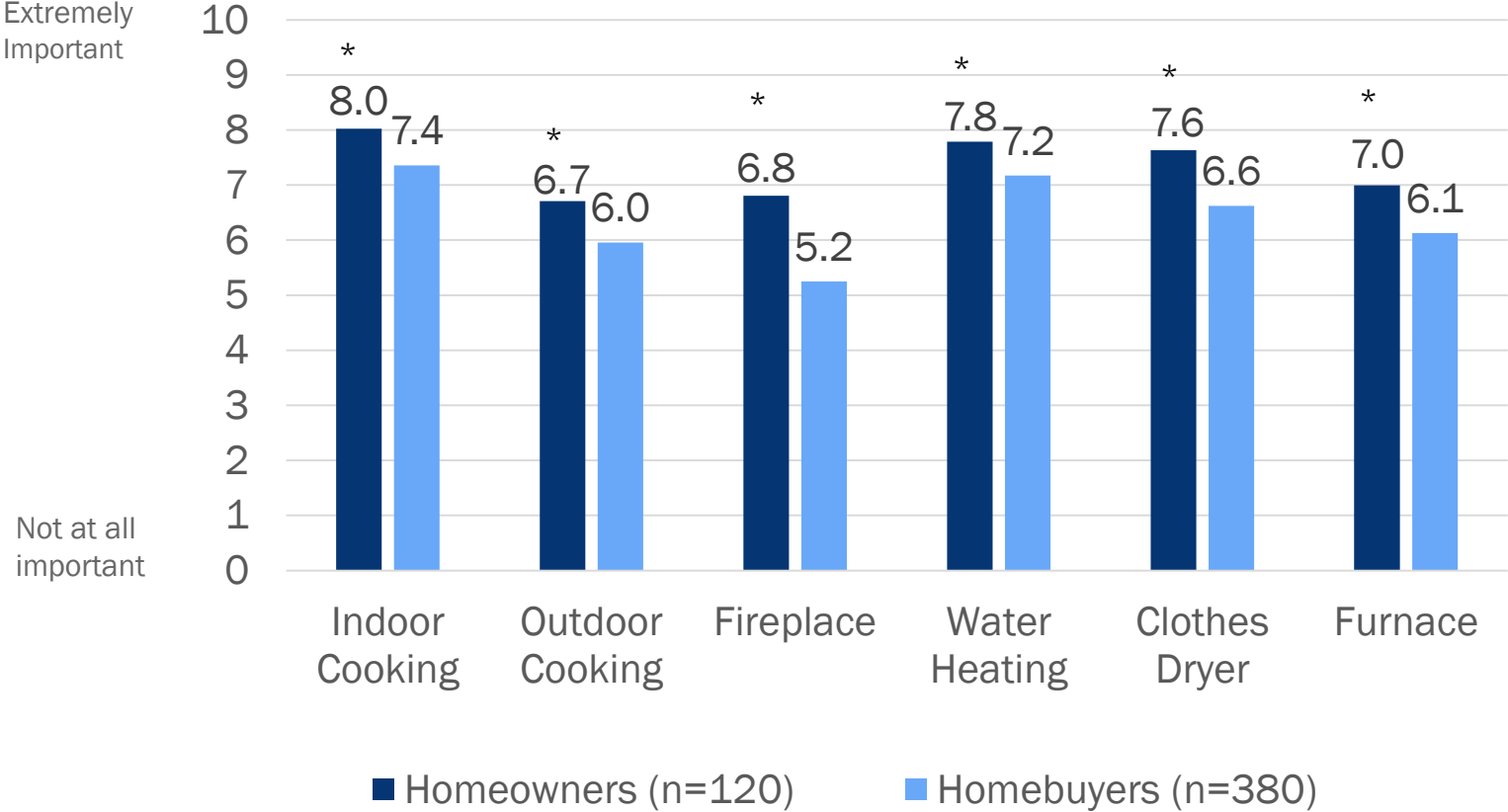
# Willingness to Pay for ZNE—Already Bought a House



# Willingness to Pay—Still Shopping



# Consumer Survey—Importance of Having Natural Gas



# Valuation and Lending for ZNE Homes

## Net ZERO Home

Seeing the Value of a Zero Net Energy Home

### Homebuilders Create

Homebuilders produce the ZNE product and must meet state building code.

### Real Estate Agents Market

Real estate agents market houses and can help spread awareness of ZNE by explaining the energy efficient and high-performance features of the home.

### Home Appraisers Value

Home appraisers measure the value of a home and can assign a dollar amount to the ZNE features of the home (i.e. solar and high-performance measures).

### Lenders Fund

Lenders generate financing such as construction loans and home mortgages. They can support ZNE by factoring in the lower operating costs (i.e. low/no energy bills) of a ZNE home, allowing home buyers to borrow more.

# Research and Analysis Topics

1. Ground-up floor plan redesigns for ZNE
2. Consumer preference and market for ZNE
3. Obstacles to full electrification
4. Most cost effective approaches to ZNE
5. **Data collection for comparison to CBECC models**
6. Ventilation strategies and IAQ measurements

# Circuit Level Monitoring

House 1 (4237)

| Main Panel Layout |              |    |         |        |     | Sub Panel Layout |                      |    |        |      |             |    |                                    |          |
|-------------------|--------------|----|---------|--------|-----|------------------|----------------------|----|--------|------|-------------|----|------------------------------------|----------|
| CT#               | Load         |    | Ph      | Load   | CT# | CT#              | Load                 |    | Ph     | Load | CT#         |    |                                    |          |
| CT1 30A           | Dryer        | 30 | 30A 2P  |        |     | CT1 30A          | Dinning Nook Outlets | 1  | 20A 1P | A    | 15A 1P AFCI | 2  | Smoke Alarms                       | CT9 30A  |
| CT2 30A           |              | 28 |         |        |     | CT2 30A          | Kitchen GFCI         | 3  | 20A 1P | B    | 15A 1P AFCI | 4  | Master Bed + Master Bath + Outlets | CT10 30A |
| CT3 30A           | Oven         | 26 | 30A 2P  | 30A 2P | 25  | CT7 50A          | By Fridge            |    |        |      |             |    |                                    |          |
| CT4 30A           |              | 24 |         |        | 23  |                  | Furnace              |    |        |      |             |    |                                    |          |
| CT5 50A           | Water Heater | 22 | 30A 2P  | 35A 2P | 21  | CT8 50A          | Kitchen GFCI         | 5  | 20A 1P | A    | 15A 1P AFCI | 6  | Great Room + Outlets               | CT11 30A |
| CT6 50A           |              | 20 |         |        | 19  |                  | By Hood              |    |        |      |             |    |                                    |          |
|                   | Sub Panel    | 18 | 100A 2P |        |     | CT3 30A          | Washer               | 7  | 20A 1P | B    | 15A 1P AFCI | 8  | Bedrooms 2-3 + Outlets             | CT12 30A |
|                   |              | 16 |         |        |     | CT4 30A          | Dishwasher           | 9  | 20A 1P | A    | 15A 1P AFCI | 10 | Master Bed + Master Bath + Lights  | CT13 30A |
|                   |              |    |         |        |     | CT5 30A          | Refrigerator         | 11 | 20A 1P | B    | 15A 1P AFCI | 12 | Dining + Great Room + Lights       | CT14 30A |
|                   |              |    |         |        |     | CT6 30A          | Microwave            | 13 | 20A 1P | A    | 15A 1P AFCI | 14 | Kitchen + Nook + Lights            | CT15 30A |
|                   |              |    |         |        |     | CT7 30A          | Disposal             | 15 | 20A 1P | B    | 15A 1P AFCI | 16 | Entry + Bedrooms 2-3 + Lights      | CT16 30A |
|                   |              |    |         |        |     | CT8 30A          | Bath GFCI            | 17 | 20A 1P | A    | 15A 1P AFCI | 18 | Garage Opener + Sprinklers GFCI    | CT17 30A |
|                   |              |    |         |        |     |                  |                      |    |        | B    | 15A 1P AFCI | 20 | Garage GFCL + Exterior Plugs       | CT18 30A |

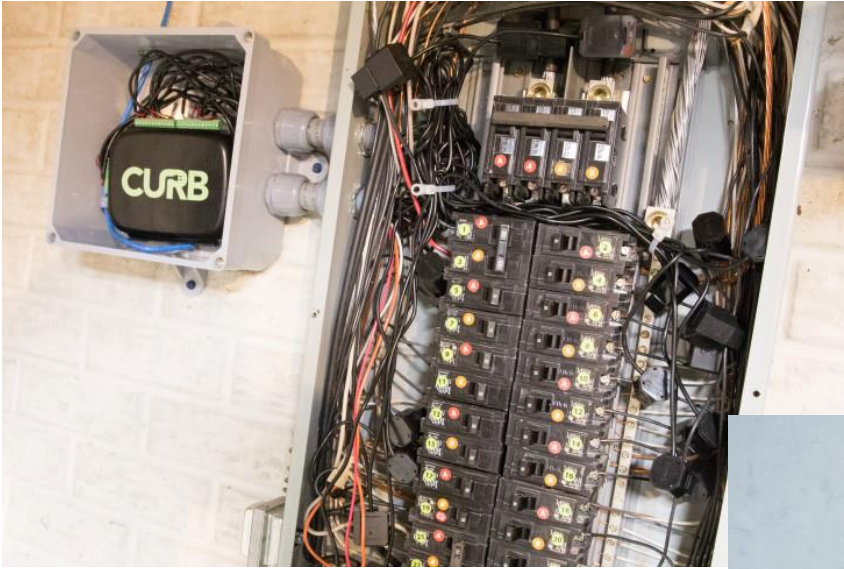
# Circuit Level Monitoring

House 2 (4244)

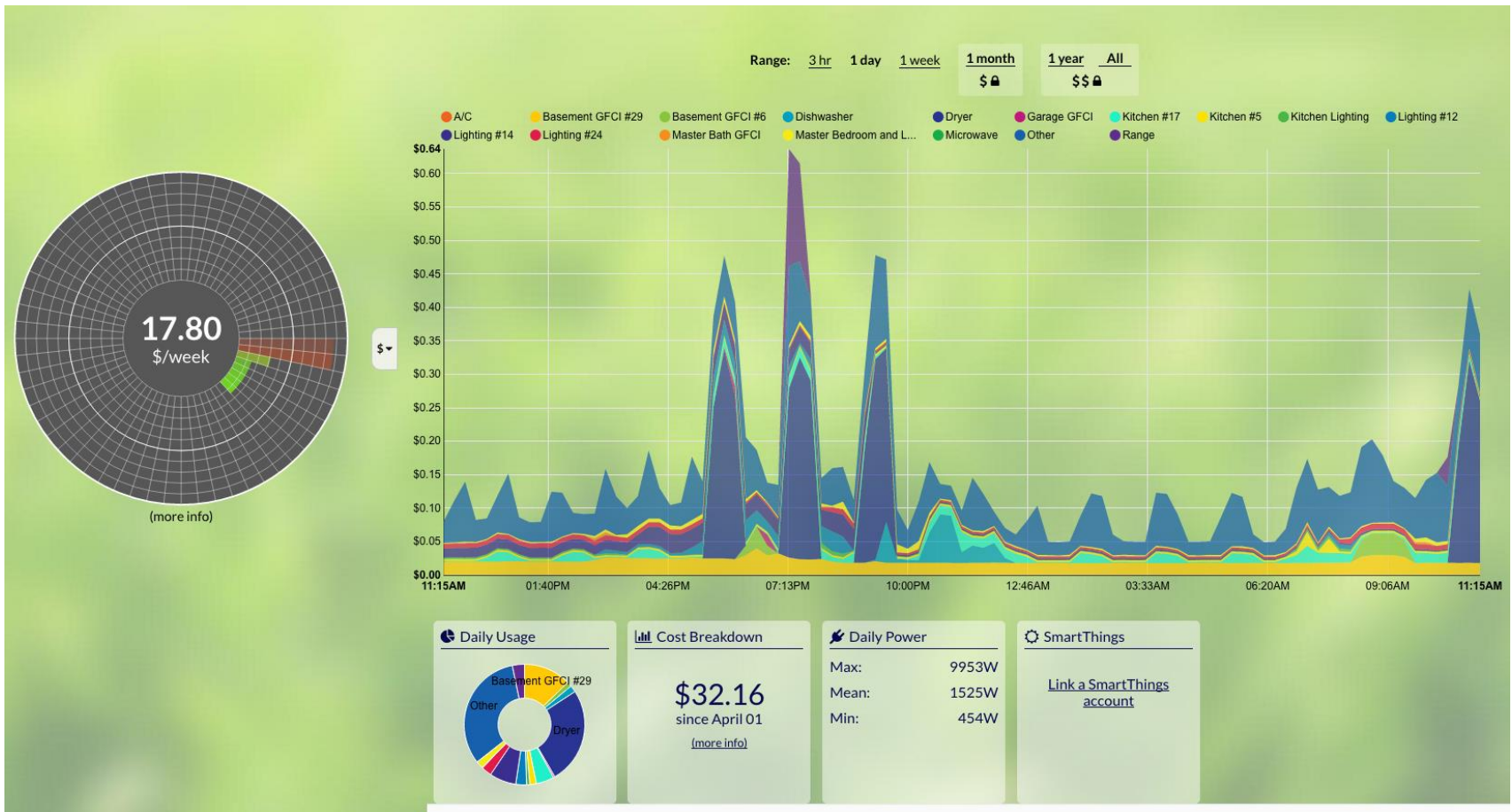
| Main Panel Layout |               |    |         |      |        | Sub Panel Layout |                  |          |              |              |             |        |  |             |                                    |                                      |          |  |
|-------------------|---------------|----|---------|------|--------|------------------|------------------|----------|--------------|--------------|-------------|--------|--|-------------|------------------------------------|--------------------------------------|----------|--|
| CT#               | Load          |    | Ph      | Load | CT#    | CT#              | Load             |          | Ph           | Load         | CT#         |        |  |             |                                    |                                      |          |  |
| CT1 30A           | Power Blaster | 16 | 15A 1P  | B    |        | CT1 30A          | Dining Outlets   | 1        | 20A 1P       | A            | 15A 1P AFCI | 2      | Laundry + Bedrooms 2-3 + Bath 2 + Lights | CT9 30A     |                                    |                                      |          |  |
| CT2 30A           | Washer        | 14 | 20A 1P  | A    |        | CT2 30A          | Microwave        | 3        | 20A 1P       | B            | 15A 1P AFCI | 4      | Master Bed + Great Room + Outlets        | CT10 30A    |                                    |                                      |          |  |
|                   | Sub Panel     | 12 | 100A 2P | B    | 40A 2P | 11               | Range            | CT6 30A  |              |              |             |        |  |             |                                    |                                      |          |  |
|                   |               | 10 |         | A    |        | 9                |                  | CT7 30A  |              |              |             |        |  |             |                                    |                                      |          |  |
| CT3 50A           | Furnace 220   | 8  | 30A 2P  | B    | 35A 2P | 7                | A/C Unit         | CT8 50A  |              |              |             |        |  |             |                                    |                                      |          |  |
|                   |               | 6  |         | A    |        | 5                |                  | CT3 30A  | Kitchen GFCI | 5            | 20A 1P      | A      | 15A 1P AFCI                              | 6           | Master Bath + Living Room + Lights | CT11 30A                             |          |  |
| CT4 30A           | Dryer         | 4  | 30A 2P  | B    | 30A 2P | 3                | Water Heater 220 | CT9 50A  | CT4 30A      | Refrigerator | 7           | 20A 1P | B  | 15A 1P AFCI | 8                                  | Bedroom 2 + Outlets                  | CT12 30A |  |
| CT5 30A           |               | 2  |         | A    |        | 1                |                  | CT10 50A | CT5 30A      | Kitchen GFCI | 9           | 20A 1P | A  | 15A 1P AFCI | 10                                 | Entry + Kitchen + Dinning + Lights   | CT13 30A |  |
|                   |               |    |         |      |        |                  |                  |          |              |              |             |        | B  | 15A 1P AFCI | 12                                 | Bedroom 3 + Outlets                  | CT14 30A |  |
|                   |               |    |         |      |        |                  |                  |          | CT6 30A      | Dishwasher   | 13          | 20A 1P | A  |             |                                    |                                      |          |  |
|                   |               |    |         |      |        |                  |                  |          |              |              |             |        | B  | 15A 1P AFCI | 16                                 | Garage Door Opener + Sprinklers GFCI | CT15 30A |  |
|                   |               |    |         |      |        |                  |                  |          | CT7 30A      | Disposal     | 17          | 20A 1P | A  |             |                                    |                                      |          |  |
|                   |               |    |         |      |        |                  |                  |          | CT8 30A      | Bath GFCI    | 19          | 20A 1P | B  | 15A 1P AFCI | 20                                 | Garage GFCI                          | CT16 50A |  |



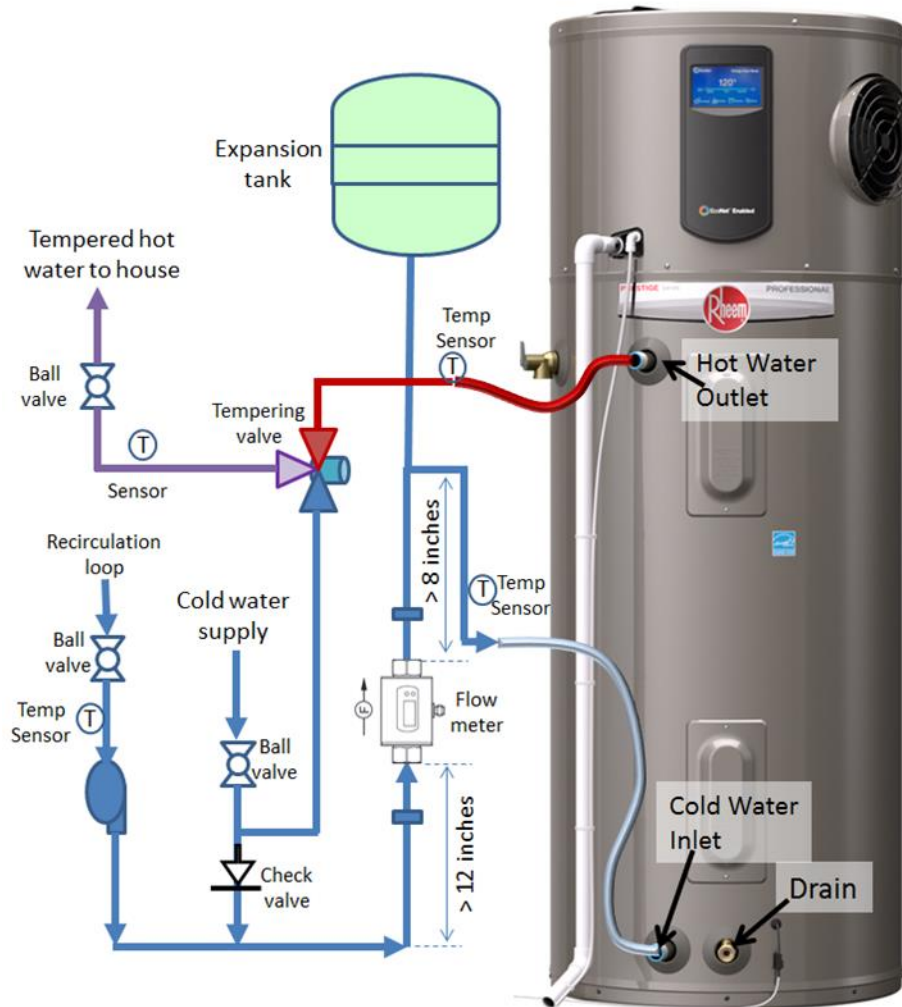
# Circuit Level Monitoring



# Circuit Level Monitoring



# Water Heater Instrumentation



Part No. FMM75-1001



# HPWH Research

- Thermal Storage/Load Shift
  - Install thermostatic mixing valve
  - After morning peak water demand, slowly begin raising setpoint from 125 up to 140 using abundant power and off-peak rates
  - At 3pm or 4pm (depending on TOU rate schedule), set back to 125
  - Study whether the heat pump or heating element turned on before the end of TOU peak (8pm or 9pm)

# HPWH Research

- Ducting in/out of Unvented Attic
  - Single story homes only at this time
  - Water heaters come equipped to receive 6” flex
  - Once in attic, run supply and return air ~10’ each direction (away from each other)
  - Measure air temp and humidity at the duct terminations and attic temp and humidity
  - Does the WH run more efficiently? Faster recovery? Any difference in attic temperature?



[gtorvestad@consol.ws](mailto:gtorvestad@consol.ws)

209-603-0534