JCM Feasibility Study through City to City Collaboration for Low Carbon Society

Introduction of high efficient waste processing facility under Integrated Waste Management Plan in Chiang Mai, Thailand

Entrusted by the Ministry of Environment, Japan in 2017

February 28, 2018

EX Research Institute Limited

Content

List of Tables & Figures

Abbreviation

Abbreviation	
AEDP	Alternative Energy Development Plan
CMPO	Chiang Mai Provincial Office
CMU	Chiang Mai University
DNA	Designated National Agency
EEDP	Energy Efficiency Development Plan
EPC	Engineering, Procurement & Construction
ERC	Energy Regulatory Committee
EX	EX Research Institute Limited
GHG	Greenhousegas
IPP	Independent Power Producer
JCM	Joint Creditting Mechnism
MOEJ	The Ministry of Environment, Japan
MOI	Ministry of Interior
MONRE	Ministry of Natural Resources and Environment
MRV	Monitoring , Reporting & Verification
NAMAs	National Appropriate Mitigation Actions
NCPO	National Council for Peace and Order
NSSE	Nippon Steel & Sumikin Engineering Co., Ltd.
O&M	Operation & Manitenance
ONEP	Office of National Enegy Plan
PAO	Provincial Administrative Organization
PCD	Pollution Control Department
PMJ	Price Management of Japan Co., Ltd.
PPP	Public-Private Partnership
PDRC	People Democratic Revolution Council
TGO	Thai Greenshousegas Management Organization
WtE	Waste to Energy

1. Outline of the Project

1-1 Objective

The Feasibility Study had been implemented by EX Research Institute Limited in collabpration with the city of Kitakyushu with purpose of realization of low carbon society in Chiang Mai province, northern part of Thailand, through introduction of WtE plant and/or Biogas collection & utilization facilities under Joint Creditting Mechanism

1-2 Background of the Study

(1) Climate Change

The Government of Thailand has ratified both United Nation Framework Convention on Climate Change on December, 1994 and Kyoto Protocol under UNFCCC on August, 2008. On July 2003, The Government of Thailand had assigned Office of the Ministry of Natural Resources and Environment Policy and Planning Office as Designated National Agency (DNA) for UNFCCC, then set up Thai Greenhouse Gas Management Organization (TGO) on July 2007 and empowered them as DNA.

The Government of Thailand submitted 2nd National Communication, including National Inventry, in 2015 and reported 210.23 million tonsCO2, 2.8 million tons of NH4 and some amount of NO as its' GHG emission, of which contains 150 million CO2t from Energy Sector, 16 million CO2t from Industry, 44.2 million CO2t from LULUCF, 2 million tons of NH4 from Agriculture Secter, 0.41 million tons of NH4 from energy sector and 0.4 million tons of NH4 from waste sector. The Government of Thailand reported 54.4 million tons of CO2 as an amount of Co2 absorbed, thus NET GHG emission was 228 million CO2t in total.

Beside above, the Government of Thailand published "Power Development Plan formulate in line with the Energy Efficiency for 2011-2030" in 2011 and announced their target of reduction of 7-20 percent of GHG emission in comparison with that of base year, i.e. 2005[1] (medium term goal) and 25 percent reduction per energy unit by 2030[2]. In the National Strategic Plan for Climate Change (2008-2012) published by the Government of Thailand in 2008, The Government of Thailand referred mitigation (GHG emission reduction) together with integrated development of carbon sink as strategy 2 of the plan. The Government of Thailand is under preparation of "Master Plan on Climate Change 2013-2050[3]" and there is a description of "mitigation and strengthen of carbon sink" along with others, such as "adaptation", "development of technologies, database and knowledge can support low carbon development" and "Awareness rising and capacity building for the actual working level in charge of climate change" in

[1] 183,287KtonCO2 was emitted in 2005

[2] The Government of Thailand committed 7% of GHG emission reduction at COP20

[3] The Technical Sub Committee have approved the plan has on August, 2014 and planned to be submitted to the Climate Change Committee

the plan. In the description, as for mitigation, the Government of Thailand has prioritized 8 sectors, including power, transportation, building, industry, waste management, agriculture, forestry, and urban management.

In term of Joint Crediting Mechanism initiated by the Government of Japan, the Government of Thailand agreed to continue to consider the possibility of forming it up as "a concrete measure to realize GHG emission reduction by Japan and countries in Mekong region" under the Action Plan for the Green Mekong Initiative" formulated on October, 2010, then after having many twists and turns, the government of Thailand became one of the countries who participate in Joint crediting Mechanism through process of drafting bilateral agreement by Thai Greenhouse Gas Management Organization, Approved by the cabinet on August 14th, 2015, then signed by both government on November 19th, 2016.

Under the background mentioned above, the Government of Thailand express their intention to strengthen its activities on mitigation and expects much from Joint Crediting Mechanism as one of driving force for mitigation actions. With interest as business, as well as contribution for mitigation in Thailand, expressed by potential investors for the project, EX Research Institute Limited implemented the Study.

(2) Waste Management

According to "Situation of Municipal Solid Waste" published by Pollution Control Dept., one of the competent government agencies responsible for waste management in Thailand in 2016, There is 27.06 million tons / year of municipal solid waste generated in total per year, and it means that 1.14kg / day / person of municipal soid waste generated in the year. The figures shown above is 13 increased in total and 10 percent increased per person per day. Therefore the Government of Thailand has announced its policy of putting high priority in 3Rs promotion in order to minimize amount of waste to be generated, then introduce appropriate processing & disposal. Number of local authorities which tackling with waste issues in the ares is increasing with the policy set up the Government mentioned above. However as 3Rs activities need some time as well as various factors, such as awareness raising, rules & regulations, foundamentals to be penetrated in, the Government of Thailand, as well as local authorities are struggling with the issues. As mentioned, appropriate waste management become one of the serious issues, especially in large cities, and therefore the Government of Thailand promotes integrated waste management center for the area under a concept of clustering for wide area processing. In addition, there are 2,057 open dump sites existing in Thailand and some of them are still under operation and amount of municipal waste landfilled and accumulated in the open dumps reached to 30.5 million tons in total.

EX Research Institute Limited. together with city of Kitakyushu has implemented the study aiming

to realize appropriate waate management in Chiang Mai province as well as in Thailand through implemention of the project, in which the project owener will combust or anaerobic digest municipal solid waste generated in the area, remove landfilled and accumulated old waste in landfill to restore landfill, as well as sort plastic waste out as raw material for RDF.

(3) Investors

There are two or more potential investors for the targeted project, i.e. Chiang Mai Waste 2 EnegyCo., Ltd., (hereinafter referred as "CMW2P"), who signed up the waste procuremenet contract with BANTAN group for WtE project, and local authorities &/or private sector working with local authorites in the province. Landfill which CMW2P expects to receive procurement of municipal solid waste is located inside 320 ha of land area owend by BANTAN group. It was developed in 1997 and continue to receive municipal solid waste from local authorities in the province. The landfill is regarded as one of candidates for wide are processing center in southern part in Chiang Mai. BANTAN group need to have CMW2P's WtE project to be developed soon, as BANTAN group needs to have advantage from having such processing facilities in their area. Details of CMW2P and local authorities with private sector will be stated in 4-1 below.

(4) Party conducts the study

The party conducts the study is EX Research Institute Limited (hereinafter refered as "EX"). EX is a thinktank engaging in unrban design and consultation for environmental related issues, established in 1972.

EX has been engaging numbers of project in climate change, including those for Joint Crediting Mechanism started in 2010. The Project of Introducing High Efficiency Refrigerator to a Food Industry Cold Storage in Indonesia is the first JCM project to issue carbon credit under JCM and is one of the project which EX engaged in as a consultant with scope of works of feasibility study, development of methodology and support for MRV implementation.

EX has set up local corporation in both Philippines and Thailand with purpose of enhancement of its activities in the area. EX, as a part of its business expansion, has strong intention to be involved in the project as a member in an international consortium

（5）Japanese Local Authority

City of Kitakyushu has been supporting Chiang Mai province in the field of environment since 2000. City of Kitakyushu invited members of staff from Chiang Mai Provincial Office (hereinafter refereed as "CMPO") in 2017 and both city of Kitakyushu and CMPO started discussion as for cooperation in development of eco town in Chiang Mai province. City of Kitakyushu dispatched its representative to Chiang Mai Province on March, 2017 and both parties agreed to implement "the

Project on Integrated Waste Management in Chiang Mai province", which covers supporting realization of eco town in Chiang Mai focusing on appropriate waste management in the area. City of Kitakyushu worked for introduction of appropriate waste processing facilities with JCM subsidy under the city-city cooperation between CMPO and city of Kitakyushu.

1-3 Scope of Works of the Study

EX, the party to conduct the study, engaged in the JCM project development study on "Waste to Energy by utilizing Waste Heat from MSW incineration at Rayong Integrated MSW Management Center" Under city to city cooperation for realization of low carbon society in 2016. EX focused in enhancement of city of Kitakyushu's activities in supporting integrated waste management in the province and JCM project development, while EX did collect data & information in addition to any of those collected throught implementation of the said project in 2016.

1-4 Organizational structure for the study implementation

EX acted as total coordinater for the project, in collaboration with two technology providers, i.e. Nippon Steel & Sumikin Engineering Co., Ltd. (hereinafter referred as "NSSE") and Price Management of Japan Co., Ltd. (hereinafter referred as "PMJ") under the framework of city-city coorperation between CMPO and city of Kitakyushu. NSSE provided technical support for Waste to Energy, while PMJ provided that for anaerobic digester. Chiang Mai University, one of the highest academic institutes in the northen part of Thailand supported for the project as one of outsourcing parties in the project. Organizational structure for the project is as per Figure 1-1 below.

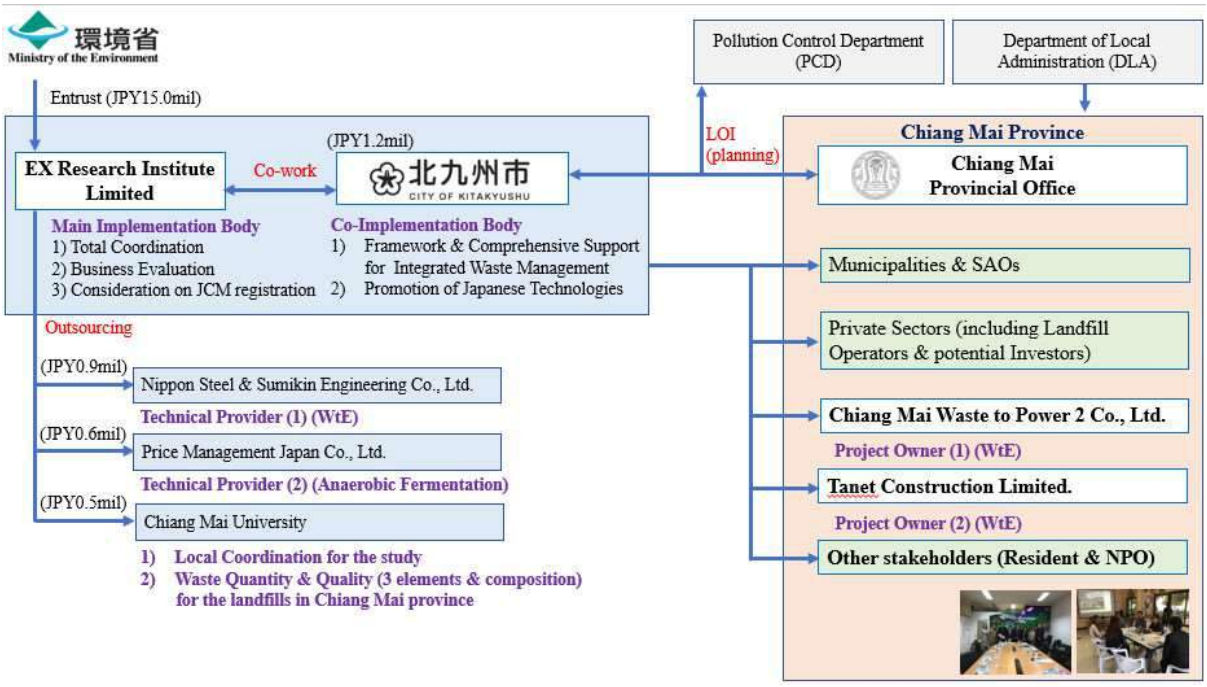


Figure 1-1Organizational Structure for the study implementation

1-5 Implementation Schedule

The Study team implemented the study as per schedule shown in Table 1-1

Table 1-1 Implementation Schedule for the Study

Description	2017									2018	
	4	5	6	7	8	9	10	11	12	1	2
Collection of General Data & Information	■	■	■								
Collection of Chiang Mai Province's Waste Related information	■	■	■								
Supporting CMPO's Integrated Waste Management project	■	■	■	■	■	■	■	■	■	■	■
Feasibility Study for the targeted project				■	■	■	■	■			
Consideration on Technologies to be introduced & employed							■	■	■	■	
Feasbility study for JCM registration							■	■	■		
Consideration on Business Plan										■	
Supporting works for Japanese technology providers by city of Kitakyushu	■	■	■	■	■	■	■	■	■	■	■
Meeting & Site survey in Thailand		■			■				■		■
Workshops & Meeting in Japan		■		■	■				■	■	■
Reporting Works											■

2. General Information

2-1 Kingdom of Thailand

(1) Country & Land

Kingdom of Thailand (hereinafter referred as "Thailand") with its land area of 51.4km2, is located at the area covered by 5-21 north latitude degree (about 1,600km) and 97-106 east longitude (800km), which is in the central part of the Indochina peninsula. It borders on Kingdom of Cambodia in east, the union of Myanmar (hereinafter referred as "Myanmar") in west, The Federation of Malaysia in south and Laos Peoples Democratic Republic and Myanmar. The country can be divided into four regions, i.e., mountain area in north, central plain in the Chaopraya River basin, Although Mekong River flows in the northeastern area of the country, irrigation in the area is not good enough and soil is rather poor with less moisture and fertilizer holding ability, as the most of the area is covered by Korart plateau, the southern part of the country is in Malay peninsula, is between gulf of Siam and Andaman sea.

(2) Climate

Thailand is classified tropical monsoon (Am) for the southern part, and Savanna for the other areas in Koppel climate classification. However, the Metrological Agency of Thailand classified the areas in the country into five, i.e., North, Northeast, Central, East and South. There are little differences among the area, however, in general, there is a south-west monsoon blow from Indian ocean bring wet wind and rain and typhoon occurred in East China Sea sometime bring heavy rain together with strong wind. Monsoon start blow at southern part of the country sometime on the month of May, then go up north, there are monsoon in both north and northeastern areas on the month of August, then all the areas including central and south in the country on the month of September and October. There is another monsoon from northeast on and after the month of October, which is from mainland of China and bring cold air to all the area in the country. There are three seasons, i.e. Middle of February – Middle of May as hot season, middle of May to Middle of October as wet season and middle of October to Middle of February as cool-dry season. There are consecutive hot days with more than 40 degrees Celsius in the hot season, while days with lower temperature are recorded in cool-dry season. There are days with less than 10 degrees Celsius as lowest temperature in the day in highland areas in both north and northeastern areas, while weather in both south and eastern part of the country is rather warmth in comparison with other areas in the country due to the influence of monsoon.

(3) People

Majority of Thai is Tai Family. There are Tai Noi Family, which are mixed race between Chinese and Tai in the central part, Tai Yai, Tai Muang and hill tribes in the north, Laotian in northeast and Malay south, however they are assimilating through marriages among different families and races.

There are minorities such as Karen, Hmong, and Akha tribes in the mountain area, in addition, Khmer, immigrant from neighboring countries are living in the country.

(4) Religion

Majority of Thai is Buddhist. Thai Buddhism is Theravada bossism missed up with Hinduism and Animism, therefore Thai have faith in gods in Hinduism, Aged large trees, strangely shaped rocks other than Buddha. There are many people have faith in Islam living in 3 provinces in southern part of the country, i.e., Naratiwart, Hatyai and Yala.

(5) Language

An official language in Thailand is Thai. Thai language was created in reference to Khmer character in thirteen centuries. Thai consist of forty-two consonants and thirty vowels and write in horizontal from left to right. There are lots of vocabularies derived from Sanskrit or Pali and even English, which are used as Thai vocabulary as it is recently.

(6) Form of the Government

Form of Government in Thailand is constitutional monarchy with the king of Rattanakosin dynasty as the head of the country. His Royal Highness Price Vajiralongkorn ascended to the throne as King X on December 1st, 2016, after death of His Majesty the King Bhumibol Adulyadej on October 13, 2016.

(7) Politics

There were drastic changes in politics in Thailand, starting from Antigovernment activities against Taksin Authority, which had been formed since 2001, became intensified in 2006, and a military coup occurred on September in 2006. Then Peoples Power Party, in line of ex. Premier, kept majority and took power in government administration after general election held on December, 2006. However, the government was collapsed on December, 2008. After the end of People Power Party's rule, The Democratic Party came into office with power until May 2011, then Thai Contribution Party became the ruling party because of another general election held on July, 2011. Administration management done by the Thai contribution party lasted for more than two years, however draft law for amnesty cause political instability again in Thailand. During protest government initiated by Peoples Reform Democratic Committee, last election was held on February, 2014, however as judged by the national supreme court, the result of the election became ineffective and in addition the court dismissed the prime minister on a charge of abuse of office powers. With the background said above, National Council for Peace and Order was set up to hold absolute power over the country and keep on holding its power as of January, 2017.

(8) Economiy

General Domestic Product (GDP) of Thailand in 2015 reached to 395 billion U.S. Dollar, and US$5,878. - per capita. Economic growth rate is 2.8%. Unemployment ratio in Thailand is 0.8%, which is low level in the world, and agriculture sector, fishery sector and manufacturing sector employ a lot of foreign labors from neighboring countries. Major economic activities in the country is primary industry in terms of number of persons engage in, which covers almost forty percent in total number of person engage in economic activities, while manufacturing industry in terms of GDP, which occupied approximately thirty-four percent, by sector.

Amount of export was 212 billion US dollars and that of import was 177.5 billion dollars. Electric Appliances & Parts, Automotive and parts, machine tools, agricultural products & processed products are the main items for export, while machine tools, crude oil and electric parts are the main items for import. Since ASEAN Economic Community (AEC) was inaugurated by the end of the year 2015, Thai expects to have further economic development due to less limitation on man-power, material, and capital crossing boarders among countries in the community.

Furthermore, Thai is in rich with tourism resources, such as beach resort in southern part and historical places and heritage in the central & northern parts, and therefore tourism is counted as one of the most important industries in Thailand. There were 26.55 million tourists in 2013, then once reduced to 24.81 million in 2014, number of tourist visited to Thailand increased and reached to 29.88 million, which is almost 30.00 million in 2015. As number of tourist visited to Thailand reached to 9 million for the first three months, which is 15.45 percent increase from figures recorded in previous year), the Government of Thailand prospect to have 32-35 million tourists would visit to Thailand in 2016.

(9) Administrative Organization

Administrative Division in Thailand is divided into three categories, i.e., central government, local governments and local administrative offices. The central office consists of cabinet and authorities under different ministries. The local governments are administrative agencies set up at each province as local agencies of the central government headed by the governor dispatched by the Ministry of Interior. Other ministries dispatch their personnel to the local government to support their activities in provincial level. The local administration conducted by local administrative offices mean local administration in their jurisdictional areas and local administrative offices have legislatures with authority to issue notifications and/ or ordinances and executive bodies.

2-2 Chiang Mai Province

General information & data of Chiang Mai province, where the study team conducted the

studyisas follows;

(1) Geographical Information

Chiang Mai province is located about 700km far from Thai capital, Bangkok with latitude of N.16 and longtitude of E.99. Land level in average is 310m high from sea level. Land area of the province is 138 wide (east – west), and 320km long (north to south) as longest, total land area is 20,107.057 square kilometer and the largest province in northern part of Thailand. Country, local authorities adjacent to Chiang Mai province are as per shown in Table 2-1 below.

Majority of the land is located in mountain area with shrubs and propotion of the land utilization is 69.92 percent for forest, 12.82 percent for agriculture and 17.26 percent for residential area..

Table 2-1 Country, Local Authorities adjacent to Chiang Mai province

県境	隣接国・県(郡)
North	ミャンマー連邦
South	ターク県(サムガオ郡、メーラマ郡、ターソンヤン郡、東側はチェンライ県のメーサールアン郡、ムアン・チェンライ郡、メーサルアイ郡、ウィアン・パーパオ郡)
East	ランパン県(ムアン・パーン郡とムアン・ランパン)、及びランプーン県(バーンティ郡、ムアン・ランプーン郡、パーサン郡、ウィアン・ノーンロン郡、バーンホン郡、並びにリー郡)
West	メーホーソン県(パイ郡、ムアン・メーホンソン郡、クンユアン郡、メーラーノイ郡、メーサリアン郡、スックムーイ郡)

(2) Population

According to the cencus 2016, population in Chiang Mai province is 1,735,762, containing 843,088 of male and 892,674 of female. Number of household is 768,855 accordingly. Population in Chiang Mai province by Amphur and Local Authorities is as per shown in Table 2-2 below.

Table 2-2 Census 2016 for Chiang Mai province

	Amphur	Male	Female	Total	No. of Household
1	Mueang Chiang Mai	6,298	7,028	13,326	10,435
2	Mae Taeng	27,067	27,045	54,112	22,934
3	San Sai	8,395	9,314	17,709	8,163
4	San Kamphaeng	23,636	25,925	49,561	23,197
5	Chiang Dao	12,414	12,759	25,173	10,714

	Amphur	Male	Female	Total	No. of Household
6	Mae Chaem	29,024	27,800	56,824	16,612
7	Mae Rim	40,472	41,445	81,917	34,417
8	Mae Wang	13,377	13,483	26,860	9,164
9	Mae Ai	34,069	33,700	67,769	26,366
10	Chai Prakan	14,978	14,884	29,862	10,887
11	Chom Thong	28,283	28,947	57,230	18,704
12	Doi Lo	12,724	13,207	25,931	11,063
13	Doi Tao	11,611	11,447	23,058	8,372
14	Doi Saket	21,945	23,635	45,580	20,009
15	Wiang Haeng	22,527	22,036	44,563	8,671
16	San Pa Tong	28,591	31,760	60,351	24,087
17	Fang	53,570	54,239	107,809	38,523
18	Saraphi	20,709	23,195	43,904	19,649
19	Hang Dong	33,607	37,087	70,694	37,760
20	Phrao	18,811	19,051	37,862	15,018
21	Omkoi	30,929	30,193	61,122	20,499
22	Hot	12,799	13,023	25,822	9,186
23	Samoeng	9,366	8,932	18,298	5,670
24	Mae On	10,631	10,665	21,296	8,854
25	Galyani Vadhana	6,296	5,797	12,093	3,710
26	Other 53 local authorities which have their own resident book in total	310,959	346,077	657,036	346,191
Total		843,088	892,674	1,735,762	768,855

Source: Census B.E.2559(2016)

(3) Socio-Economy

A report published by the Government of Thailand said there were 25Amphurs, 204 municipalities & SAOs & 2066villages[4] in Chiang Mai province, and 173.3million people was registatered as resident in the province[5](2012). Gross Provincial Product (GPP) per capita is THB113 thousand, 22.14 percent of GPP is from the Primary Industry, 10.12% from the Secondary, and 67.83 percent from the tertiary industry[6]. The tertiary industry occupied almost two-third of GPP, as Chiang Mai province is well-known international

[4] As per an official announcement on January, 2017

[5] As per an official announcement on August, 2016

[6] As per an official announcement on August, 2016

tourist city and receiving 9.3 million tourist in 2015.

(4) Administration

There are 2 dategories of local administration, i.e, provincial office & district office as branch offices for central government and Provincial Administrative Office (PAO), Municipality and Sub District Administrative Office (SAO) as local authorities. As stated in (4) abovem there were 25Amphurs, 204 municipalities & SAOs & 2066villages in Chiang Mai provinc and Chiang Mai PAO, 121 municipalitis and 89 SAOs administrate the area in the province. Number of municipalities and SAOs by Amphur in the province is as per shown in Table 2-3 below.

Table 2-3 Administrative Office in Chiang Mai province

	Amphur	T. Nakorn	T. Muang	T.Tambol	SAO
1	Mueang Chiang Mai	1	1	8	1
2	Mae Taeng	-	1	5	7
3	San Sai	-	1	11	-
4	San Kamphaeng	-	1	6	3
5	Chiang Dao	-	-	7	2
6	Mae Chaem	-	-	2	6
7	Mae Rim	-	-	6	5
8	Mae Wang	-	-	1	5
9	Mae Ai	-	-	1	6
10	Chai Prakan	-	-	2	2
11	Chom Thong	-	-	6	1
12	Doi Lo	-	-	3	1
13	Doi Tao	-	-	1	5
14	Doi Saket	-	-	13	1
15	Wiang Haeng	-	-	1	2
16	San Pa Tong	-	-	6	7
17	Fang	-	-	4	6
18	Saraphi	-	-	12	-
19	Hang Dong	-	-	10	2
20	Phrao	-	-	6	4
21	Omkoi	-	-	1	6
22	Hot	-	-	3	4
23	Samoeng	-	-	1	4
24	Mae On	-	-	-	6
25	Galyani Vadhana	-	-	-	3

	Amphur	T. Nakorn	T. Muang	T.Tambol	SAO
計		1	4	116	89

Source: Chiang Mai Province 4 years Development Plan (BE2589-2561)

3. . Feasibility study for the targeted Projects

3-1 Relevant laws & regulations

The study team conducted literacy research as for laws & regulations governing the targeted project in order to secure the procedure for the project development.

As far as Waste to Energy project concerns, the study team have base data & information through the study conducted in 2016, thus the study team focused on BE2560 National Cleanliness and Order maintain ACT, which is 2nd edition of BE2535 and laws and regulations governing biogas related project.

（1）National Cleanliness and Order Maintein ACT

National Cleanliness and Order Maintein ACT is an Act related to cleanliness and maintenance of order, enacted in 1992. Complicated & non-consistent legal system, unclear jurisdiction among relevant government authorities and licensing & approval for public – private partnership have been the biggest issues in waste management in Thailand since 2010, when relevant parties actively discuss appropriate waste management and recognize obstacles in realization of appropriate waste management. Current Administration regards appropriate municipal solid waste management as one of the most important challenges and try to improve situation. Revision of National Cleanliness and Order Maintein ACT is one of their achievement in their management, and proclamated Revised 2nd revision on January 17, 2017. BE2560 National Cleanliness and Order Maintein ACT, consist of preamble and 12 Articles, revoke, revise parts of that, and add on, that of BE2535,

Outline of National Cleanliness and Order Maintein ACT, both that of BE2535 & BE2560 is as follows;

Article	Provision
4	Partial revision of Article No. 4 of B.E. 2535 ACT (Definition)
5	Partial revision of Article No. 4 of B.E. 2535 ACT (Tariff, Exemption and policy on tariff setting)
6	Added Clause 2, 3 & 4 intoArticle 34 of B.E. 2535 ACT
7	Partial revision of Article 42 & 43 of B.E. 2535 ACT
8	Added Clause 1 & 2 into B.E. 2535 ACT

In the ACT, definition in Article 4 is revised, then revision in the Article 42 and the Article 43 are from revision of definition in Article 4, while provision is as per that of BE2535.

Tariff for wate realted service prescribed in the Article 5 is shown in Table 3-1below[7]。

Table 3-1 Tariff for waste related services provided by the local authority

	Description		Fee (THB)	Unit
2	Sewage & Solid Waste Collection & Transportation License		10,000	Time
3	Sewage & Solid Waste processing & disposal License		50,000	Time
4	Sewage & Solid Waste utilization License		50,000	Time
5	Sewage & Solid Waste Management Fee			
	5.1	Solid Waste Collection & Transportation Fee		
		Less than 120kg, 600litter or 0.6m3	150	Month
		Excess of base unit above, per unit (Less than 120kg, 600litter or 0.6m3)	150	Month
	5.2	Solid Waste Process & Disposal Fee		
		Less than 120kg, 600litter or 0.6m3	200	Month
		Excess of base unit above, per unit (Less than 120kg, 600litter or 0.6m3)	200	Month
	5.3	More than 3.600kg, 18thousand litter, 18m3 per month, per unit (as per described in 5.1 & 5.2 above)	200	Month
	5.4	Occassional Collection & Disposal		
		5.4.1 Less than 120kg, 600litter or 0.6m3 as Unit, per unit	200	Time
		5.4.2 More than 240kg, 1,2oo litter or 1.2m3 Per unit (Less than 120kg, 600litter or 0.6m3 as Unit)	200	Time
		5.4.3 Less than 120kg, 600litter or 0.6m3 as Unit, per unit	200	Time
		5.4.4 Additional charge levied on collection & transportation of solid waste in excess of 240kg or 1,200 litters, or 1.2cubic meters unit stated in 5.1 & 5.2 shall be used as a unit. Amount in the right is service charge per one unit	200	time

Article No. 5 mentioned above is amended from BE2535 Act, in which, only advertisement license fee

[7] Service charge for sewage treatment fee etc. are omitted

prescribed, in terms of Empowerment of both the Minister of Interior & the Minister of Health to determine the fees not exceeding those prescribed in the ACT. Local authorities still hold the right to determine fares at the rate below ceiling fee prescribed in Article 5 above but base low is shifted from Public Health Act (Article No. 63) to BE2560 Act.

Article No. 34 of BE2535 ACT prohibite excresion at public places, therefore it seems less relevance with provisions added as 34-2, 34-3 & 34-4 into the Article. In the BE2560 ACT, of which details are as follows;

Article 34-2

Local authorities, except for Provincil Administrative Organization, administrate jurisdicted areas have authority & obiligation in collection and processing of sewage & solid waste. In order to fulfill obligation mentioned above, local authorities might outsourcing to other government agencies, other local authorities, including Provincial Administrative Organization and/or private companies or conduct joint implementation with other local authorities in accordance with rules, procesudes and condition prescribed by notification of the Ministry of Interior. Outsorcing to private sector is not regarded as joint investment, therefore will not be applicable for Public-Private Partnership ACT. Rules, procesudes and condition prescribed by notification of the Ministry of Interior shall keep cositency with Public-Private Partnership ACT as follows;

Government, Government Agencies, Local Authorities, including Provincial Administrative Organization might collect & store sewage and solid waste by receiving an authority transfer in accordance with Article 34-2 above, thus collection means, approval beased on agreement among stakeholders, including utilization and/or recycle of collected material in accordance with the rules, methodologies and procedures prescribed in Article 34-2,

For the case any local authorities or Provincial Administrative Organizations, receive an authority transfer from other local authorities in accordance with the second paragraph of Article 34-2, it will not be applicable for “operation outside of the jurisdicted areas under “Local Authory Act”.

Local authorities shall responsible for collection of collection, transportation & processing fees in the area, which is prescribed by ordinance & not exceeding the rate fixed by the notification of the ministry

Hazardous Industrial Waste & Non Hazardous Industrial Waste defined by the Factory Act, , except for any of those to be collected by local authorities together with sewage and/or solid waste shall be managed as follows; Local authorities, Government Agenies and other local authorities including provincial Administrative Organizations, who received an authority transfer shall notice officer in charge sutipulated by the Factory Act to cope with cases. The offier in charge who received such notice shall take action within 3 days after receipt of such notice. For the case, no actions taken by the officer in charge, then Local authorities, Government Agenies and other local authorities including provincial Administrative

Organizations, who received an authority transfer shall well consider and cope with the cases, while the officer in charge sutipulated by the Factory Act shall take responsible for any loss to be incurred, if any.

Collection, Transportation & Processing of sewage & solid waste shall be in accordance with rules, method sutipulated by the notification of the Ministry of Interior, while local authorities shall be compliance with rules, method & standard sutipulated by other laws, if any.

Article No. 34-3

Any parties wish to collect, transportat, process & dispose sewage & solid waste as business shall obtain license and approvel from the head of local authorities. Application & Issuance of approval, extention, temporary approval and/or license shall be in accordance with rules & method announced by local authorities.

Validity of the license to be issued under the paragraph 1 above shall be as follows;

(1) 1 year after the date of issuance for Collection & Transportation License
(2) 5 yeasr after the date of issuance for processing & disposal of sewage & solid waste
(3) 5 years after the data of issuance for utilization of sewage & solid waste

Issuance of License

The parties obtained licnese shall be regarded as the party obtained license in accordance with Article 34-3 Collection, Trasnport & Processing of sewage & solid waste for maintain of Public Cleansing & order for public benefit in Public Health Act. Transferred authority to local authorities to announce rules on administration in jurisdicted areas as follows;

(1) To regulate operation of the areas where citizen will enter and receive sewage & solid waste
(2) Method to sort, collect, transport, process & disposal of sewage & solid waste
(3) Tariff for waste related services set up by local authorites, government agencies, other local authorities, including Provincial Administrative Organizations or private sector who received authority transfer from local authority as for collection, transportation, processing & disposal of sewage & solid waste.
(4) Licensing fee for the license presctribed in rhe Article No. 34-2, but not exceeding the fee announced by the notification of the ministry.
(5) Other rules & regulation in sewage & solid wasate management

Implementation of collection, transporation and processing of the sewage & solid waste shall be in accordance with announcements of local authority based on the paragraph 1 above. Local authority shall responsible for set up area where receive sewage and solid waste.

Article 34-4

In sewage & solid waste management, The Depatment of Local Administration, the Ministry of Interior shall propose, instructi and support to local government, in accordance with Provincial Development Plan. The Depatment of Local Administration shall propose national budeget to the cabint, if necessary.

Eovironmental impact aseessment in accordance with provision in National Environment Conservation Act shall be conducted upon preparation of the plan stated in the paragraph 1,

The Minister of Interior shall form central committee to advise and monitor for local authorities' implementation stated in paragraph 1 & 2 above. The central committee shall consit of representatives from the Pollution Contorl Department, Publicworks & Urban Planning Department, Department of Industrial Works, Department of Local Administration, Department of Environmental Conservation and Departmenr of Health. The central committee might invite representatives from other government agencies as member, if necessary.

The Governor of province shall form committee monitoring local authorities' implementation based on paragraph 1 & 2 above in receipt of authority transfer from the Minister of Interior.

Penalty is prescribed by Article No. 58 and violater against the Article No. 24 & 25 shall be penaltized not exceeding THB2,000.-, then THB100.-/day during days after any violation found until fixing it. Inaddition Revised Law (BE 2560 LAW) prescribes less than 6 months of detention and/or THB50,000.- of fine will be imposed on violter against Article No 34-1, 34-2, 34-3, 34-4

As per explained aobve, and by the government of Thaialand, the BE2560 ACT is integrated laws of
BE2496 Local Administartion ACT (1953), BE2542 Decentralization ACT (1992), BE2556 Public-Private Partnership ACT (2013), BE2535 Public Health ACT (1992), in which prescribe municipal solid waste management, and as a result, added administration into BE2535 ACT, which prescribed obligation of the people in maintain cleanliness and order. Waste related provision in National Cleanliness and Order maintain ACT is as follows;

Article	Provision
6	● Ower and/or tenant of rhe building shall maintain cleanliness and order of the building, land area and road adjustcent to the building / land area. Owner of the market shall take responsibility for cleanliness of area including road adjustcent to the area. ● Responsible party for the above, might appoint third party to fulfill its obligation.

26	Prohibition on disposal of wate at green areas owned by state company and local authorities
31	(2) prohibition on disapoal of waste except for the appointed containers by local Authorities
32	(1) prohibition on disposal of waste in public place (2) prohibition on inappropriate waste management at places where visible from outside of the area.
53	TH10,000.- against violater of the Article No. 6
54	THB2,000.- against violater of the Article No. 26, 31 & 32

(2) BE2550 年 Energy Business Reorganizatio ACT (2007)

Energy business was categorized by sector by BE2550 Energy ACT enacted based on reorganization plan of energy industry of the Government of Thailand in 2007. The ACT stated that the government of Thailand will achieve stable & effective power supply, in terms of quality & quantity at reasonable cost Socioeconomic and environment and sustainable development, realization fo stable and efficient power supply through participation of community and private sector, shall be taken into account,

Energy Regulatory Committee

Energy Regulatory Committee (ERC) is a committee founded in 2007 in compliance with Article 10-29, Chapter II of BE2550 Energy Act and received imperial sunction on February 1, 2008. The committee responsible for contingency between national policy and gas or power business operations and set up secretariat for administration in accordance with Article 30-46 in chapter II of the ACT.

Authorities transferred to the Committee by the providion of BE2550 Energy ACT is as follows;

(1) Notification on classification of energy business and report for Imperial sunction
(2) Standardization on safety of electric system & responsibility
(3) Regulated on power procurement issuance of request for submission of proposal for power sales, monitoring on power procurement procedures and keep transparency.
(4) Report for National Plan and policy such as Power Development Plan, Investment Plan for Power sector, Natural Gas procurement plan, Energy system expansion plan
(5) Inspection on efficiency & transportation on business operation by Energy Business Licensee
(6) Management & Supervision on regulation & standard for customer service & quality
(7) Proposal for Office organization for committee member and officer
(8) To Regulate & issue notification as for Adjustment of interest among committee members, officers and stakeholders

(9) Contribution for energy foundation, to regulate and issue notification as for condtions, method met with policy set up by the National Energy Committee
(10) To issue announcement for penalty on administration
(11) To advice on Energy business operation
(12) To Promote & support energy related research & study
(13) To raise awareness in the field of energy
(14) To promote & support human resource development in energy efficiency
(15) To promote effecvite operation of enegy business, economic & efficient energy consumption with consideration of less environmental impact, and balance of natural resources.
(16) To consider relationship among government agencies in implementation prescribed by the Law
(17) To implement other duties under authority & obligation of ERC by law.

Regulation on Energy Business

In the law, Part I of Chapter III prescribes licensing for energy business. The Article No. 47 prescribes that energy business operator shall obtain license from ERC even if the party will not profit from their operation, except for the type of business prescribed by royal decree. The Article No. 50 followed by prescribes eligibility of the applicant, type of licnes, procedure, cost & expenses shall be as per ERC's decision.

Type of Business operation not required for business license

Type of business operation with capacity not required for business license is prescribed by the Article No. 47 of BE2550 Energy Act and Royal Decree announced in 2009. Five type of business operations are sutipulated by the Article No. 3 and as far as gas business concern, business operation of storage of natual gas with capacity less than 50,000 litter & gasification of liquid

ERC issued notification as for licnese for energy business in accordance with the Article No. 50 ofBE2550 Energy Act, of which details is as follows;

Article	Provision
4	Classification of applicant (individual, private compmnay, government agency, state enterprixe, corporation, etc)
5	As per provision prescribed in Article 48 of BE2550 Energy ACT
6	Parties wish to obtain license for energy business shall submit application as per classification stated inArticle 4-4 above (include format)
7	Any parties wish to establish business operation listed below shall submit application listed below (1) Power business

	1) Power generation license 2) Power transmission license 3) Power control management 4) Power distribution license 5) Power system management system (2) Gas business 1) License for gas transport by pipeline 2) Exploration & wholesale license 3) Gas retail license by distribution networks 4) Gas storage & gasification license

License for the targeted project in the study will be (1)1) in the Artivle No. 7 for RDF power plant and (2) 2) & 3) for biogas collection & utilization depending on the operation.

Tariff

Tariff shall be set up by the cometent Minister with approval by National Eneegy Committee in accordance with the Article No. 64 in Section II, Chapter III　Article No. 65 prescribed that ERC is empowered to set up tariff for each categories of business operation, as per policy & guideline given by National Energy Plicy Committee.　ERC is said to consider following point. The Article No 66 prescribes that ERC's disclosure methodology to set up the tariff.

(1) To refrect actual cost & consider reasonable profit for energy business operator
(2) To meet with National Energy demand & maintain efficiency
(3) To motivate energy business operator to improve efficiency in their operation
(4) To consider fairness for business licenssss & customers
(5) To consider decentralization of power producers and poor consumers
(6) To set up clear and transparent tariff & publication
(7) To avoid unfairness among energy users (parties need energy)

Technical Standard

Technical Standard for energy business operators is prescribed in Part III, Chapter III. To say exactly, Energy Business Operators shall meet with technical standard set up by ERC in the Article No. 73.

Power Development Fund

Part IV in Chapter II prescribed Power Development Fund (PDF). PDF is founded with purpose to support expansion of power service areas, promotion of renewable energy and others with less environmental impact and support to the community with impact by construction of power plant.

In the Article No. 96 stated that Power business operator shall contribute to the fund in accordance with the Article 11-10 of the ACT.

ERC issued notification based on the provision mentioned above on November 15, 2010 and prescribed energy business operators contribution to the fund in detail. Tariff set up by the Article No. 5 of Notification is as follows;

<table>
<tr><th>区分</th><th>Contribution</th><th>Remarks</th></tr>
<tr><td>Construction period</td><td>THB50,000 per year. Monthly payment for the case construction period of less than 12 month, but not less than 15,000.-</td><td>Payment shall be completed within 5 days at the beginng of the month</td></tr>
<tr><td>Operation period</td><td><table><tr><th>Category</th><th>Fee (satang/unit)</th></tr><tr><td>Natural Gas</td><td>1.0</td></tr><tr><td>Heavy Oil / Diesel</td><td>1.5</td></tr><tr><td>Coal</td><td>2.0</td></tr><tr><td>Wind & PV</td><td>1.0</td></tr><tr><td>Hydro</td><td>2.0</td></tr><tr><td>Others (Waste)</td><td>1.0</td></tr></table></td><td>Within 45 days after closing monthly account at the end of each month</td></tr>
</table>

The Article No. 7 followed by mandated energy business licnesees to submit report covering items mentioned below.

	Decription	
1	Amount of power generated by utilization	
	A	Export to national grid
	B	Power supply to users other than export to national grid
	C	Self-consumption (facilities other than power generation)
	D	Self-consumption at power plant
2	Amount of power generated by Fuel	
3	Contribution to the Foundation	

In the biogas collection & utilization business, collected biogas will be utilized on site or supplied to other parties, thus electric fee and gas price available at site are important in feasibility study. With understanding mentioned above, the study team checked eletrci price & gas fee in Thailand.

（3）BE2542 年　Commodity Price & Service Fee Act (1999 年)

BE2542 Commodity Price & Service Fee Act is the law in relevant to commodity price & service fee enacted in BE2542 (1999), which is revision of BE2522 ACT. The Article No.8 in the Chapter 8 prescribed the establishment of the central committee for commodity price & service fee and

appoint the Minister of Commerce as chairman of the committee. The Article No 9 prescribed authority of the committee as follows;

- Publication of listed commodities in accordance with the Article No. 24
- Provision on price control method in accordance with the Article No. 25
- Order to the manufacturers and distributers of the controlled commodities to submit statement In accordance with the Article No.26
- Approval on Notification in accordance with the Article No. 27
- Provision on indication of commodity price & service fee in accordance with the Artile No.28
- Provision on adjustment of commodity price and service fee In accordance with the Article No. 29
- Provision on license & approval extention fee in accordance with the Article No. 33
- Understanding of demand-supply for the controlled items & services and Adjustment. To appoint provincial committee and secretariat and clerks for the secretariat office as its representative.
- Coping with compliance
- Summorning witness
- Other operation under the authority & obligation by the Law.

The Article No. 16 and onward in the Chapter II, prescribed that the set up of the secretariat for the committee as (1) to set up secretariat at Department of Domestic Trade, the Ministry of Commerce and appoint Director General as chief secretariat for the office. The Article No. 17 prescribed that the authority & obligation of provincial committee for the commodity price and service fee.

Price & fee of the controlled items is prescribed in the Chapter III and later, Authority of central committee of issuance of notification indicting price & fee for controlled items with approval of the cabinet in order to adjust price & fee. Such notification shall be issued at least once a year, ecxept for the case of base fractuation for cost estimation. For such case, the committee shall issue notification immediately and the notification shall be entered into force on and after the next day of such notification published. The article No. 25 prescribed authority of the committee after the issuance of notification in accordance with the Article No. 24 as follows;

- Fixation of deal price
- Fixation of maximum profit for deal of specific commodity
- Prescription of regulation & standard for manufacturing, import, export, sales, distribution and storage
- Prescription on area and period of announcement to be applied

- Request to relevant government authorities to submit report as for their plan, including, quantity, capital, production plan, cost, import & export plan, purchasing plan, distribution plan & method
- Report on fractuation of stock
- Limitation on import & export
- Order to business operator to improve efficiency in their operation
- Supply of the product at pre-fixed price
- Distribution of commodity with higher than ceiling price set up by
- Storage of commodity with book value higher than ceiling price set up by

The government of Thailand empowered the central committee to force producers, distributers, resellers and importers to indicate name of business operator, purchase price, wholesale price, specification. Quality, mass, volume, weight together with name of controlled item with amont of controlled item contained In the Article No. 26, and commodity price by the Article No. 28.

3-2 Business Permission for Biogas Collection & Utilization

One of the project under consideration in the Study is to collect and utilize biogas from municipal waste. Biogas to be collected would be utilized as alternative of natural gas, LNG, LPG, or generate steam or power to be procured to users. Business said above is defined as "Factory" and categorized as "Group 3" by the Notification No. 1 of the Ministry of Industry in B.E. 2535 (1992) published under the Factory Act on September 24, 1992. Therefore, party wish to establish business shall obtain factory license in accordance with ministerial orders and notification under the Act.

Code	Description	Group 1	Group 2	Group 3
88	Power generation, distribution & sales	-	-	All
89	Non-Natural gas generation, supply, distribution & sales[8]	-	-	All
102	Generation of Steam to be supplied	-	-	All

Although further study would be needed, the party wish to establish any type of business mentioned above is required to obtain factory license. In addition, party wish to establish Separation & refining of natural gas (no. 7) shall complete Environmental Impact Assessment, while not for power generation with capacity less than 10MW (No. 18).

However, the study team obtained information mentioned above from literacy study and need to conduct further study for final confirmation.

[8] No description for Natural Gas

3-3 Current Situation for Business development & operation

（1）Climate Change

Activities in the field of climate change in Thailand are as described in 1. Outline of the Project, (2) background 1) climate change above. The Government of Thailand, about National Energy Saving Plan for 20years (2011-2030) and Thailand NAMAs toward 2020, set up its intermediate target of 7-20 percent GHG emission reduction by 2020 in comparison with amount of GHG emitted in 2005, and 25% of GHG emission reduction from energy per GDP. The Government of Thailand announced again in Intended National Determined Contribution (INDC) submitted on October 1, 2015 that The Government of Thailand will reduce 20 percent of GHG emission in comparison with that of 2015 (up to 25% depending on support for appropriate technologies, financial support, and capacity building to be provided based on balanced and ambitious agreement under UNFCCC)

Appendix to INDC

Baseline	An amount of GHG emission in 2030 estimated based on that in 2005 (in the absence of major mitigation actions) (Estimated amount of GHG emission in 2030 (BaU) = 555MtCO2e)
Duration	2021-2030
Targeted Sectors	Economy Wide (Including land use, but will judge for land use change and forestry)
Targeted GHG	Carbon Dioxide (CO2), Methane(CH4), Nitrogen-Oxide(N2O)), HFCs, PFCs and SF6
Premise & Methodology	IPCC 4th Assessment Report National Statistics including sector-wise activities and socio-economic prospection
Progress in Planning	- Conducting Public Hearings for INDC - Interest among stakeholders is under adjustment at both cross-agencies type work-group and stirring committee consist of representatives from representative agencies from each sector, academic sector, and private sector - Organized three times of national investigative commissions in assessment phase - Drafted in accordance with National plans listed bellows; National Economic Development Plan Master Plan for Climate Change (2015-2050) Power Development Plan (2015-2036) Master Plan for Development of Smart Grid in Thailand (2015-2036)

	Energy Efficiency Development Plan (2015-2036) Alternative Energy Development Plan (2015-2036) Plan for environmentally sustainable transportation system (2013-2031) National Industry Development Plan (2012-2031) Road Map for Solid & Hazardous Waste Management
International Market Mechanism	The Government of Thailand recognizes importance of market mechanism in enhancement of cost-effective mitigation actions. And therefore, the Government of Thailand looks for measures, such as source of finance, capacity development and technology development & transfer, which will support realization of sustainable & resilient low carbon society together with possibility of utilization of bilateral, regional, and international market mechanism.
Review & Adjustment	The Government of Thailand reserve the right to review and adjust its INDC in accordance with new agreement under UNFCCC.

Statement in relevant to mitigating in the INDC is as follows;

- Amount of GHG emission was 5.63tCO2e/person and 409.54TCO2e/GDP in 2012 in Thailand
- The Government of Thailand has already achieved 4% of emission reduction at the time COP20 was help in Lima, Peru, and continue to make effort to achieve its target of 7 percent emission reduction by 2020
- The Government of Thailand has promoted fuel conversion from coal to natural gas since the beginning of 1980s and 72 percent of power generated in total in Thailand was generated by natural gas in 2005. Consequently, it would cost much to reduce more GHG emission in energy sector.
- The Ministry of Energy placed energy security and economy & ecology as base principal, prepared power development plan (2015-2036), Energy Efficiency Plan (2015-2036)、Alternative Energy Development Plan (2015-2036) in which the Ministry set up its targets of 20 percent for ratio of renewable energy utilization in capacity basis and 30 percent in consumption basis by 2036
- In the Plan for Environmentally Sustainable Transportation System (2013-2031). The Government expect further GHG emission from improvement of bus transportation system, double lines for railway and expansion of train-service areas in Bangkok Metropolitan and introduction of new motor way tax system based on amount of CO2 emission.

（2）Municipal Solid Waste

1）Current Situation

Municipal solid waste related Data & Information is published in Annual Environment Report published by Pollution Control Department, Ministry of Natural Resources & Environment

“Situation of Municipal Solid Waste B.E.2559 (2016) is the latest edition of the report at present and waste

flow shown in the report is as per Figure 3-1 below.

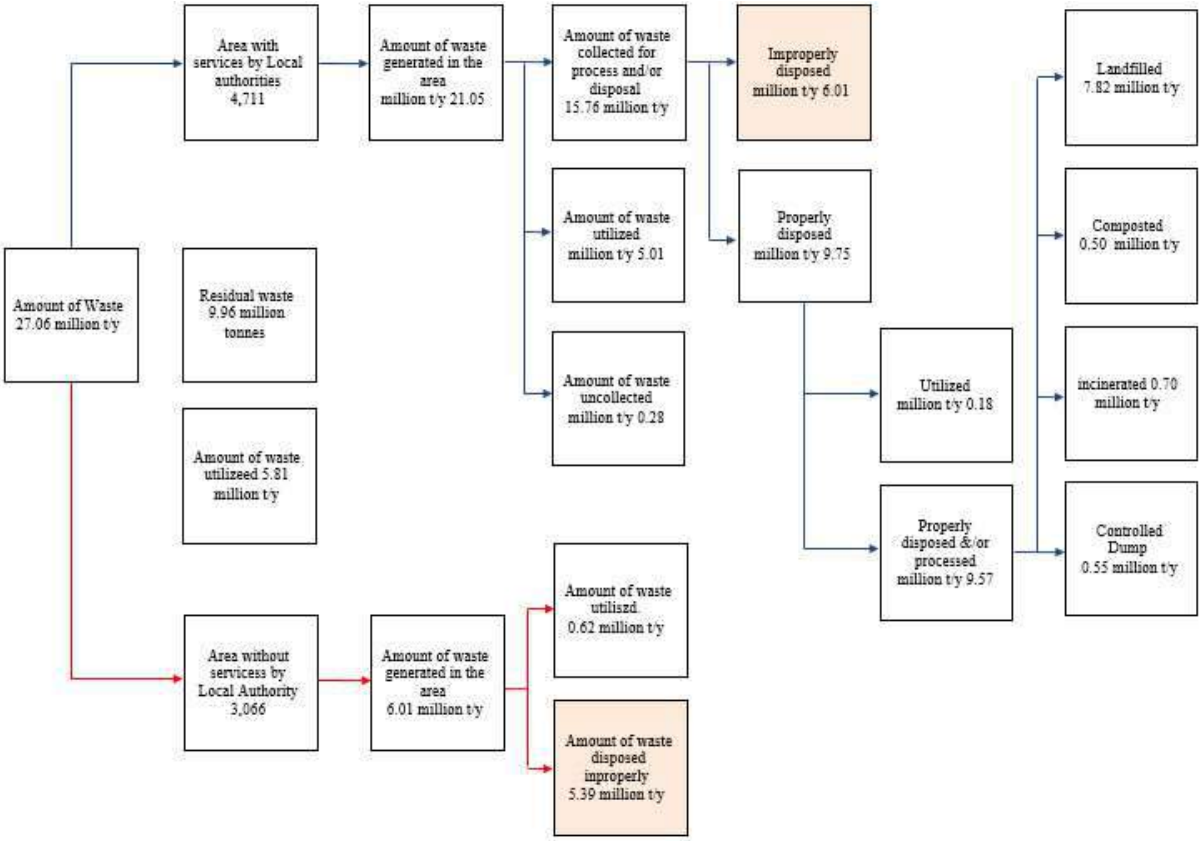


Figure 3-1 Flow of Municipal Solid Waste in Thailand

Source: The Study Team / Data Source: Pollution Control Dept.

Amount of Municipal Solid Waste generated

27.06 million tons of municipal solid, in total or corresponding to 1.14kg per person per day of waste was generated in 2016 and are 0.6 percent in total and 0.9% per person per day increased from those of previous year. Figure 3-2 shows trend of amount of municipal solid waste generated in total and that of per person per day for 2008 – 2016 Both total amount and amount per person per day were increased except for 2014 with global recession

Figure 3-2 Trend of amount of municipal waste generated in Thailand

Source: The Study Team (DATA Source: Pollution Control Dept.)

However the figures shown in the report are calculated by an equation of x "population in the administrative district" and default value for "estimate amount of waste generated per person per day by administrative class" is set up by Pollution Control Dept. as per shown in Table 3-2 Estimated amount of waste generated per person per day by administrative class. And furthermore, Pollution Control Dept. did not mention how they adjust population, with aspect of flow-in & flow out without residential registration transfer, including foreigners in the area

Table 3-2 Estimated amount of waste generated per person per day by administrative class

Administrative Class (Thai)	Estimated Amount of Waste (kg/person/day)
Large City (Tesabarn Nakorn)	1.89
Medium City (Tesabarn Muang)	1.15
Small City (Tesabarn Tambol)	1.02
Pattaya Special City	3.90
SAO(OBT)	0.91

Source: Pollution Control Dept.

Among all municipal solid waste generated, 4.21 million tons of municipal waste or 16 percent was from Bangkok, 11.16 million tons or 41 percent is from Pattaya & other municipalities and 11.69 million tons is from Sub District Administrative Organizations

Collection & Transportation

The Government of Thailand empowered local authorities to manage municipal solid waste, including collection & transportation, generated in the area by the laws.[9]。 There are 7,777 local authorities existing in Thailand, who owe obligation for collection & transportation of municipal solid waste. Among all local authorities, 4,711 local authorities or 60.6 percent provide collection & transportation service in their areas, while 3,066 local authorities or 39.4% do not provide any of such services in the area. The Government of Thailand reported that the areas, where local authorities do not provide collection & transportation services, have less population in large land area, and most of household behave what Thai people in rural area do, i.e. throw organic waste into their land, sell recyclable waste & plastic waste to junk shop subject to further study for confirmation.

21.05 million tons of waste was generated in the areas where collection and transportation services were available, while 601 million tons in the areas without such services. Number of Transfer Station is still limited, i.e.14 places in total, including 7 owned by governmental sector and remaining 7 owned by private sector.

Processing & Disposal

Amount of municipal solid waste recycles in 2016 was 5.81 million tons or 21 percent of waste in total, increased by 3 percent and that appropriately processed and/or disposed was 9.57million tons increased 4 percent in comparison with those in last year.

Amount of municipal solid waste processed and deposed in Transition (2008-2016) is as per shown in Figure 3-3 below. The Government of Thailand regard Sanitary Landfill, Controlled Dump with daily disposal less than 50 ton, as appropriate disposal in Thailand, Composting. Incineration with flue-gas treatment facilities and others. Amount of processing & disposal by type is 7.82 million tons for appropriate disposal, 0.5 million tons for landfill, 0.7 million tons for incineration and 0.55 million tons for others in 2016.,

[9] BE2560 National Cleanliness & Order ACT Article34 Clause2

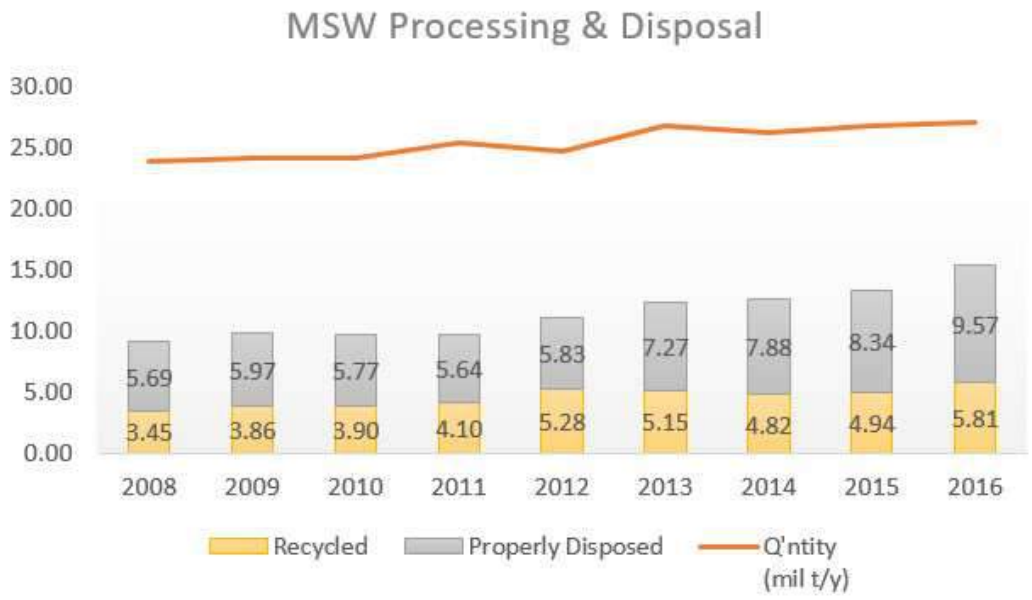


Figure 3-3 Waste Processing & Disposal by type in Thailand

Source: Pollution Control Dept.

Number of waste processing and dispoal facilities existing in Thailand is as per Table 3-3 below.There are 2,480 inappropriate waste disposal sites, including open dumps in Thailand, which both local authorities and private companies operate, while there are 330 appropriate waste processing & disposal facilities existing in Thailand, containing 92 Sanitary Landfills, 202 Controlled Dumps, 19 incinerators with flue-gas treatment facilities (including 12 incinerators with capacipity less than 10tons/day), 12 composting facilities and 5 MBTs.

Table 3-3 Number of waste processing & disposal facilities by owner and type in Thailand

Processing & Diposal Method	Govt	Private
1. Appropriate processing & disposal (330 in total)		
1) Sanitary Landfill	84	8
2) Controlled Dump with amount of waste disposed less than 50 tons / day	129	73
3) Incinerator with flue gas treatment facilities (>10tons)	1	6
4) Incinerator with flue gas treatment facilities (<10tons)	12	-
5) Compost	9	3
6) MBT	4	1
2. Inappropriate processing & disposal (2,480 in total)		
1) Controlled Dump with amount of waste disposed more than 50 tons / day	6	9

2) Open Dump	1,802	255
3) Open Burning (Incineration without incinerator)	326	8
4) Incinerator without flue-gas treatment facilities	59	15

Source: Pollution Contorl Dept.

Among facilities listed inTable 3-3, details of Incinerators existing in Thailand is as ber Table 3-4 & Table 3-5 below.

Table 3-4 Incinerator with flue-ga treatment facilities (>10tons)

区分	Owned by Government (1 ヵ所)	Owned by Private Sector (6)
1	Ayutthaya	Bangkok
2		Songkhla
3		Phuket
4		Khon Kaen
5		Kanchanaburi
6		Saraburi

Table 3-5 List of Incinerators with flue-gas treatment facilities (<10tons)

Facilities owned by Government (12)		
	Location	No. of Incinerator
1	Phitsanulok	2
2	Phichit	1
3	Kamphaeng Phet	1
4	Prachin Buri	1
5	Ratchaburi	2
6	Nong Khai	1
7	Loei	1
8	Rayong	1
9	Nakhon Si Thammarat	1
10	Krabi	1

Clustering for Wide Are Processing

The Government of Thailand prescribed the Ministry of Interior as the center, promotes wide area processing of municiapal solid waste in the country. There are 324 clusters in Thailand containing 10 large clusters with more than 500tons /day of waste, 11 middle size cluster with 300-500 tons/day of waste, and 303 small clustes with amount of waste less than 300tons/day.

National Target

The Government of Thailand set up its National Taerget in waste management as follows;

[Framework]

- Encourage citizens, including children, and the private sector to reduce waste at the source by following the 3Rs concept (Reduce, Reuse, Recycle)
- Establish proper disposal methods for municipal solid waste and household hazardous waste by using centralized facilities for clusters of municipalities emphasizing waste utilization and waste to energy methods
- All relevant sectors participate in the management of solid and hazardous waste

[Target]

	Description		
1	municipal solid waste are disposed properly (19.6 mil tonnes)	>75%	2021
2	All accumulated waste are disposed properly (30.5 mil. tonnes)	100%	2019
3	Household hazardous waste are collected and disposed properly (0.17 mil tonnes)	>30%	2021
4	All infectious waste are collected and disposed properly (0.05 mil tonnes)	100%	2020
5	All hazardous industrial waste management collected and disposed properly (2.06 mil tonnes)	100%	2020
6	Local government organizations have systems for waste separation at the source (households) (3,889 LGO)	>50%	2021

1）Chiang Mai province

There was 605,351.16 tons of waste generatedfrom 210 local authorities in Chiang Mai province. 149 among 210 local authorities in total provided waste collection& transportation service, while remaining 61 local authorities did not provide such services in the area. Waste flow, including collection & transportation in the area, is as per below Figure 3-4 and Table 3-6.

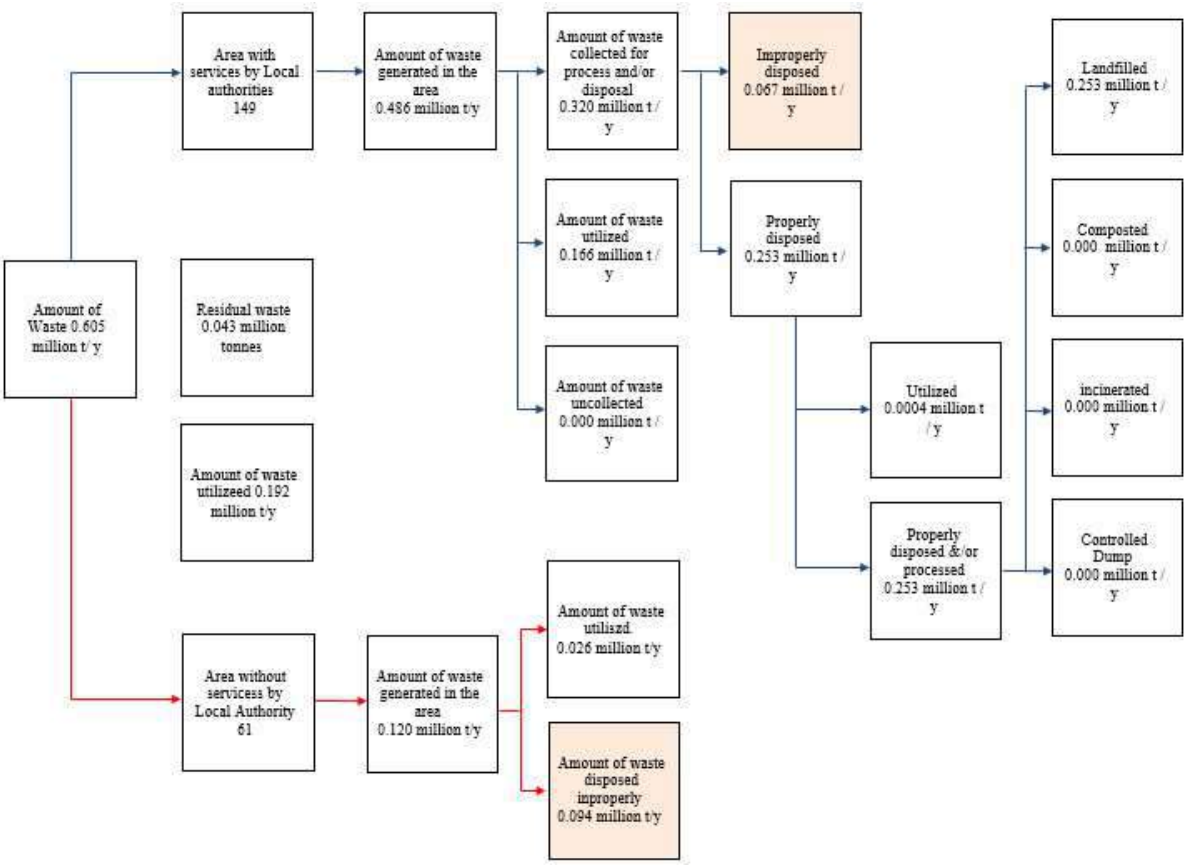


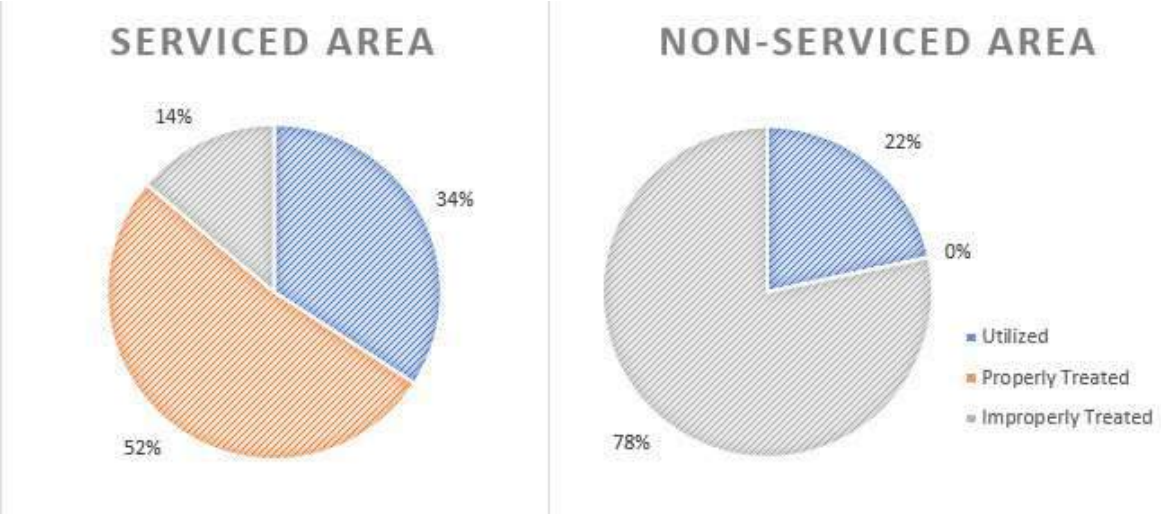
Figure 3-4 Waste Flow in Chiang Mai province

Source MONRE

Table 3-6 Amount of waste in Chiang Mai by category

Collection	Generation	Utilized	Appropriate				Inappropriate
			Landfill	Compost	Combustion	Others	
Areas with service	485,773.54	166,035.60	252,545.16	0.00	0.00	0.00	67,192.77
Areas without services	119,577.63	25,875.68	0.00	0.00	0.00	0.00	93,701.95
Total	605,351,16	191,911.28	252,545.16	0.00	0.00	0.00	160,894.72

Source: MONRE



Municipal Solid Waste Generation

There was 605 thousand tons of municipal solid waste generated from 210 local authorities and area governed by provincial administrative office.in the province per year.

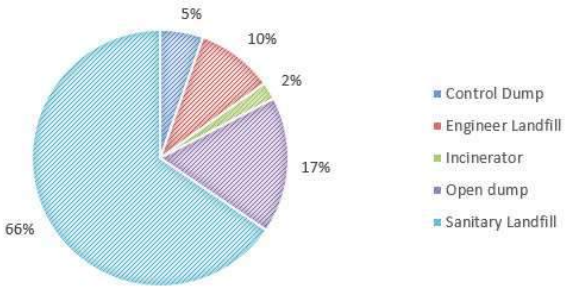
Collection & Transportation

149 among 210 local authorities either by themselves or outsourcing to private sector on contract basis, provided waste collection & transportation, while remaining 61 local authorities did not provide any of services in the area. Amount of waste uncollected was 486 thousand tons per year and 166 thousand tons was delivered for recycling, while 253 thousand tons was transported to landfills for final disposal. Among those there are 3 clusters in Chiang Mai, i.e. 1 large cluster and 2 middium clusters, of which details are shown below.

Processing & Final Disposal

As stated above, municipal solid waste collected had been transported to recycling shop and/or landfills for recycling and/or final disposal. There are 3 landfills for appropriate final disposal in Chiang Mai, those are Wiang Fang (Engineered Landfill) in northern part, Doi Saket in central part and Hord (Sanitary Landfills) in southern part in the province. 26 tons of municipal solid waste per year was reclcled and 94 tons per year was inappropriately disposed in the non-serviced areas in the province.

Categories	Q'ty(t/d)
Control Dump	49.73
Engineer Landfill	88.72
Incinerator	20.20
Open dump	157.65
Sanitary Landfill	600.00



Hazardous Waste (Fluorescent Light, Container for Petcicide etc., Battery & Spray Cans etc.)

Collection, Transportation and Processing of hazardous waste is managed by local authorities in the

procvince. Local authorities in the province have set collection boxes for hazardous waste generated in the are, collect and temporary stored at their own warehouses. Althought the Ministry of Interior announced its policy to assign provincial offices as responsible government agencies to collect and appropriately process hazarodu waste generated in the area, Chiang Mai provincial office is under planning for collection & appropriate processing as of February 2018.

Clustering for wide area processing

As stated, clustering for wide area processing in Thailand is promoted by the Ministry of Interior and the Ministry of Natural Resources and Environment. Both Ministries set up a National Plan and announce their national plan to provincial offices, then provincial offices shall set up plan for clustering for wide area processing in the area by collecting data & information from local authorities as well as supporting in planning & administarion. Clustering for appropriate waste management is promoted by Provincail committee for waste management, which adjust interest among stakholders in the province. Clustering plan announced by the Ministry of Interior and the Ministry of Natural Resources and Environment is as below.

Class	Name	Amount of Waste Generated	Amount of waste landfilled	Local Authorities in Cluster (Amphur)
1 (L2)	North FANG	357.85t/d	7,806.75t	Mea Ai、Fang、Chai Prakan、Phrao、Chiang Dao、Wiang Haeng　計 6 郡
2 (L1)	Central DOI SAKET	995.93t/d	12,081.36t	Mae Thong,　Doi Saket、San Sai、Mae On、San Kampheaeng、Saraphi、Muang Chaingmai、Mae Rim、Hang Dong、Samoeng、Galyani Vadhana　計 12 郡
3 (L2)	South HORD	365.14t/d	2,100.41t	Mae Chaem、Mae Wang、San Pa Tong、Doi Lo、Chom Thong、Hot、Doi Tao、Om Koi　計 8 郡

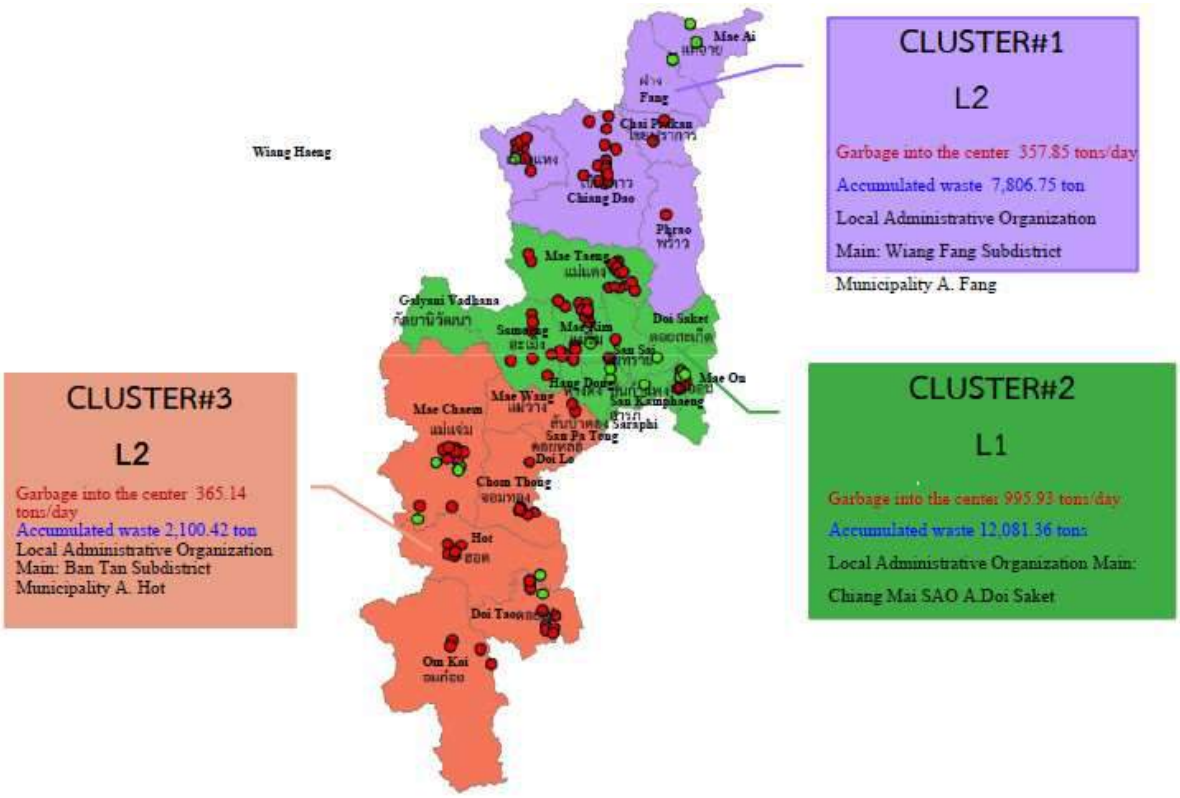


Figure 3-5　Clusters for wide area processing in Chiang Mai province

Source:　Chiang Mai Natural Resources & Environment Bureau

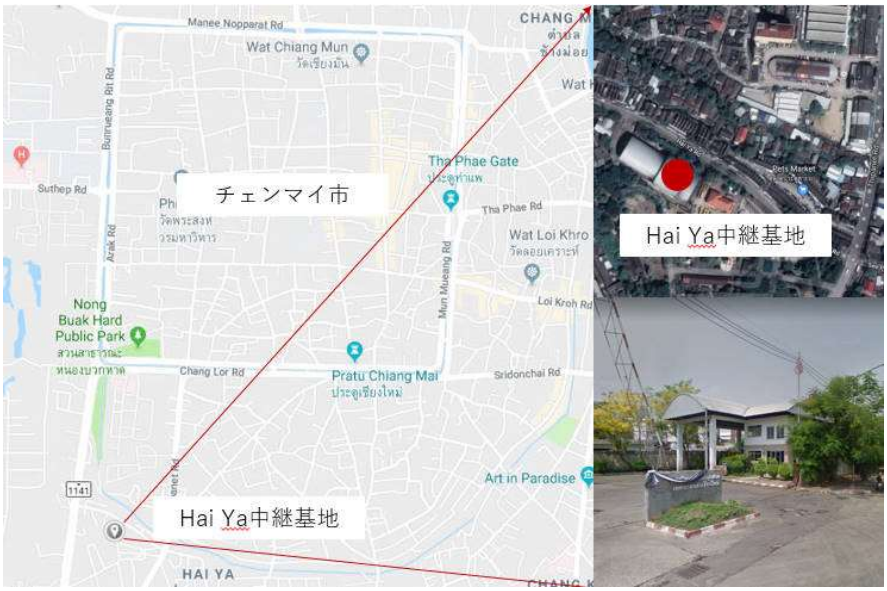
Among 3 clusters shown in Figure 3-5, Waste Management Center with waste sorting machines, composting facilities and sanitary landfill for Cluster 2 has been established by Chiang Mai Provincial Administrative Office (PAO) at Doi saket District. The center started operation once, but because of disputes with resident in the area as for odder and incleanliness, the center was forced to shut down for repairing facilities and improvement of its operation. In 2017, the center completed reapiring of its facilities and selected new operator, then resumed its operation by receiving municipal solid waste from local authorities in the District

Waste Quality

The Study Team conducted waste sampling & analysis for the municipal solid waste generated in the area, of which details are as follows;

- Outline

The Study Team conducted waste sampling & analysis targeting for municipal solid waste generated in Chiang Mai province, which is base data for planning & designing facilities targeting in the study.

Location	:	MSW Transfer Station at Hai-Ya, Chiang Mai city, Chiang Mai province 
GPS	:	Latitude N:18.774735　Longtitude E::98.978437
Durtion	:	September 24-30, 2017
Implementation	:	Chiang Mai University

A part of municipal solid waste generated in Chiang Mai city is collected by waste collecting vehicles and transported to Hai Ya transfer station, transhipped to 20FT x 2 joint trailers, then transported to sanitary landfill located in Hord District, the southern part of Chiang Mai province for final disposal.

- Sampling Method

Amount of waste transported to Hai Ya transfer station during sampling work was as per shown in the table below.

	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Amount (t)	182	221	227	189	203	217	175	198	227	175

- Analysis Method

Analysis method after sampling work was as per shown in Figure 3-6

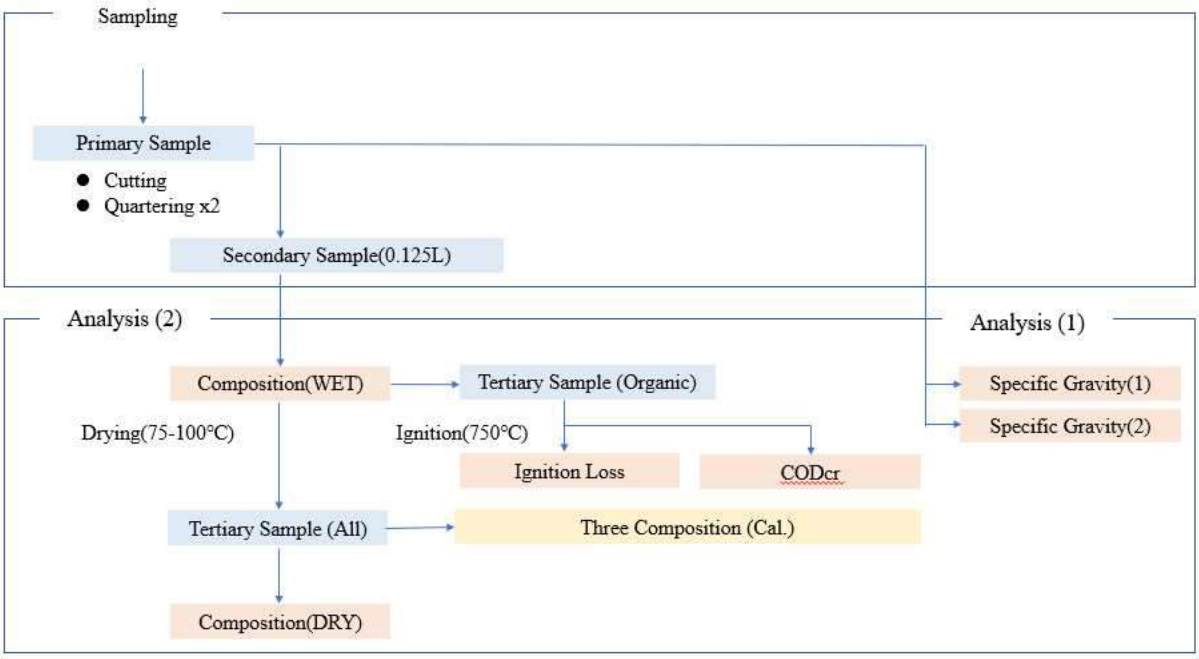


Figure 3-6 Analysis process

- Specific Gravity

Specific Gravity analysis was conducted in accordance with the method explained in the Notification of the Ministry of Environment, Japan No. 95, or (i) put collected waste into plastic container with capacity of 100litters in full, (ii) dropped the container from 30cm hight from ground level to the ground, (iii) put additional waste into the container to fill the space to full, (iv) repeated(ii) & (iii) above for twice. (3 times in total), (v) weighted the container after (vi), (vi) reduce weight for vacant container from the value obtained from (v) above, then (vii) calculated specific gravity from the equation of value obrained from (vi) devided by volume of the container.

Specific Gravity Analysis

- Composition Analysis

The Study Team conducted composition analysis of the municipal solid for both dry and wet

basis. As for the analysis for wet basis, the Study Team cut the municipal solid waste collected into small pieces, then well mingled for quartering to obtain 0.15 litter of sample. Then sorted the sample into 9 categories, containing (i) Food Waste, (ii) Paper Waste、(iii) Plastic Waste, (iv) Rubber & Leather Waste, (v) metal waste, (vi) Glass & Ceramics, (vii) grass, branches & leaves, (viii) fabric & fiber waste, and (ix) Others. As for analysis for dry basis, dried collected sample by oven, sorted into 9 categories then weighted for each. Waste composition analysis for boh wet & dry basis was conducted at laboratory in Chiang Mai University.

- Ignitiion Loss & Chemical Oxigen Demand

	September 2017							AVR	MAX	MIX
	24	25	26	27	28	29	30			
Orgnic Waste	-	-	-	-	-	-	-	-	-	-
Waste Water	21,486	13,075	17,905	17,406	18,571	29,481	26,150	20,582	29,481	13,075

- Analysis Report

- Specific Gravity

Result from Specific Gravity Analysis is aa per shown in table below.

	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Specifiv Gravity	0.15	0.22	0.22	0.16	0.20	0.25	0.15	0.19	0.25	0.15

- Composition

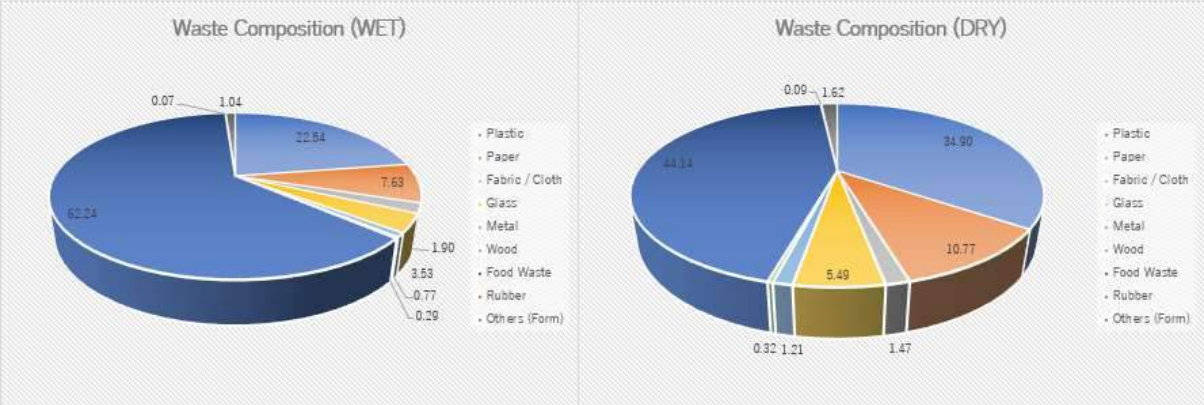
Result from Composition Analysis is aa per shown in table below.

WET(%)

Waste Gategory	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Plastic	21.97	21.47	22.53	25.71	22.07	21.21	22.82	22.54	25.71	21.21
Paper	8.22	8.22	6.96	9.11	5.54	3.96	11.36	7.63	11.36	3.96
Fiber/Cloth	6.38	1.21	2.51	1.24	-	0.75	1.18	1.90	6.38	0.00
Glass	5.08	2.74	3.87	4.18	3.00	3.16	2.70	3.53	5.08	2.70
Metal	1.14	0.70	0.16	0.92	0.64	1.01	0.83	0.77	1.14	0.16
Biomass	-	0.38	0.31	0.51	0.01	0.14	0.66	0.29	0.66	0.00
Food Waste	54.72	64.43	63.12	57.02	68.33	68.13	59.95	62.24	68.33	54.27
Rubber	0.03	0.01	-	0.12	-	0.29	-	0.07	0.29	0.00
Others	2.45	0.83	0.54	1.17	0.42	1.34	0.50	1.04	2.45	0.42

DRY(%)

Waste Gategory	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Plastic	27.65	33.73	35.88	38.15	36.34	35.15	37.38	34.90	38.15	27.65
Paper	10.61	11.45	10.26	11.95	7.29	6.44	17.38	10.77	17.38	6.44
Fiber/Cloth	4.50	0.99	2.16	1/12	0.00	0.64	0.88	1.47	4.50	0.00
Glass	6.88	4.25	6.30	6.39	4.96	5.25	4.39	5.49	6.88	4.25
Metal	1.61	1.12	0.26	1.34	1.05	1.71	1.37	1.21	1.71	0.26
Biomass	0.00	0.43	0.35	0.47	0.01	0.16	0.82	0.32	0.82	0.00
Food Waste	45.15	46.65	43.93	38.71	49.67	47.84	36.99	44.14	49.67	36.99
Rubber	0.05	0.02	0.00	0.12	0.00	0.46	0.00	0.09	0.46	0.00
Others	3.55	1.36	0.87	1.74	0.68	2.33	0.79	1.62	3.55	0.68



- Three Components

	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Ash	5.65	6.50	4.61	7.21	6.51	6.10	6.28	6.12	7.21	4.61
Moisture	23.99	30.29	28.45	25.50	30.73	30.67	25.76	27.91	30.73	23.99
Comustible	70.36	63.21	66.94	67.29	62.76	63.24	67.96	65.97	70.36	62.76

- Ignition Loss for Organic Waste (%)

	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Paper	84.48	86.25	87.66	84.36	85.63	86.37	88.56	86.62	88.56	84.38
Food Waste	88.86	83.32	92.48	82.21	87.54	91.43	90.99	96.60	88.12	82.21
Biomass	-	97.39	97.04	96.24	96.41	96.28	96.26	96.60	97.39	96.24

Chemical Oxigen Demand

	September, 2017							AVG	MAX	MIN
	24	25	26	27	28	29	30			
Organic Waste	-	-	-	-	-	-	-	-	-	-
Waste Water	21,486	13,075	17,905	17,406	18,571	29,481	26,150	20,582	29,481	13,075

（3）Energy

1）National Policy

The government of Thailand assumed the ecnomic growth ratio of the nation in average for the period of 2014 -2036 as 3.95 percent per year GDP base with population increase ratio of 0.03 percent per year. And estimated power demand increasing ration as 2.67 per / year after taking energy saving into consideration, then obtained 326,119GWh as total demand for power with capacity demand of 49.655 MW in 2016. Against demand mentioned, There are source of power supply with capacity of 37,612MW in total in 2014, but those with capacity of 24,736 will be deconstructed during 2015-2036. Consequently the Government of Thailand set up its power development plan by sourc as per table below.

	Category		Capacity(MW)
1	**Renewable Energy**		**21,648**
	Details	**Domestic**	**12,105**
		Overseas	9,543
2	Pumped storage power		2,101
3	Co-generation power		4,119
4	Conbined Cycle power		17,478
5	Thermal & Nuclear power		12,113
Total			57,459

Current Situation

Power Supply by source in 2014 is as per shown in the table below.

Capacity			
1	Combined Cycle	21,145	56.2
2	Thermal	7,538	20.0
3	Renewable Energy	8,476	22.5
4	Gas Turbine & Diesel	154	0.5
5	EGAT-TNB connected	300	0.8
Total		37,612	100.0

Power Development Plan

The Government of Thailand announced public offering for power producers in 2017 under the notification of the Ministry of Energy published on February 8, 2017. With this announcement, power procurement from SPP HYBRID FIRM & VSPP SEMI FIRM, which were newly added into original power development plan, will be certainly executed Revised power development plan for renewable energy is as follows;

Quota allocation for renewable energy in the Power Development Plan			850-1,000MW
SOURCE	NEW	SPP HYBRID FIRM	300MW
	NEW	VSPP SEMI FIRM	289MW
	NEW	Biomass in South(Government)	53MW
	NEW	PV(Private)	119MW
	NEW	Waste to Energy	78MW
	NEW	Biomass in South (Biogas)	8MW
	NEW	PV(Government)	100MW
	Total		953MW

The Ministry of Energy announced in its press release on February 8, 2017 that power procurement from renewable energy would be in a range of 850MW-1,000MW as capacity of power generation basis, and with quota allocated by the announcement for public offering this time, The Ministry of Energy achieve their target in power procurement from renewable energy. The Government of Thailand explained that Power purchasing from SPP HYBRIDFIRM announced this time is newly introduced in addition to the existing quota allocated to other sources, while some parties express their concern on re-structuring of power procurement from renewable energy.

The announcement of power purchase from SPP HYBRIDFIRM was implemented as per announcement of Energy Regulatory Committee as of September 27, 2017 and 17 companies were selected for further negotiation with competent government agencies, of which detail is shown in Table 3-7 below

Table 3-7 List of Developers for SPP HYBRID

No.	Developer	Location	Capacity (MW)	Quota (MW)
1	Kaset Phol Power Plant Co., Ltd. (Kaset Phol Power Plant Project)	Udon Thani	40.00	27.00
2	Korach Industry Co., Ltd. (Biomass Power Project 3)	Nakhon Ratchasima	22.00	13.84
3	Sri Chaopraya Co., Ltd.	Nakhon Si	25.00	21.50

No.	Developer	Location	Capacity (MW)	Quota (MW)
	(Thung Yai 1 Clean Power Plant Project)	Thammarat		
4	Bio Power Plant Co., Ltd. (Thung Yai 2 Clean Power Plant Project)	Nakhon Si Thammarat	25.00	21.50
5	Thaico Technology Co., Ltd. (SPP Hybrid Firm Renewable Energy Project, 2017 24 MW (Krabi))	Krabi	30.00	24.00
6	Thaico Technology Co., Ltd. (SPP Hybrid Firm Renewable Energy Project, 2017 16MW (Pathio-Chumphon))	Chumphon	20.00	16.00
7	Thaico Technology Co., Ltd. (SPP Hybrid Firm Renewable Energy Project, 2017 16 MW (Udon Thani))	Udon Thani	20.00	16.00
8	Sri Chaopraya Co., Ltd. Ranong Clean Power Plant Project	Ranong	23.00	20.00
9	Mitr Phol Bio-Power (Phuviang) Co., Ltd. (SPP Biomass Power Plant Project Mitr Phol Bio-Power 5)	Khon Kaen	27.00	16.00
10	Thaico Technology Co., Ltd. (SPP Hybrid Firm Renewable Energy Project, 2017 16 MW (Sawee-Chumphon))	Chumphon	20.00	13.85
11	Surin Electric Co., Ltd. (Surin Power Plant Project (Project 3))	Surin	22.00	11.29
12	Blue Solar Farm 1 Co., Ltd. (Blue SPP Jawrakeyai Project)	Suphan Buri	35.60	12.00
13	Bio Power Plant Co., Ltd. (Khlong Khlung Clean Power Plant Project)	Kamphaeng Phet	20.00	13.31
14	Bang Sai Phumiphat 16 Co., Ltd. (SPP Hybird Sukhothai Project)	Sukhothai	17.00	13.29
15	Super Solar Energy Co., Ltd. SPP Hybrid Firm Renewable Energy Project, 2017)	Sa Kaeo	32.00	16.00
16	Bang Sai Phumiphat 20 Co., Ltd.	Phichit	26.00	21.00

No.	Developer	Location	Capacity (MW)	Quota (MW)
	(SPP Hybird Phichit Project)			
17	PST Energy 1 Co., Ltd. (Rong Fong Biomass power plant Project)	Phrae	30.00	23.42

Tariff will be applied for the SPP HYBRID is as follows;

Category	Price (THB/UNIT)			Contract
	FIT_F	FITv	FIT	
SPP HYBRID Capacity: 10-50MW	1.81	1.85	3.66	20years

Source: Energy Regulatory Committee

Power Producer categorized "SPP HYBRID" shall employ at least one technology in addition to Photovoltaic power generation technology. As RDF is one among other technologies can be employed in combination with photovoltaic power generation,

As far as quota allocated to Waste to Energy, the Government of Thailand announced revised schedule for public offering for "78MW of Quick Win Project"on November 14, 2017, which was originally announced on October 22, 2016, then postponed on February 23, 2017. Outline of the Annoucement published by Eneegy Regulatory Committee as of November 14, 2017 is as follows;

- Announcement of Energy Regulatory Committee on power purchasing from Waste to Energy under Feed in Tariff.

Eneegy Regulatory Committee announces revision and addition on its' notification on BE2559 power purchasing from Waste to Energy under Feed in Tariff / Notification No.1 December BE2559), due to amendment of [National Cleanliness & Order Maintain ACT (BE2535)](amended to BE2560 2nd Edition)

Article 1	This Announcement is called [the Notification of power purchasing from Waste to Energy under Feed in Tariff / BE2560]
Article 2	This announcement will be effective on and afte a day after the announcement published.
Article 3	To add a phrase of *"Owner" means Provincial Administrative Organizations, Local Authorities,*

<table>
<tr><td></td><td>BangkokMetropolitan Administation, Pattaya Special City and other local authorities establsiehd by law.
After Definitiion for “Operation” in Article 3. Definition of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste]</td></tr>
<tr><td>Article 4</td><td>To delete description of “steering committee for selection of municipal solid waste processors, the Ministry of Interior” from Article 3. Definition of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste]</td></tr>
<tr><td>Article 5</td><td>To revise Article 6-1 of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste BE2559] As follows;
<table>
<tr><th></th><th>Plan</th><th>Schedule</th></tr>
<tr><td>1</td><td>November 2 -15, 2017</td><td>National Grid & System check</td></tr>
<tr><td>2</td><td>November 7, 2017</td><td>Briefing & Start of Preparation</td></tr>
<tr><td>3</td><td>November 16 -30, 2017</td><td>Application</td></tr>
<tr><td>4</td><td>January 5, 2018</td><td>Notice on successful applicants</td></tr>
<tr><td>5</td><td>January 5-April 6, 2018</td><td>Confirmation on offer, including power selling price</td></tr>
<tr><td>6</td><td>May 4, 2018</td><td>Notice on contractor</td></tr>
<tr><td>7</td><td>Within 120days after final selection (by Aug. 2018)</td><td>Sign up contract with EGAT &/or PEA.</td></tr>
</table></td></tr>
<tr><td>Article 6</td><td>To replace Article 7 of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste BE2559] into
Article 7 Place to receive application & proposal, confirm on offer including power selling price shall be office of Energy Regulatory Committee at No. 319 19th Floor Chamchuri Square Phayathai Rd., Pathumwan Bangkok 10330. Energy Regulatory Committee shall issue receipt for application & proposal, request for confirmation on offer, including power selling price</td></tr>
<tr><td>Article 7</td><td>To amene Article 8 of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste BE2559] Application
8.1 Any parties which to be an owner of business shall prepare documents in accordance with the format and guidance given in appendix of this announcement, sign by all representative owners and seal. Sign and Seal shall be made in all pages and make it as original. For the case any discrapancies between original and copy,</td></tr>
</table>

<table>
<tr><td></td><td>Energy Regulatory Committee regard original as correct.
8.2 Any parties which to be an owner of business shall submit application form attached with documents listed in 11.1 later
(1) Approval from Provincial Administrative Organizations, Local Authorities, BangkokMetropolitan Administation, Pattaya Special City or other local authorities establsiehd by law regarding business application under the Notification of power purchasing from Waste to Energy under Feed in Tariff / BE2560
(2) A copy of appointment letter as administrator and ID card (either as government officer or citizen)
(3) Report on grid connectivity check under the Notification of power purchasing from Waste to Energy under Feed in Tariff / BE2560
8.3 Any parties which to be an owner of business shall submit application form by the date noticed by the Energy Regulatory Committee. For the case applicant would Appoint other party as its representative, the representative shall submit power of attorny listed in 11.2 later with both applicant & representative's signed Idntification card (of Government Officer or Citizen) stated "the same as original". Energy Regulatoru Committee refuse to receive application after the time & date noticed by the committee.</td></tr>
<tr><td>Article 8</td><td>To add following sentence into Article 8-1 of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste BE2559]
Article 8-1 Application for Power sales
Very small power producer, (VSPP defined in Article 8) shall submit 4 types of application forms listed in the table below
<table>
<tr><th>Document</th><th>Q'ty</th></tr>
<tr><td>1. Application & Proposal for Power sales</td><td>1 set</td></tr>
<tr><td>2. Documents list for application & proposal</td><td>1 set</td></tr>
<tr><td>3. Warranty for application & proposal</td><td>1 set</td></tr>
<tr><td>4. Copy of documents mentioned in 1-3 above</td><td>3 sets</td></tr>
</table>
(2) VSPP shall prepare application and proposal in accordance with the format andguidance given as appendix of this announcement, sign clearly in all pages by all representatives and seal, if any, then keep it as original. VSSP shall prepare 3 copies based on the original mentioned above. The Committee regard original as correct, for the case any discrepancies between original and copy.
(3) VSPP shall submit proposal based on certificate for VSPP prescribed in 11.4 and bid bond prescribed in 11.7. For the case applicant would assign its representative, then applicant shall submit power of attorney prescribed in 11.5 together with signed identification cards stated "as the same as original" for both applicant and</td></tr>
</table>

	its representative. The representative shall present original identification card upon submission of application form. (4) VSPP shall submit application form with bid bond to the committee by the time & date set up the committee. The committee will refuse any application without bid bond (5) The committee will issue a receipt to applicant upon receipt of application form (after checking documents) (6) The committee will not allow any revision on submitted application except for 1) VSPP request to return application form submitted by written 2) VSPP will replace into new proposal by the time & date set up in 6.1 above. (for the case VSPP replaced its proposal, new acceptance number will be given)
Article 9	To replace Article 11 of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste BE2559] into Article 11. The Committee regards Appendix to this Announcement as a part of the Announcement 11.1 Application Form 11.2 Power of Attorney for submission of application form 11.3 Report on Grid Connectivity 11.4 Proposal for Power Sales 11.5 Power of Attorney for submission of proposal 11.6 List of documents for application & proposal 11.7 Bid Bond 11.8 Appropriaty of power purchasing from municipal solid waste based WtE 11.9 List for "Quick Win WtE Projects" & grid connectivity for the project sites where the Ministry of Interior, Bangkok Metropolitan Administration and Local authorities reported as candidates. 11.10 Project Site (shall not be inside water source and natural conservative area) 11.11 Provision of Energy Regulatory Committee on power purchasing from Renewable Energy based VSSP BE2558 11.12 BE2559 Provision of grid connection published by MEA 11.13 BE2559 Provision of grid connection published by PEA 11.14 Self-Assessment for project site
Article 10	To delecte Article 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 11.10 & 11.11 of the Notification of Energy Regulatory Committee [power purchasing from waste to energy from combustion of municipal solid waste BE2559]

Detail of the Quick Win Projects mentioned above is as per shown in Table 3-8 below.

Table 3-8 Quick Win Projects

No	Province	Projext Owner	Project Site	Plant	Capacity (MW)
1	Ayutthaya	Ayutthaya PAO	T. Maha Phram A. Bang Ban	1	5
		Nakhonloung Subdistrict Municipality	T. Bang Rakam A. Nakhon Luang	1	8
			T. Nong Khainam A. Nong Khae Saraburi	1	8
2	Nonthaburi	Nonthaburi PAO (2)	Moo 2 T. Khlong Khwang A. Sai Noi	1	8
		Nonthaburi PAO (3)	Moo 8 T. Khlong Khwang A. Sai Noi	1	5
3	Rayong	Rayong PAO	Moo 3 T. Nam Khok A. Mueang	1	8
4	Nong Khai	Nong Khai PAO	T. Phon Sawang A.Mueang	1	6
5	Krabi	Krabi Town Municipality	T. Sai Thai / T. Thap Prik A. Mueang	1	4.4
6	Tak	Mae Sod Subdistrict Municipality	T. Maepa A. Mae Sot	1	5.5
7	Udon Thani	Udon Thani City Municipality	T. Nong Na Kham A. Mueang	1	8
8	Bangkok	Nong Khaem Waste Disposal Center	45 Phutthamonthon Sai 3 Nong Khaem, Bangkok	1	3
		On nut Waste Disposal Center	Soi On nut 86, On nut, Prawet, Bangkok	1	3

Revised schedule for power development plan set up by Energy Regulatory Committee is as per shown in below.

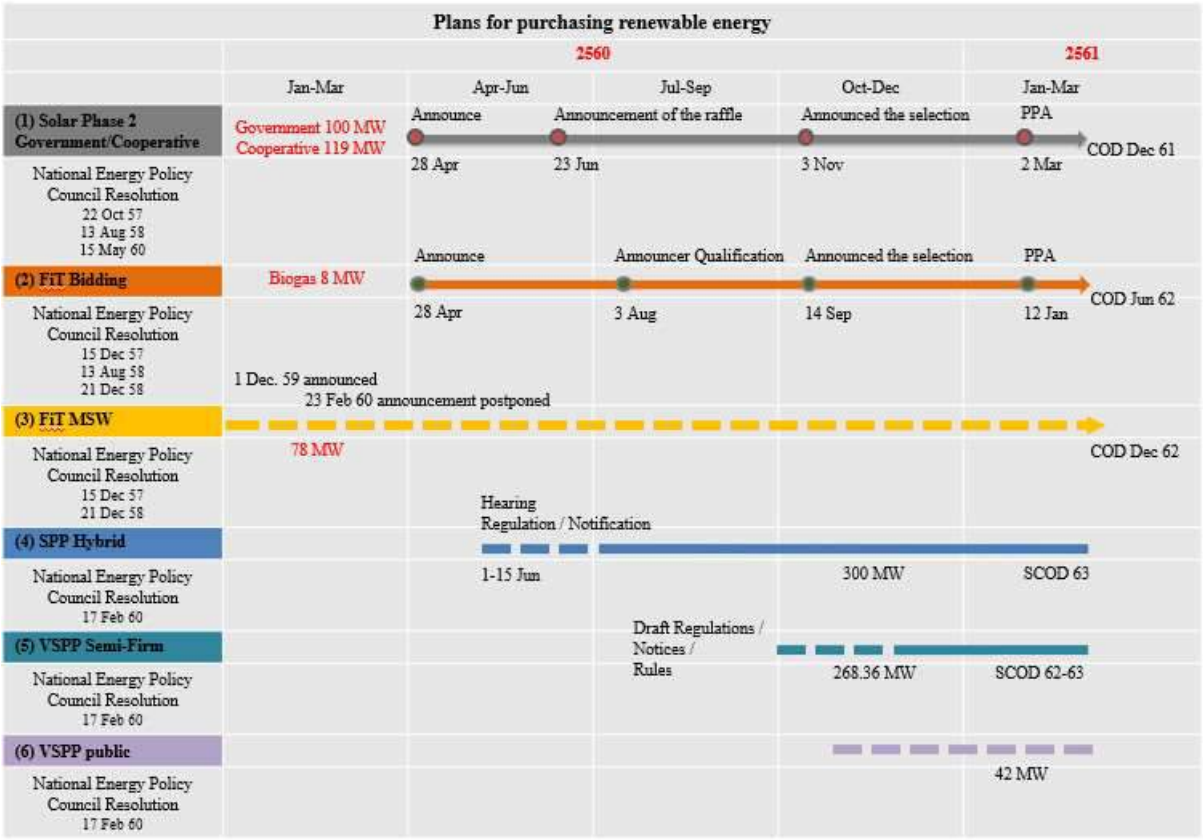


Figure 3-7 Revised Schedule for Power Development in Renewable Energy Sector

Source : Energy Regulatory Committee

As mentioned, appropriate waste management is one of the most urgent issues in Thailand and therefore the government of Thailand tackle with it as one of the most important challenges. The government of Thailand comes to recognize obstructions, such as insufficient legisrative system, enforcement of laws & regulation, ability of local authorieis, lack of source of finance and etc., in the appropriate waste management through their activities in the past. Actions taken by the Government in the past 3-4 years were to settle such issues one by one and relevant parties recognize rapid progressed for realization of appropriate waste management by clustering with centralized waste processing facilities

4. . Feasibility of the Targest Project

The Study Team studied the feasibility, including applicability to JCM, for the targeted projects, i.e. WtE project to be developed at waste management centers in large clusters in the province and biogas collection & utilization facilities at waste management center in middle size cluster and other areas administrated by local authorities in the province.

4-1 Outline of the Targeted Projects

（1） Waste to Energy

1） Outline

Outline of the Waste to Energy project targeted in the Study is as follows;

Owner	:	Chiang Mai Waste 2 Power Co., Ltd.
Project Site	:	Bantan 7, Hord District, Chiang Mai
GPS	:	Latitude N: 18.037563　Longtitude E:98.708333
Location	:	
Remarks	:	Municipal Solid Waste or RDF based WtE plant with power generation capacity of 10MW

2） Project Owner

Project Owner for the project is Chiang Mai Waste 2 PowerCo., Ltd. (hereinafter referred as “CMW2P”), of which details are as follows;

Company Name	:	Chiang Mai Waste 2 Power Co., Ltd.
Head Office	:	Bangkok, Thailand
Registered Capital	:	THB20 million (approx.. 70 million Japanese Yen)
Establishment	:	2015
Shareholders	:	Ferrum Energy Co., Ltd.　100%

CMW2P is a compmay established by Ferrum Energy Co., Ltd. as its 100% owned special purpose company for the WtE project in Hord. Ferrumu Energy Co., Ltd. is one of group companies belongs to Ferrum Co., Ltd., is a public company engage in sales of communication related appliances. CMW2P has agreed with BANTAN Group, is an owner of landfill in Hord district as for procurement of waste, including landfilled & accumulated waste in existing landfill. Ferrum Co., Ltd., CMW2P’s mother company’s profile is as per shown below.

Company’s Name	:	Ferrum Public Company Limited
Head Office	:	M-LINK BUILDING, 73 SOI SUKHUMVIT 62, SUKHUMVIT

		ROAD, BANG JAK, PHRA KHANONG, Bangkok10260
Website	:	http://www.ferrum.co.th/index.html
Establishment	:	1998
Business Line	:	Mobile Phone related business & Energy
Registered Capital	:	THB2,006,000,000.- (approx.. 6.62 billion Japanese Yen)
No of Employees	:	-
Annual Turnover	:	THB1,164,140,000.-(approx.. 3.84billion Japanese Yen)
Affiliates	:	Ferrum Energy Co., Ltd. Ferrum Asia Energy Co., Ltd. Chiang Mai Waste to Power 2 Co., Ltd. and Others

(2) Biogas Collection & Utilization

As for Biogas collection & utilization, The Study Team had conducted following activities with purpose of employment of high efficient biogas collection & utilization technology belong to Japan Price Management from the city of Kitakyushu.

- Introduction of company, technology and products at seminar organized in Chiang Mai
- Site survey at potential project sites where local authorities expressed their interest in introduction of biogas project in their area.
- Questionnaire survey
- Follow up works for questionnaire survey above
- Waste sampling & analysis for the selected site(s)

- 1) Introduction of company, technology and products at seminar organized in Chiang Mai

Dr. Yoshi, President from Price Management Japan participated in the 2nd Study in Chiang Mai, including 1st workshop in Chiang Mai held on August 23, 2017 and introduced themselves, their technology and products at the workshop, of which details are as follows;

Date	Activities
Aug 22	Introduction of company, technology and products to Chiang Mai provincial office and Chiang Mai University.
Aug. 23	Introduction of company, technology and products to local authorities in the province (160 local authorities) and answered to questions raised by the participants to the workshop
Aug 24-25	Visited Intakin municipality, Muang Gai municipality, who expressed keen interest in introduction of biogas collection & utilization unit in their area.


2nd Official Meeting (Left) and 1st Workshop in Chiang Mai (Right)

The Study Team visited Intakin municipality on August 24th and Muang Gai municipality on August 25th to study current situation as for waste management and exchange ideas as for introduction of biogas collection & utilization unit. Current Situation of waste management in both municipalities are as per description in 4-3 3).

2) Interesting parties in the province

The Study Team prepared, distributed & collected questionnaire to interesting parties, including 4 local authorities expressed their interest from the beginning, in the province. Questionnaire was prepared by the Study Team with referece to Manual for Development Biogas Project (Revision) published by the Ministry of Environment, Japan and finalized by parties involved in the project, i.e. Chiang Mai Provincial Office and Chiang Mai University, then distributed to interesting parties selected by Chiang Mai Provincial Office. Summary of screening mentioned above is shown in the Table 4-1.

Table 4-1 Summary of the Interest in development of Biogas related facility in the area

	Local Authority	District	Status
1	Mae Jo municipality	Sansai	Interest in development of Biogas project, but need to secure finance
2	Donkaew Municipality	Sansai	Municipality is trying to develop household biogas digester but not yer successed. Municipality would like to have support from the Study Team to modiy household model or develop centralized biogas system in the area.
3	Muang Gai Municipality	Chiang Dao	Interest in development of biogas project (oral stataement)
4	Intakhin Municipality	Mae Taeng	Ditto

5	Wiang Fang	Fang	Ditto
6	Doi Saket	Doi Saket	Put priority in WtE, but if found it difficult for them to develop WtE, then consider to develop biogas project instead.
7	Ku Chang SAO		Concerning environment in the area as tourism is important industry in Ku Chang area, where a lots of elephant zoos existing. One of the elephant farms in the area is under consideration on introduction of biogas digester for decomposting elephant'dung generated at their farm. Local Authority consider to process organic waste generated in the area together with elephants' dung at the facility

4-2 Support for Integrated Waste Management in Chiang Province by city of Kitakyushu as a part of JCM project development

Integrated Waste Management in Chiang Mai is a core project the provincial office in Chiang Mai Eco-Town project and as requested by Chiang Mai provincial office, city of Kitakyushu has been supporting it since May 2017.

（1）Policy & Direction

After having discussion among the parties involved in, the Study Team has proposed policy & direction of the project implementation as below and approved by the Governnorof the province.

- City of Kitakyushu is entrusted by the Ministry of Environment, Japan to conduct the JCM project development study in Chiang Mai province and city of Kitakyushu will support Chiang Mai provincial office's integrated waste management as a part of the study mentioned above.
- City of Kitakyushu will propose infrastructure development for integrated waste management to be developed under JCM, if possible.
- Procedure to realize integrated waste management in the province is as per shown in Figure 4-1, or Understanding of current situation→confirmation on Target→Analysis on Gaps→Consideration on countermeasures→set up actions plan. Chiang Mai provincial office will take full responsibility for implementation, while city of Kitakyushu will support for gap analysis, set up action plans including countermeasures for each issues in the area. Countermeasures include technologies for appropriate waste processing, such as WtE and biogas
- Progress of the project will be reported in Official Meetings to be periodically organized during project implementation.

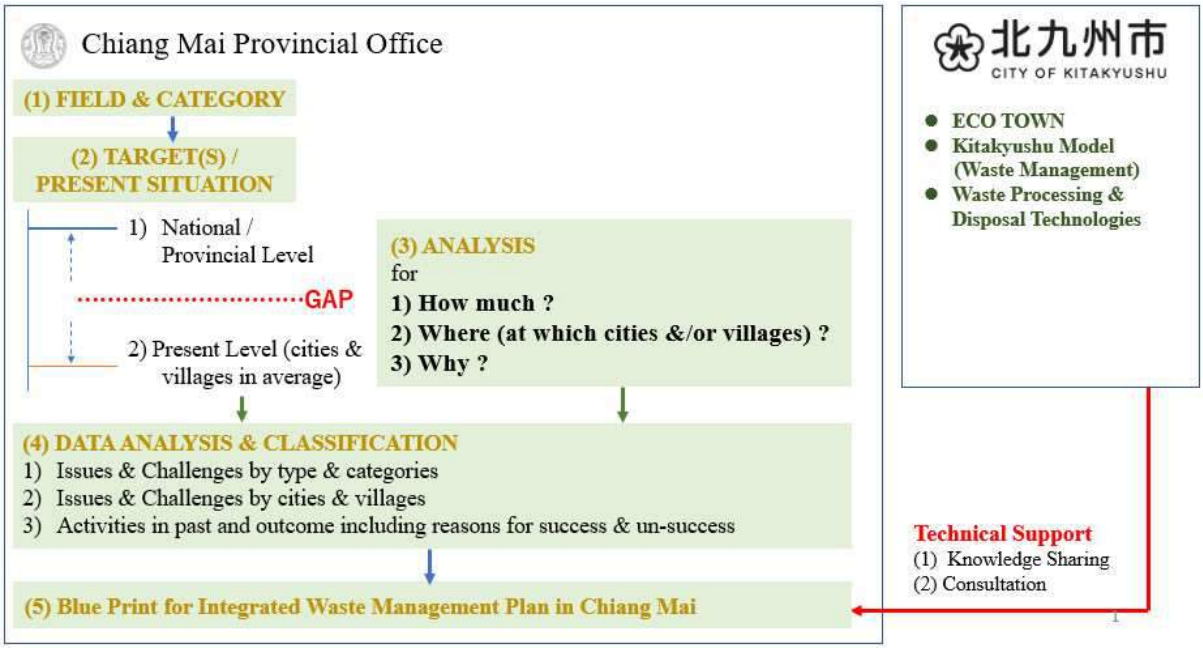


Figure 4-1 Procedure to realize integrated waste management in Chiang Mai province

（2）Current Situation of Waste Management by Local Authorities in the province

1）Current Situation & Challenges

Pollution Control Department published data & information as for municipal solid waste in Chiang Mai as per shown in Figure 3-4, however the Study Team needed to update data & information as the published data is that of 2015, then the provincial office sent its questionnaire to local authorities to update their current situation, then conducted interview with selected local authorities. The Study Team found that most of all local authorite, except for a few, did not have any exact data & information as for municipal solid waste in the area. Challenges, including lack of data & information, in waste management in the province are as per Figure 4-2.

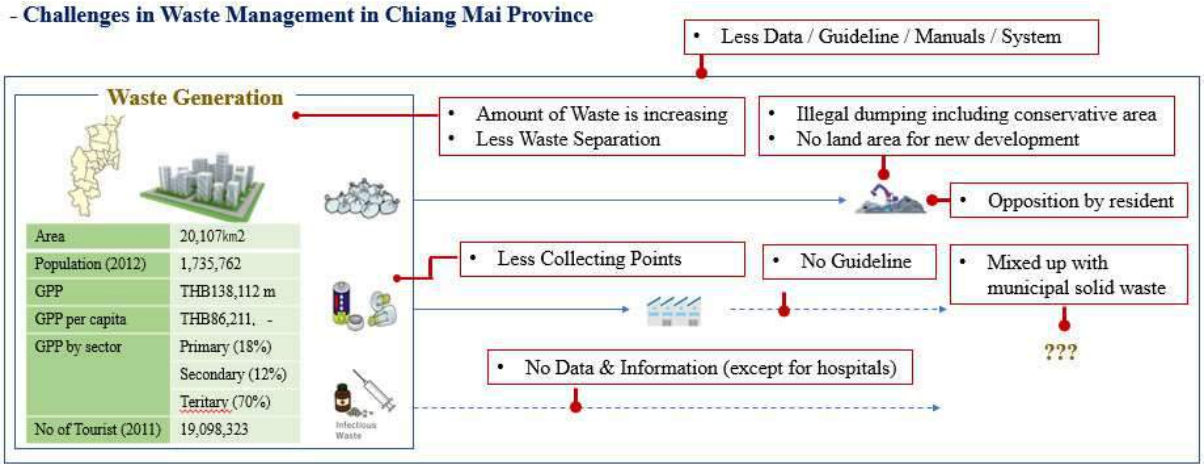


Figure 4-2 Challenges in Waste Management in Chiang Mai province

Clustering for wide area processing is one of the most important factors for development of waste management center. And therefore the government of Thailand insist local authorities to join to any clusters in the area. However in spite of instruction given by the government, a lots of local authorities in the province have not yet made clear as for their decision. As a result, clusters with local authorities commitment are as per figure shown in the left, and far from their plan shown in Figure 3-5. There is a waste management center in Wiang Fang, northern part of Chiang Mai regarded as center for north cluster. The waste management center in Wiang Fang receive municipal solid waste generated in 3 districts in north, i.e. Wiang Fang District, Prakan District and Mae Ai District.

In the central part of the province, there is a waste management center, owned by Chiang Mai Provincial Adminisitrative Organization, located in Doi Saket District, where municipal solid waste generated in 3 districts is transported, processed and diposed, and in the southern part of the province, a private company own and operate sanitary landfill and municipal solid waste generated in local authorities in the central and southern part of the province is transported & disposed at the center based on annual contract, but on agreement under clustering plan. 6 districts, including Chiang Dao 郡、Phrao 郡、Mae Chaem decleared that they will not belong to any clusters in the province.

Details of 3 waste management centers mentioned above is as below.

Waste Management Center in Northen area of the province

Name	:	Wiang Fang Waste Management Center
Location	:	617 Moo 3 T. Wiang Fang A. Fang, Chiang Mai Province
Owner		Wiang Fang municipality
Land Area	:	150 rai (24ha)
Facilities	:	(i) Engineered Landfill (ii) Sorting Facilities (iii) Composting Facilities
Amount of Waste receiving	:	60-80 tons / day
Local Authorities transport and dispose waste	:	Local Authorities in Wiang FangDistrict, Prakan District, Mae Ai District

Others	:	The center refuses requests from local authorities located in other districts to receive municipal solid waste generated in their areas, because of its capacity. The center will receive those once the center expand its capacity to do so.

Landfill located in waste management center in Wiang Fang(L) & plastic waste (R)

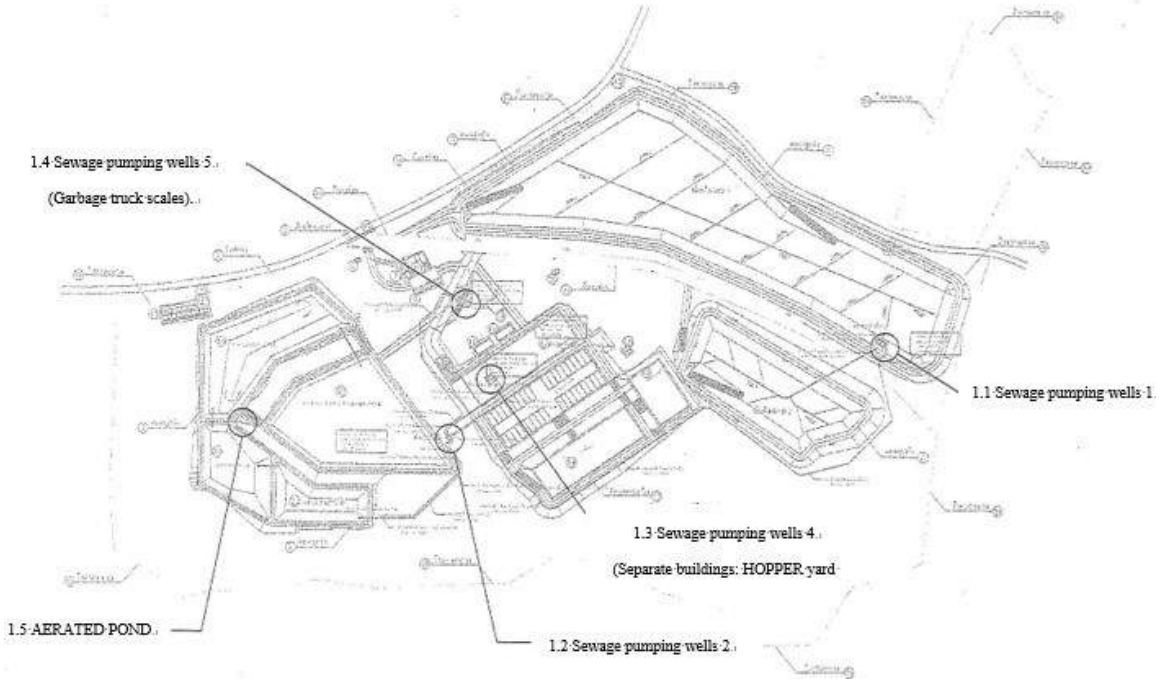
Second Sorting of Plastic Waste(L) & Compositng Line (Final Process)（R）

Waste Management Center in Central Part of the Province

Name	:	Waste Management Center in Doi Saket
Location	:	Ban Pa Tueng Noi Moo 1 T. Papong A. Doi Sa Ket, Chiang Mai Province
Owner	:	Chiang Mai Provincial Administrative Organization (PAO)
Land Area	:	160rai (25.6ha)
Facility	:	(i) Sanitary Landfill (ii) Sorting Line (150tons/line x 2Line) (iii) Composting Facility (broken)
Amount of municipal solid wate receiving	:	300 tons/day (planned but receiving 30 tons/day as trial)
Local authorities	:	Local Authorities in Doi Saket district & other district in the central part of

transport MSW		the province
Others	:	

Landfill at Waste Management Center in Doi Saket(L)& Sorting Line (R)



Area map of the waste management center at Doi Saket

Waste Management Center in the Sourthern Part of the province

Name	:	Saitary Landfill at HORD
Location	:	T. Ban Tan A. Hot, Chiang Mai Province
Owner	:	Tha Chiang Thong Company Limited
Land Area	:	320Ha
Facilities	:	Sanitary Landfill LFG collection & Utilization facilities
Amount of MSW	:	Approx. 600 tons/day

receiving		
Covered areas	:	Chiang Mai municipality & local authorities in central & southern part of the province
Others	:	

Landfill at Hord(L) and LFG collection facilities (R)

To secure stable procurement of municipal solid waste covering project period is one of the crutial factors, when any parties consider to develop waste management center. Thus clustering for wide area processing is most impoertant not only for realization of the targeted project, i.e. WtE project in the southern part of the province, but also other projects in Thailand, Therefore the study team put highest priority in clustering in the study.

2） Target in waste management set up by the local authorities in the province

The study team found that most of local authorities set up their targets in waste management asper those given by the central government, while some set up their own higher target than those given by the central government. With limited resources, most of local authorities put priority in 3R promotion

（3） Revised Schedule for integrated waste management in Chiang Mai province

Findings from the study as for current situation of waste management in the province is as per stated above, and could not obtain enough support for updating data & information from local authorities in the province, the study team have revised schedule for integrate waste management as per Figure 4-3 below.

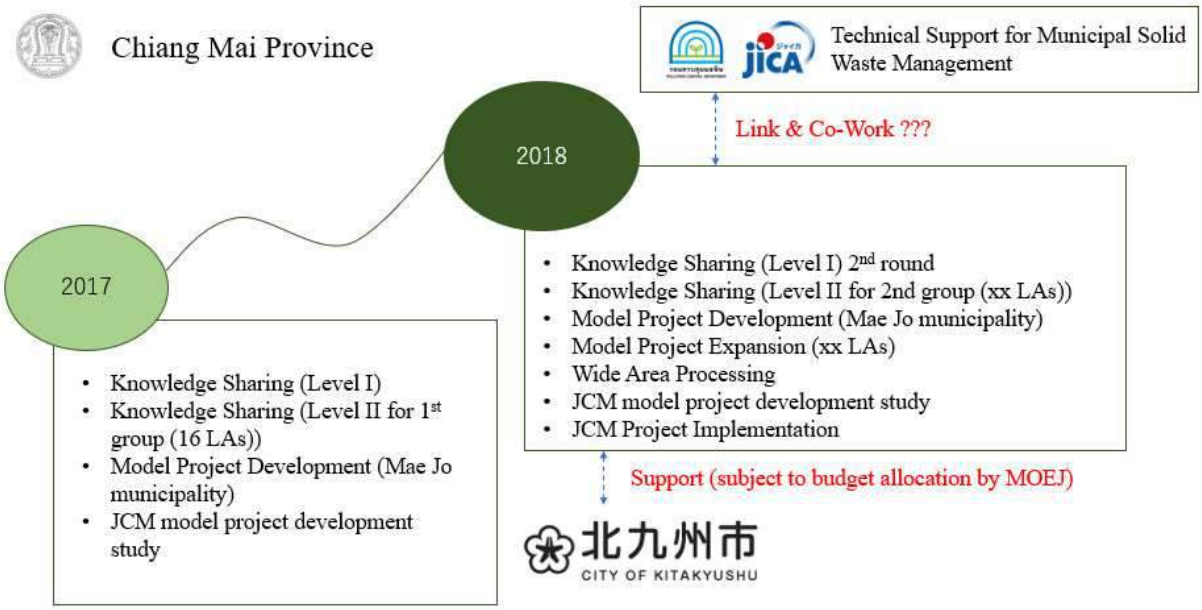


Figure 4-3 Revised schedule for integrated waste management in Chiang Mai province

Further capacity buildings for understanding waste management in both their own area and wide area seems be required for making consensus on wide are processing, the study team organized 1st workshop in Chiang Mai inviting all local authorities in the province and 2nd workshop inviting only interesting local authorities to upgrade their waste management. The study team introduced waste management in Japan and that of Kitakyushu to share knowledge and experience and had face-face discussion with some local authorities.

4-3 Knowledge Sharing & Capacity Building

(1) 1st Workshop in Chiang Mai

As a part of knowledge sharing & capacity building under the project, the study team organized 1st workshop in Chiang Mai, of which details are as follows;

1) General Information

Title : 1st workshop for integrated waste management in Chiang Mai under city to city cooperation between Chiang Mai provincial office & city of Kitakyushu

Venue : Chiang Mai Grandview Hotel

Time & Date : 09:00-17:00 August 23, 2017

Organizer : Chiang Mai Provincial Office & City of Kitakyushu

Co-Organizer : Pollution Control Dept., Ministry of Natural Resources & Environment

Facilitator : Chiang Mai University & EX Research Institute

Participants :

	Parties	Person
Local Authorities in the province	160	209
Hospital	15	21

Hotel	6	14
Chiang Mai provincial Office	2	4
Central Government	1	2
Chiang Mai University	4	22
Department Store	2	3
Waste Processors & Landfill Operators	3	5
Others	10	18
Total	**203**	**298**

2) Program

Time	Program
09:00-09:30	Opening - Opening by Mr. Chanon Khamthong, Director of Natural Resources & Environment Bureau - Welcome Address by Mr. Pawin Chamniprasart, the Governor - Welcome Address by Mr. Junichi Sono, Director, Kitakyushu
09:30-10:30	Keynote Address by Suwan Nanthasarut, Deputy Director General, Pollution Control Dept. Ministry of Natural Resources & Environment
10:30-11:00	Lecture I Integrated Waste Management in Chiang Mai province by Natural Resources & Environment Bureau - Current Situation & challenges - Environmental & health impact by inappropriate waste processing & disposal - Outline of the project under city – city cooperation between Chiang Mai provincial office & city of Kitakyushu
11:00-11:30	Lecture II Introduction of Kitakyushu Waste Management Model By city of Kitakyushu
11:30-12:00	Lecture III Technologies applicable for Integrated Waste Management in the province - Waste to Energy (WtE) by Nippon Steel & Sumikin Engineering - Biogas collection & utilization by Japan Price Management
12:00-12:25	Lecture IV Possible Financial Support applicable for the project...JCM subsidy By EX Research Institute
13:30-14:30	Questions & Answers and Free Discussion By Chiang Mai University
12:25-12.30	Conclusion & Closing By Mr. Chanon Khamthong, Director of Natural Resources & Environment Bureau

14:30-17:00	Individual Discussion (1) WtE by Nippon Steel & Sumikin Engineering Co., Ltd. (2) Biogas by Price Management of Japan Co., Ltd. (3) JCM by EX Research Institute Limited. (4) Integrated Waste Management by city of Kitakyushu

3) Presentations

Keynote	Municipal Solid Waste Management in Thailand Suwan Nanthasarut, Deputy Director General PCD, MNRE
	Presentation: Appendix 1-1
Lecture I	Integrated Waste Management in Chiang Mai province by Natural Resources & Environment Bureau
	Presentation: Appendix 1-2
Lecture II	Introduction of Kitakyushu Waste Management Model By city of Kitakyushu
	Presentation: Appendix 1-3
Lecture III-I	Technologies applicable for Integrated Waste Management in the province - Waste to Energy (WtE) by Nippon Steel & Sumikin Engineering
	Presentation: Appendix 1-4
Lecture III-II	Technologies applicable for Integrated Waste Management in the province - Biogas collection & utilization by Japan Price Management
	Presentation: Appendix 1-5
Lecture IV	Possible Financial Support applicable for the project...JCM subsidy By EX Research Institute
	Presentation: Appendix 1-6

4) Questions & Answers and Free Discussion

Summary of comments given by participants are as follows;

- Expecting further support from provincial office
- Technical & Financial Information as for appropriate waste processing & disposal is not enough
- There are a lot of problems in the area (open dumps to be shut down, alternative for final disposal at open dumps, and cost & expenses for alternative disposal)
- Enforcement of laws & regulation is required
- Lack of resources (both human and finance) at local authority level, thus let local authority be in charge only for collection, while upper level shall responsible for processing & disposal.
- The same standard shall be applied to all local authorities (no need to pay attention to situation in each local authority)

- Material categorized as non-degradable waste shall be reduced or stopped using
- Concern on health impact on using PE container as food container
- Complain against smoke & odder from incinerator nearby

Delivering Welcome Address by the Governor(L) & Photo Session (R)

Delivering Keynote addressed by Mr. Suwan, DDG (L) & Questions & Answer (R)

(2) 2nd Workshop in Chiang Mai

1) General Information

Title : 1st workshop for integrated waste management in Chiang Mai under city to city cooperation between Chiang Mai provincial office & city of Kitakyushu

Venue : Chiang Mai Grandview Hotel

Time & Date : 09:00-17:00 August 23, 2017

Organizer : Chiang Mai Provincial Office & City of Kitakyushu

Co-Organizer : Pollution Control Dept., Ministry of Natural Resources & Environment

Facilitator : Chiang Mai University & EX Research Institute

Participants :

	Party	Person
Local Authority	16	30
Provincial Office	3	6
Central Government	1	3
JIVA	1	1

Chiang Mai University	4	22
Others	10	18
Total	**35**	**80**

2) Program

Time	Program
09:30-09:55	Opening Welcome Address I by Vice Governor Welcome Address II by Mr. Junichi Sono, Director, City of Kitakyushu
09:55-10:20	Lecture I Progress Report of the Project by Natural Resources & Environment Bureau
10:20-10:40	Lecture II Waste Management by city of Kitakyushu By city of Kitakyushu
10:40-11:00	Lecture III Introduction of Biogas Projects By Chiang Mai University
11:20-12:20	Introduction of waste management by local authorities in the province I By Representatives from Local Authorities
13:00-14:20	Introduction of waste management by local authorities in the province I By Representatives from Local Authorities
14:20-15:30	Free Discussion To realize integrated waste management in the province Moderator: Chiang Mai University + EX Research Institute
15:30	Conclusion & Closing

3) Presentations

Lecture I	Progress Report of the Project by Natural Resources & Environment Bureau
	Presentation: Appendix 2-1
Lecture II	Waste Management by city of Kitakyushu By city of Kitakyushu
	Presentation: Appendix 2-2
Lecture III	Introduction of Biogas Projects By Chiang Mai University
	Presentation: Appendix 2-3
Free Discussion	To realize integrated waste management in the province By EX Research Institute
	Presentation: Appendix 2-4

(3) Individual Discussion with Local Authorities in the Province

The study team visited 10 local authorities in the province during conducting 4 times of study in Chiang Mai province and explained outline of the project as well as exchange ideas as for appropriate waste management in the area. Among 10 local authorities visited, introduce the cases of Muang Gai municipality and Mae Jo municipality as follows;

1) Muang Gai municipality

At Muang Gai municipality, The Mayor, chief clerk of the municipality, members of city council and management from environment bureau welcomed the study team at their office. The Mayor delivered welcome address followed by introduction of waste management in Muang Gai city and discussion. Current situation of waste management explained by the municipality is shown in Figure 4-4. As shown in the figure, municipality engages in awareness raising among the citizen in the area and promotes 3R activities, and as a result municipality succeeded to reduce amount of waste generated in the area in some extent. Collection & transportation service is provided by the municipality, while have problems in final disposal.

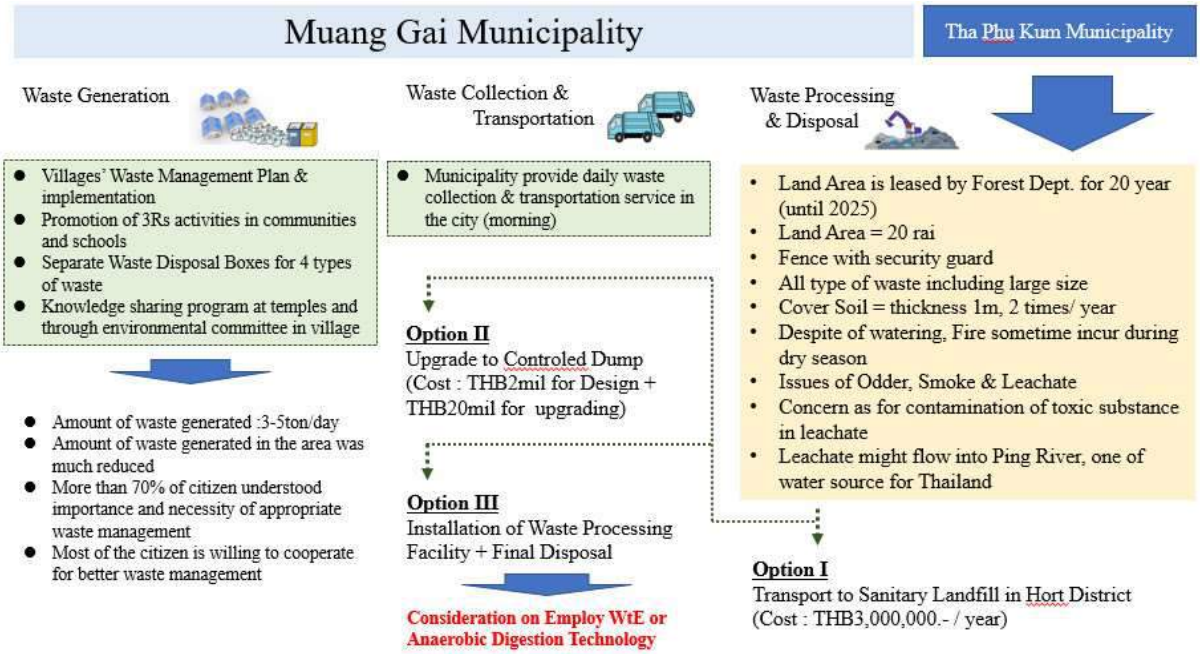


Figure 4-4 Waste management in Muang Gai municipality

The Municipality continue to throw waste away at the area, where the municipality rent from Forest Department under the 20 years lease agreement, Despite of 20 years lease agreement and 8 years left until the end of the agreement, municipality concerns that the Forest Department might revoke the agreement, as the area is located inside the forest conservation area, and the government of Thailand announced not to throw waste away into open dump, especially inside conservation areas. In addition to the agreement with the land owner, it is reported that there are odors, fires caused of LFG at the land. Some concern that Leachate

from the land contaminate with underground water and caused water pollution in the area. Muang Gai municipality is in the northern part & mountain area of the province and Ping river flow nearby the land is one of water sources for Thailand.

Muang Gai municipality, with recognition mentioned above, considers (I) to suspend using existing open dump and transport municipal solid waste generated in the area to sanitary landfills in the province, (II) to upgrade existing open dump to controlled dump and (III) to introduce waste processing facilities to reduce amount of waste to be sent to final disposal site. According to the municipality, Option I will cost them THB3 million per year, For the Option II, the municipality is not sure whether the municipality to develop controlled dump at the land area where they are using as open dump or not, especially after the end of the lease agreement in 2025. And therefore, the municipality seriously considers finding out the way to move ahead for the Option III.

The municipality explained that, with background explained, they expressed their keen interest in the study conducted by both Chiang Mai provincial office and city of Kitakyushu. The municipality said although they had keen interest in development of biogas facility in the area, the municipality still did not set up any plan, as they did not have any experts, did not share information & exchange ideas with other local authorities in the area.

The study team suggested that initial investment as well as operation cost / unit might gradually reduce depending on the capacity of the facility, means that with capacity of 2 tons cost 30-40% more than that of 10 tons per unit basis (Dr. Yoshi). Thus, it might be better for the municipality to discuss with local authorities nearby and invite them to participate in the project.

In reply to the suggestion placed by the study team, the municipality replied that “the municipality used to discuss as for development of WtE plant in the area but failed. Citizen in the municipality might not welcome waste generated in other areas to be transported in the municipality, while the municipality is willing to pay for processing & disposal fee to the others, if necessary. The municipality took note of advice on financing, i.e. better to find private investor than waiting for national budget to be allocated to the project by the study team.

A meeting with Muang Gai municipality (L) & Site Tour (R)

2) Mae Jo municipality

Mae Jo city is one of satellite city of Chiang Mai city, located 10km north from Chiang Mai city. Although population of the city reported in census is 24,337, there might be more than 50,000 people living in the city, as there are large numbers of student studying at Mae Jo university and workers working for BETAGRO, one of the largest food processer's factory in the area.

Mea Jo municipality has engaged in environmental issues, including waste management in the area, and there are numbers of community with high level of awareness for waste issues, including Phepaha community, which won the waste management contest in Thailand. Chiang Mai provincial office appointed the municipality as model city for other local authorities in the area, and the municipality accepted offer made by the provincial office.

In reply to the request placed by the study team, the municipality disclosed data & information as for waste management in the area as per shown in Figure 4-5. The study team referred situation of waste management in Mae Jo city as material for discussion among the participants at the 2nd workshop in Chiang Mai.

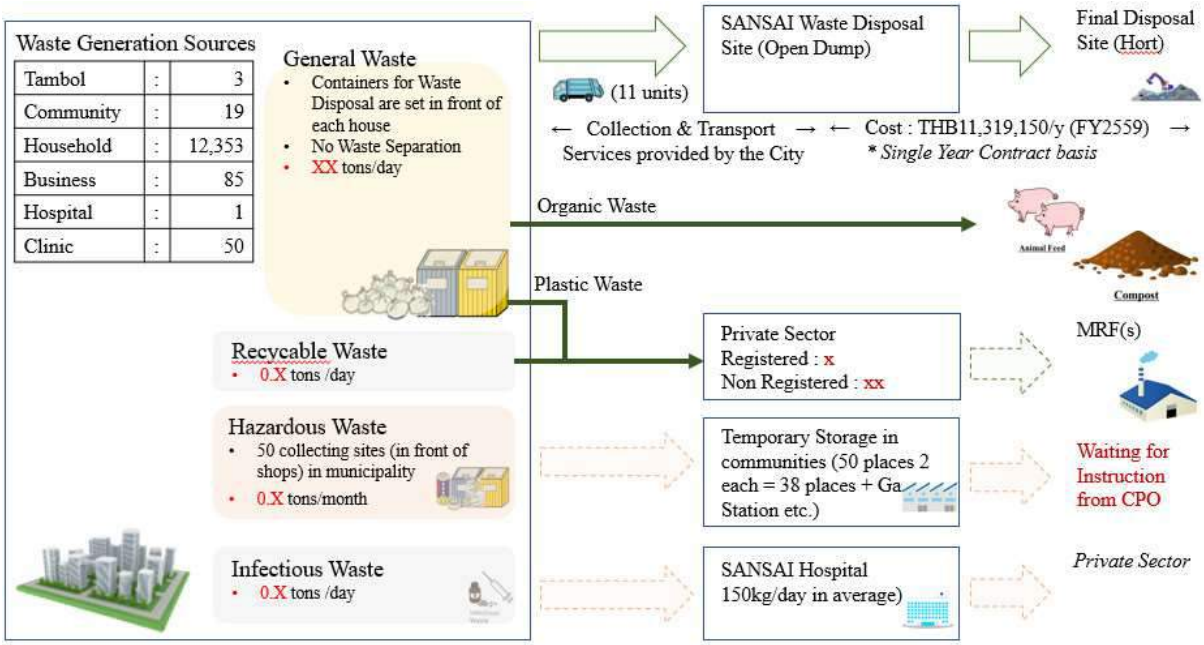


Figure 4-5 Current Situation of Waste Management in Mae jo municipality

The municipality promotes 3R activities and successfully reduced amount of waste generated in the city. In addition, waste generated in the municipality is transported to temporary storage for waste located at Sansai district, transshipped then transported to sanitary landfill located in the southern part of the province for appropriate final disposal. However, the municipality recognizes their issues that cost & expenses for waste transportation & disposal is remain high, less progress in waste separation in the areas where people in and out, no system for hazardous waste management after collection by the municipality, and flow of infectious waste in the area, except for those generated at Sansai hospital, is not clear. The municipality assigned Sansai hospital as collection center of infectious waste for appropriate processing, however Sansai hospital refused to receive any of such infectious waste to be transported to the hospital for temporary storage and further processing, because of limitation of resources, i.e. human resources, and area for storage.

Temporary storage for waste located at SANSAI district

The study team visited Phepaha community and other, which won the contest in waste management in the

municipality. As the municipality recognizes communities successfully penetrate 3R activities are in the old words, means the area where people live for long time, with fixed resident

Waste related activities in Mae Jo city

A professor from Mae Jo university, who is the leader of the community in promotion of 3R activities commented that they proud what they did as of today and have strong confidence in waste management in community. As far as the municipality has contracted sanitary landfill for final disposal, not necessary to develop any facilities for waste management in the area.

4-4 Official Meeting between Chiang Mai provincial office and city of Kitakyushu

Chiang Mai provincial office and city of Kitakyushu held official Meetings when the study team visit Chiang Mai based on the agreement at the 1st official meeting. Both parties organized 4 official meetings during the study starting from 1st official meeting held on June 2017 to 4th held during final study in Chiang Mai before the end of the Study. Summary of the official meetings is as below;

(1) 1st Official Meeting

Time & Date	:	09:00- June 30, 2017
Venue	:	Meeting Room at Chiang Mai provincial office
Participants	:	1. Chiang Mai Provincial Office (Mr. Pawin Chamniprasart the Governor and others (3)) 2. City of Kitakyushu (Mr. Junichi Sono and others (2)) 3. Nippon Steel & Sumikin Engineering Co., Ltd. (2) 4. Chiang Mai University(3) 5. EX Research Institute (Mr. Ohno, Chairman and other (1)
Conclusion	:	1. Both parties agreed to implement the study as per proposal 1) Targeting municipal solid waste, hazardous waste, and infectious waste 2) Studying 3R promotion, appropriate processing & disposal, and efficiency improvement on collection & transportation 3) Studying JCM project development as a method to promote appropriate

waste processing & disposal

4) Organizing workshops as occasions to share information as well as exchanging ideas among stakeholders (2 times in the study)

2. To regard the study as a part of activities in realization of integrated waste management in the province and sharing information with provincial waste management committee

3. Output from the study shall be added into action plan to be implemented. Putting high priority in implementation. (Chiang Mai provincial office might suspend the study for the case no output forms the study)

4. To have close communication among members in the study team

Distributions : 1. Program

2. Presentation & proposal for the Study

3. Kitakyushu Model (Waste Management)

1st Official Meeting (Center: The Governor)

(2) 2nd Official Meeting

Time & Date : 14:30- August 22, 2017

Venue : Meeting Room at Chiang Mai University

Participants : 1. Chiang Mai provincial office (Mr. Chanon Kamthong Natural Resources & Environment Bureau and other (1)

2. City of Kitakyushu
(Mr. Hiroshi Yasutake and other (1)

3. Nippon Steel & Sumikin Engineering Co., Ltd (2)

4. Price Management of Japan (Dr. Yoshi)

5. Chiang Mai University (8)

5. EX Research Institute (Mr. Takagi)

Conclusion : 1. Progress Report

2. Agreement on changing policy & direction of the study
(to enhance ability of local authorities in planning & enforcement)

Distributions : 1. Program
2. Progress Report (Presentation)

(3) 3rd Official Meeting

Time & Date : 09:00- December 13, 2017

Venue : Meeting Room at Chiang Mai provincial office

Participants : 1. Chiang Mai provincial office
(Vice Governor and others (6)
2. City of Kitakyushu (Mr. Sono & others (2))
3. Nippon Steel & Sumikin Engineering Co., Ltd. (1)
4. Chiang Mai University (3)
5. EX Research Institute (1)

Conclusion : 1. Progress Report
2. Discussion on procedure including the study phase II
(Chiang Mai provincial office officially requested city of Kitakyushu to continue the study focusing on capacity building of local authorities in terms of (1) planning in waste management, (2) enforcement and (3) public relation with citizen)

Distributions : 1. Program
2. Progress Report (Presentation (1)
3. Reference (Presentation(2) JCM & Biogas Projects)

3rd Official Meeting

(4) 4th Official Meeting (Final Meeting in the study in 2017)

Time & Date : 09:00- February 12, 2018

Venue : Meeting Room at Chiang Mai Provincial Office

Participants : 1. Chiang Mai provincial office (the Governor and others (6)

2. City of Kitakyushu (Mr. Sono & other (1)
3. Nippon Steel & Sumikin Engineering Co., Ltd. (2)
4. Chiang Mai University (2)
5. EX Research Institute (1)

Conclusion : 1. Final report of the study
2. Discussion on the study phase II in 2018
- The Provincial office appreciate continued support provided by city of Kitakyushu and hope to extend to next Japanese fiscal year.
- The provincial office request city of Kitakyushu to upgrade waste management in the province by supporting not only for local authorities but also 3R promotion at household level (expecting better output by combination of two aspect, i.e. Local authority level & household level)

Distributions : 1. Program
2. Final Report for the Study in 2017
3. Introduction of Kitakyushu's activities in planning & public relation with citizen in waste management sector

4-3 Feasibility Study for the targeted projects

（1）Waste to Energy Project

1) Infrastructure

Water Supply

Potential owner of the targeted project plan to develop the project with water cooling system. 50m3 per hour of water, as loss from vapor and make up for boiler, will be required for facility operation with water cooling system. Thus 396 Thousand cubic meters of water per year, which is from a n equation of 50m3 / hour x 7,920 hours / year (24 hours / day x operation days of 330 / year) will be required There are 3 deep wells, 2 reservoirs with capacity of 100 thousand m3 each and the other with capacity of 80 thousand existing in the area and those water sources can be sources for water supply for the project. Locations of reservoirs are shown in the map below.

In project development plan, assumed source of supply will be wells, which the project owner will expand for getting more water, and reservoirs with capacity of 500 thousand cubic meter, which will be newly developed by connecting two existing reservoirs with capacity of 100 thousand cubic meter, while leave the reservoir with capacity of 80 thousand as reserve. Collect rain water & surface water to be kept in the reservoirs. As the water to be utilized by the project will not have any conflict in water right. Water from reservoirs will be utilized after water treatment. Plan for development plan for 500 thousand cubic meters of reservoir is as per below.

Figure 4-6 Plan for Water Supply for the targeted project

Connectivity with National Grid & Transmission Line

Hord sub-station of Provincial Electricity Authority (PEA), is about 25km far from the project site and the nearest. Distance between the project site and the sub-station is 30km on road distance, thus if transmission lines will be laid along roads, 30km of transmission cabling works will be required, however actual cabling works might be about 25km, as part of the land area between is owned by BANTAN group and expect to have short cut cabling in their land area. Since the cost & expenses for cabling works is 2 million Thai Baht / km in average, it will cost 50-60 million Thai baht. Transmission line will be transferred to PEA, one the project owner complete cabling & connecting works, thus no cost & expenses will incur for management & maintenance. Location map of the project site & substation is as follows;

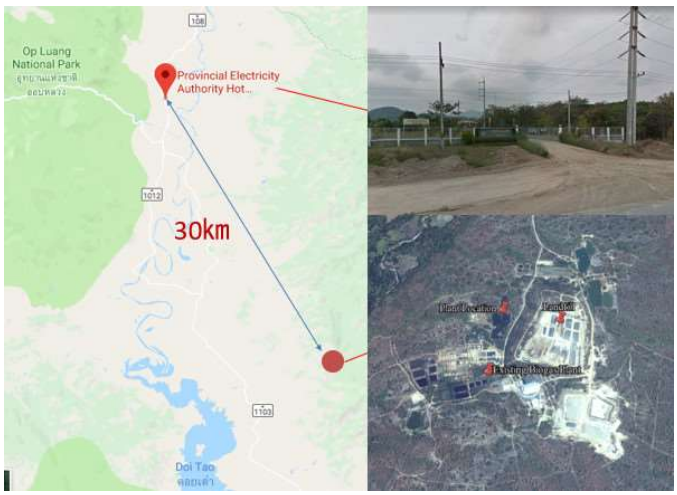


Figure 4-7 Location Map of the Project site & Sub-Station(L) & Sub Station (R)

Feeder utilization at Hord Sub Station is as per shown in Figure 4-8. There is free space in Feeder No. 11 and enable to connect transmission line to the feeder at present

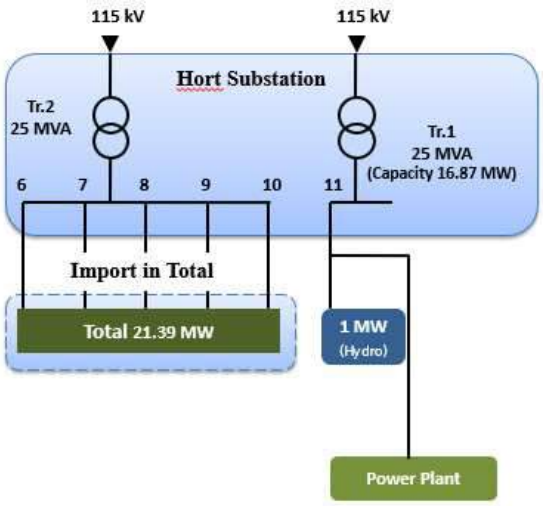


Figure 4-8　Feeder utilization at Hord Sub Station

2) Municipal Solid Waste (MSW)

Quantity of MSW receiving

According to BANTAN group, an owner & operator of the landfill, they are receiving 600 tons / day of municipal solid waste in total generated in the province, including 300 tons / day in Chiang Mai city.

Landfilled & Accumulated old MSW

Quantity

Operation record disclosed by BANTAN group is as per shown in Table 4-2 below.

Table 4-2 Operation Record of Landfill in Hord

Area	Zone	Utilization Period	Q'ty	
			(t/d)	Total
C1	Z1	1997.03.01-2002.06.01 (1,918)	250	421,960
C2	Z3	2002.06.02-2004.10.01 (852)	300	255,600
C3	Z3	2006.04.02-2007.06.01 (350)	425	148,750
C4	Z2	2007.06.02-2008.10.01 (426)	487	207,462
C5	Z4	2008.10.07-2009.11.15 (409)	450	184,050
C6	Z4	2009.11.16-2011.02.17 (458)	500	229,000
C7	Z4	2011.02.18-2011.07.31 (163)	500	81,500
C8	Z2	2011.08.01-2012.05.31 (304)	500	152,000
C9	Z4	2012.06.01-2012.10.31 (152)	500	76,000
C10	Z3	2012.01.01-2013.07.15 (256)	550	140,800
C11	Z6	2013.07.16-2013.12.18 (155)	600	93,000
C12	Z4	2013.12.19-2014.07.31 (224)	600	134,400
C13	Z4	2014.08.01-2014.12.31 (153)	600	91,800
		2015.01.01-	600	
Total				2,216,322

Waste Quality

BANTAN group conducted waste analysis for landfilled & accumulated old MSW in 2016 and disclosed a part of data to the study team. Data & Information disclosed by BANTAN group is as follows;

Sampling Method

Selected a point each in three zones, i.e., Z1、Z3、Z5, drilled the points to 15-meter depth from the ground level to collect primary samples.

Figure 4-9 Zoning & Sampling Points at Landfill in Hord

Items Analyzed

Conducted (1) composition analysis, (2) three components and (3) net calorific value analysis by utilizing secondary sample obtained from mixing & quartering of primary sample obtained at Z1, Z3 and Z5.

Result of Analysis

(Parts of) Result of analysis disclosed by BANTAN is as follows;

Composition analysis

The physical composition of solid waste	Hot Landfill in 2558 (% w/w)			
	Pit Z1 (18 Year)	Pit Z3 (3, 13 Year)	Pit Z5 (2, 6 Year)	Average (8.4 Year)
Waste food, Leaves	0.33	0.29	0.00	0.21
Wood (wooden crate, twigs)	3.31	1.36	1.98	2.22
Paper	2.30	0.39	0.00	0.90
Plastic	**25.15**	**34.55**	**58.46**	**39.39**
Tire	0.34	2.11	2.31	1.59
Fabric	5.11	5.98	2.92	4.67
Leather waste	0.00	0.00	0.00	0.00
Other (sanitary napkin, Diapers	14.89	1.52	0.00	5.47
Include burnable parts.	51.44	46.21	65.67	54.44
Glass	1.01	0.21	0.00	0.41
metal	0.19	0.71	2.06	0.99
Hazardous waste	0.09	0.00	0.00	0.03
Other (Have size <30 mm.)	47.27	52.87	32.27	44.14
Include unburnable parts.	48.55	53.79	34.33	45.56

Calorific Value

4,256kcal/kg (Low Calorific Value / Moisture 0%)

（2） Biogas Utilization

In general, biogas generated at the facility can be utilized in various ways, such as

- Alternative fuel for power generation
- Fuel cell
- Alternative fuel for thermal energy for industrial use
- Alternative fuel for vehicle
- Alternative fuel for cooking

Biogas utilization listed above is, by any means, use as alternative fuel, and can be divided into two groups, i.e. (i) to utilize biogas as alternative gas for various purpose, including with refining process and (ii) to utilize gas as alternative fuel to generate either power or thermal energy. Consideration on both cases in details is as follows;

1） Biogas utilization as alternative LPG/LNG

Biogas can be utilized as alternative fuel for industrial use, automobile, and cooking. As LPG is widely used for industrial use and cooking in Thailand. The study team studied possibility of biogas utilization as alternative of LPG in Thailand

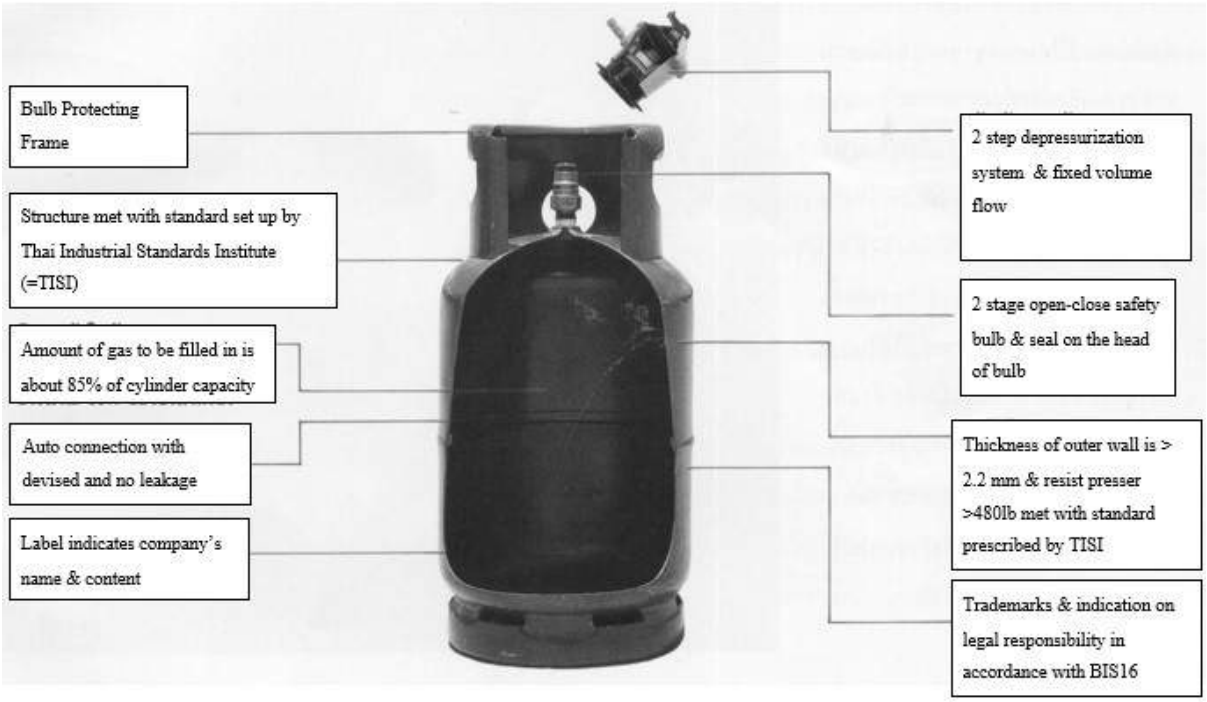
LPG for Industry with small scale and cooking

LPG is commonly used as fuel for cooking at household as well as restaurant in Thailand. As no gas pipeline laid from suppliers to users, LPG is compressed and filled into gas cylinder to be delivered to each user via retail shops in town. Standard specification for gas cylinder prescribed in Thailand is as shown below.

- Standard Specification of LPG in Thailand

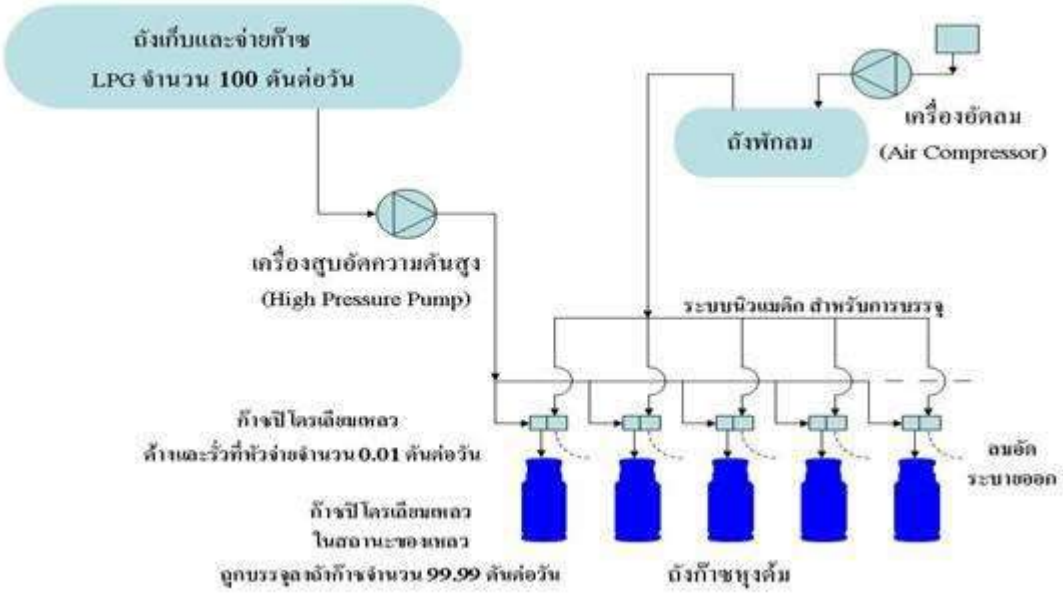
Composition	:	Propane Gas 30%＋Butane Gas 70%
Presser	:	120psi
Octane No.	:	95-108
Characteristic	:	Colorless & odorless
Others	:	Add smell by methacrylic acid methyl ester

- Standard specification for gas cylinder in Thailand



- Gas cylinder filling system

Establishment of gas cylinder filling system will be required for the case potential project owner will engage in filling operation or no such services available in the area. Standard specification of gas cylinder filling system prescribed by the Dept. of Industrial Works, which administrates Thai Industrial Standard (TIS).



Gas cylinder filling system

Source: Depatment of Industrial Works

Gas supply to the users in the area through gas-pipeline

There are some projects, in wich business operator collect methane gas from organic waste and supply it to users in the area through laid HDPE gas pipeline. Chiang Mai University, which participate in the study as a member, has developed a project in Hord district, southern part of the province.

2) Power Generatio, utilization and sales of power

Technologies applicable for power generation by utilizing biogas are gas engine and turbine for facilities with large scale and micro gas turbine. Gas turbine has advantage of quick start, no cooling water required and applicable for various types of gases, while it reuires special knowledge in maintenance. The study team consider gas engine as possible technology to be employed in the targeted project, as gas turbine costs much in addition to the disadvantage mentioned above.

Power generated by the project operation can theologically export to the national grid. However system for power purchase from Independent power producers under FIT is under development in Thailand and difficult to agree with power company, power to be generated in the project can be utilized for self-consumption and/or supply to third parties as ESCO. Since fuel cell seems too early to be introduced to Thailand, the study team focused on self-consumption + ESCO as only possible business model for the project.

3) Electricity & gas fee in Thailand

As mentioned, in the targeted project, biogas will be collected and utilized as alternative fuel for various ways, including as power plant. And depreciation of initial cost for the project development as well as operation cost for the project will by covered by cost reduction from operation as usual. The study team researched electric & gas fee in order to make sure cost reduction by fuel switching in the project.

Electric Fee

Electric Tarif is controlled by the central committee for commodity cost & service fee in accordance with the B.E. 2542 Price of commodities & services ACT. There are only 2 organizations, i.e. Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA), enable to supply electricity to unspecified large numbers of users, while the government of Thailand allows Energy Service Company, or ESCO to supply eletrcity to specific user(s). MEA supply electricity to users in Bangkok Metropolitan, including Bangkok, Nontaburi province and Samut Prakarn province, while PEA covers all provinces other than areas covered by MEA. Since the site for targeted project is in Chiang Mai province, the study team researched tariff published by PEA.

Electrici Tariff published by PEA covers 7 cetegories, i.e. for (1) household, (2) small enterprise, (3) medium enterprise, (4) large enterprise, (5) specific business operator, (6) Non Government Organization and (7) agriculture (pumping works for irrigation), and provide different rates for each category. Other than classification of users, PEA set up different rates depending on receiving voltage, receiving hour (peak or off peak), of which details is as per appendix 3.

Power to be generated from the targeted project will be self consumed unless otherwise export to enterprises and/or government office nearby. And if it will be electric fee per unit is THB3.20 (about JPY10) by quantity of electricity actually consumed + monthly service charge of THB312.40 (about JPY1,030.-) / user

Gas Fee

Gas Fee is controlled by the Central Committee for Commodity Cost & Service Fee. Present Gas Fee was announced by Director General of the committee in [BE2560 the announcement of the committee No. 13 regarding LPG price filled in gas cylinder forcooking purpose] published on September 6, 2017. In which the committee stated;

Reference is made to BE2560 Announcement No. 13 of the Central Committee for Commodty cost & Service Fee published on May 2, 2017,

Energy Policy & Planning Office decided to increase retail price of LPG to THB21.15/kg, which is THB0.67 increased from previous price of THB20.49/kg on after September 6, 2017, due to increase of LPG price in the international market.

The Central Committee for commodity price & service fee will adjust retail price for LPG filled in gas cylinder for cooking purpose as below, based on the announcement published by the Ministry of Energy.

Article 1 This Announcement will be effective on and afterSpetember 6, 2017

Article 2 To revoke BE 2560 Announcement No 13 of the Central Committee as for retail price of LPG fillied in gas cylinder (for cooking) published on May 2, 2017,

Article 3To revise retail price of LPG filled in gas cylinder with capacity of 15kg and to be delivered to users within 5 km from retailer in Bangkok, Nontaburi province, Patumthani province and Smut Prakarn province as not exceeding THB353.-/ cylinder, but not including delivery charge for high floor.

Retailer of LPG (for cooking) shall indicate gas fee, delivery charge and other cost &

expenses, if any. If any, do not comply with the provision, will be penaltized upto THB10 thousand fine in accordance with Article No. 24 of B.E.2542 Commodity Price & Service Fee ACT. Retailer would sell LPG at the price more than ceiling price set up by will be punished up to 5 years detention and penaltized upto THB100 thousand fine.

Article 4 If any retailer does not cooperate, or sell LPG at inappropriate price, the Cental Committee will enforce laws & regulation more strictly, and punish any of such retailer upto 7 years detention or penaltize upto THB14 thousand fine or both

As per stated in Annoucement above, the Central Committee will strictly cope with the cases of violation of provision in price indication, sales of LPG beyonf ceiling price announced and sale of LPG out of appropriate range upon receipt of any of such reports at Domestic Sales Dept. 1569, Provincial Committee for Commodity Price & Servicw Fee and the Central committee

Gas fee is adjusted as per internation market price. Transition of gas fee in the past 2 years is as per Figure 4-10 below.

Figure 4-10 Gas Fee in transition

Source: EXRI ASIA / Data Source : the Central Committee

4) Consideration on Technogy to be employed in the targeted project

Technology considered to be employed in the targeted project in the study is high efficient bio digester with biogas utilization facilities. Core technology, or high efficient bio digester is proposed by Price Management of Japan, which has already developed biogas digesters in many places in Japan, including Watari-cho, Miyagi Pref. anf Yokohama cho, Aomori pref.

Vegetable waste based biogas digester in Watari cho, Miyagi prefecture

Characteristic of the technology is as follows;

- Realized high efficient degragation by 2 step process with heat trelance micro organism
- NH4 absorption at solubilization unit
- Digest liquid circulation to adjust Ph, reduce amount of digest liquid to be discharged and to improve degradation of organic componds
- Ralized degradation of various type of organic compound by employment of dry method

Details of each characteristic mentioned above is as follows;

Realized high efficient degragation by 2 step process with heat trelance micro organism

Anaerobic fermentation is limited to acid fermentation process, thus there are a lot of researches and experiments for improvement of acid fermentation to degrade organic compound to low molecular. Price Management of Japan (PMJ) has patent with No. 5749846, which referred to the unexamined patent application No. 2011-83761 and proposed to improve effieiency by connecting disolubilization tanks in line. In the patent, there are at least a few tanks connected in line and organic compounds flow into the first tank will be partially disolubilized and flew to 2nd tank, then flew to 3rd, 4th until flew to anaerobic fermentation tank. Specific microorganisms, such as that secrete protease, lipase, glycosidase, and/or cellurase or mix up wih those microorganisms depending on the characteristic of organic compounds to be used for biogas generation. In the application, PMJ referred additional devise of NH4 removal unit to be installed with the line

Professor Yasuhiro Ishibashi found heat trelance microorganisms and promote bio degragation by utilizing heat tolerance microorganism. Dr. Yoshi, president from PMJ is one of post graduates from KumamotoPrefacture University, where Dr. Yoshi received lectures from Professor Yasuhiro Ishibashi. The heat torelance microorganism secrete heat torelance protease under aerobic & high temperature of 80c. Professor Ishibashi registered the heat torelance microorganism as new variety of thermophilic microorganism or Bacillus sp.MU3 at NITE (Registration No. AP-156, then applied

for patent with unexamined patent application no. 2007-167047. Charactaristic of the microorganism is described by Professor Ishibashi as follows;

- Molecular Weight: about 57,000
- Superiority in heat torelance (Active in a range of 45-80℃)
- Wide pH range (the Most suitable Ph is 6.0)
- High protein degradation

5) Project Site

Assessment of the project site

The study team selected waste management center for the northern region of Chiang Province in Wiang Fang district as potential project site to develop the targeted project. Items which the study team considered are as per shown in the table below.

	Items	Assessment	Current Situation
1	Interst & Intention of Local Authorities	◎	Local Authorty dispatched its representative to obth 1st &2nd workshops held in Chiang Mai and expressed its interest & intention to develop biogas project in the area. The study team visited local authority twice during the study in Chiang Mai and confirmed their intention.
2	Amount of MSW receiving at the site	◎	Project site is inside waste management center and 60-80tons of MSW in the area is transported to the centerper day. Local authorities transport their MSW to the center will continue to transport their MSW to the center for final disposal
3	Resident in the area	◎	Project site in inside existing waste management center, thus it might not be difficult to get consensus from resident in the area.
4	Investor	△	Local authority signed up a 6 year contract with private sector for operation of waste management center. The local authority will invite public offers from private sector for new 6 years contract for operation of the center by the end of 2018. Waste Utilized Co., Ltd., current operation expressed their interest in extention of contract
5	Environmental Impact	◎	Water treatment facilities is established at the center. Digest liquid generated from operation in the project will be sold as liquid fertilizer to orange farms in the area. Thus there will be no environmental impact on the area from waste water from the facility. There might be odor from

			operation, but as there is no village nearby, no impact on environmentin the area.

Location Map of Waste Management Center for the Northern part of Chiang Mai

Profitability of Waste Management Center

According to Waste Utilized Co., Ltd. a contractor for operation & management of the center, profitability of the waste management center is as follows, while the operator shall take responsibility for facilities in the center, thus sometime cost a lot for repairing and maintain existing factilities.

(1) Income

	Description		Unit Price (THB)	Q'ty	Total (THB1,000)
1	Tipping Fee	General	600.-/t	15,887.5ton	9,526.5
		Wiang Fang M	400.-/t	4,197.5ton	1,679.0
		Wiang SAO	0.-/t	1,825.0ton	0.0
2	Sales of recyclable waste		10,000.-/t	2,190.0ton	21,900.0
3	Sales of plastic waste for material recycle		3,000.-/t	1,145.0ton	3,435.0
4	Sales of RDF	Fresh	1,500.-/t	3,335.0ton	5,002.5
5	Sales of Soil Conditioner		1,500.-/t	1,825.0ton	2,737.5
Total					44,279.5

(2) Cost & Expenses

	Description		Unit Price (THB)	Q'ty	Total (THB1,000)
1	Management Fee (Wiang Fang)	General	100.-/t	21,910.0ton	2,191.0
2	Rental Fee		250,000.-/年	1	250.0
3	Labor Cost	Manager	15,000.-/月/人	2人x12か月	360.0
		Worker	7,500.-/月/人	70人x12か月	6,300.0
4	Utilities		100,000.-/月	12か月	1,200.0
5	Transportation Cost (RDF)		600. -/t	4,480ton	
6	Operation & Maintenance Fee		TBC		
計					12,386.8

Slide: 2 of 2

5. Consideration on JCM project registration

The study team considered MRV methodologies for the targeted project in the study for JCM registration,

of which details are as follows;

5-2 RDF power plant

As most of project registered under JCM referred to methodologies and tools published for Clean Development Mechanism or CDM, under UNFCCC, the study team conducted literacy research to study the possibility of the targeted project, i.e. RDF power plant.

At first, emission reduction projects are classified into 15 sectors in CDM, among all sectors, Sector No, 1-9 is categolized as Industry while 10-13 as absorbtion.

Sectoral Scope in CDM

● Energy Industries (Renewable / Non-Renewable Sources)
● Energy Distribution
● Energy Demand
● Manufacturing Industries
● Chemical Industry
● Construction
● Transport
● Mining/Mineral production
● Metal production
● Fugitive emission from fuels (solid, oil and gas)
● Fugitive emission from production and consumption of halocarbons and Sulphur hexafluoride
● Solvent Use
● Waste Handling & Disposal
● Afforestation and reforestation
● Agriculture

Source: UNFCCC Website

There are another classification defined in Booklet for CDM Methodologies in 2014 by UNFCCC, in which UNFCCC categorized Sector No. 1-3 for Energy and 4-15 for the others, then grouped by operation, mitigation actions and others

Grouping by Operation Type

● Electricity generation & supply
● Energy for industries
● Energy for transport
● Energy for households and buildings

Grouping by Mitigation Actions

- Displacement of more GHG intensive output
- Renewable Energy
- Low Carbon Electricity
- Energy Efficiency
- Fuel and Feedstock switch

Grouping by Others for Sector No.4 - 15

- Displacement of more GHG intensive output
- Renewable Energy
- Energy Efficiency
- GHG destruction
- GHG emission avoidance
- Fuel Switch
- GHG removal by sinks

5-1 RDF Power Plant

(1) Methodology

The study team identified Sectoral No. 1 Energy and No. 13. Waste in CDM sectoral scope as applicable sector for the RDF power plant, as its operation is (1) to dig landfilled & accumulated old MSW out, (2)to segregate old MSW to sort combustible waste out to obtain RDF, then (3) to generate power from combustion of RDF as alternative fuel, And did (1) Electricity Generation & Supply and (2) Energy Efficiency. Methodologies applicable sectors mentioned above is as shown in the Table 5-1 and Table 5-2 below.

Table 5-1 Methodologies for Energy Sector might applicable for the targeted project

Methodology	Outline (Name & Eligibility)
AM0014	Natural Gas Package Cogeneration
AM0048	New cogeneration project activities supplying electricity and heat to multiple customers
AM0049	Methodology for gas based generation in an industry activity
AM0061	Methodology for rehabilitation and/or energy improvement in existing power plant
AM0062	Energy efficiency improvement of a power plant through retrofitting turbines
AM0076	Methodology for implementation of fossil fuel trigeneration in existing industrial facilities
AM0084	Installation of cogeneration system supplying electricity and chilled water to new and

	existing customers
AM0102	Greenfield cogeneration facility supplying electricity and steam to a greenfield industrial customer and exporting excess electricity to a grid and/or project customer(s)
AM0107	New natural gas based cogeneration plant
ACM0006	Electricity and heat generation from biomass
ACM0013	Construction and generation of new grid connected fossil fuel fired plants using a less GHG intensive technology
ACM0018	Electricity generation from biomass residues in power only plants
AMS-II.B	Supply side energy efficiency improvement – generation
AMS-II.H	Energy efficiency measures through centralization of utility provisions of an industrial facility
AMS-III.AL	Conversion from single cycle to combined cycle power generation

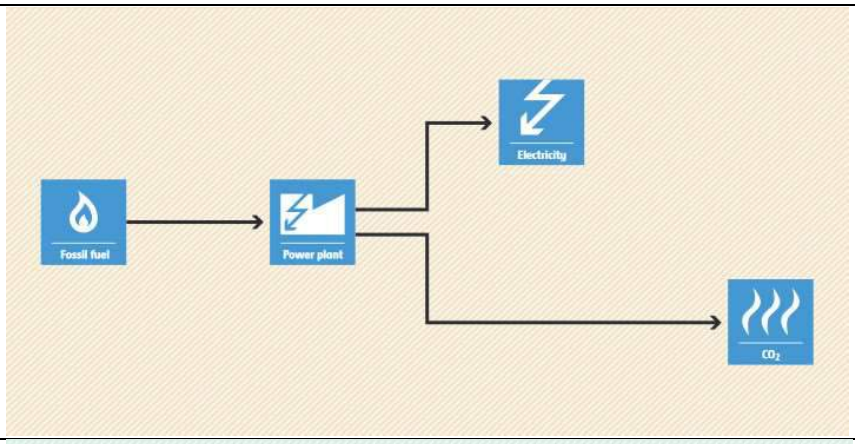
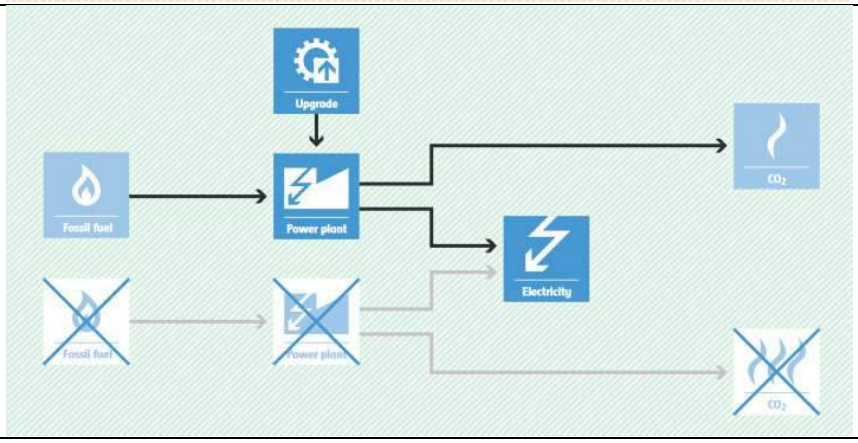
Table 5-2 Methodologies in Waste Sector might applicable for the targeted project

Methodology	Outline (Name & Eligibility)
AMS-III,AJ	Recovery and recycle of material from solid waste
AMS-III.BA	Recovery and recycle of material from E-waste

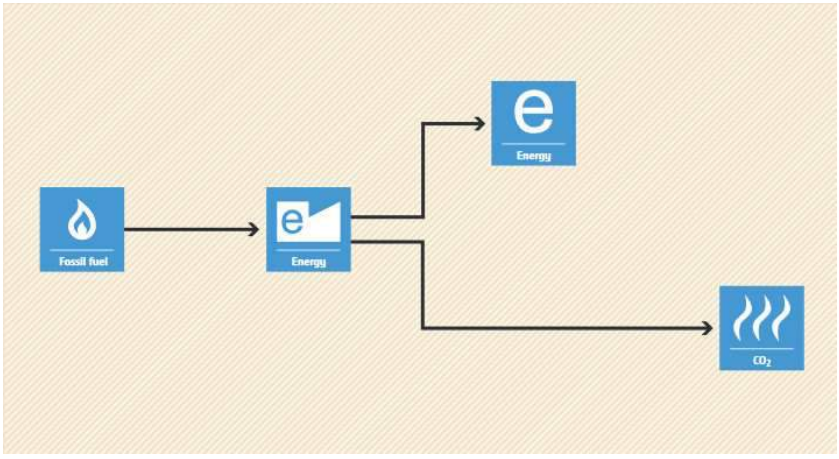
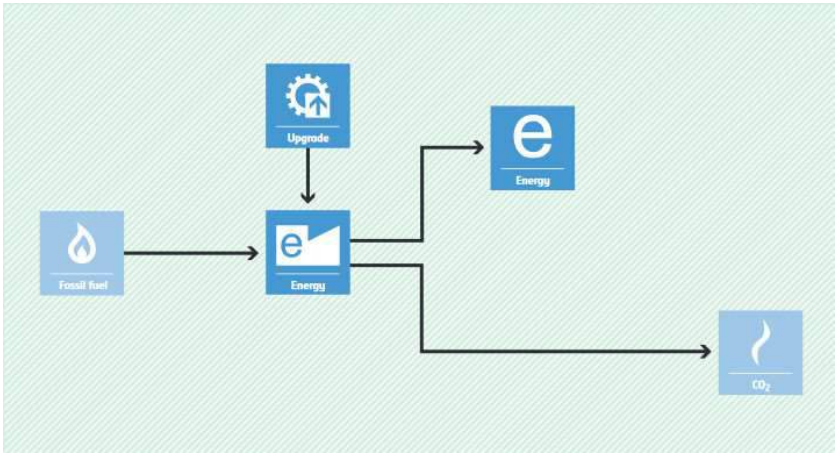
After studying all methodologies listed in the Table 5-1and Table 5-2 above. The study team has selected 2 methodologies, i.e., ACM0013 Construction and generation of new grid connected fossil fuel fired plants using a less GHG intensive technology and AMS-II B Supply side energy efficiency improvement – generation for small scale CDM.

Outlines of the selected methodologies are as follows;

ACM0013 Construction and operation of new grid connected fossil fuel fired power plants using a less GHG intensive technology	
Typical project	Construction and operation of a new grid connected fossil fuel fired power plant that supplied electricity to the grid using more efficient power generation technology than would otherwise be used with the given fossil fuel.
Type of GHG emissions mitigation action	Energy Efficiency
Important conditions under which the methodology is applicable	- Only supply of power to the grid is applicable (no cogeneration) - The identified baseline fuel category is used as the main fuel category in more than 50% of the total rated capacity of power plants which were commissioned for commercial operstion in the most recent five calendar/fiscal years prior to the publication of PDD for global

	stakejolder consultation, whithin the electric grid to which the project plant will be connected. - At least five new power plants can be identified as similar to the project plant (in the baseline identification procedure)
Baseline Scenario	
Project Scenario	

AMS-II B Supply side energy efficiency improvement – generation	
Typical Project	Introduction of more-efficient electricity and/or thermal energy generation units or compete replacement of existing power stations, district heating points and cogeneration units by new equipment with a higher efficiency or retrofitting of existing fuel fired generation units in order to increase their efficiency
Type of GHG emission mitigation actions	Energy efficiency Technology with higher efficiency reduced fuel consumption for energy generation and thereby reduce GHG emission.
Important conditions under which the methodology is applicable	- Baseline and project technologies utilize fossil fuel to produce energy - Renewable energy projects are not applicable

Baseline Scenario	
Project Scenario	

- As mentioned, conditions given in each methodology, such as “The identified baseline fuel category is used as the main fuel category in more than 50% of the total rated capacity of power plants which were commissioned for commercial operstion in the most recent five calendar/fiscal years prior to the publication of PDD for global stakejolder consultation, whithin the electric grid to which the project plant will be connected” for ACM0013 and “Introduction of more-efficient electricity and/or thermal energy generation units or compete replacement of existing power stations, district heating points and cogeneration units by new equipment with a higher efficiency or retrofitting of existing fuel fired generation units in order to increase their efficiency” for AMS-II B, provent projet registration. In addition, as AMS II B is an approved methodology for small scale CDM. Maximum energy saved will be limited to not exceeding 60GWh or equivalent per year.

Despite of conditions given in the AMS II-B, the CDM Executive Board approved to register new projects categorized in project typeII & type III with conditions given at EB69. Conditions given and procedures indicated in the decision is as follows;

Type II and III Greenfield projects (new facilities) may use a Type II and Type III small-scale methodology provided that they can demonstrate that the most plausible baseline scenario for this project

activity or PoA is the baseline provided in the respective Type II and Type III small-scale methodologies.2 The demonstration must include an assessment of the alternatives of the project activity or PoAs using the following steps:

Step 1

Identify the various alternatives available to the pr oject proponent that deliver comparable levels of service, including the proposed project activity or PoA undertaken without being registered as a CDM project activity or PoA.

Step 2

List the alternatives identified in Step 1 that are in compliance with local regulations. If any of the identified baselines is not in compliance with local re gulations, then exclude that alternative from further consideration).

Step 3

Eliminate and rank the alternatives identified in Step 2 taking into account barrier tests specified in the "Guidelines on the demonstration of additionality of small-scale project activities".

Step 4

If only one alternative remains that:

(a) Is not the proposed project activity or PoA undertaken without being registered as a CDM project activity or PoA; and

(b) Corresponds to one of the baseline scenarios provided in the methodology; then the project activity or PoA is eligible under the methodology.

Judging form the information obtained through literacy research, the study team regarded AMSII B as the methodology with highest affinity with the target project and conduct further literacy research for applicability to the RDF power plant.

AMS-II B Supply side energy efficiency improvement – generation V 09
Technology / Measure This category comprises technologies or measures to improve the efficiency of fossil fuel generating units that supply an electricity or thermal system by reducing energy or fuel consumption by up to the equivalent of 60 GWhe per year. Examples include efficiency improvements at power stations and district heating plants and co-generation. The technologies or measures may be applied to existing stations or be part of a new facility. A total saving of 60 GWhe is equivalent to maximal saving of 180 GWhth in the fuel input to the generation unit. Baseline The energy baseline is the technical losses of energy within the project boundary. In the case of retrofit measures, the energy baseline is calculated as the monitored performance of the existing generating unit. In the case of new facilities, the energy baseline is calculated using a standard for the equipment that

would otherwise have been installed selected in accordance with relevant paragraphs of 'general guidance

Leakage

If the energy efficiency technology is equipment transferred from an other activity or if the existing equipment is transferred to another activity, leakage is to be considered.

Monitoring

Energy savings shall be measured after implementation of the efficiency measures, by calculating the energy content of the fuel used by the generating unit and the energy content of the electricity or steam produced by the unit. Thus both fuel use and output need to be metered

Methorological Tool to be referred is as follows;

Methogological Tool to determine efficiency of thermal or electric generation system

This is revised tool of that of version 1.0 entried into force on the date of the publication of EB87 meeting report on November 27, 2015.

Scope

- The tool describes various procedures to determine the baseline efficiency of an energy generation system, for the purpose of estimating baseline emissions. The tool may be used in case of project activities that improve the energy ef ficiency of an existing system through retrofits or replacement of the existing system by a new system.
- This tool provides different procedures to determine the baseline efficiency of the energy generation system: either a) a load-efficiency function is determined which establishes the efficiency as a function of the operating load of the system or b) the efficiency is determined conservatively as a constant value.

Applicbility

This tool is applicable to energy generation systems that: (a) Generate only electricity (and no heat); or (b) Produce only thermal energy (and no electricity). Also, the following conditions apply:

•The tool is not applicable to cogeneration systems and waste heat recovery systems;
•The tool can be applied only if load is the main operating parameter that influences the efficiency of the energy generation system.

Methodologies referring to this tool should specify for which energy generation systems the tool is used and whether a load-efficiency function and/or a constant efficiency should be determine

Definition

(a) Efficiency.

Efficiency is defined as the net quantity of useful energy generated by the energy generation system per quantity of energy contained in the fuel fired. In case of boilers that are used only for thermal

energy generation (and not for power generation), the efficiency is defined as the net quantity of useful heat generated per quantity of energy contained in the fuel fired in the boiler. In case of power plants producing only electric power (not cogeneration plants), the efficiency is defined as the net electricity generated by the power plant as a whole divided by the quantity of energy contained in the fuel fired.

(b) Load.

Load refers to the output of the energy generation system at which the system is operated during efficiency determination tests. It is expressed in kW or MW.

(c) Load – Efficiency function.

A mathematical function representing the efficiency of the energy generation system as a function of the load.

(d) Regression analysis.

Regression analysis is a statistical method used to establish cause-effect for the investigation of relationships between the variables.

(e) Performance curves.

Performance curves are a graphical representation of the efficiency of the energy generation system at different loads and different operating conditions. For example, performance curves of a boiler illustrate the efficiency against load at different operating conditions, such as the steam pressure and temperature.

(f) Regression Analysis

a statistical method used to establish cause effect for the investigation of relationships between the variables.

Parameter

This tool provides procedures to determine the following parameters:

Parameter	SI Unit	Description
μ	Dimensionless	Efficiency of the energy generation system as a constant value
$\mu=f(L)$	Dimensionless	Load-efficiency function expressing the efficiency of the energy generation system as a function of the load at which the system is operated

Baseline Methodology procedure

Project participants may use one of the following options to estimate the efficiency of the energy generation system:

(a) Option A:

Use the manufacturer's load-efficiency function;

(b) Option B: Establish a load-efficiency function based on measurements and a regression analysis;

(c) Option C: Establish the efficiency based on historical data and a regression analysis;

(d) Option D: Use the manufacturer's efficiency values;

(e) Option E: Determine the efficiency based on measurements and use a conservative value;
(f) Option F: Use a default value
Project participants should document which option is used to establish the efficiency of the relevant system, including, in the case of options (B), (C) or (E), the type of measuring equipment used, details of how the measurements were carried out and the measurement result

(2) Reference Emission

Considering applicability of the methodology to the targeted project in the study, baseline (reference scenario for JCM) will be the similar project, i.e. RDF power plant under operation in Thailand.

(3) Project Emission

The project team set up project scenario through consultation with technical provider with reference to the methodological tool referred above.

(4) Quantification of GHG emission reduction

GHG emission reduction will be quantified from Reference emission and project emission quantified above.

In Japan, Waste Research Foundation published directry for incinerators in Japan and related data & information is open to the public. The study team expect the government of Thailand to prepare similar database to be published with purpose of sharing information & knowledge, improvement of efficiency in project development and transparency.

5-2 Biogas Collection & Utilization

(1) Reference Scenario

The targeted project is to segregate organic waste from fresh MSW, originally intended for dispoal in a solid waste disposal site (SWDS), degradate the orgnic waste by anaerobic digestion, collect & utilize biogas as alternative energy. Therefore reference scenario for the targeted project will be as follows;

- Fresh MSW is disposed at inappropriate SWDS and therefore CH4 & N2O is emitted from SWDS.
- Users for thermal energy and/or electricity consume those generated from fossil fuel and/or import from national grid

From the assumed reference scenario mentioned above, reference emission for the targeted project is as follows;

Emission (Type of GHG & sources of emission)	unit	Included
CH_4 emission from decomostion of waste at SWDS	tCH_4	Yes
N_2O emission from decomostion of waste at SWDS	tN_2O	No[10]
CO_2 emission from decomostion of waste at SWDS	tCO_2	No[11]
CO_2 emission from on-site fossil fuel consumption	tCO_2	Yes
CO_2 emission from on-site electricity consumption	tCO_2	O

Landfill gases emitted from SWDS are generated from the process of decompose of organic compound into low molecular weight until the gaseous level. Under aerobic condition, Carbon will be converted to CO2, Hydrogen to H2O, Nitrogen to NH4, and Sulfer to Sulfate ion, while various reactions will be incurred under semi-anaerobic condition, depending on oxidation-reduction level & verieties of microorganisms exist. A representative reaction is as per swhon below, and there will be almost same amount of CH4 & CO2 to be generated under anaerobic condition, after acid fermentation, in which easily degradable organic matter will be converted to intermediate. There are 5 stages in CH4 generation at SWDS.

Stage No	Stage	Duration
I	Degragation of Organic Matter under aerobic condition	A few hours
II	Easily decomposable orgaic matter is converted into organic acid	A few months
III	Organic acid start convert into CH4	A year
IV	Stable conversion from organic cid into CH4.	A few decade
V	Stable period	A few centrury

Source: Japan Waste Management Association

CH4 emission from SWDS is recommended to be quantified by both First Order Decay Model and Mass model in IPCC guideline published in 1996, then only First Decay Model in that in 2000. In First Order Decay Model, estimate amount of CN4 emitted at SWDS from amount of degradable organic componds and aging of MSW under assumption of amount of CH4 to be emitted at SWDS is in propotion to amount of degradable organic compounds and degradation will advance at the same rate under the same condition. If it is amount of CH4 emitted from SWDS is the most in the next of waste disposal then gradually reduce year by year.

[10] No quantification method is established due to less quantity (IPCC Guideline (2006))

[11] IPCC Guideline (2006)

According to the IPCC guideline, Half life time for each type of waste is in a range of approximately 3-35 years, thus the guideline request to collect MSW desposed at SWDS for not less than 50 years, and for the case no such data is available, then proof the estimated amount of emission is not underestimated

There are 3 tier for quantification of GHG emssion

Tier	Description
1	To utilize IPP default data to fill in missing country-specific data
2	To utilize IPP default parameters and good quality country-specific activity data
3	To utilize country-specific key parameters and good quality country-specific activity data

As there is no country-specific key parameters and good quality country-specific activity data available, IPCC dfault values will be applicable for the project to be implemented in Thailand.

CH4 emission from SWDS is quantified by an equation shown below;

$$CH_4\text{Emission} = [\sum_x CH4generated_{x,T} - R_T] \times (1 - OX_T)$$

where

CH_4 Emission	=	ICH4 emitted in year T
T	=	Inventory Year
X	=	Waste category or type/material
R_T	=	Recovered CH4 in year T
OX_T	=	Oxidation Factor in year T

$$CH_4generated_T = DDOC_m decomp_T \times F \times 16/12$$

where

DDOCm decomp$_T$	=	Mass of DOC decomposted in year T	Gg
F	=	Fraction of Ch4 by volume, in generated landfill gas	%

$$DDOC_{m\ decompT} = DDOC_{maT-1} \times (1 - e^{-k})$$

where

DDOCma$_{T-1}$	=	DDOC accumulated in the SWDS at the end of year T	Gg
K	=	Reaction Constant ln(2)/ $T_{1/2}$(y-1)	年

Mass of Decomposable Organic Carbon (DOCm) is quantified as follows;

(i) Type of waste (MSW, waste water, Industrial Waste or others)
(ii) Waste Composition
(iii) Type of Solid Waste Disposal Site
(iv) Data described in 3.2.3 (differenct source by Tier)

$$DDOC_m = W \times DOC \times DOC_f \times MCF$$

where

DDOCm	=	Mass of decomposable DOC deposited	Gg
W	=	Mass of waste deposited	Gg
DOC	=	Degradable organic carbon in the year of deposition,fraction	GgC/Gg Waste
DOCf	=	Fraction of DOC that can decompose	%
MCF	=	CH4 correction factor for aerobic decomposition in the year of deposition (fraction)	%

$$L_o = DDOC_m \times F \times 16/12$$

where

L_O	=	CH4 generation potential	GgCH4
DDOCm	=	Mass of decomposable DOC	Gg
F	=	Fraction of CH4 in generated landfill gas	%

First Order Decay

With a first order reaction, the amount of product is always proportional to the amount of reactive material. This means that the year in which the waste material was deposited in the SWDS is irrelevant to the amount of CH4 generated each year. It is only the total mass of decom posing material currently in the site that matters. This also means that when we know the amount of decomposing material in the SWDS at the start of the year, every year can be regarded as year number 1 in the estimation method, and the basic first order calculations can be done by these two simple equations, with the decay reaction beginning on the 1st of January the year after deposition.

$$DDOC_{maT} = DDOC_{mdT} + (DDOC_{maT} \times e^{-k})$$
$$DDOC_{m\,decompT} = DDOC_{maT-1} \times (1 - e^{-k})$$

where

T	=	Inventory year	
DDOCma	=	DDOCm accumulated in the SWDS at the end of year T	Gg
$DDOCma_{T-1}$	=	DDOCm accumulated in the SWDS at the end of	Gg

		year (T-1)	
$DDOCmd_T$	=	DDOCm deposited into the SWDS in year T	Gg
$DDOCm\ decomp_T$	=	DDOCm decomposed in the SWDS in year T	Gg
K	=	Reaction constant (ln(2)/ $T_{1/2}$	年
$T_{1/2}$	=	Half life time	年

IPP default Value

IPP Default values applicable for the project site are as per shown in the table below.

OX

Type of SWDS	Default Value
Managed, unmanaged & uncategoried SWDS	0
Managed covered with CH4 oxidising material	0.1

MCF

Classification of SWDS	Default Value
Managed Aerobic	1.0
Managed Semi Aerobic	0.5
Unmanaged deep (>5m waste) and/or high water level	0.8
Ditto shallow (<5mwaste)	0.4
Uncategorized SWDS	0.6

K

Waste Type		Climate(Tropical・moist & wet[12])	
		Default	Range
Salowly degrading	Paper / Fabric	0.07	0.06-0.08
	Wood Straw	0.035	0.03-0.035
Moderately degrading	Other(non-food) organic putrescible / garden waste	0.17	0.15-2.0
Rapidly degrading	Food Waste Sewage Sludge	0.4	0.17-0.7
Bulk Waste		0.17	0.15-0.2

$T_{1/2}$

Waste Type		Climate(Tropical・moist & wet)	
		Default	Range
Salowly degrading	Paper / Fabric	10	8-12
	Wood Straw	20	14-23

[12] Ambient Temperature higher than 20c in average & Annual rainfall more than 1,000 ㎜

	Moderately degrading	Other(non-food) organic putrescible / garden waste	4	3-5
	Rapidly degrading	Food Waste Sewage Sludge	2	1-4
	Bulk Waste		4	3-5

(2) Quantification

Reference emission will be quatified by the methodologies with actual situation or default valuesprovided by IPCC or Host country.

Project emission will be quantified based on the study mentioned above, while as there are stil some options, the study team will quantify once make business model more clear.

Emission reduction will be quantified by the equation of reference emission – project emission

6. . Environmental Integrity & Contribution for sustainable Development

6-1Environmental Integrity

The project under planning is power generation project utilize waste heat from MSW incineration. To operate incinerator as source of heat supply is essential for the project, EXRI researched flue gas emission standard in other than environmental standard for effluent, noise, vibration as follows;

(1) Emission Standard for Flue Gas

Pollutant	Emission Source(Fuel)	Combustion
Total Suspended Particulate (TSP)(mg/m3)	Incinerator & Boiler (Biomass and other fuel)	≦320
Sulfur Dioxide (SO_x)(ppm)		≦60
Oxides of Nitrogen (NO_x) (ppm)		≦200
CO(ppm)	Applicable for all	≦690
Sulfuric Acid(ppm)		≦80
HCl(mg/m3)		≦160
Antimony(mg/m3)		≦16
Arsenicum(mg/m3)		≦16
Copper(mg/m3)		≦24

Lead(mg/m3)		≦24
Chlorine(mg/m3)		≦24
Mercury(mg/m3)		≦2.4

Reference Condition :25℃ at 1 atm or 760mm Hg & dry basis

（2）Effluent Standard

Effluent standard is different depending on discharging points, i..e, river or irrigation 排 cannel. Table 5-2 indicate effluent standard for both river and irrigation cannel.

Parameter	Discharge point	
	River	Irrigation cannel
Ph	5.5-9.0	6.5-8.5
TDS	<3,000mg/l	1,300mg/l
SS	<50mg/l	30mg/l
Temperature	<40℃	<40℃
Color & muddiness	Acceptable	Acceptable
Sulphide (H_2S)	<1.0mg/l	<1.0mg/l
Cyanide (HCN)	<0.2mg/l	<0.2mg/l
Fat, Oil & Grease	<5.0mg/l	<5.0mg/l
Formaldehyde	<1.0mg/l	<1.0mg/l
Phenols [13]	<1.0mg/l	<1.0mg/l
Free Chlorine	<1.0mg/l	<1.0mg/l
Pesticides	Not detected	Not detected
Biochemical Oxygen Demand (BOD)	<20.0mg/l	<20.0mg/l
Total Kjeldahl Nitrogen (TKN)	<100.0mg/l	-
Chemical Oxygen Demand (COD)	<120.0mg/l	-
Zinc (Zn)	<5.0mg/l	<5.0mg/l
Hexavalent Chromium	<0.25mg/l	<0.3mg/l
Trivalent Chromium	<0.75mg/l	-
Arsenicum (As)	<0.25mg/l	<0.25mg/l
Copper (Cu)	<2.0mg/l	<1.0mg/l
Mercury (Hg)	<0.005mg/l	<0.005mg/l
Cadmium (Cd)	<0.03mg/l	<0.03mg/l
Selenium (Se)	<0.02mg/l	<0.02mg/l
Barium (Ba)	<1.0mg/l	<1.0mg/l

[13] Methyl phenol is added into parameter for discharge to irrigation cannel

Lead (Pb)	<0.2mg/l	<0.1mg/l
Nickel (Ni)	<1.0mg/l	<0.2mg/l
Magnesium (Mn)	<5.0mg/l	<0.5mg/l
Radioactive substance	-	Not detected
Tar	-	Not detected

（3）Noise Standard (Factory)

1）Maximum Noise <115dB

2）Maximum noise per operation hour(s) per day is as follows;

Operation Hours	Max Noise(dB)	Operation Hours	Max Noise(dB)
>12	87	<2	100
<8	90	<1 1/2	102
<6	92	<1	105
<4	95	<1/2	110
<3	97	<1/4	115

Environmental standards prescribed in Thailand are as above, while some of the project owner agreed with resident to work for more strict emission standard and/or effluent standard. Since the lower environmental impact is one of the strong point for Japanese EPC, the implementation body of the study will promote such low environmental impact technologies

6-2 Contribution for Host Country's sustainable development

Realization of appropriate MSW processing & disposal with low National Burdon

As stated, amount of municipal solid waste has been increasing due to economic development and changing of nation's life style. Along with constrain of landfill capacity and growing of national awareness, waste management in Thailand is in transition period. Waste Management in unprofitable operation and therefore, the Government is requested to improve balance of payment for sustainable operation. The targeted project will contribute to host country's sustainable development through business operation by （i） De-toxify and reduction of waste which is currently landfilled and (ii） reduction of operation cost by getting income from selling power generated from waste heat from MSW incineration

Technical Tranfer

There are only four MSW incineration based WtE plants, which EXRI targeted in the study, in Thailand as of October 2016, and technical transfer for operation & maintenance is required for popularizing of the technology. Nippon Steel & Sumikin Engineering (NSENGI) together with Suteinmuller Babcock, their affiliated company, have comprehensive knowledge starting from support on documentation for the administrative offices to operation & maintenance, as they have more than 500 reference sites in the world,

where they had installed their stalker type incinerators with power generation facilities and support for operation & maintenance. City of Kitakyushu, the other implementation body for the study administrate waste management, i.e., 3R promotion, optimization of waste collection & transportation and preparation & implementation of waste management plan, as local government. As strongly requested by the local stakeholders, the project owner will transfer technology & knowledge from both NSENGI & City of Kitakyushu to local parties through implementation of the project.

Job Creation & vitalization of local economy

In the targeted project, the project owners intend to procure various facilities, equipment, and machines, except for any of those for higher efficiency and low environmental impact, from local parties and contract local parties for civil & construction works. Thus, the targeted project would create job opportunities and expect economic effect in the area. Other than construction period, the targeted project would create another job opportunity by employment of management and many members of staff, including operators, maintenance staff, security guard for business operation. The target project and concerning parties would contribute for local economy by paying various taxes as well.

Lower environmental impact and realization of low carbon tourist city

Chiang Mai province is well known as the province in northern mountain area of Thailand. Ping river, one of a tributary of Menam River and water source for Thailand, flow from the north to south of the proinve. The government of Thailand, which take countermeasures to improve water quality in the country in recent years, concluded one of reasons for deterioration of water quality in Thailand is water pollution incurred at water source caused by inappropriate environmental management in the area. The targeted project in the study will improve environmental management at water source through realization of appropriate waste management in the area, which contribute improvement of water quality in Thailand. Beside the targeted project contribute for development of sustainable tourism, which Chiang Mai province, as a tourist city needs.

Appendix:

1 - 1　1st WS Presentation (i)

1 - 2　1st WS Presentation(ii)

1 - 3　1st WS Presentation(iii)

1 - 4　1st WS Presentation(iv)

1 - 5　1st WS Presentation(v)

2 - 1　2nd WS Presentation(i)

2 - 2　2nd WS Presentation (ii)

2 - 3　2nd WS Presentation (iii)

2 - 4　2nd WS Presentation (iv)

3 Electric Tariff

Project for

Waste Management in Chiang Mai Province

Under city-city cooperation between Chiang Mai province & city of Kitakyushu

1st Seminar in Chiang Mai
August 23, 2017

By Pakawan Sansee
Natural Resources & Environment Bureau
Chiang Mai Provincial Office

Content

1. Progress of the Project (1) Milestones

2017: May, June, Jul, Aug, Sep, Oct, Nov, Dec
2018: Jan, Feb

- May 16 : Kick off Meeting held at the Ministry of Environment, Japan (Tokyo)
- June 28-July 1 : Kick off & first meeting in Thailand
  - Official Meeting between Provincial Office & City of Kitakyushu
  - Official Meeting among Provincial Office, Municipalities & Kitakyushu
  - Tour to Waste Management related sites
- July 24-28 : 1st JCM Workshop in Japan (Kitakyushu & Kawasaki)
- August 21-26 Japanese Study Team 2nd Visit Chiang Mai
- August 23 : 1st Seminar for Integrated Waste Management in Chiang Mai

Data & Information Collection



Reporting & Assessment

1. Progress of the Project (2) Conclusion of the 1st General Meeting

1. Joint Presentation done by City of Kitakyushu & Natural Resources & Environment Bureau, Chiang Mai Provincial Office was approved by the Governor

2. Basic Concept of the Study is as follows;

Target	1) Municipal Solid Waste (3RS + Appropriate Processing + Disposal) 2) Hazardous Waste (Disposal + Collection + Storage + Appropriate Processing & Disposal) 3) Infectious Waste (ditto)
Process	1) To update data & information 2) To analyze data & information above 1) and make issues in order 3) To conduct gap analysis between target set up by and current situation 4) To draw blue print for integrated waste management 5) To prioritized projects and/or programs to be implemented in action plan (for next year) 6) To consider project implementation under JCM 7) To share data, information & knowledge among stakeholders in the province, including organizing seminars
Output	1) Blue print for integrate waste management plan with action plan including projects proposal

3. Chiang Mai Provincial Office regards the project as external resource for waste management project for the province and link the project with provincial committee for waste management.

4. Blue print for integrated waste management with action plan will be considered as a part of Master Plan for Waste Management for the Province

5. Both Chiang Mai Provincial Office and City of Kitakyushu evaluate output of the project implemented in 2017-2018 and decide whether both parties will extend the project or not (including signing a MoU and/or LOI)

2. Workflow for the Project

Chiang Mai Provincial Office

(1) FIELD & CATEGORY

↓

(2) TARGET(S) / PRESENT SITUATION

1) National / Provincial Level

GAP

2) Present Level (cities & villages in average)

(3) ANALYSIS
for
1) How much ?
2) Where (at which cities &/or villages) ?
3) Why ?

(4) DATA ANALYSIS & CLASSIFICATION
1) Issues & Challenges by type & categories
2) Issues & Challenges by cities & villages
3) Activities in past and outcome including reasons for success & un-success

(5) Blue Print for Integrated Waste Management Plan in Chiang Mai

北九州市 CITY OF KITAKYUSHU

- **ECO TOWN**
- **Kitakyushu Model (Waste Management)**
- **Waste Processing & Disposal Technologies**

Technical Support
(1) Knowledge Sharing
(2) Consultation

5

1. Progress of the Project (3) Updating Waste Management in Chiang Mai Province

- Data & Information Sources…Publications -

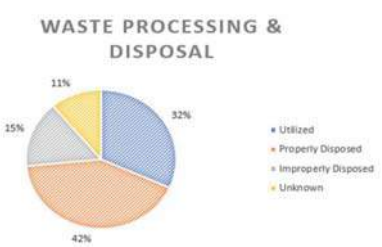
Level	Publications
National	1) Road Map for Solid & Hazardous Waste Management (2558-2562) 2) Master Plan for 3) National Waste Management Plan (2016-2021)
Province	1) Solid & Hazardous Waste Management Plan for Chiang Mai Province (2558-2562) 2) Development Plan for Chiang Mai Province (2561-2564) 3) Unauthorized Data provided by local authorities in Chiang Mai Province in 2560
City & Village	1) Development Plan

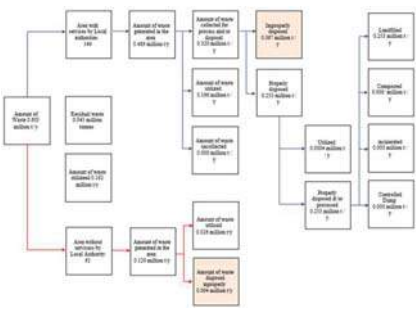
Wide Area Processing Plan (DOLA/MOI)

or

???

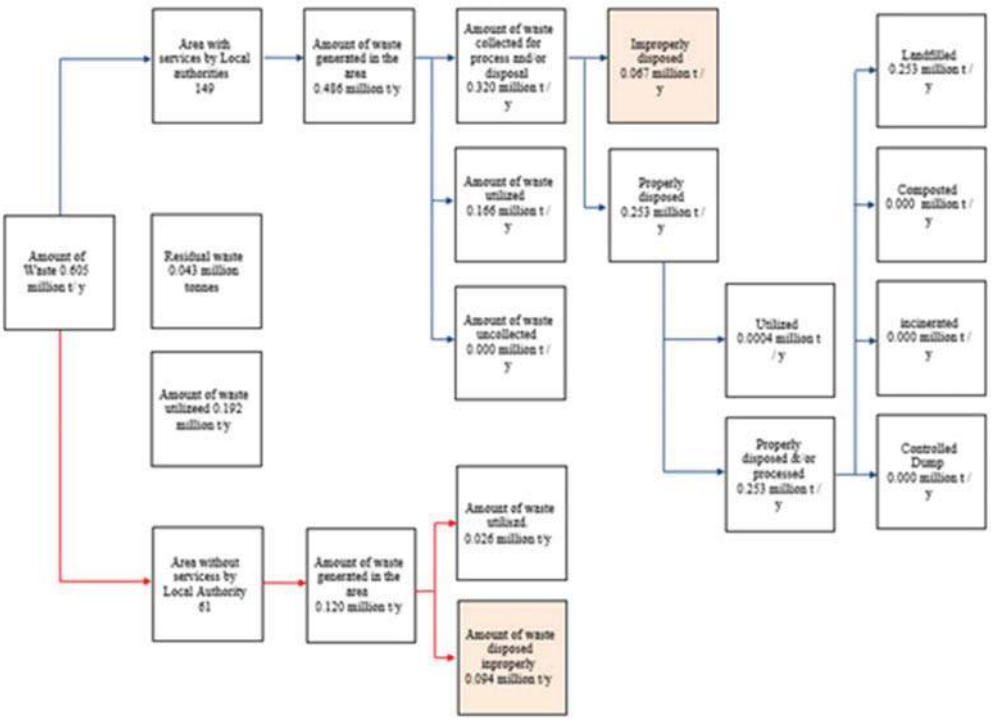
Data & Information available is correct ?





1. Progress of the Project (4) Latest Targets set up in Waste Management Sector in Chiang Mai Province

- Current Situation of Waste Management in Chiang Mai -



No of Local Administration	210 (149/61)
Amount of MSW	605,351.16 t/y
Amount of waste utilized &/or recycled	191,911.28 t/y (31.7%)
Amount of MSW properly disposed	253,001.41 t/y (41.8%) (including 456.25t/y of MSW recycled)
Amount of MSW improperly disposed	160,894.72 t/y (26.6%)
Amount of old MSW	42,978.96 tons
No of Disposal Sites	

1. Progress of the Project (5) Targets consider to be newly set up in Waste Management Sector in Chiang Mai Province

- Targets for waste management set up by the Central Government -

National Solid Waste Management Plan (2016-2021)

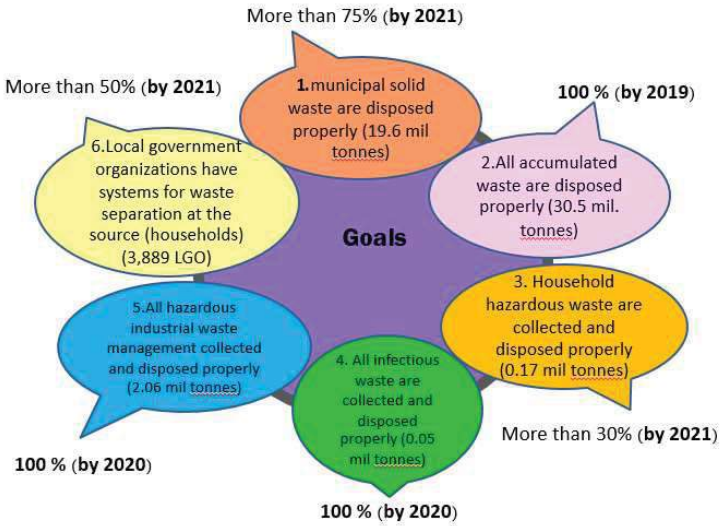
Presented by Pollution Control Department & Approved by the Cabinet on May 3rd, 2016

Framework

Encourage citizens, including children, and the private sector to reduce waste at the source by following the 3Rs concept (Reduce, Reuse, Recycle)

Establish proper disposal methods for municipal solid waste and household hazardous waste by using centralized facilities for clusters of municipalities emphasizing waste utilization and waste to energy methods

All relevant sectors participate in the management of solid and hazardous waste



1. Progress of the Project (4) Gaps between Targets and current situation

- Challenges in Waste Management in Chiang Mai Province

- The increase of remaining solid waste.
- Remaining solid waste and solid waste disposal site in forest.
- Local people protest against solid waste management facility.
- Illegal dumping.
- Inefficient solid waste management database.
- Inefficient waste segregation at the source .
- Insufficient collected station of hazarded waste.

2. Knowledge Sharing…Waste Management in Japan (1)

Laws

(1) Basic Environment Act,
(2) Basic Act on Establishing a Sound Material Cycle Society,
(3) Waste Management & Public Cleansing Act

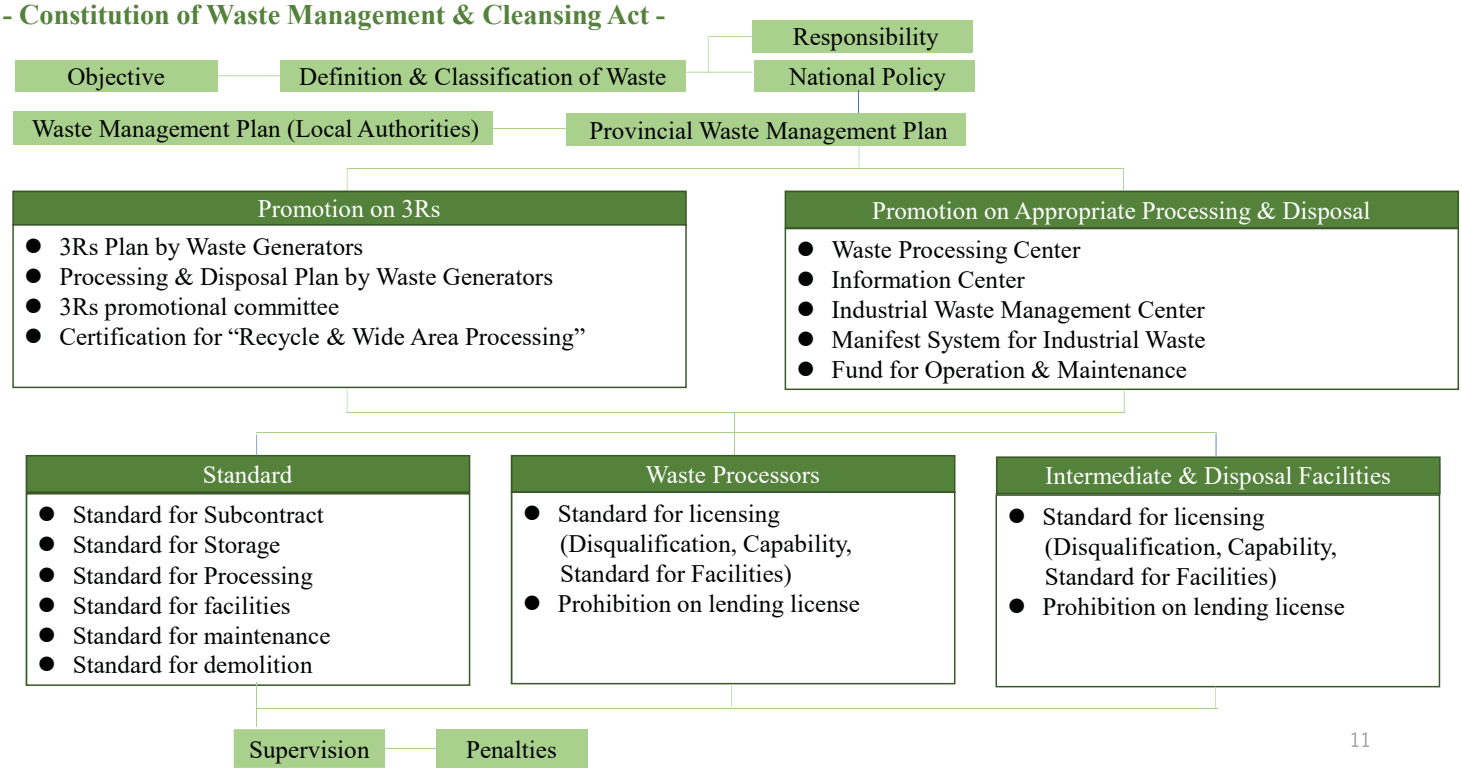
- **Principal Law for Waste Management in Japan**
- **Waste Disposal at Waste Generating Points**
- **Waste Storage**
- **Collection & Transportation**
- **Intermediate Processing**
- **Final Disposal**
- **Recycle**

(4) Recycle Promotion Acts

- Containers & Packaging Waste,
- E-Waste (A/C, TV, Refrigerator, Washing Machine, Small Electric Appliances)
- C&D Waste,
- Food Waste &
- ELV

2. Knowledge Sharing…Waste Management in Japan (2)

- Constitution of Waste Management & Cleansing Act -



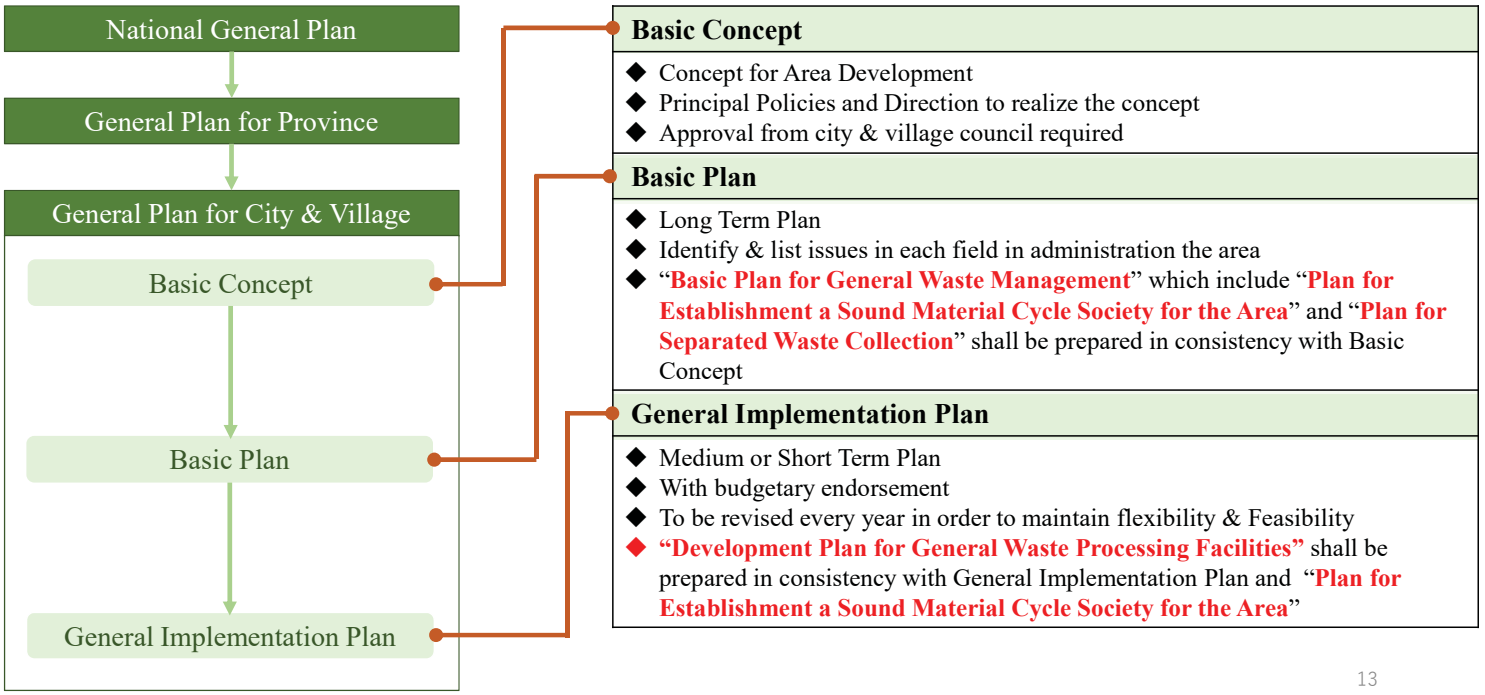
2. Knowledge Sharing…Waste Management in Japan (3)

- Roles & Functions for Government Authorities in Different Level -

Level	Roles & Functions
National	• Basic Policy & Planning at National Level • Gathering Information & Technology Development • Standard for Processing, Facilities & Subcontracting • Monitoring on Waste Export & Approval on Waste Import
Province	• Approval for General Waste Processing Facilities • Supervision on General Waste Processing Facilities (Reporting, Inspection, Orders for improvement & implementation
City & Village	• Enactment of General Waste Management Plan • Responsible for General Waste Processing & Disposal • Observance for Processing Standard • Observance for Subcontracting Standard • Approval for General Waste Processors based on their observance on processing standard • Supervision on General Waste Processors (Reporting, Inspection, Orders for improvement & implementation

2. Knowledge Sharing…Waste Management in Japan (4)

- Correlation among plans set by different Authorities in Japan (How about in Thailand ???)



2. Knowledge Sharing…Waste Management in Japan (5)

"Basic Plan for General Waste Management"

PROVISION in Waste Management & Cleansing Act

[ARTICLE NO. 6]

◆ Local Authorities (city & village level) shall prepare "Basic Plan for General Waste Management"

◆ "Basic Plan for General Waste Management" shall contain following subjects;

(1) Estimated Amount of General waste to be generated and processed in the Area,
(2) Measures to reduce amount of General Waste generated in the Area
(3) Types & categories of waste for separate disposal and collection
(4) Standard for Appropriate Waste Processing & Waste Processors
(5) Establishment of Waste Processing Facilities
(6) Others in related to General Waste Processing

◆ "Basic Plan for General Waste Management" shall maintain consistency with "Basic Concept" which is prescribed by Article 2-4 in the Act for Local Authorities

◆ "Basic Plan for General Waste Management" shall be harmonized with those drawn by neighboring local authorities

◆ Local Authorities shall notify revisions / modifications, if any in published "Basic Plan for General Waste" without delay.

GUIDELINE by the Ministry of Social Welfare (Environment)

CHAPTER 1. Draw up "Basic Plan for General Waste Management"

1. General Waste Management Plan is consist of two plans, i.e.
   (1) "Basic Plan for General Waste Management" which is a basic plan for long term covering 10-15 years to be renewed every 5 years or whenever there are any significant changes in premises adopted in planning. And
   (2) "General Implementation Plan" which is an annual plan for General Waste Management covering 3Rs, Waste Collection & Transportation, Processing and Disposal.
2. Local Authorities are requested to check & access the targets and achievement in waste management when they renew Basic Plan
3. Local Authorities, especially those who participate in wide area management, are requested to draw Basic Plan in harmonization with other local authorities.
4. Preparation of general data & information related to general waste (*as per list shown in next page*)

CHAPTER 2. Content of "Basic Plan for General Waste Management"

1. "Basic Plan for General Waste Management" shall contain following subjects;
   (1) Estimated Amount of General waste to be generated and processed in the Area,
   (2) Measures to reduce amount of General Waste generated in the Area
   (3) Types & categories of waste for separate disposal and collection
   (4) Standard for Appropriate Waste Processing & Waste Processors
   (5) Establishment of Waste Processing Facilities
   (6) Others in related to General Waste Processing

CHAPTER 3. Correlation with Basic Concept

CHAPTER 4. Correlation with Basic Plan drew by other Local Authorities

Reference (1) Preparation of general data & information related to general waste

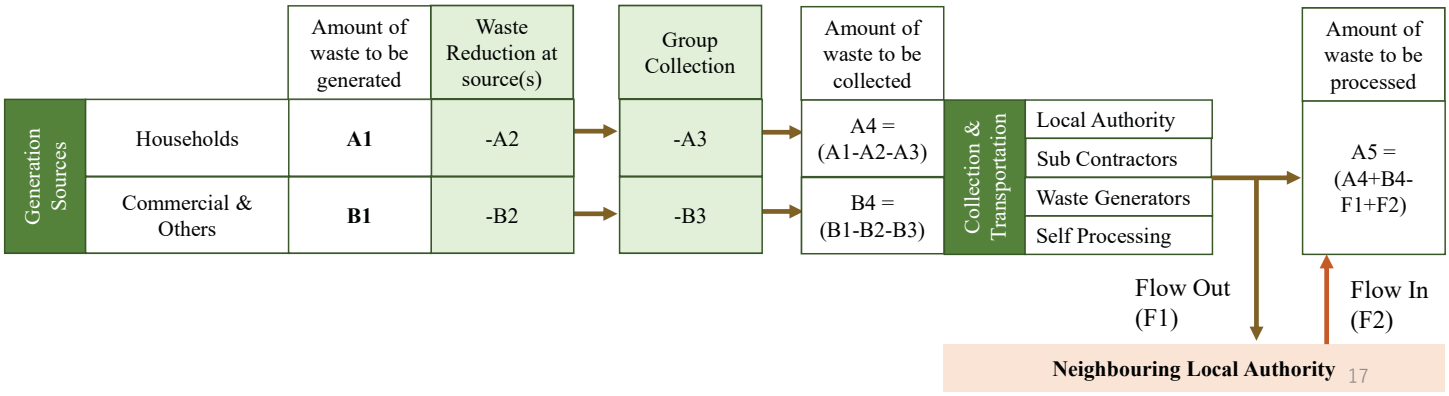
(1) Basic Information	(2) Amount & Characteristic of waste	(3) 3Rs related activities
1) Population & Distribution 2) Town & Villages 3) Industries 4) Land Utilization 5) Plans (e.g. Development Plans)	1) Amount of waste generated by type (including oversize garbage and hazardous waste) 2) Characteristic of waste (including composition & calorific value)	1) Separate disposal & collection of waste 2) Resource recovery from oversize garbage 3) Group collection by communities 4) Resource recovery by private sector 5) Composting
(4) Waste Management	Date & information for waste collection, transportation, processing & final disposal for at least past 5 years	
(5) Organization for waste management	Organization, Operation system, budget and cost & expenses for waste management covering collection, transportation, processing & final disposal	
(6) Technologies	Technologies for waste processing	
(7) Neighboring local authorities	Policy, Direction & outline of projects in the field of waste management, which neighboring local authorities enacted or going to enact	
(8) Laws, Regulations and Ordinances applicable for the area	Laws, Regulations and Ordinances applicable for waste processing facilities to be established in the area.	

2. Knowledge Sharing…Waste Management in Japan (8)

Reference (2) Contents of "Basic Plan"

(1) Amount of waste to be generated in the area shall be estimated by taking following factors into consideration
  1) population transition,
  2) impact by 3Rs & group collection by communities,
  3) self processing by waste generators
  4) flow in from & flow out to neighboring local authorities, if any,
  5) development plan (commercial & residential area)
  6) Tourist

(2) Classification of waste
  1) by source of generation, i.e. domestic, commercial, others (offices & factories)
  2) by collection & transport, i.e, by local authority, by subcontractor(s) or by waste generator(s)



2. Knowledge Sharing…Wide Area Processing in Japan (8)

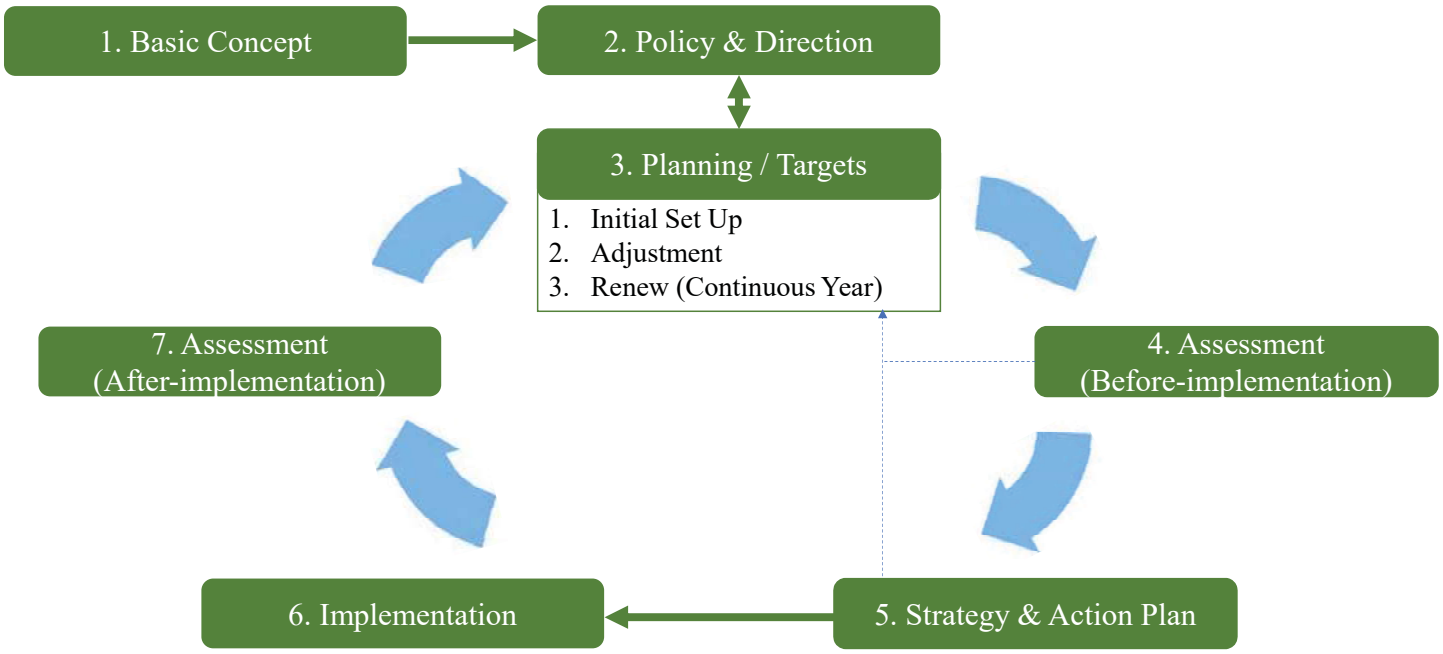
Reference (3) Contents of "Wide Area Processing Plan"

◆ Planned by Provincial Office Level
◆ By Notification for Wide Area Processing Plan issued by the Ministry of Health in 1997

[Objectives]
1. Countermeasure for Dioxin emission reduction
2. Advanced Treatment of Bottom Ash
3. Promotion of Material Recycle
4. Promotion of Thermal Recycle
5. Securement of final disposal sites (landfill)
6. Cost Reduction in Public Works

[Contents]
1. Duration: 10 years
2. Cluster
3. Facility Development Plan for each cluster
4. Amount of Dioxin emitting & to be emitted in future (estimation)
5. Waste Management in transitional period
6. Utilization plan for RDF, if any
7. Others (Transportation of waste & RDF, Amount of material to be recycled (present – plan), Amount of Power generated (present – plan), Waste Separation & Segregation in each cluster
8. Assessment method for wide area processing plan

3. Proposal for Integrated Waste Management I



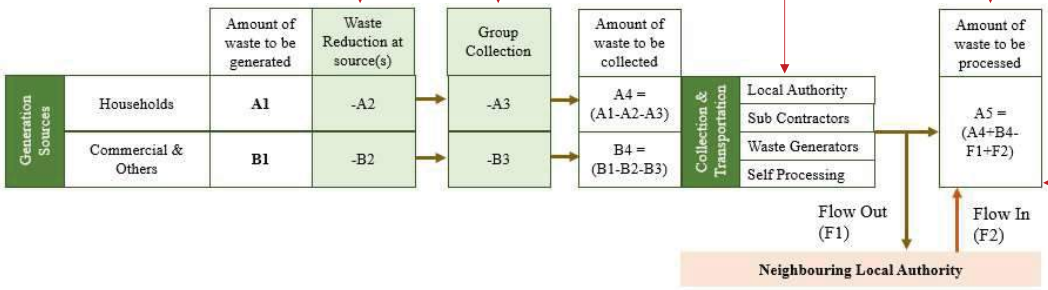
3. Proposal for Integrated Waste Management

THEME	I	PLANNING
DESCRIPTION	"PLANNING" is the First Step for Appropriate Waste Management, if it is, how Chiang Mai provincial office enhance planning by Local Authorities in the province	
REFERENCE	1) Waste Management Plan (city & village level) in Thailand 2) Waste Management Plan (city & village level) in oversea (Japan) 3) Current Situation in Chiang Mai province	
CONSIDERATION	1) How Chiang Mai provincial office enhance local authorities in planning for waste management? 2) What are the expecting achievement from activities to be selected in 1) above? 3) Which kind of resources Chiang Mai provincial office needs for implementation 1) above? 4) Whether Chiang Mai provincial office enable to allocate resources required in 3) above to the project? 5) Whether Chiang Mai provincial office requires external support from any parties or not?	
PROCEDURE	1) Literature Survey + Technical Support from City of Kitakyushu 2) Questionnaire Survey to local authorities in the province 3) Summarization of questionnaire 2) above and assessment	
PROPOSED ACTIVITIES	1) Capacity Building for local authorities 2) Introduction of Successful Models in Thailand to local authorities in the province 3) Develop a format & guideline for local authorities in the province 3) Support for parts of planning such as (6), (7) & (8) by provincial office, if necessary	

3. Proposal for Integrated Waste Management

	Contents in Basic Plan	L/As	Province	Remarks
(1)	Basic Information	✓		Chiang Mai Provincial Office with support from central government and external source, conduct capacity building for local authorities in the province as well as develop a format for "Basic Plan for Waste Management (Chiang Mai – Kitakyushu Model)
(2)	Amount & Characteristic of waste	✓		
(3)	3Rs related activities	✓		
(4)	Waste Management	✓		
(5)	Organization for waste management	✓		
(6)	Technologies		✓	Chiang Mai Provincial Office in connection with central government, local authorities in the area and external source update information to be provided to local authorities in city & village level
(7)	Neighboring local authorities		✓	
(8)	Laws, Regulations and Ordinances applicable for the area		✓	

Consideration for introduction of "Kitakyushu Model"



Chiang Mai Provincial Office

Central Government

JCM

External Resource

北九州市 CITY OF KITAKYUSHU

21

3. Proposal for Integrated Waste Management

Central Government

External Resource

北九州市 CITY OF KITAKYUSHU

Chiang Mai Province

Chiang Mai Provincial Office

- ◆ Provincial Waste Management Committee
- ◆ Sub Committee (Proposed to be established for the project)
  - Communication with Local Authorities in the Province & External
  - Capacity Building & Guideline Preparation
  - Operation of Information Center
  - Data Collection (Waste Management in the Area) & Analysis
  - Promotion of 3Rs, Appropriate Processing & Wide Area Processing
  - Research for Technologies / Know-How in Waste Management

(1) Support for Preparation of Basic Plan (Capacity Building / Guideline & Data & Information)
(2) Guide & Supervise Waste Management as per guidance of central government
(3) Coordinate & Promote 3Rs, Appropriate Waste Processing & Wide Area processing

(1) Consultation
(2) Data & Information sharing

Local Authorities in the Area

22

+++ Preparation of Questionnaire to be distributed to & collected from Local Authorities in Province

(Points to Check e.g.)

- How many local authorities in city & village level

1) understand as for current situation of waste management exactly ?
2) understand targets set up by both central government & provincial office ?
3) set up their targets in waste management ?
4) set up target in consistency with those set up by both or either by central government & local government ?
5) Any other targets which are not mandated by the central government or provincial office ?
6) drew & published their development plan ?
7) put those target into their development plan ?
8) drew & published waste management plan ?
9) Put target(s) set up in waste management plan ?

4. Schedule (1)

DATE	SCHEDULE
2017/08/23	1st Seminar for Integrated Waste Management in Chiang Mai - At Chiang Mai Grandview Hotel - 08:30-16:00 - Expecting 200 participants - Hosted by The Governor with Chiang Mai Natural Resource & Environmental Bureau - Director General from Pollution Control Department will participate as representative of MONRE and give a lecture as for Waste Management in Thailand - Introduction of (1) Project, (2) Waste Management in Chiang Mai, (3) Kitakyushu & its waste management, (4) Technologies and (5) JCM by lecturers including those from Japanese Study Team
2017/08/24	Sites visit (site with possibility & potentiality to introduce anaerobic fermentation) - Intakin SAO - Wiang Fang SAO
2017/08/25	Ditto - To be confirmed

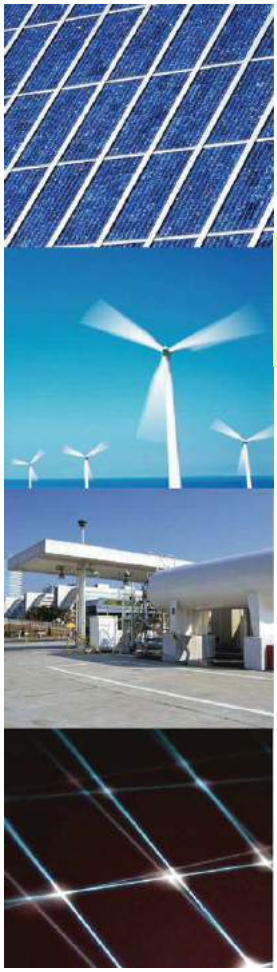
1. Progress of the Project (1) Milestones

Data & Information Collection

- Sep 01 : Progress Report Meeting held at the Ministry of Environment, Japan (Tokyo)
- Nov 6-21 COP23 Bonn, Germany (only the case being invited)
- Dec : 2nd Seminar workshop for the project (Chiang Mai)
  3rd Official Meeting
- Jan : 2nd JCM Workshop in Japan (Kitakyushu & Tokyo)
- Jan : High Level Meeting (only the being invited)
- Feb : Final Meeting for the Project

Reporting & Assessment

THANK YOU



Kitakyushu model for Waste management

Kitakyushu Asian Center for Low Carbon Society, City of Kiakyushu

City located near to other Asian nations, rich in nature, and developed as a manufacturing area

■ **Kitakyushu City**
Population: 977,000 (2010) Area: 487.88 Km²
GDP: 3,430 billion yen (2010)

Rich nature and branded food materials


Karst Plateau Hiraodai


Wakamatsuhoku Beach


Ouma Bamboo Shoots


Kanmon Straits Octopuses


Kokura Beef


Buzen-Sea Oysters


Wakamatsu Special Tomatoes

Major companies in Kitakyushu area


Nippon Steel Corporation


Yaskawa Electric Corporation


TOTO Ltd.


Mitsubishi Chemical Corporation


Toyota Motor Corporation · Nissan Motor Co., Ltd.


Mitsubishi Materials Corporation

Regional resources (Experience with overcoming pollution problems) (1)

Company visit by citizens

Citizens

Partnership

Government

Companies

Reinforcement of restrictions and supervision

Agreement to prevent pollution

Kitakyushu City with recovered environments

1960s

Present

Solution of pollution problems is a starting point for international cooperation on environmental issues.

Transferring the experience of overcoming pollution problems so that developing nations need not repeat the same mistake

Regional resources (Development of international cooperation on environmental issues) (2)

Partnership with other Asian nations for mutual prosperity

Received trainees: 7,453 persons from 150 nations; Dispatched specialists: 175 persons to 25 nations
Promotion of cooperation networking between Asian cities and environmental improvement projects : 67 projects

Kitakyushu Initiative Network
(62 cities in 18 nations)

Water supply project at Phnom Penh

Air pollution survey in Mongolia

Contribution to environmental improvements in Dalian, China
(Dalian City received the Global 500 Award in 2001.)

Exchanged memorandum for cooperation on eco-town with Tianjin City
(At the Prime Minister's official residence)

Driving forward the waste composting project with Surabaya City, Indonesia
(Adopted by over 20,000 families)

Kitakyushu Asian Center for Low Carbon Society

Kitakyushu City was selected as Eco-Model City in 2008

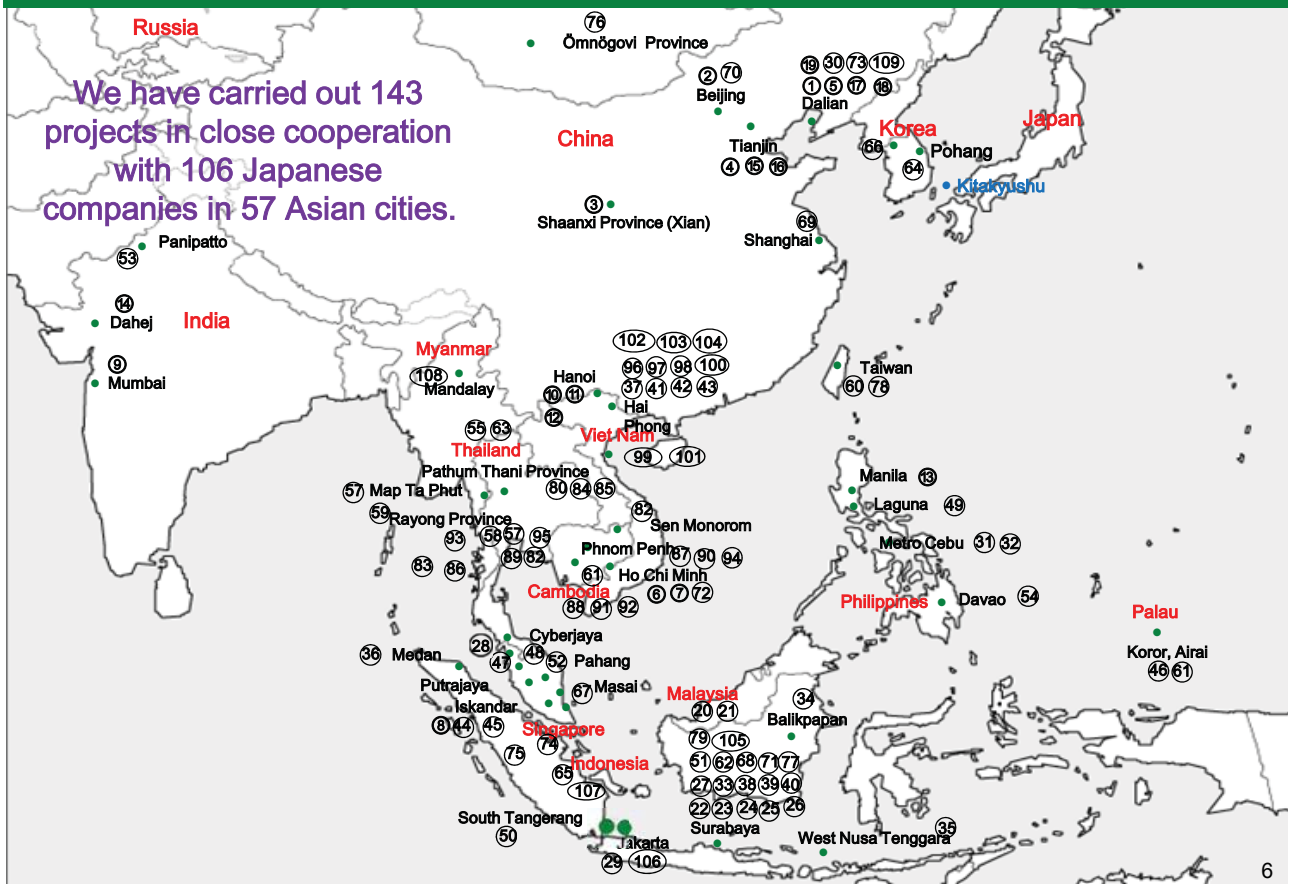
CO2 reduction: -200%(50% in domestic, 150% in overseas) by 2050 based on CO2 emission in 2005

Utilization of the environmental technologies developed through the solution of pollution problems and manufacturing processes, and the City to City network established by international cooperation in the past

Kitakyushu Asian Center for Low Carbon Society opened in June 2010

"Changing the approach from environment cooperation to environment business"

Diverse Project Development Map



Visits by World Leaders

Kitakyushu's actions are the focus of international attention

Xi Jinping
President of PRC
(Dec 2009)

"Kitakyushu's rich experiences in environmental protection and development of advanced technologies deserve to be used as a model for application in China today."

The People's Daily (Dec 17, 2009)

Arkhom Termpittayapaisith
Secretary General, NESDB **(Oct 2013)**


Rayong eco-town to copy Japan lead

Photo courtesy of The Daily NNA

Bangkok Post (Oct. 25, 2013) reported that

"The Kitakyushu eco-town is a good example of communities and factories living together in harmony, while Rayong is home to many industrial factories along the Eastern Seaboard"

" Kitakyushu has become a clear example of development by shifting from heavy to environmental industries."

OECD
BETTER POLICIES FOR BETTER LIVES

OECD Green Cities Programme


Paris, France


Chicago, U.S.A.


Stockholm, Sweden


Kitakyushu, Japan

"Green Growth in Kitakyushu, Japan" issued by OECD in 2013

"Green Growth in Haiphong, Vietnam" issued by OECD in 2017

Thanks to the support of Kitakyushu, the OECD report is being made on ground that Haiphong City is positioned as the Green Gross City in Asia

Support for the Thailand Eco-Industrial Town Concept

Based on the Green Industry Concept, the Eco-Industrial Town Concept aims to create an eco-friendly industrial complex in cooperation with industrial estates, local communities, DIW, and IEAT .

Thailand
National Social and Economic Development Board (NESDB)
MOI | MNRE

Inter-governmental (G-to-G)

Japan
METI, MOE

Support

Department of Industrial Works (DIW)
IRPC Eco Industrial Zone (DIW)
This is the largest petrochemical complex in Southeast Asia. It is owned by IRPC Public Company Limited, a oil refining and petrochemical company, under the umbrella of PTT, the largest energy company in Thailand.

Signing of MoU between DIW, IRPC and City of Kitakyushu

Support

Industrial Estate Authority of Thailand (IEAT)
Map Ta Phut Industrial Estate (IEAT)
An industrial estate established in 1988 with a focus on the heavy and chemical industries, Map Ta Phut IE received a large amount of yen-based loans from the Overseas Economic Cooperation Fund (OECF) of Japan. The estate is well-located near the Port of Map Ta Phut and U Tapao International Airport.

Signing of MoU between IEAT and City of Kitakyushu

Support | Support

Rayong PAO, Rayong City, Map Ta Phut City
Municipal Waste Management
Collaboration with industrial park and community
Energy utilization

Mutual consent between NESDB and City of Kitakyushu

City of Kitakyushu (Asian Center for Low Carbon Society)

Kitakyushu Model
Support tool that has systematically arranged the know-how, experience, and technologies acquired in Kitakyushu's quest to overcome pollution and become an environmentally-advanced city.

Kitakyushu Eco-Town
Japan's largest, leading resource recycling and circulation base. About 30 recycling businesses are being developed or are in operation in Eco-Town.

Kitakyushu Smart Community
Focusing on plant cogeneration, the Smart Community aims to achieve the local supply and local consumption of energy to connect factories and residences.

Kitakyushu – Chiang Mai Cooperation Project: Project Overview

北九州市 CITY OF KITAKYUSHU

"Set up a voluntary Target for GHG emission reduction (-50% for the city and -150% for the Asian countries)"

2000 Kitakyushu Initiative Network（ESCAP）
2008 Selected as Environmental Model City (Green Frontier Plan)
2010 Establishment of Asia Low Carbon Center (Technical Support & Transfer)
2011 Selected as Environmental Future City (set up voluntary target on mitigation)

Letter of Intent (to be signed within 2017) ↕ **City to City Cooperation**

Chiang Mai Province (General Information)

Land Area	20,107㎢
Population(2012)	1,682,382
GPP	THB138,112 m
GPP per capita	THB86,211. -
GPP by sector	Primary (18%)
	Secondary (12%)
	Teriary (70%)
No of Visitor(2011)	19,098,323

(Waste Related Information)

	Cluster	MSW
1	Sansaai	803.10t/d
2	Muang Chiang Mai	677.00t/d
3	Saraphi	267.87t/d
4	Chai Prakan	53.65t/d
	Total	1,801.00t/d

City-City Cooperation between Chiang Mai province & City of Kitakyushu

- Recommendation on city-city cooperation by the Minister of Natural Resources & Environment
- Kitakyushu invited province to JCM city-city workshop (2017)
- Private Sector from the city provides technical support to parties in Chiang Mai (2015-)
- Kitakyushu supported city's 3Rs promotion in Chiang Mai (2010-)
- Kitakyushu received a personnel for six months trainning (2009)
- Kitakyushu invites city to participate in seminars, workshops (2000-)

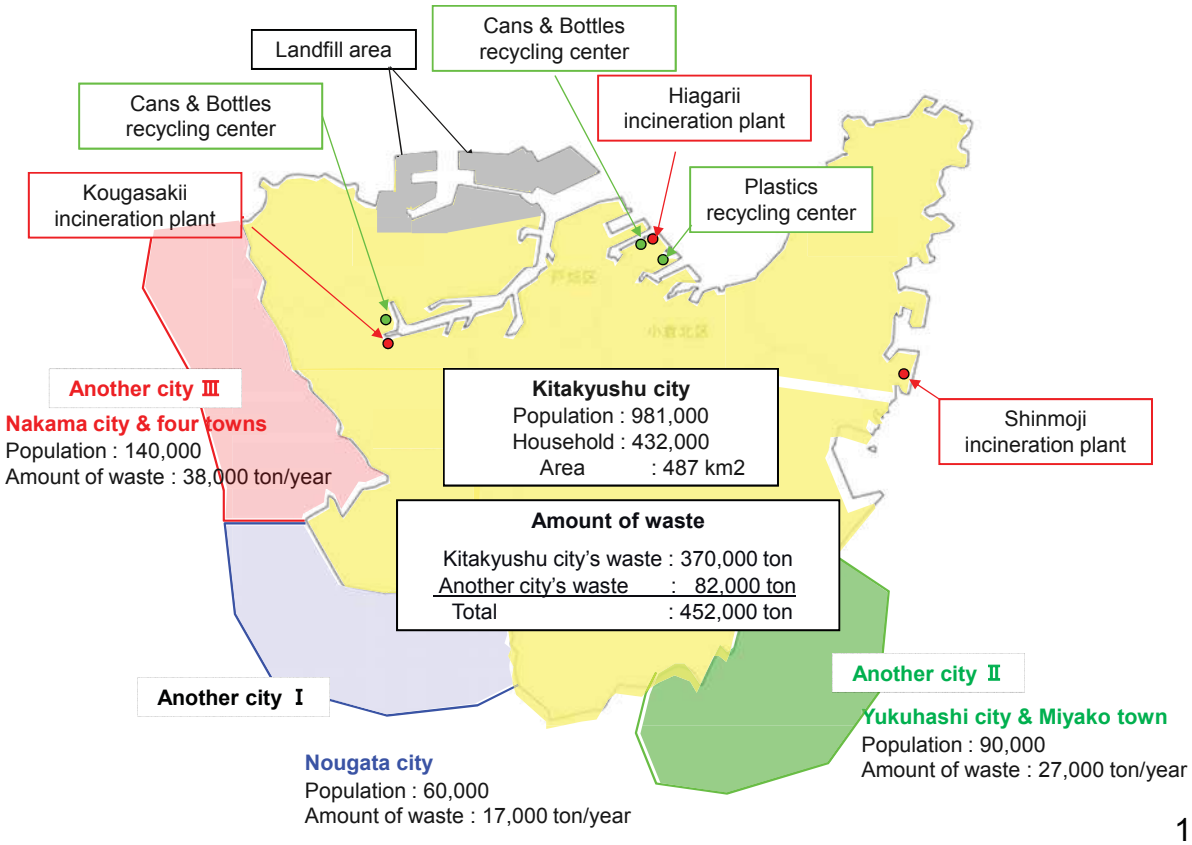
Targeted project in Provincial Development Plan
Chiang Mai province will achieve appropriate waste treatment & disposal by 2019 by 3Rs, efficiency improvement in waste management and appropriate treatment & disposal

Target (JCM) & Activities in the study

Waste Generation | Collection & Transportation | **Intermediate Treatment** | Disposal

- To provide comprehensive support on **Integrated Waste Management** in the area (support each step as waste management shown in above)
- To select suitable technologies (**Japanese Technology with high efficiency**) for **Appropriate Waste Treatment** in Integrated Waste Management in the area
- To select projects with high possibility, including WtE planned by Chiang Mai Waste to Power for feasibility study including JCM registration
- To materialize projects and registered as JCM project

Waste treatment in Kitakyushu City



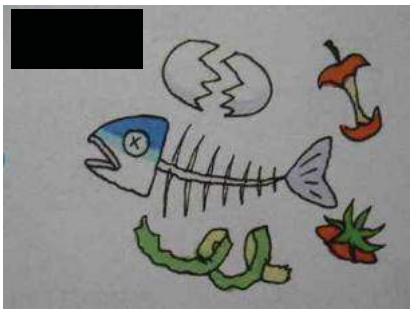
Many kinds of domestic waste in Kitakyushu

Cans and Bottles

PET Bottles

Plastic Containers

Paper



Kitchen Garbage

Others

Waste Collection Point

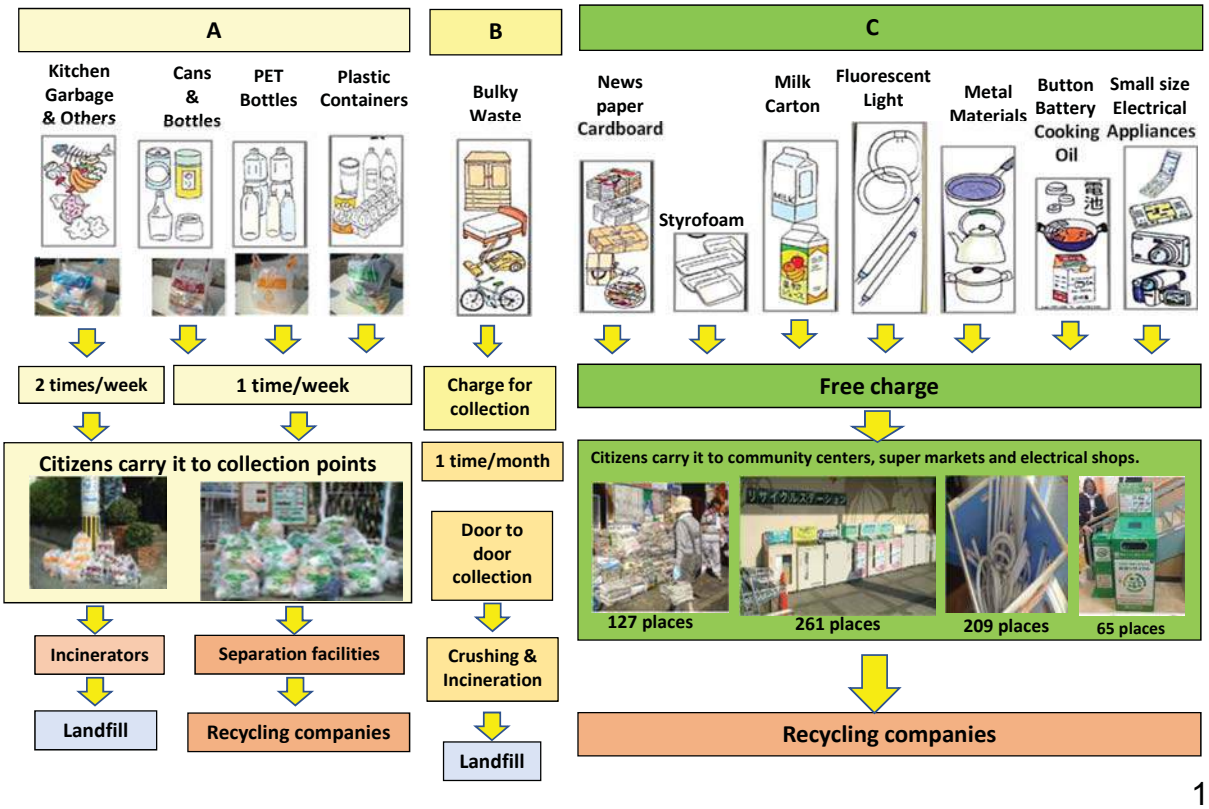
Number of collection point（32,000 points）
One point consists of around 10-15 households
Two times a week collection

Waste Collection of Kitchen Garbage and Others

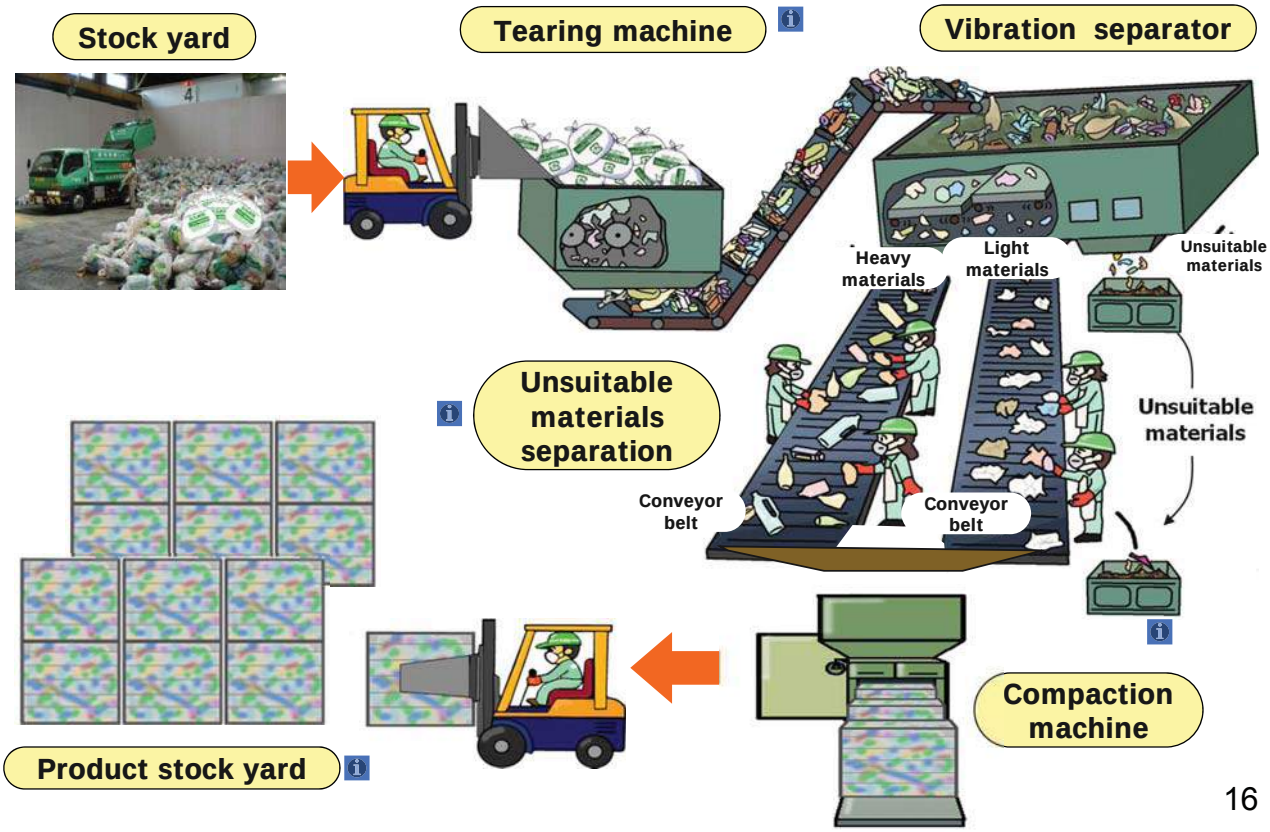
Two times a week collection

The worker sweep the collection point after collection

Waste separation and recycling system in Kitakyushu City



Flow chart of separation in Can &Bottle Recycling Center



After separation

Transparent bottle

Brown bottle

Other bottle

PET bottle

Steel & Aluminum can

Plastic bag

Combustible Waste Incineration Structure

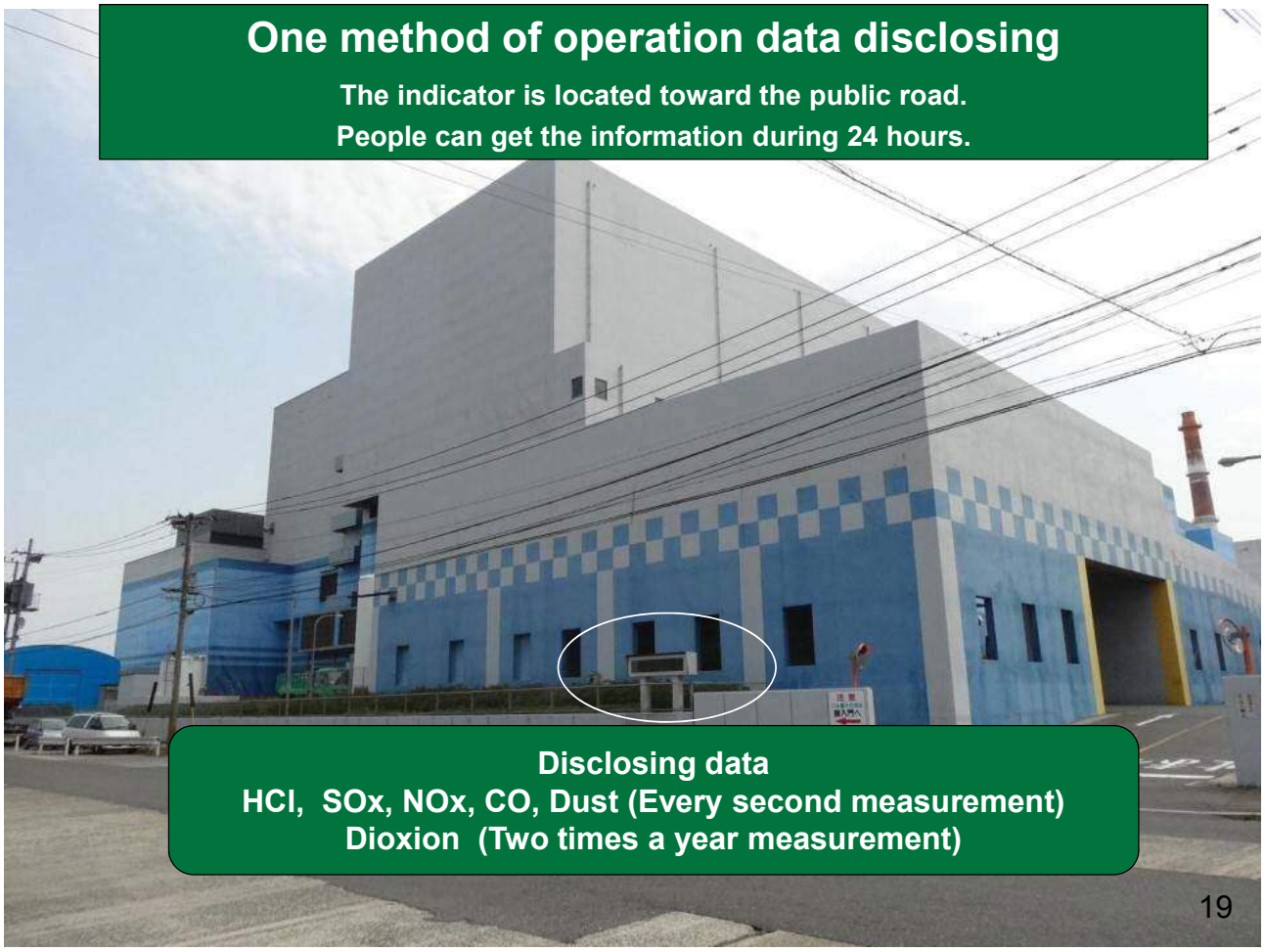
Municipal responsibility

Collection & Incineration & Landfill

900℃ 24hours operation without fuel

One method of operation data disclosing

The indicator is located toward the public road.
People can get the information during 24 hours.



Disclosing data
HCl, SOx, NOx, CO, Dust (Every second measurement)
Dioxion (Two times a year measurement)

How to increase citizen's cooperation for 3R activity.

1. Hold many public meetings for explanation of separation and recycling system.
2. Charge waste management fee for raising citizen's concerning.
3. Set different price between kitchen garbage and recyclables.

※These 2 methods are "Kitakyushu's Challenges", so we can not prove whether it will be applicable or not in Thailand now.

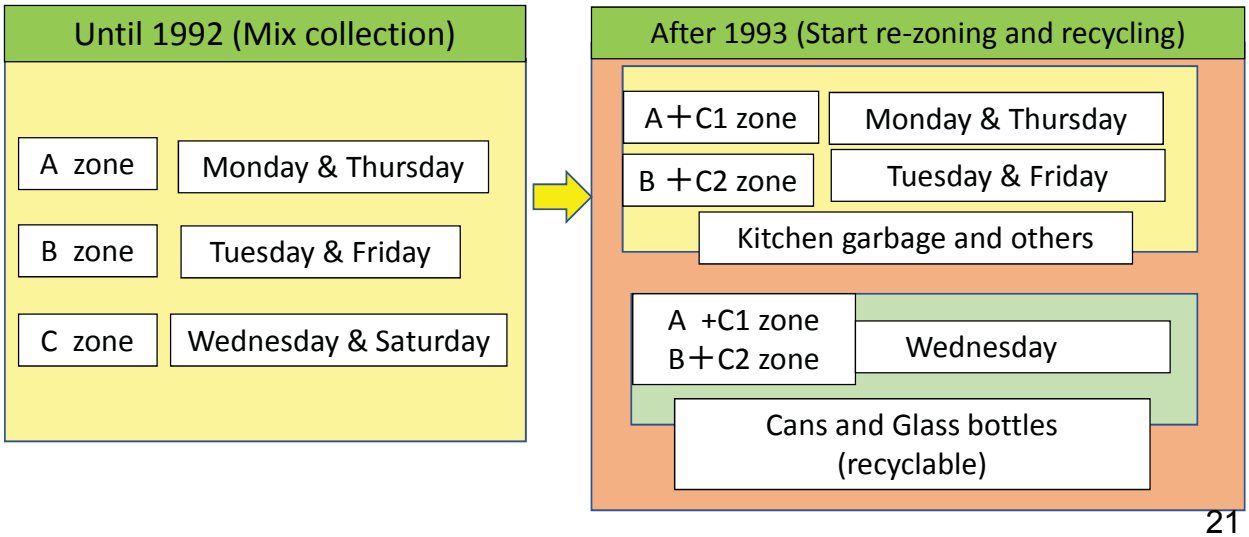
45 liter	50 ¢	45 liter	20 ¢
25 liter	33 ¢	25 liter	12 ¢

However, raising citizen's cost consciousness for waste is very important !!
Proper separation should be given some incentive compared to no separation!!

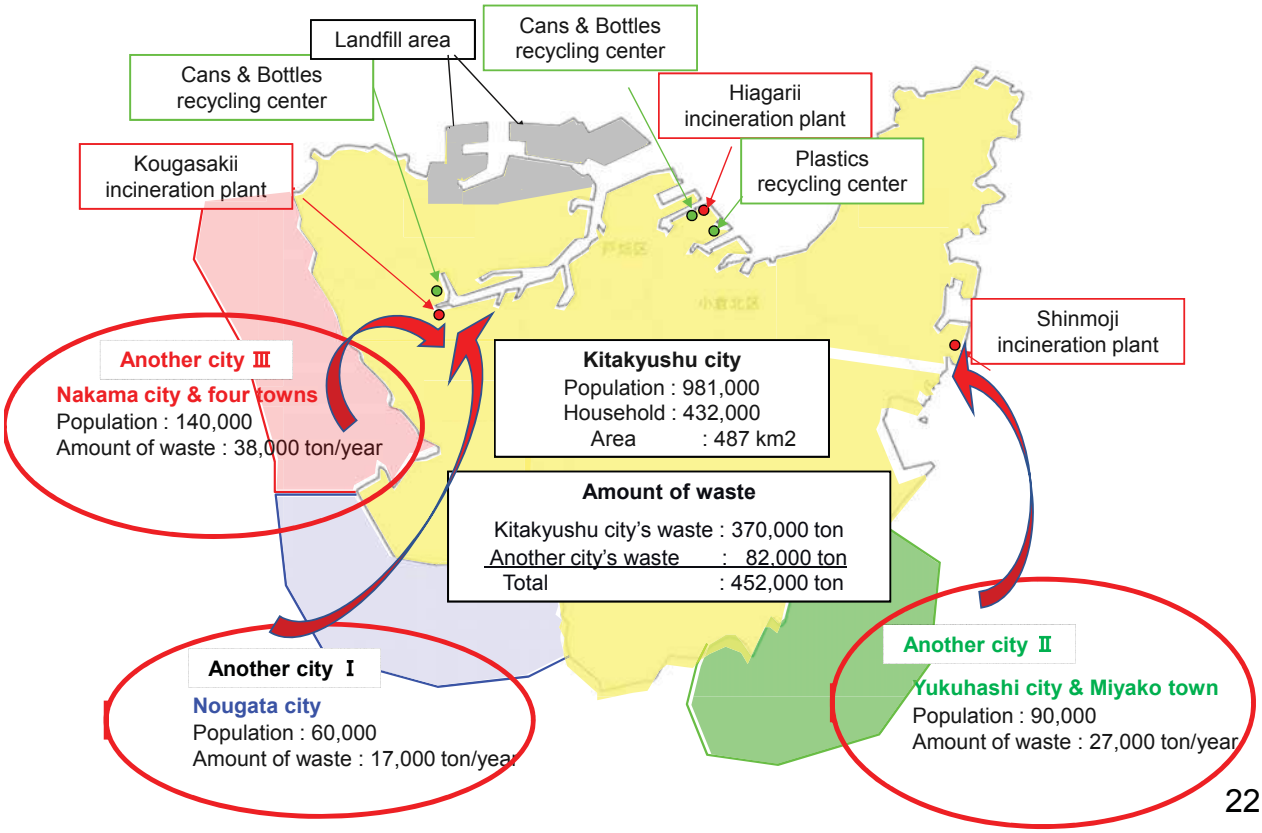
How to reduce cost of waste treatment

Decrease collection frequency for kitchen garbage and others and carry out new recycling system.

① Re-zoning collection area inside city.
② Promoting recycling system to reduce kitchen garbage.
③ Cooperating with private companies.

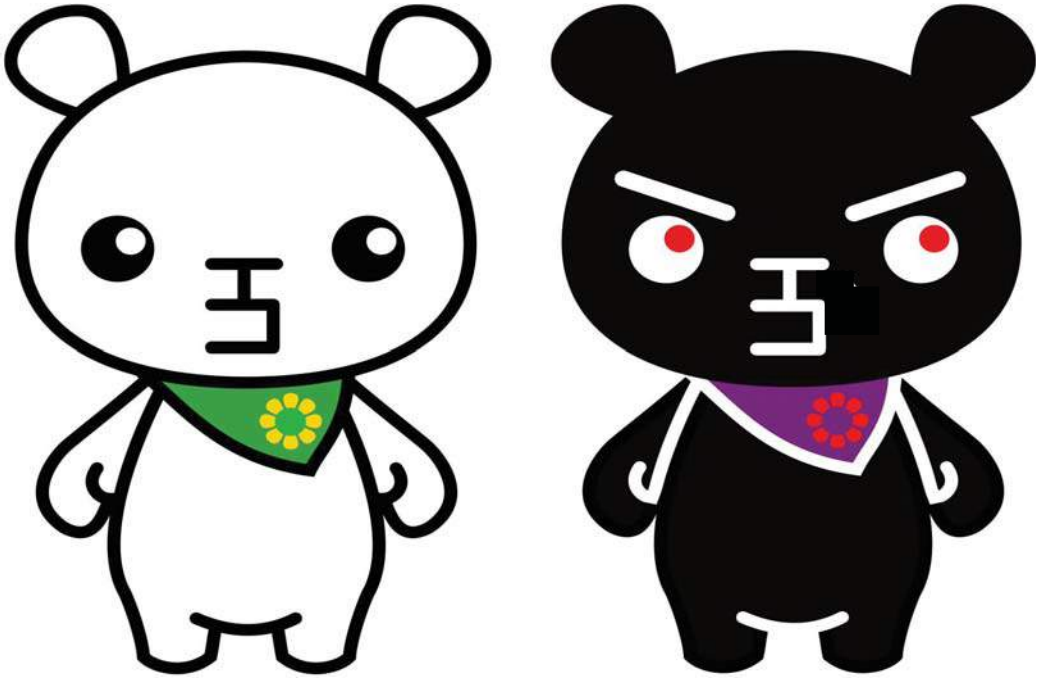


Collaboration with neighbor cities for reduction of total cost



Thank you for your attention

khob khun krab!!



高効率バイオマス発電事業
High Efficiency Biogas Generation System

日本プライスマネジメント株式会社
Price Management of Japan Co., Ltd
吉　赫哲

http://www.price-management.jp/

Comnany Outline

社　　名：日本プライスマネジメント株式会社
代 表 者：代表取締役社長　吉　赫哲
設　　立：2011年6月8日
資 本 金：2,000万円
本社所在地：福岡県北九州市若松区ひびきの 1-8
TEL: 093-691-1177　FAX: 093-695-3499

Office

福岡事業所
〒822-0017 福岡県直方市殿町6-25
TEL: 0949-28-8089 FAX: 0949-28-8859
熊本営業所
〒860-0856 熊本県熊本市中央区妙体寺町8-10 3F
TEL: 096-342-5019 FAX: 096-342-5059
東京営業所
〒104-0033 東京都中央区新川2-8-5 3F
TEL: 0120-552-386

Assosicated Company

（株）日価商事
（株）イナズマラボラトリ
（株）LSB
（株）Engine Techwin

Business Guide

- acid electrolyte products
- earthquake Countermeasures products
- Science device
- Health food
- UV-LED products Development
- Biogas Generating System

バイオガス発電事業

Biogas Generation System

- Outline of Biogas Generation
- Unique technology of PM Japan
- Biogas generation system of PM Japan

Biogas generating system

Plant Type

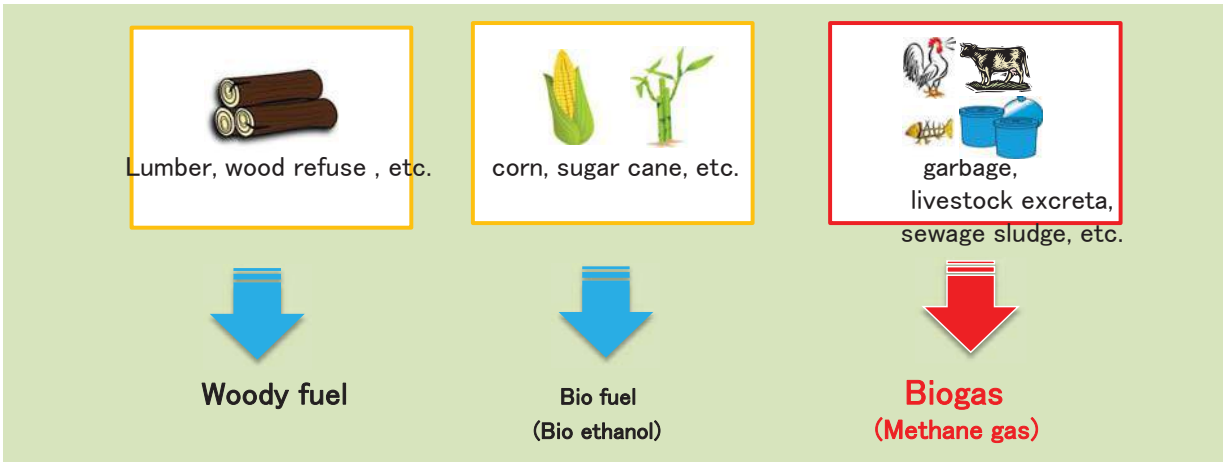
- 4 times by hyper-thermophilic solubilization system
- Return to Methane fermentation liquor
- Solubilization system
- Mid temperature Methane fermentation

Container Type

- Upto 30t/day
- Approximately 3 month to deliver
- Stock and transit of Gas
- Effective in remote island, distant lands and disasters

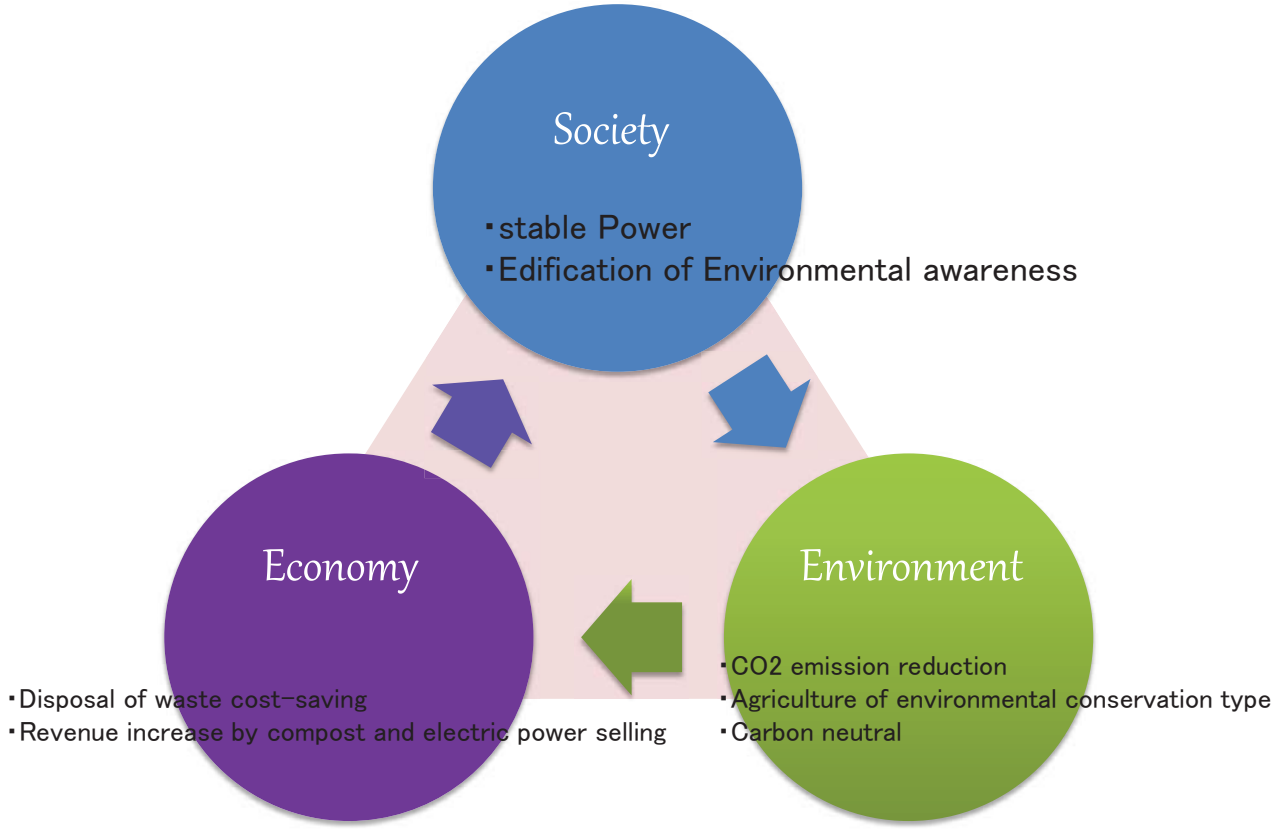
What is Biogas Generation?

Biomass-based Generation



Recycling of organic waste

Merit of Biogas Generation



Feature of PMJ Biogas Generation system

- **4 times as prior art**

  2 times as solubilization

  2 times methane gas

- **return of methane fermentation liquor**

  Realization of Rapidly methane fermentation by no dilution water

  greater energy efficiency by warming liquor reduction

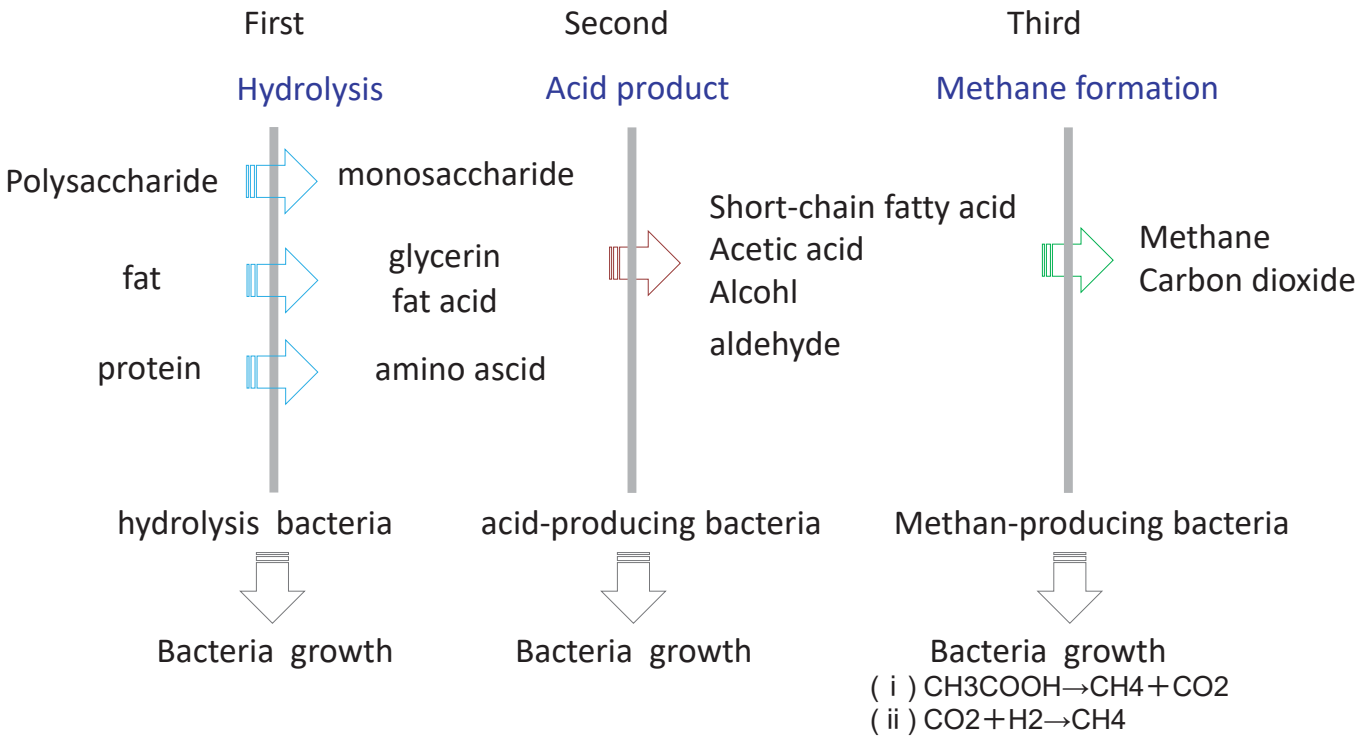
- solubiliztion system

  Improved decomposition rate of solid matter. By reducing the number of pathogenic microorganisms. Removal of ammonia, sand-bath

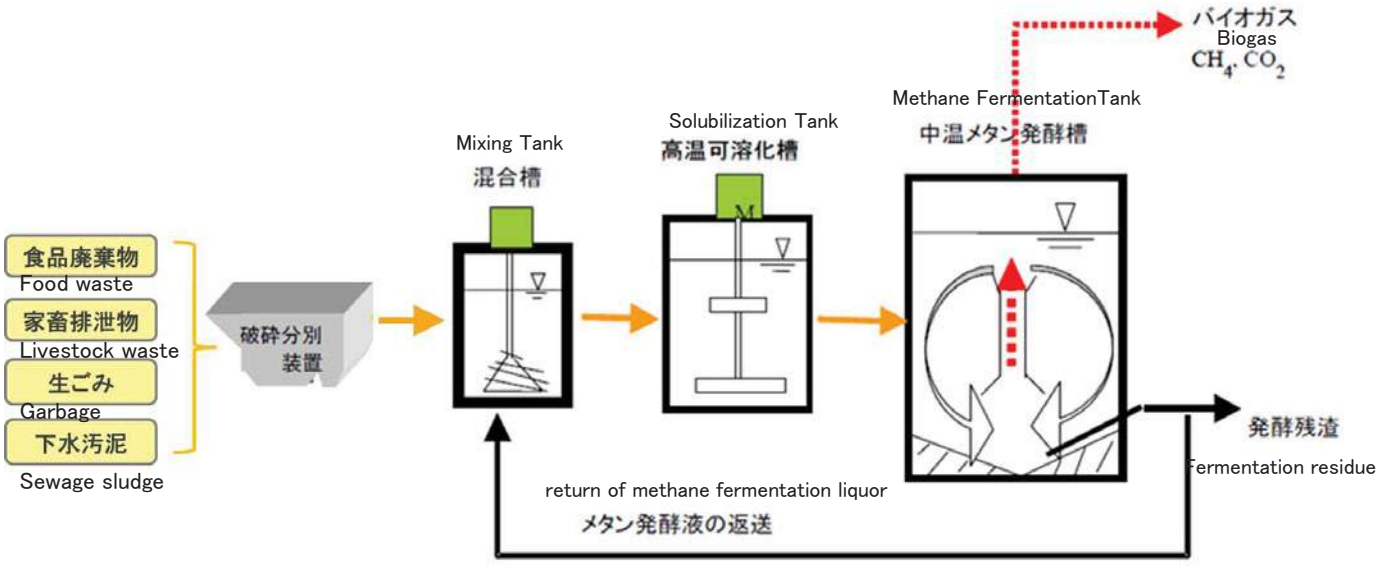
- **High temperature and high concentration methane fermentation**

  Naturally holds the concentration of methane-producing bacteria at high concentration. Stable operation and high decomposition rate (over 95%)

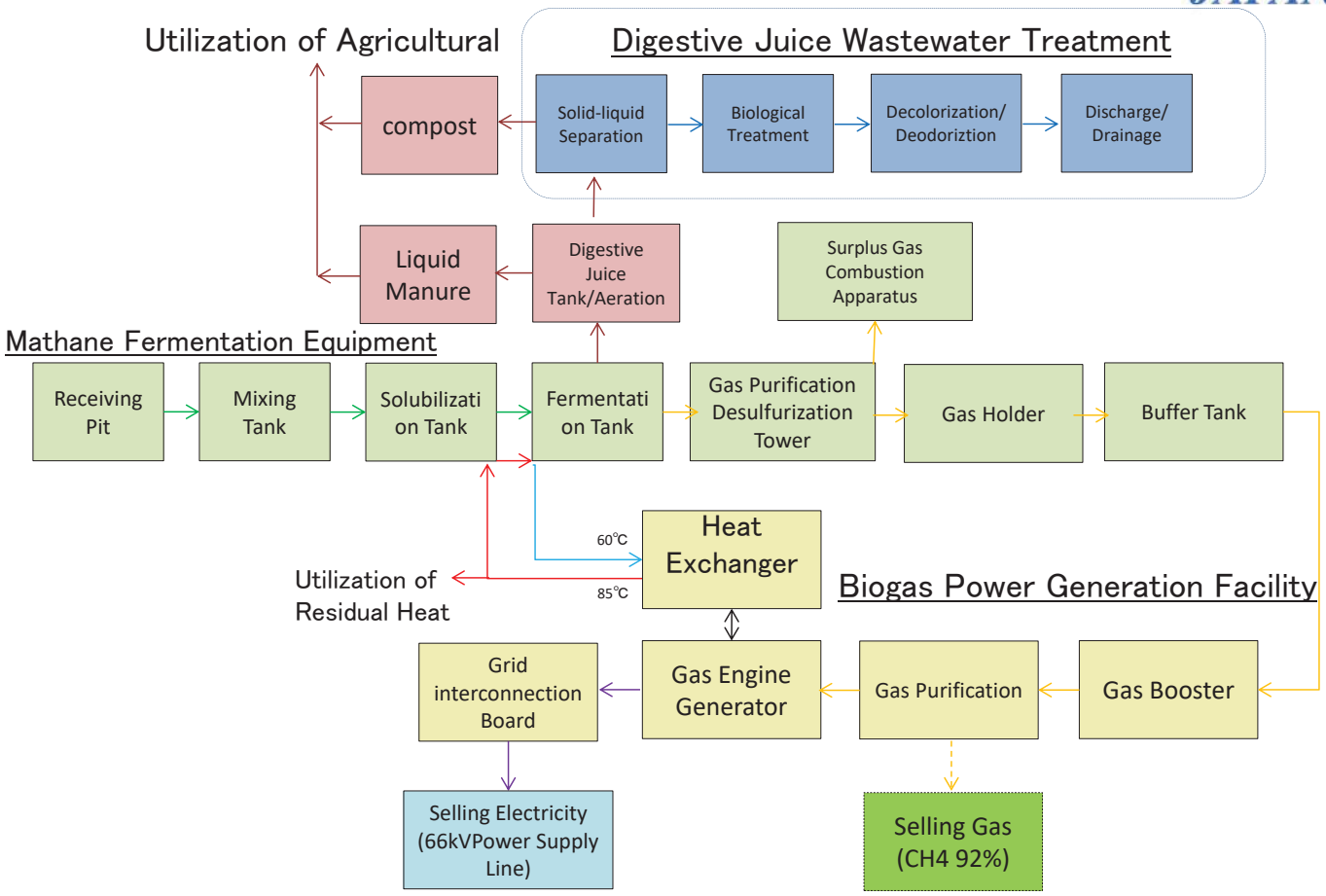
Biogas Generation Process



Summary of Methane fermentation system



Biogas Power Generation Facility Schematic



Unique technology

(Solubilization fungus culture apparatus)

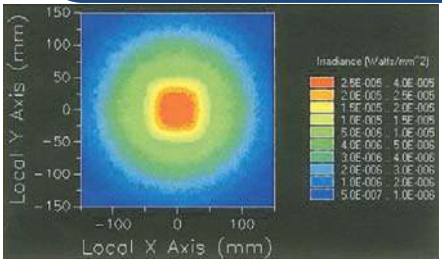
Suppress propagation of various fungus by uv-led light irradiatio

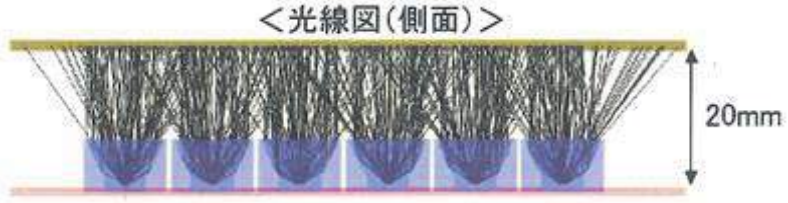
It suppresses the propagation of various funguses and enables the supply of stable solubilization fungus by using uv-led processed water.

特許：第5500488号

特許：第5798645号

***Oceanus* Ⅰ**





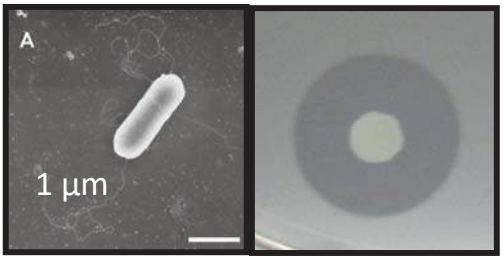
※受光面距離20cm、受光面積30cm×30cm、
光線数10万本/1PKG

Solubilization system

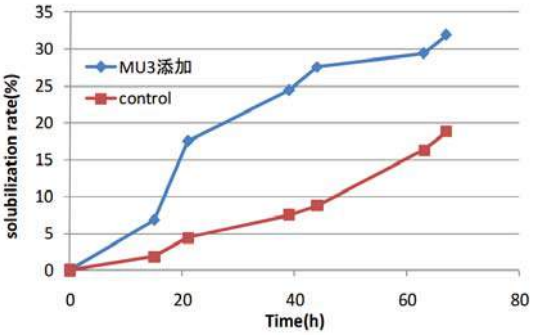
By high-temperature aerobic solubilizing bacteria, 80 ℃
Perform high temperature solubilization under aerobic - high temperature conditions

Anoxybacillus sp. MU 3 strain is a high temperature bacterium isolated in hot spring area Production of heat-resistant protease under aerobic-high temperature condition at 80 ℃

特許：第5749846号
国際特許：WO 2016/047786 A1



***Anoxybacillus* sp. MU3**
Electron micrograph of MU 3 strain and skim milk solubility

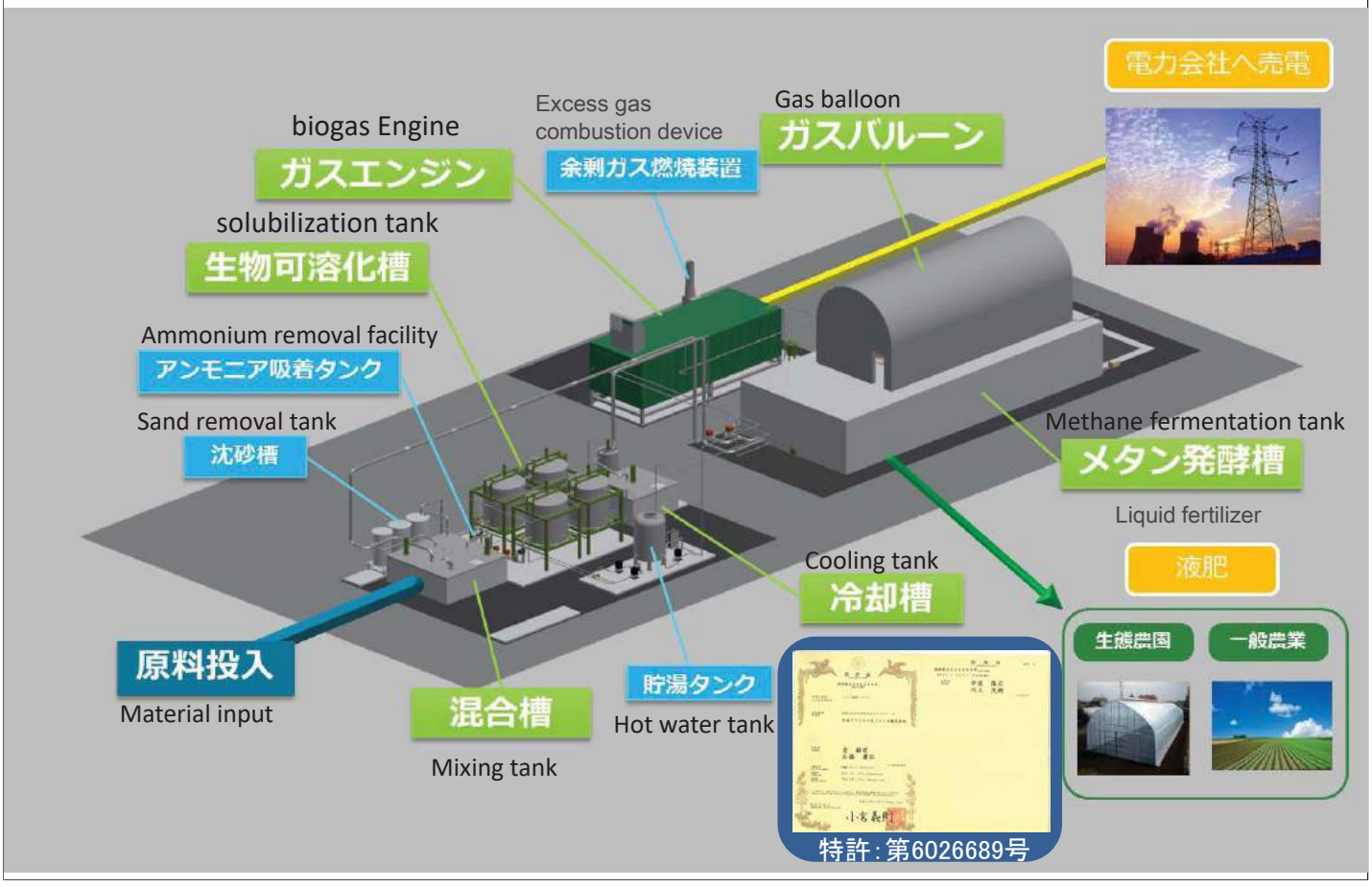


Change in solubilization rate by administration of solubilizing bacteria

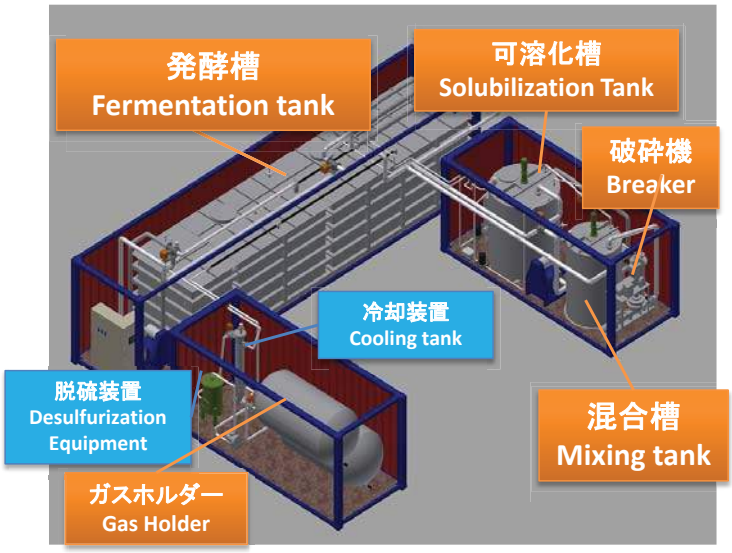
Ability of the enzyme produced by the fungus
- Molecular weight about 57,000
- Excellent heat resistance (can grow at 45 ~ 80 ° C)
- Wide pH range (Optimum pH is around 6)
- High proteolysis

技術提供：熊本県立大学　石橋康弘 教授

Plant type biogas generation sisytem



Container type Biogas generation system



特許：第6026689号

Rough Standard of System

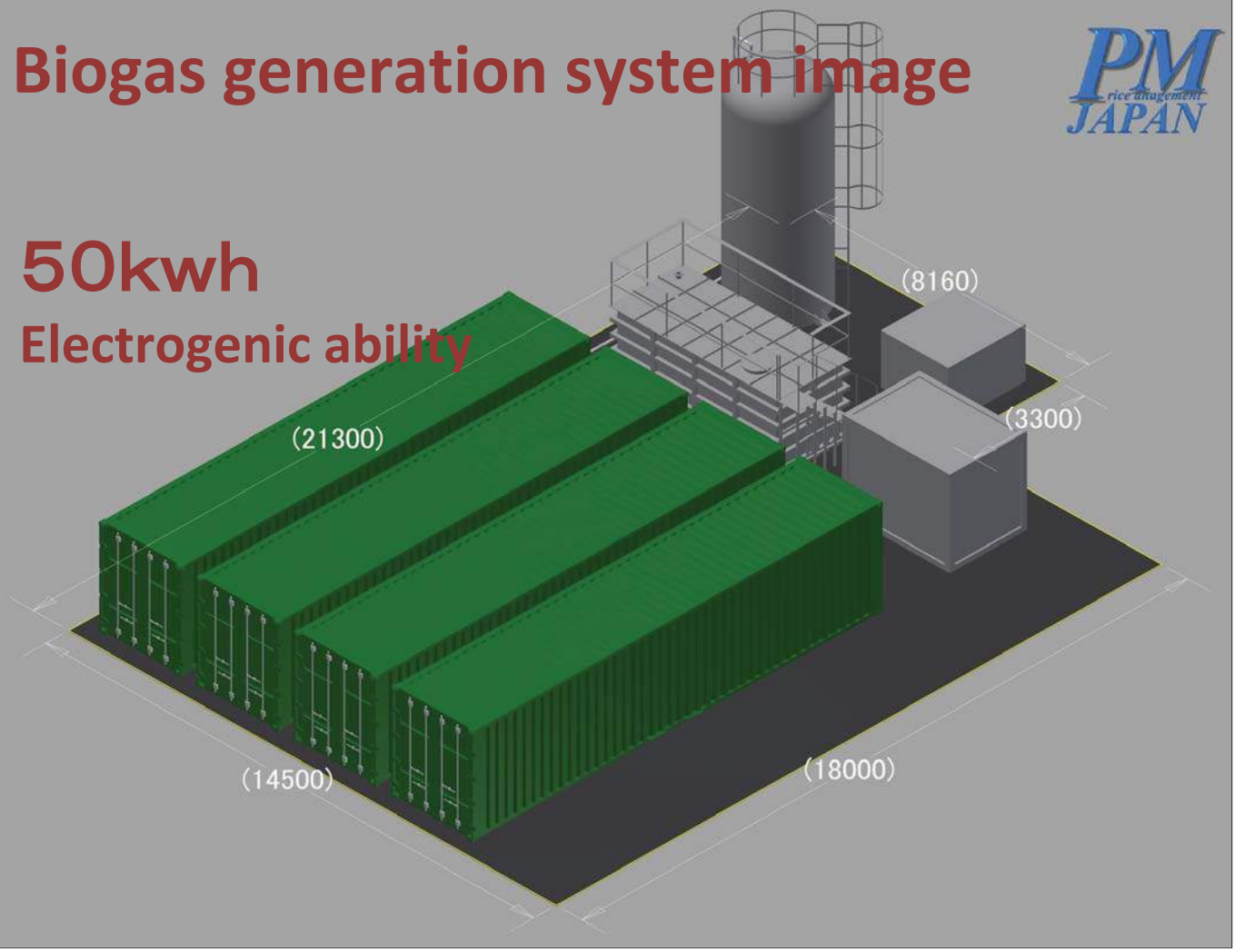
原料処理量（1日当り）	設備規模	発電量 ※1（kWh/日）
2t	2t	～400
2～4t	4t	400～800
4～6t	6t	800～1,200
6～8t	8t	1,200～1,600
8～10t	10t	1,600～2,000

※1 生ごみを原料として用いた場合。

Container transferable

Biogas generation system image

50kwh
Electrogenic ability



How to use waste heat

Waste heat generated during power generation can be used for various purposes!!

It can be used for heating and hot water supply at facilities such as hospitals and nurseries. It can be used for the swimming pool at the hotel and athletic facilities.

It can also be used for agriculture. By using waste heat for the heating used for house cultivation, utility costs can be drastically reduced.

Binary - electricity generation is also possible. Binary power generation is a power generation system that makes steam from a liquid with a low boiling point using a heat source and turns a steam turbine.

Water disposal of Digestive fluid)

Methane fermentation

Fermentation resudue

Solid-liquid separator

Water disposal

Outfall(sewerage/River

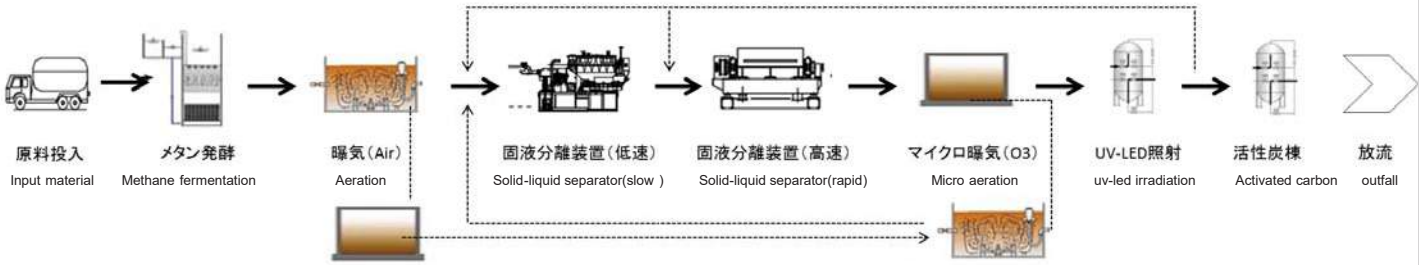
compost/Liquid fertillizer)

throughput

処理量：150m³/d

Livestock manure urine biomass material Water quality diagram (Flow of digestive juice treatment)

原料 material		BBF(消化液) digestive juice		BCS(腐植土) Humus soil		低速 slow		高速 rapid		O3-UV		活性炭	
BOD	30000	BOD	12840	BOD	4866	BOD	3211	BOD	2087	BOD	25	BOD	20
COD	20000	COD	10400	COD	2288	COD	1602	COD	1041	COD	77	COD	61.6
SS	30000	SS	11250	SS	8212	SS	2545	SS	331	SS	225	SS	180
T-N	5400	T-N	1793	T-N	77	T-N	44	T-N	35	T-N	35	T-N	35
T-P	900	T-P	765	T-P	666	T-P	313	T-P	47	T-P	47	T-P	47



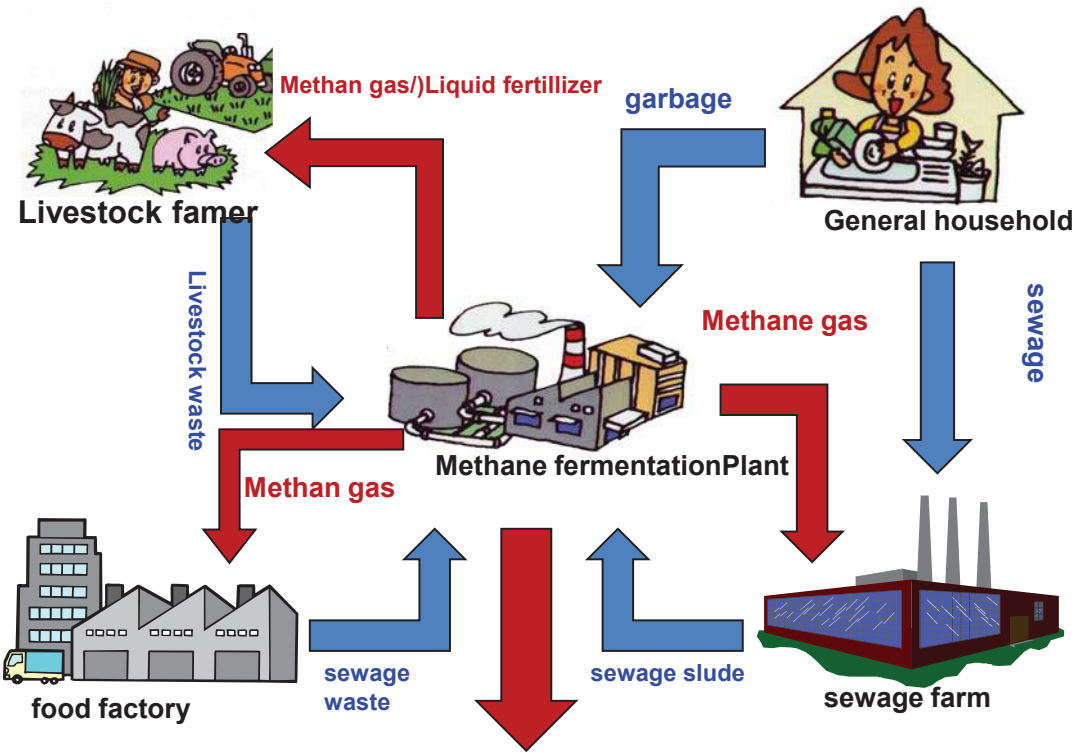
Removal rate 除去率(%)		Removal rate 除去率(%)		Removal rate 除去率(%)		Removal rate 除去率(%)		Removal rate 除去率(%)		Removal rate 除去率(%)	
BOD	57.2	BOD	62.1	BOD	34.0	BOD	35.0	BOD	98.8	BOD	20.0
COD	48.0	COD	78.0	COD	30.0	COD	35.0	COD	92.6	COD	20.0
SS	62.5	SS	27.0	SS	69.0	SS	87.0	SS	32.0	SS	20.0
T-N	66.8	T-N	95.7	T-N	43.0	T-N	20.0	T-N	O	T-N	O
T-P	15.0	T-P	13.0	T-P	53.0	T-P	85.0	T-P	O	T-P	O

含水率 98.9%

日本プライスマネジメント株式会社

Technical Objective

PM rice management JAPAN



Effective use of Methane gas

Than you for listening

日本プライスマネジメント株式会社

〒808-0135　北九州市若松区ひびきの1番8号

TEL：093-691-1177　FAX：093-695-3499

http://www.price-management.jp

Make it possible ???

JCM

（Joint Crediting Mechanisms initiated by the Government of Japan)

EX Research Institute Limited / EXRI ASIA
(a member of Team Kitakyushu)

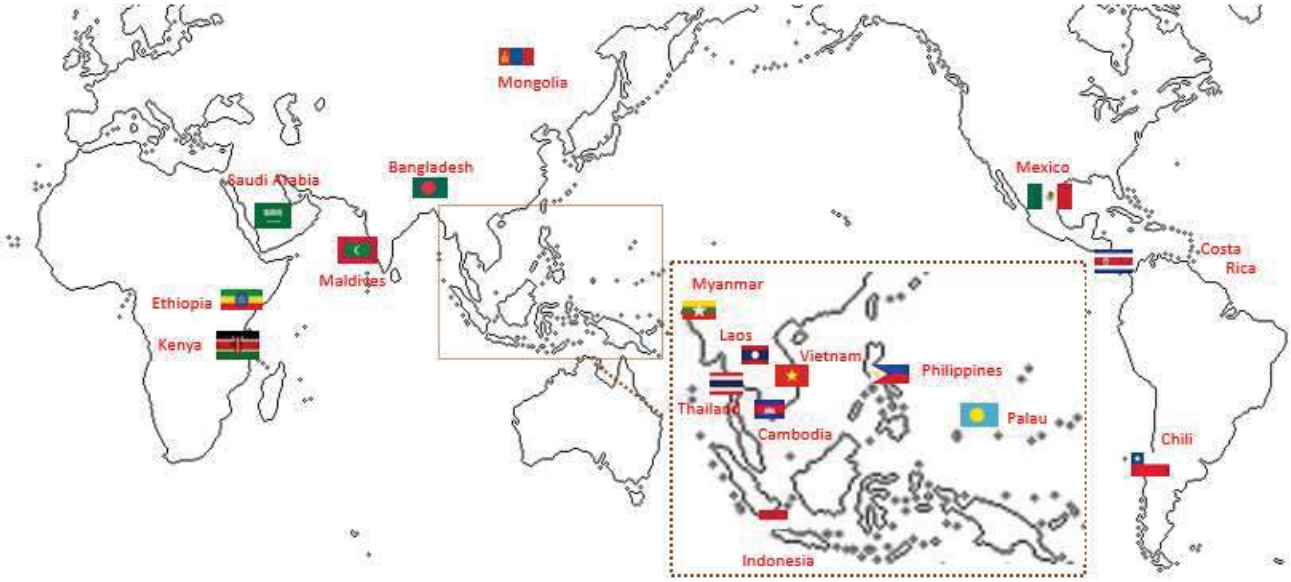
CONTENT

1. What is JCM ?

- A New Mechanism in Climate Change (Mitigation) initiated by the Government of Japan
- Developed with ultimate purpose of realization of NET-Reduction of GHG Emission

1. What is JCM ? (continued from previous slide)

- Administrated by Joint Committee formed by the Government of Japan and that of host country (bilateral base)(17 countries)



1. What is JCM ? (continuous from previous slide)

- Both host country and Japan plan to count GHG emission reduction as a part of INDC submitted to UNFCCC under Agreement
- Financial Support in a form of subsidy to be granted to the Projects, which will contribute for CO2 emission reduction (**JCM Subsidy by the Government of Japan**), is applicable for eligible projects.

Source: UNFCCC

2. Background…issues in the world

Background…framework for international cooperation

Developed Countries

Contribution / Trust Fund

International Organizations

Multilateral Cooperation | **Bilateral Cooperation**

Financial Support / Infrastructure / Technical Cooperation / Disaster Recovery Support / Refugees Support / Human Right Protection / Education / Gender etc.)

Under Developing Countries

South-South Cooperation

Under Developing Countries

Background…International Cooperation in Global Warming / Climate Change

Market Mechanism (COP3 1997)

Developed Countries

Country B — J/I — Country A

CDM

United Nations Framework Convention on Climate Change

- Entered into force in 1994
- 197 parties

- Project (inc. T/A)
- New Mechanism (COP13-)

GLOBAL ENVIRONMENT FACILITY INVESTING IN OUR PLANET

Co-Finance

Contribution & Trust Fund

GREEN CLIMATE FUND

(Operation Entity for Financial Mechanism (COP16 2000))

Entrust

- Mitigation 50% / Adaptation 50% (>50%=LDCs, SIDS & Africa)

Accredited Entities (54)

International (27) (AAFC/ADB/AFDB/AFD/GIZ/ERDB/EIB/FAO/WB/IFC/JICA/KfW/UNDP/UNEP/FAO etc.)

Direct (27)

National (17)

Regional (10)

Under Developing Countries

Framework of Joint Crediting Mechanism

United Nations Framework Convention on Climate Change

- Kyoto Mechanism 1st Commitment Period (2008-2012)
- *Kyoto Mechanism 2nd Commitment Period (2013-2020)*
- Paris Agreement (2020-)

- INDC2030=▲25.4% (2005)
- Consider to count carbon credits generated from JCM as a part

- INDC
- Consider to count carbon credits generated from JCM as a part

Bilateral Agreement on Low Carbon Society

Government of Japan

Host Countries (e.g. Thailand)

Joint Committee

(1) Registration & (2) MRV

(3) Carbon Credit

Case of Applying for JCM Subsidy

(1) Subsidy Application

Special Account for Energy

(2) Subsidy (Grant, <50% of project cost)

(3) Carbon Credit to be generated from Project (>50%)

Project(s)

Projects registered and under registration with Joint Crediting Mechanism

27 projects in total (+ more than 100 projects subsidized & under implementation)

By Sector

- Energy Saving 20
- Renewable Energy 7

By Country

- Bangladesh 2
- Indonesia 10
- Kenya 1
- Laos 1
- Mongol 5
- Palau 3
- Thailand 1
- Vietnam 4

Source: JCM HOME https://www.jcm.go.jp/

How to develop JCM Projects

STEP 1-1. Applicability Check…Feasibility of the Project

1. Economically Feasible ?
2. Project participant(s) is financially stable ?
3. Any barrier and/or difficulty in business establishment (laws & regulation, license & etc.) ?
4. Any impact on socio economic and/or environment ?

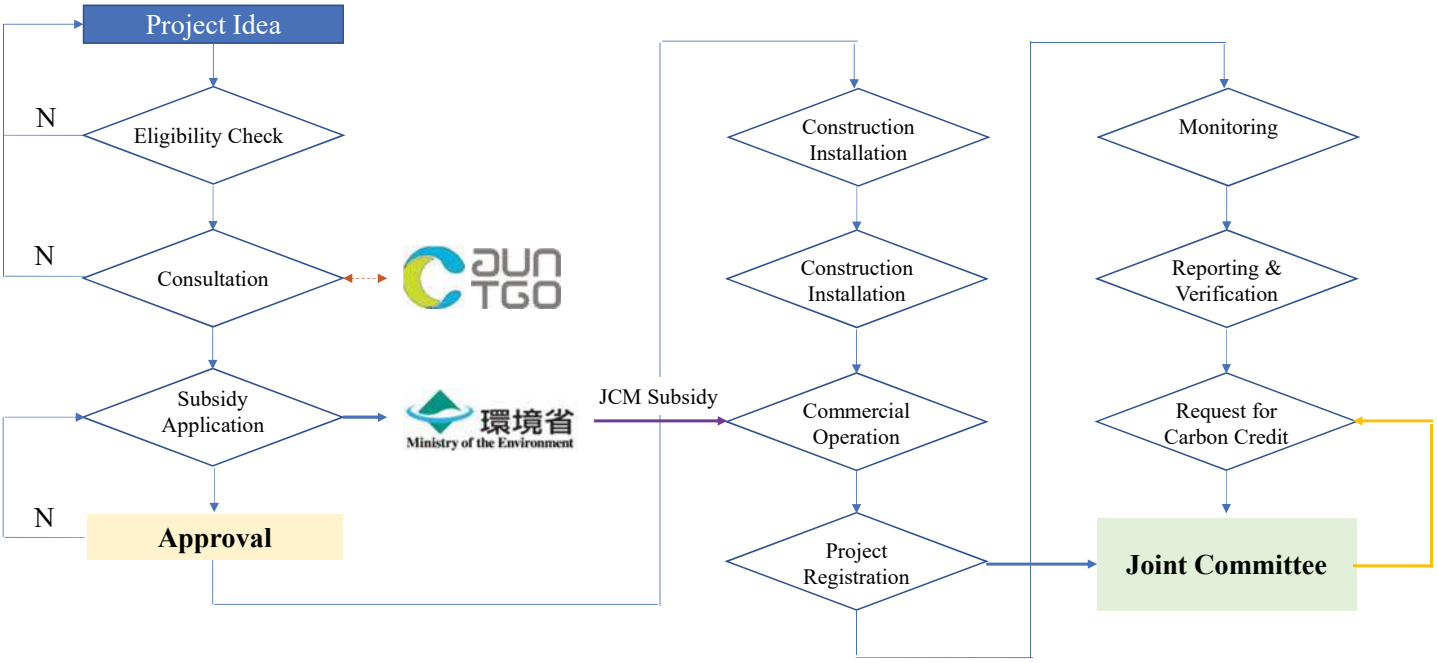
How to develop JCM Projects

STEP 1-2. Applicability Check…JCM Registration & Subsidy

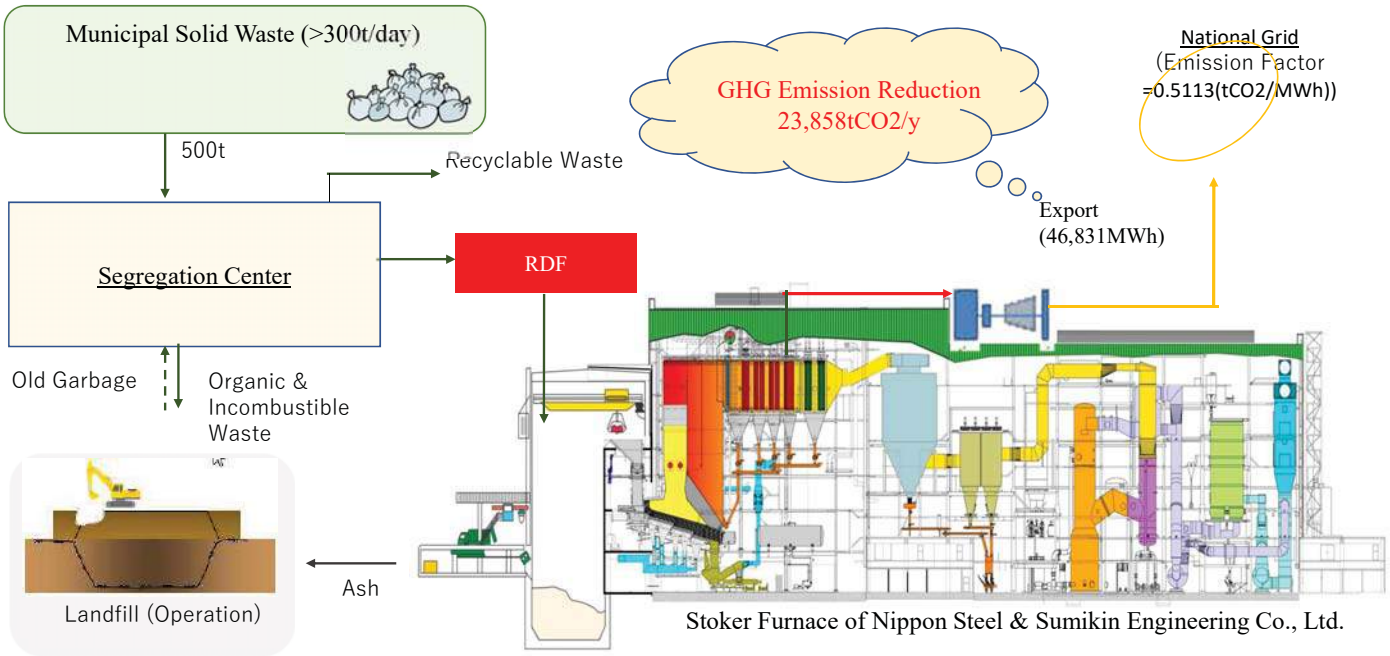
1. GHG (CO_2) emission reduction ?
2. How much GHG (CO_2) can be reduced from project implementation ?
3. With proven cutting edge technology (with high efficiency) ?
4. Any Japanese party ?
5. Proposed project has not yet been started ?
6. Proposed project will start commercial operation within 3 years (after making decision) ?
7. Ability & Capability to communicate with J/C & conduct MRV /
8. Unit cost for GHG emission reduction is preferably less than JPY4,000.-/CO_2t

How to develop JCM Projects

STEP 2. Procedure

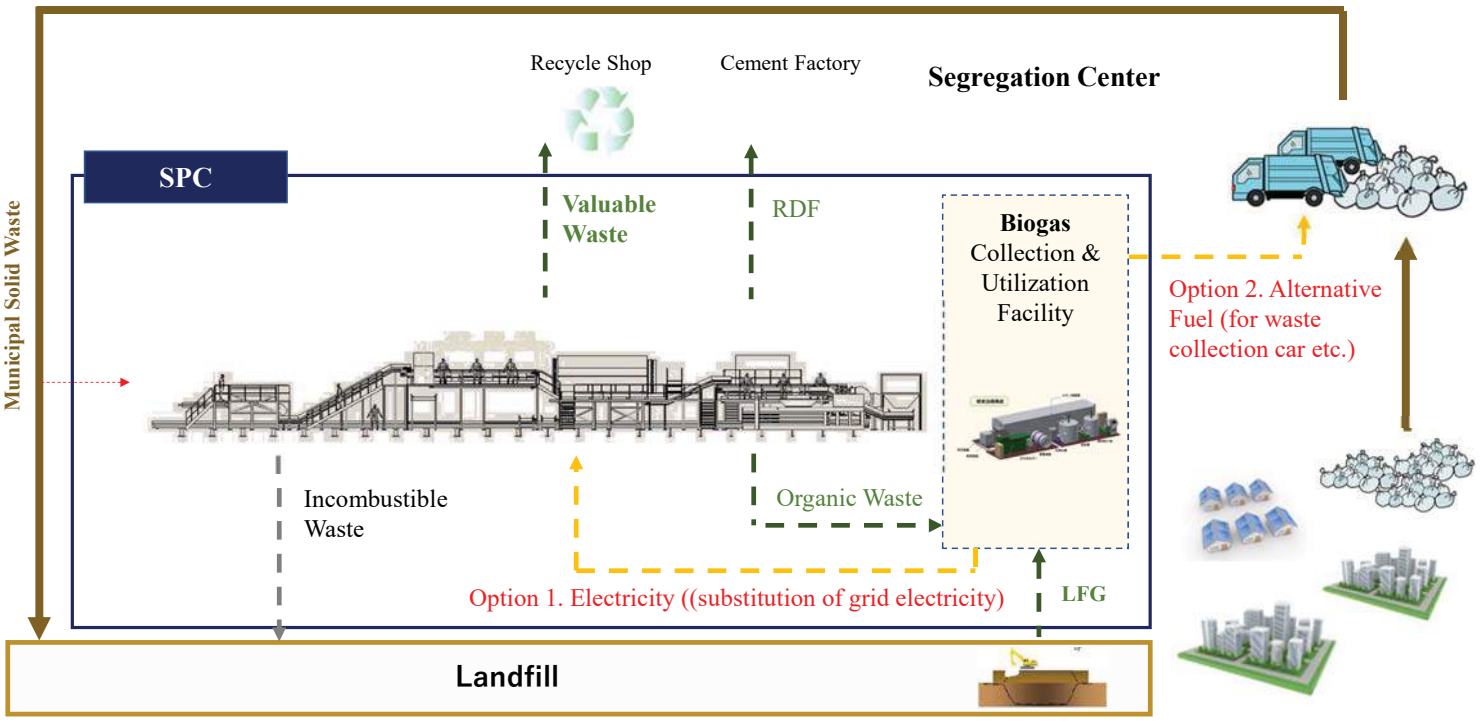


Possible Projects (1) to be developed under JCM (Waste Sector)



Stoker Furnace of Nippon Steel & Sumikin Engineering Co., Ltd.

Possible Projects (2) to be developed under JCM (Waste Sector)



Challenges in development of JCM Projects

1. Income for Business Operation

2. Cost & Expenses
(Initial Investment + Operation & Maintenance)

3. Operation & Maintenance
(with special knowledge & experience ???)

4. More Work + Cost & Expenses in management of JCM registered project

1) Development
2) Subsidy Application
3) Registration (Validation) (once)
4) Monitoring (including installment of measurement units & calibration)
5) Reporting
6) Verification
7) Methodology Development & Registration (once)
8) Corresponding with Joint Committee during project implementation period

Business Models (even with JCM subsidy) in Japan are feasible or not ???

Thank you for your attention

We welcome all of you to participate in
(1) Question & Answer Session 13:30-14:30
(2) Individual Consultation Session 14:30-16:00

Or for further information, please contact to us at
cs@exri.co.th or info@exri.co.th

โครงการ

การจัดการขยะมูลฝอยในจังหวัดเชียงใหม่

ภายใต้ความร่วมมือระหว่าง เมือง-เมือง จังหวัดเชียงใหม่ และเทศบาลเมืองคิตะคิวชู

การประชุมครั้งที่ 3
ที่สำนักงานจังหวัดเชียงใหม่
วันที่ 13 ธันวาคม 2560

จังหวัดเชียงใหม่

北九州市
CITY OF KITAKYUSHU

株式会社 エックス都市研究所
EX Research Institute Ltd.
Environmental and Regional Planning, Research and Consulting

เนื้อหา

1. ความคืบหน้าในการดำเนินโครงการ
(1) สรุปสาระสำคัญของโครงการ
1) นโยบาย และทิศทาง + ความท้าทายในการจัดการขยะมูลฝอย
2) ความร่วมมือระหว่าง เมืองคิตะคิวชู และจังหวัดเชียงใหม่
3) โครงร่างของโครงการ
4) ความคืบหน้าของโครงการ

1. (1) 1) นโยบาย และทิศทางที่จัดตั้งโดยจังหวัดเชียงใหม่ และความท้าทาย

จังหวัดเชียงใหม่

- **จังหวัดสะอาด และจังหวัดสีเขียว**
- **ECO TOWN**

เพื่อความสุขของประชาชน และการท่องเที่ยวอย่างยั่งยืน

การจัดการขยะมูลฝอยในเทศบาล
คือหนึ่งในปัญหาที่มีความสำคัญสูงสุด

- ความท้าทายในการจัดการขยะในจังหวัดเชียงใหม่

- ข้อมูลน้อย / คำแนะนำ / คู่มือ / ระบบ

แหล่งกำเนิดขยะ

พื้นที่	20,107 ตารางกิโลเมตร
ประชากร (2555)	1,735,762
ผลิตภัณฑ์มวลรวมจังหวัด	138,112 ล้านบาท
ผลิตภัณฑ์จังหวัดต่อหัว	86,211 บาท
ผลิตภัณฑ์มวลรวมจังหวัดตามภาค	ปฐมภูมิ (18%)
	ทุติยภูมิ (12%)
	ตติยภูมิ (70%)
จำนวนนักท่องเที่ยว (2554)	19,098,323

- ปริมาณขยะที่เพิ่มขึ้น
- การคัดแยกขยะที่น้อยลง

- การหุ่มตลาดทางกฎหมายและพื้นที่อนุรักษ์
- ไม่มีที่ดินสำหรับการพัฒนาใหม่

- ฝ่ายค้านถิ่นที่อยู่อาศัย

- จุดเก็บรวบรวมน้อย

- ไม่มีคำแนะนำ

- ผสมรวมกันกับขยะมูลฝอยของชุมชน

???

- ไม่มีข้อมูล (ยกเว้นโรงพยาบาล)

1.(1) 2) ความร่วมมือ ระหว่างจังหวัดเชียงใหม่ และเมืองคิตะคิวชู

จังหวัดเชียงใหม่

- Chiang Mai is one of the most popular destinations for the tourist in the world (e.g. ranked 12th for Chinese tourist)

- โครงการอีโค่ทาวน์ เป็นโครงการสำหรับปรับระดับคนในเมือง โดยวิธีที่สมดุลทางสังคม และเศรษฐกิจ รวมไปถึงสิ่งแวดล้อมและวัฒนธรรมด้วยวิธีที่มีประสิทธิภาพสูง และการพัฒนาอย่างยั่งยืน

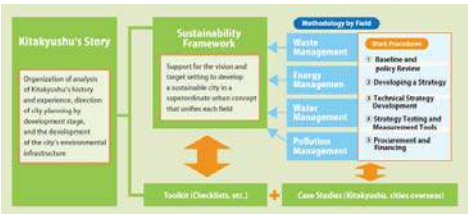
ความร่วมมือระหว่าง เทศบาลเมืองคิตะคิวชู - เชียงใหม่

2000	เมืองคิตะคิวชูเชิญเมืองเชียงใหม่เข้าร่วมสัมมนา
2009	คิตะคิวชูรับพนักงานจากเชียงใหม่สำหรับฝึกงาน 6 เดือน
2010	คิตะคิวชูสนับสนุนโครงการ 3Rs ของจังหวัดเชียงใหม่
2011	รองรัฐมนตรีว่าการกระทรวงทรัพยากรธรรมชาติ และสิ่งแวดล้อม แนะนำทั้งสองด้านว่าเป็นเมืองพี่เมืองน้อง
2015	บริษัทเอกชนของญี่ปุ่นสนับสนุนด้านเทคนิคให้กับบริษัทในเชียงใหม่
2017	คิตะคิวชูเชิญเชียงใหม่เข้าร่วมสัมมนาที่ญี่ปุ่น (คิตะคิวชู) และตกลงร่วมมือที่จะจัดโครงการ อีโค่ ทาวน์ที่เชียงใหม่

北九州市
CITY OF KITAKYUSHU

ตั้งเป้าหมายในการลดก๊าซเรือนกระจกที่ปล่อยสู่อากาศ (-50% ในประเทศ และ -150% ในอาเซียน)

2000-Kitakyushu Model & Initiative Network (ESCAP)



2008 ได้รับเลือกให้เป็นเมืองสิ่งแวดล้อมต้นแบบ
2010 จัดตั้ง Asia Low Carbon Center (สนับสนุนด้านเทคนิค และส่งต่อ)
2011 ได้รับเลือกเป็นเมืองสิ่งแวดล้อมในอนาคต
ตั้งเป้าหมายการลดก๊าซเรือนกระจก

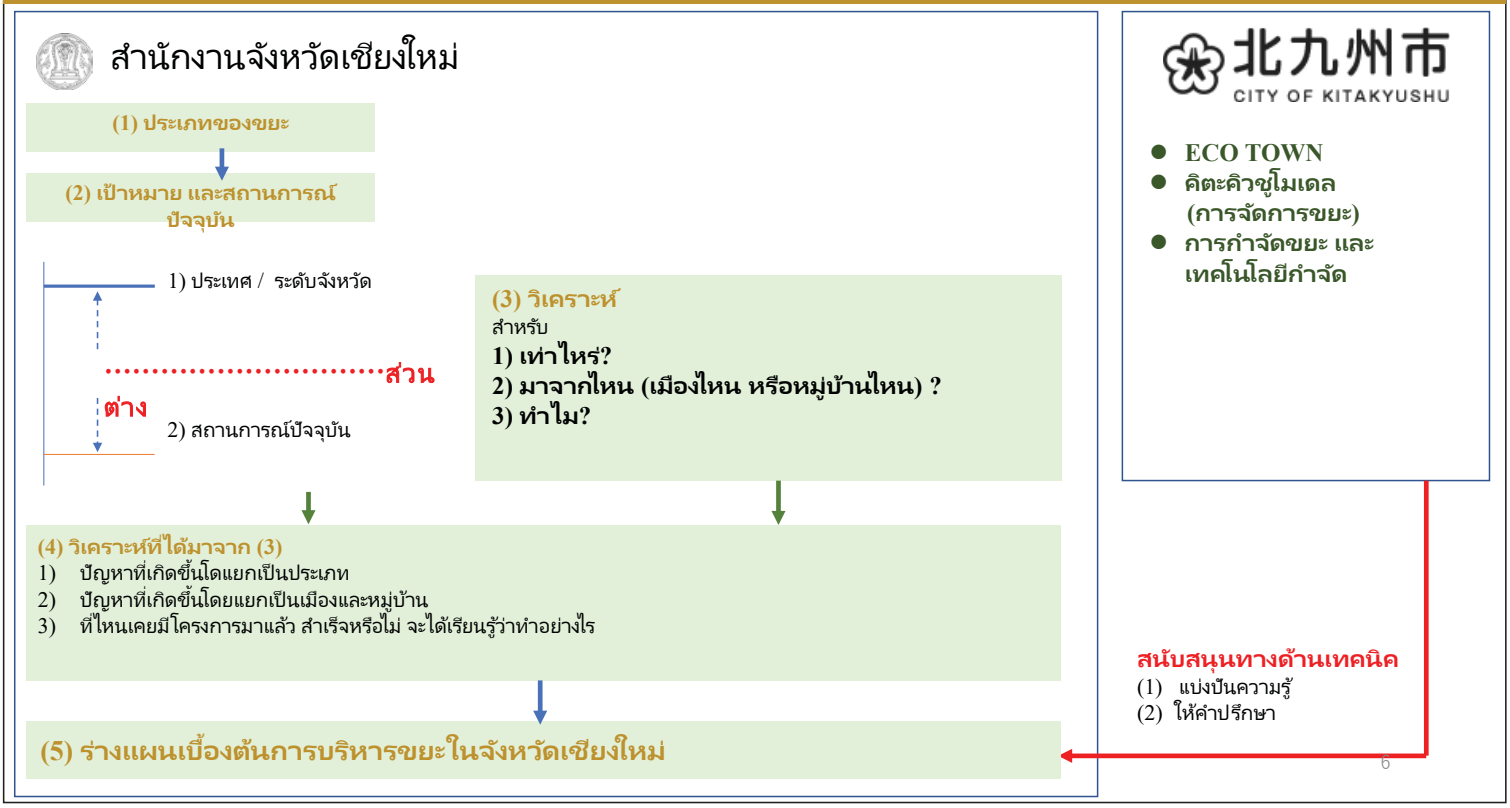
1. (1) 3) โครงร่างของโครงการ (1) สรุป

1. ผู้ว่าราชการจังหวัด เห็นชอบกับข้อเสนอของคณะทำงานตามเอกสารบรรยายที่ใช้ในการประชุมครั้งที่ 1
2. แนวคิดพื้นฐานมีดังต่อไปนี้

เป้าหมาย	1) ขยะมูลฝอยเทศบาล (3RS + การกำจัดขยะโดยวิธีที่ถูกต้อง + การกำจัด) 2) ขยะอันตราย (การกำจัด + การเก็บ + การกำจัดขยะโดยวิธีที่ถูกต้อง) 3) ขยะติดเชื้อ
ขั้นตอนการทำงาน	1) อัพเดทข้อมูล 2) วิเคราะห์ข้อมูล 3) วิเคราะห์ส่วนต่างระหว่างเป้าหมายที่ตั้งไว้กับสถานการณ์ปัจจุบัน 4) ออกแบบเบื้องต้นสำหรับการบริหารขยะ 5) เลือกลำดับโครงการที่สำคัญ (ในปีต่อไป) 6) พิจารณาดำเนินการโครงการใน JCM 7) แชร์ข้อมูลความรู้แก่ผู้ที่เกี่ยวข้องในจังหวัดเชียงใหม่ รวมถึงผู้เข้าร่วมสัมมนา
ผลงาน	1) ร่างแผนเบื้องต้นบริหารขยะรวมถึงแผนการปฏิบัติที่จะนำเสนอ

3. สำนักงานจังหวัดเชียงใหม่วางโครงการเป็นเครือข่ายภายนอกสำหรับการจัดการขยะ โดยคณะกรรมการบริหารจัดการขยะมูลฝอยจังหวัดเชียงใหม่.
4. ร่างแผนเบื้องต้นการบริหารขยะเป็นส่วนหนึ่งของแผนแม่บทบริหารขยะในจังหวัดเชียงใหม่
5. สำนักงานจังหวัดเชียงใหม่ และเทศบาลเมืองคิตะคิวชู จะพิจารณาในการดำเนินการโครงการปีหน้าต่อไปจากผลงานที่ได้มาในการปฏิบัติในปีนี้ (รวมทำสัญญา MOU หรือ LOI)

1 . (1) 3) โครงร่างของโครงการ (2) Work Flow



1. (1) 4) ความคืบหน้าของโครงการ (1) เหตุการณ์สำคัญ

2560: พ.ค. | มิ.ย. | ก.ค. | ส.ค. | ก.ย. | ต.ค. | พ.ย. | ธ.ค.
2561: ม.ค. | ก.พ.

- 16 พ.ค. : เปิดการประชุมที่กระทรวงสิ่งแวดล้อม ประเทศญี่ปุ่น (โตเกียว)
- 28 มิ.ย. – 1 ก.ค. : เริ่มการประชุมครั้งที่ 1 ในประเทศไทย
  - การประชุมอย่างเป็นทางการระหว่างสำนักงานจังหวัด และเมืองคิตะคิวชู
  - การประชุมอย่างเป็นทางการระหว่างสำนักงานจังหวัด, เทศบาล และเมืองคิตะคิวชู
  - เยี่ยมชมการบริหารจัดการขยะมูลฝอย
- 24-28 ก.ค. : การประชุมเชิงปฏิบัติการ JCM ครั้งที่ 1 ในญี่ปุ่น (Kitakyushu & Kawasaki)
- 21-26 ส.ค. : คณะจากทางญี่ปุ่นเดินทางมาเชียงใหม่ ครั้งที่ 2
- 23 ส.ค. : การสัมมนาครั้งที่ 1การจัดการขยะมูลฝอยแบบบูรณาการในจังหวัดเชียงใหม่
- 24-25 ส.ค. : เยี่ยมชมสถานที่ (อินทขิล และเมืองงาย))
- 11-15 ธ.ค. : คณะจากทางญี่ปุ่นเดินทางมาเชียงใหม่ ครั้งที่ 3
- 12 ธ.ค. : การสัมมนาเชิงปฏิบัติการครั้งที่ 2 การจัดการขยะมูลฝอยแบบบูรณาการในจังหวัดเชียงใหม่
- 13 ธ.ค. : การประชุมอย่างเป็นทางการครั้งที่ 3

การเก็บรวบรวมข้อมูล

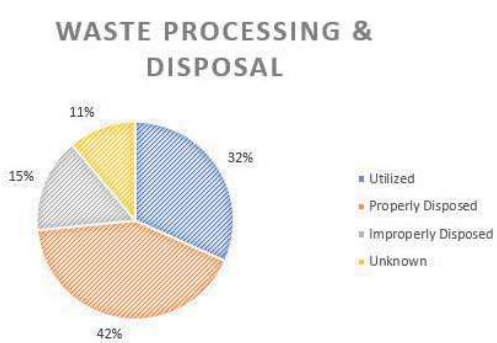
การรายงานและประเมินผล

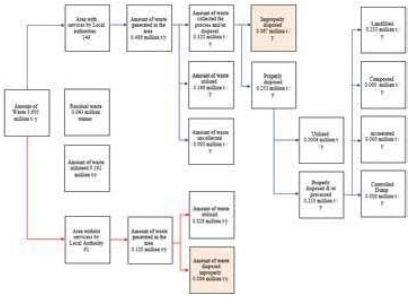


1. (1) 4) ความคืบหน้าของโครงการ (2) ข้อมูลพื้นฐานของขยะในจังหวัดเชียงใหม่ (พ.ศ. 2559)

ข้อมูลการจัดการขยะมูลฝอยในจังหวัดเชียงใหม่ (เผยแพร่)

จำนวนการปกครองท้องถิ่น	210 แห่ง (149/61)
ปริมาณขยะมูลฝอยชุมชน	605,351.16 ตัน / ปี
ปริมาณของเสียไปใช้ประโยชน์และ / หรือนำกลับมาใช้	191,911.28 ตัน / ปี (31.7%)
ปริมาณของขยะมูลฝอยที่กำจัดอย่างถูกต้อง	253,001.41 ตัน / ปี (41.8%) (รวมขยะรีไซเคิล 456.25 ตัน / ปี)
ปริมาณของขยะมูลฝอยที่กำจัดไม่ถูกต้อง	160,894.72 ตัน / ปี (26.6%)
ปริมาณของขยะเก่า	42,978.96 ตัน
ไม่มีสถานกำจัด	





มีรายงานรวมถึงสถิติในภาคขยะ แต่ ...

ยากที่จะจัดการและดูแลโดยไม่มีข้อมูลที่แน่นอน

1. (1) 4) ความคืบหน้าของโครงการ (3) ปรับปรุงการจัดการขยะในจังหวัด

สัมมนา (ประกาศ)


- การสัมมนาครั้งที่ 1 สำหรับโครงการเพิ่มประสิทธิภาพการจัดการขยะมูลฝอย ภายใต้โครงการ ECO TWON ในจังหวัดเชียงใหม่ (23 สิงหาคม 2560)

สำรวจพื้นที่ I & II



- บางส่วนของหลุมฝังกลบที่ตั้งอยู่ภายในพื้นที่ป่า และถูกบังคับให้ปิดตัวลงภายใน ?? ปี
- ไม่มีพื้นที่สำหรับการพัฒนาสิ่งอำนวยความสะดวกใหม่ (L/Fs)

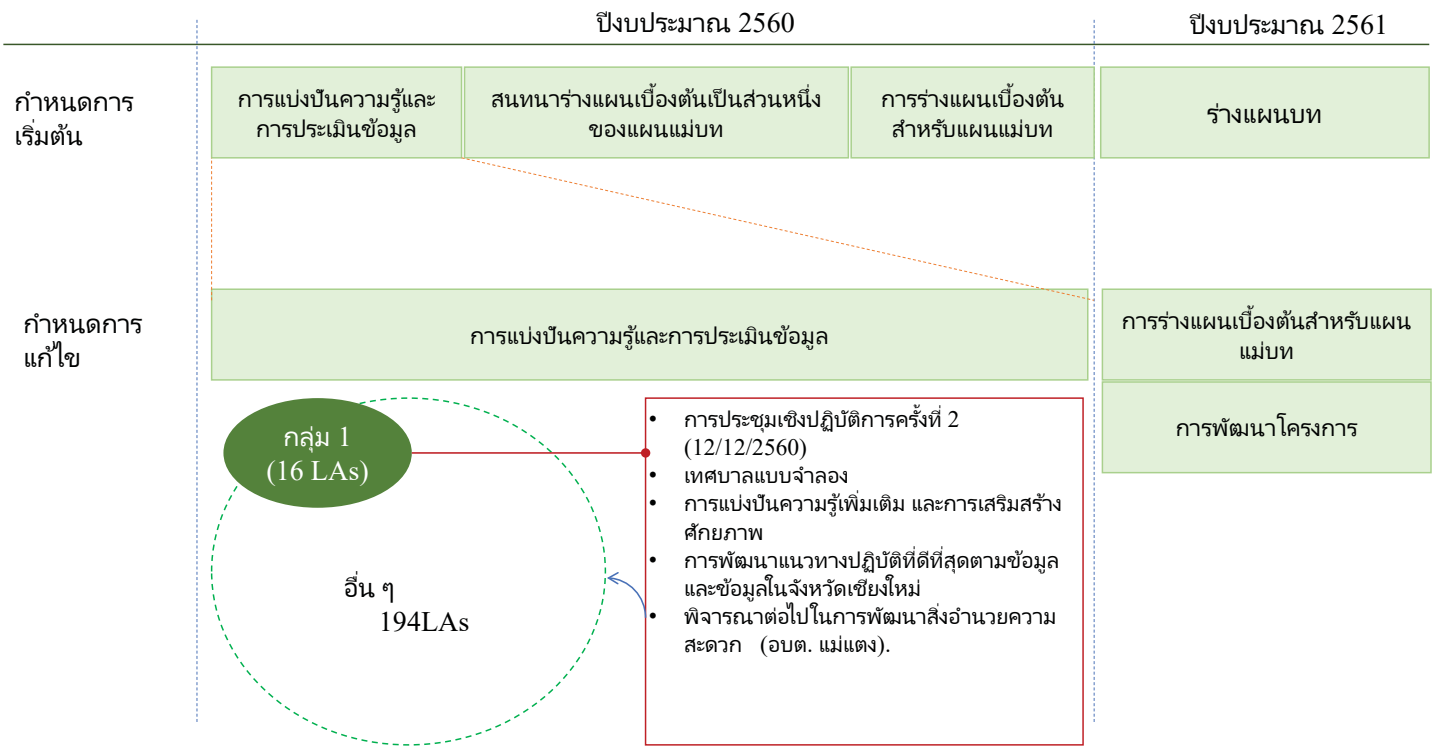
แบบสอบถามการสำรวจ

(1) แบบสอบถามสำหรับการจัดการขยะ และ (2) แบบสอบถามสำหรับโรงงานแปรรูปของเสีย (Biogas Digester)

ผลจากการสำรวจ

- บางหน่วยงานท้องถิ่นมีความกระตือรือร้นในการปรับปรุงการจัดการขยะของพวกเขาในพื้นที่ ในขณะที่ส่วนใหญ่ประสบปัญหาที่ยังไม่ชัดเจนเนื่องจากสาเหตุต่าง ๆ เช่น การขาดทรัพยากร (การเงิน, กำลังคน)
- บางคนดูเหมือนไม่กระตือรือร้นปรับปรุงการจัดการของเสียในพื้นที่ของตน
- ไม่มีระบบการเก็บรวบรวมข้อมูลที่แน่นอนในพื้นที่

1. (1) 4) ความคืบหน้าของโครงการ (4) ทิศทางของโครงการ



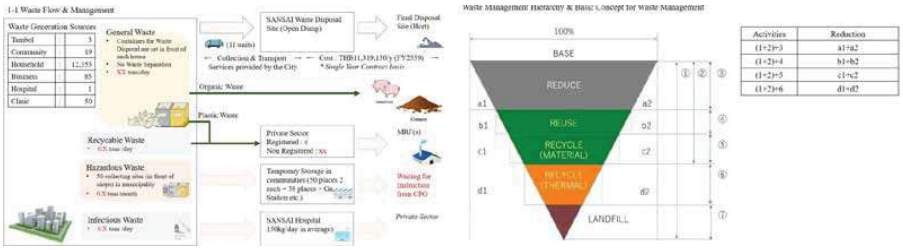
1. (1) 4) ความคืบหน้าของโครงการ (5) ในจังหวัด

การประชุมเชิงปฏิบัติการครั้งที่ 2

สถานที่	มหาวิทยาลัยเชียงใหม่	วันและเวลา	09:30-วันที่ 12 ธันวาคม 2560
ผู้เข้าร่วม	(1) ตัวแทนจากเมืองคิตะคิวชู และทีมงานวิจัย (2) ตัวแทนจากเจ้าหน้าที่ท้องถิ่นในจังหวัดเชียงใหม่ (3) ตัวแทนจากองค์การความร่วมมือระหว่างประเทศของญี่ปุ่น (JICA) (4) ตัวแทนจากกรมควบคุมมลพิษ (5) สำนักงานจังหวัดเชียงใหม่ (6) มหาวิทยาลัยเชียงใหม่		

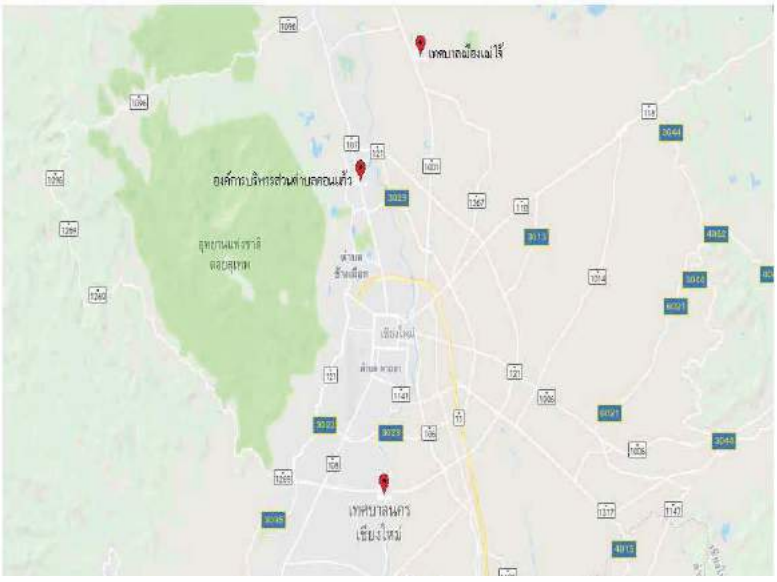
<u>ระเบียบวาระการประชุม</u>

- รายงานความคืบหน้าของโครงการ
- การแลกเปลี่ยนความรู้โดยเมืองคิตะคิวชู และมหาวิทยาลัยเชียงใหม่
- กรณีศึกษา และอภิปราย (กรณีศึกษาเมืองแม่โจ้)



1. (1) 4) ความคืบหน้าของโครงการ (5) ในจังหวัด

สำรวจพื้นที่



<u>อบต.เวียงฝาง (วันที่ 14 ธันวาคม 2560)</u>

- เครื่องคัดแยกขยะ และฝังกลบ
- คณะไปเยี่ยมชมเครื่องคัดแยกขยะ โดยใช้เครื่องจักร ว่าสามารถดึงขยะอินทรีย์ มาทำก๊าซชีวภาพได้หรือไม่
- คณะจะเก็บตัวอย่าง เพื่อวิเคราะห์ขยะก่อน และหลังคัดขยะแยกโดยใช้เครื่อง

<u>เทศบาลเมืองแม่โจ้ (วันที่ 15 ธันวาคม 2560)</u>

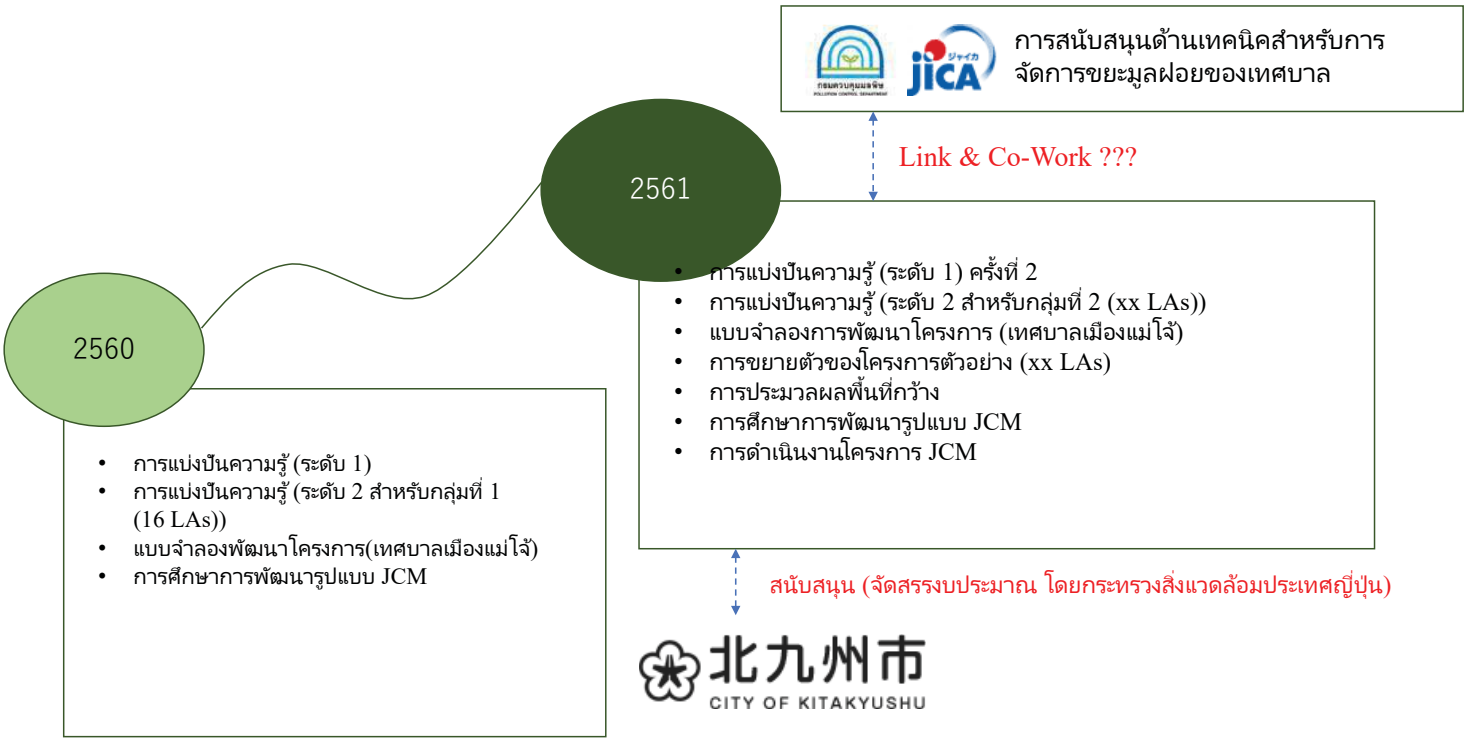
- คณะจะไปดูเมืองที่จะเลือก เป็นเมืองต้นแบบ

<u>อบต.ดอนแก้ว (วันที่ 15 ธันวาคม 2560)</u>

- คณะจะไปดูเมืองที่จะเลือก เป็นเมืองต้นแบบ

นอกจากนี้ อบต.แม่แตง แสดงความสนใจของเค้า พัฒนาบ่อผลิตก๊าซชีวภาพ โดยรวมมือกับฟาร์มเลี้ยงช้างแห่งหนึ่งอยู่ในเขตพื้นที่ ซึ่งคณะทำงาน ร่วมมือกับมหาวิทยาลัยเชียงใหม่ศึกษา โอกาสว่าจะเป็นไปได้หรือไม่

2. คาดหวังผลงานจากโครงการ (ระยะที่ 1) และข้อเสนอโครงการ (ระยะที่ 2) ที่กำลังอยู่ในระหว่างการอภิปราย



ขอบคุณ

Kitakyushu Model for Waste Management

Hiroshi YASUTAKE, Deputy Director
Kitakyushu Asian Center
for Low Carbon Society,
City of Kitakyushu

City located near to other Asian nations, rich in nature, and developed as a manufacturing area

■ **Kitakyushu City**
Population: 977,000 (2010) Area: 487.88 Km²
GDP: 3,430 billion yen (2010)

Rich nature and branded food materials

Karst Plateau Hiraodai

Wakamatsuhoku Beach

Ouma Bamboo Shoots

Kanmon Straits Octopuses

Kokura Beef

Buzen-Sea Oysters

Wakamatsu Special Tomatoes

Major companies in Kitakyushu area

Nippon Steel Corporation

Yaskawa Electric Corporation

TOTO Ltd.

Mitsubishi Chemical Corporation

Toyota Motor Corporation · Nissan Motor Co., Ltd.

Mitsubishi Materials Corporation

Regional resources (Experience with overcoming pollution problems) (1)

Company visit by citizens

Citizens

Partnership

Government

Companies

Reinforcement of restrictions and supervision

Agreement to prevent pollution

Kitakyushu City with recovered environments

1960s

Present

Solution of pollution problems is a starting point for international cooperation on environmental issues.

Transferring the experience of overcoming pollution problems so that developing nations need not repeat the same mistake

Regional resources (Development of international cooperation on environmental issues) (2)

Partnership with other Asian nations for mutual prosperity

Received trainees: 7,453 persons from 150 nations; Dispatched specialists: 175 persons to 25 nations
Promotion of cooperation networking between Asian cities and environmental improvement projects : 67 projects

Kitakyushu Initiative Network
(62 cities in 18 nations)

Water supply project at Phnom Penh

Air pollution survey in Mongolia

Contribution to environmental improvements in Dalian, China
(Dalian City received the Global 500 Award in 2001.)

Exchanged memorandum for cooperation on eco-town with Tianjin City
(At the Prime Minister's official residence)

Driving forward the waste composting project with Surabaya City, Indonesia
(Adopted by over 20,000 families)

Kitakyushu Asian Center for Low Carbon Society

Kitakyushu City was selected as Eco-Model City in 2008

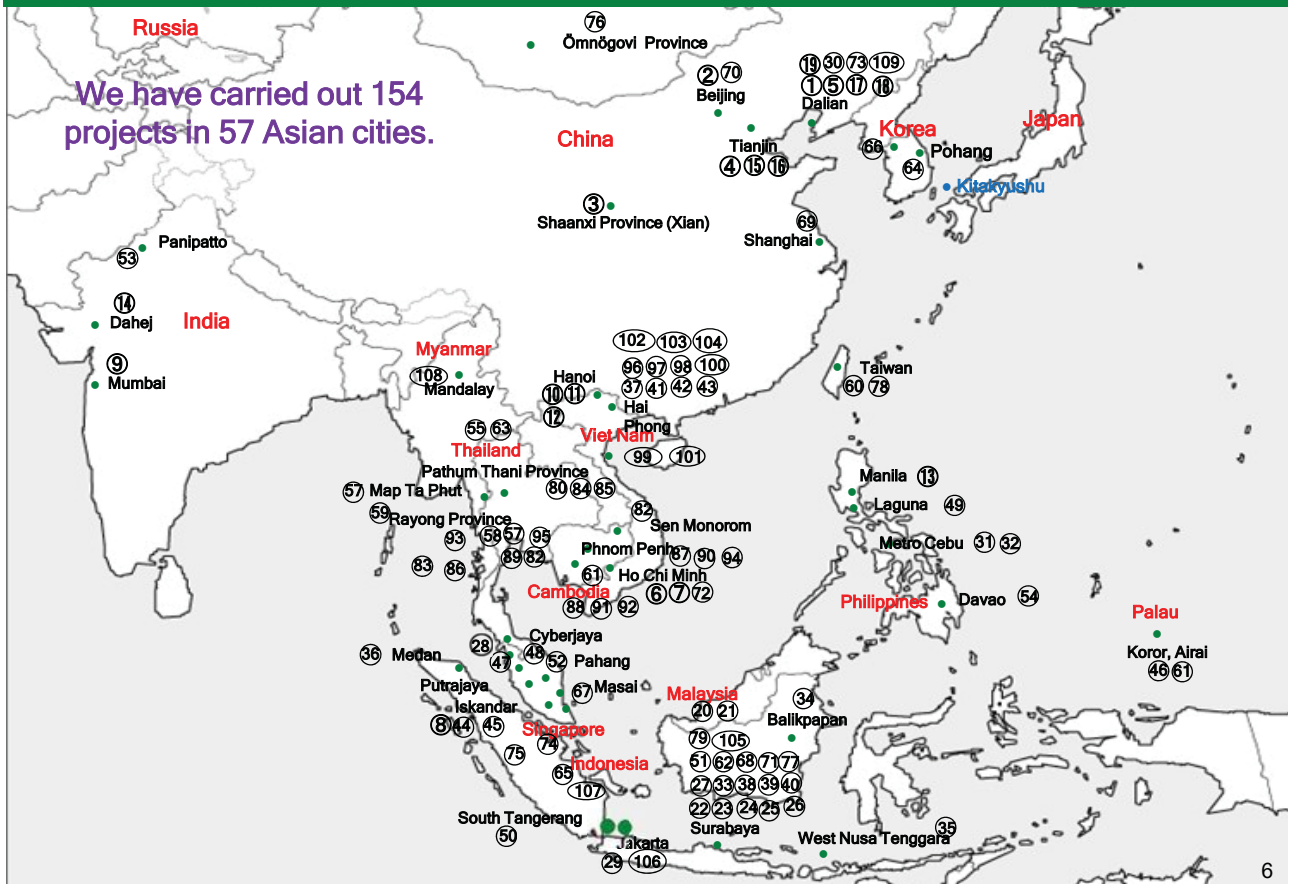
CO2 reduction: -200%(50% in domestic, 150% in overseas) by 2050 based on CO2 emission in 2005

Utilization of the environmental technologies developed through the solution of pollution problems and manufacturing processes, and the City to City network established by international cooperation in the past

Kitakyushu Asian Center for Low Carbon Society opened in June 2010

"Changing the approach from environment cooperation to environment business"

Diverse Project Development Map



Visits by World Leaders

Kitakyushu's actions are the focus of international attention

Xi Jinping
President of PRC
(Dec 2009)

"Kitakyushu's rich experiences in environmental protection and development of advanced technologies deserve to be used as a model for application in China today."

The People's Daily (Dec 17, 2009)

Arkhom Termpittayapaisith
Secretary General, NESDB **(Oct 2013)**


Rayong eco-town to copy Japan lead

Photo courtesy of The Daily NNA

Bangkok Post (Oct. 25, 2013) reported that

"The Kitakyushu eco-town is a good example of communities and factories living together in harmony, while Rayong is home to many industrial factories along the Eastern Seaboard"

" Kitakyushu has become a clear example of development by shifting from heavy to environmental industries."

OECD
BETTER POLICIES FOR BETTER LIVES

OECD Green Cities Programme


Paris, France


Chicago, U.S.A.


Stockholm, Sweden


Kitakyushu, Japan

"Green Growth in Kitakyushu, Japan" issued by OECD in 2013

"Green Growth in Haiphong, Vietnam" issued by OECD in 2017

Thanks to the support of Kitakyushu, the OECD report is being made on ground that Haiphong City is positioned as the Green Gross City in Asia

Support for the Thailand Eco-Industrial Town Concept

Based on the Green Industry Concept, the Eco-Industrial Town Concept aims to create an eco-friendly industrial complex in cooperation with industrial estates, local communities, DIW, and IEAT .

Thailand
National Social and Economic Development Board (NESDB)
MOI | MNRE

Inter-governmental (G-to-G)

Japan
METI, MOE

Support

Department of Industrial Works (DIW)

IRPC Eco Industrial Zone (DIW)
This is the largest petrochemical complex in Southeast Asia. It is owned by IRPC Public Company Limited, a oil refining and petrochemical company, under the umbrella of PTT, the largest energy company in Thailand.

Signing of MoU between DIW, IRPC and City of Kitakyushu

Industrial Estate Authority of Thailand (IEAT)

Map Ta Phut Industrial Estate (IEAT)
An industrial estate established in 1988 with a focus on the heavy and chemical industries, Map Ta Phut IE received a large amount of yen-based loans from the Overseas Economic Cooperation Fund (OECF) of Japan. The estate is well-located near the Port of Map Ta Phut and U Tapao International Airport.

Signing of MoU between IEAT and City of Kitakyushu

Rayong PAO, Rayong City, Map Ta Phut City
Municipal Waste Management
Collaboration with industrial park and community
Energy utilization

Mutual consent between NESDB and City of Kitakyushu

City of Kitakyushu (Asian Center for Low Carbon Society)

Kitakyushu Model
Support tool that has systematically arranged the know-how, experience, and technologies acquired in Kitakyushu's quest to overcome pollution and become an environmentally-advanced city.

Kitakyushu Eco-Town
Japan's largest, leading resource recycling and circulation base. About 30 recycling businesses are being developed or are in operation in Eco-Town.

Kitakyushu Smart Community
Focusing on plant cogeneration, the Smart Community aims to achieve the local supply and local consumption of energy to connect factories and residences.

Kitakyushu – Chiang Mai Cooperation Project: Project Overview

北九州市 CITY OF KITAKYUSHU

"Set up a voluntary Target for GHG emission reduction (-50% for the city and -150% for the Asian countries)"

2000 Kitakyushu Initiative Network（ESCAP)
2008 Selected as Environmental Model City (Green Frontier Plan)
2010 Establishment of Asia Low Carbon Center (Technical Support & Transfer)
2011 Selected as Environmental Future City (set up voluntary target on mitigation)

Letter of Intent (to be signed within 2017) ↕ **City to City Cooperation**

Chiang Mai Province (General Information)

(Waste Related Information)

Land Area	20,107㎢
Population(2012)	1,682,382
GPP	THB138,112 m
GPP per capita	THB86,211. -
GPP by sector	Primary (18%)
	Secondary (12%)
	Teriary (70%)
No of Visitor(2011)	19,098,323

	Cluster	MSW
1	Sansaai	803.10t/d
2	Muang Chiang Mai	677.00t/d
3	Saraphi	267.87t/d
4	Chai Prakan	53.65t/d
	Total	1,801.00t/d

City-City Cooperation between Chiang Mai province & City of Kitakyushu

- Recommendation on city-city cooperation by the Minister of Natural Resources & Environment
- Kitakyushu invited province to JCM city-city workshop (2017)
- Private Sector from the city provides technical support to parties in Chiang Mai (2015-)
- Kitakyushu supported city's 3Rs promotion in Chiang Mai (2010-)
- Kitakyushu received a personnel for six months trainning (2009)
- Kitakyushu invites city to participate in seminars, workshops (2000-)

Targeted project in Provincial Development Plan
Chiang Mai province will achieve appropriate waste treatment & disposal by 2019 by 3Rs, efficiency improvement in waste management and appropriate treatment & disposal

Target (JCM) & Activities in the study

Waste Generation | Collection & Transportation | **Intermediate Treatment** | Disposal

- To provide comprehensive support on **Integrated Waste Management** in the area (support each step as waste management shown in above)
- To select suitable technologies (**Japanese Technology with high efficiency**) for **Appropriate Waste Treatment** in Integrated Waste Management in the area
- To select projects with high possibility, including WtE planned by Chiang Mai Waste to Power for feasibility study including JCM registration
- To materialize projects and registered as JCM project

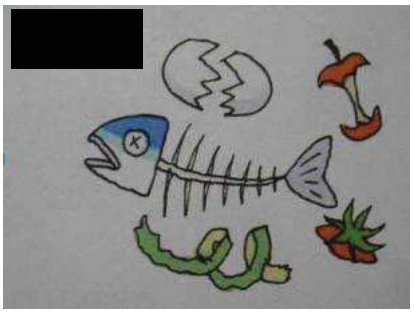
Solid Waste Treatment in Kitakyushu City

Cans and Bottles

PET Bottles

Plastic Containers

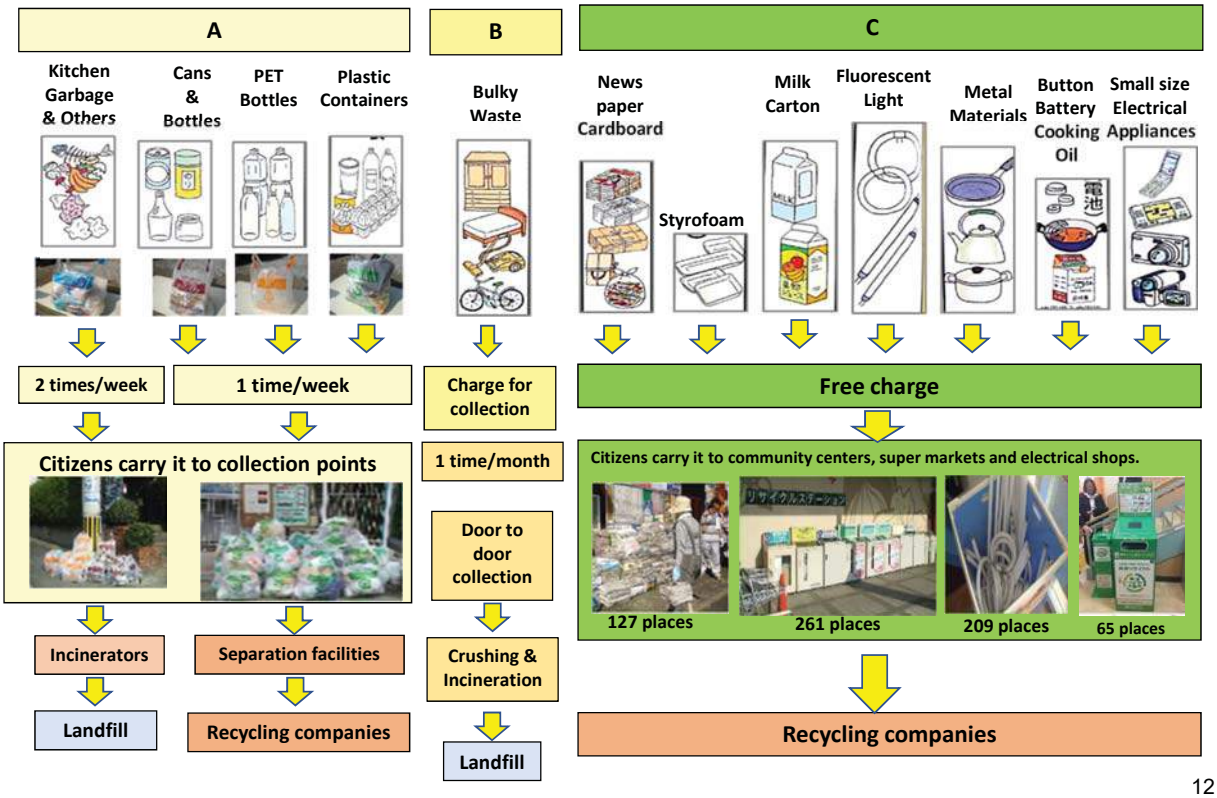
Paper



Kitchen Garbage

Others

Waste separation and recycling system in Kitakyushu City



Combustible Waste Incineration Structure

Municipal responsibility

Collection & Incineration & Landfill

900℃ 24hours operation without fuel

How to reduce cost of waste treatment

Decrease collection frequency for kitchen garbage and others and carry out new recycling system.

① Re-zoning collection area inside city.

② Promoting recycling system to reduce kitchen garbage.

③ Cooperating with private companies.

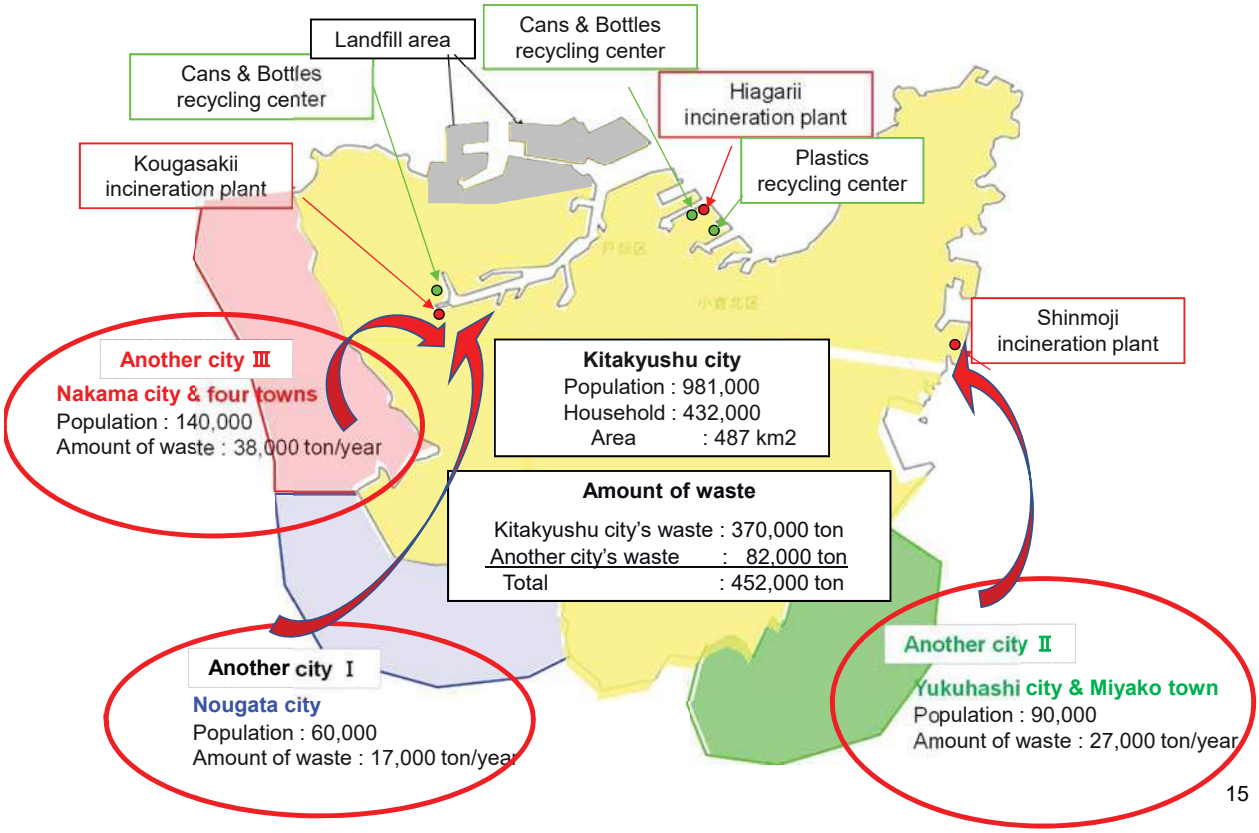
Until 1992 (Mix collection)

A zone	Monday & Thursday
B zone	Tuesday & Friday
C zone	Wednesday & Saturday

After 1993 (Start re-zoning and recycling)

A＋C1 zone	Monday & Thursday
B ＋C2 zone	Tuesday & Friday
Kitchen garbage and others	
A +C1 zone B＋C2 zone	Wednesday
Cans and Glass bottles (recyclable)	

Collaboration with neighbor cities for reduction of total cost



How to increase citizen's cooperation for 3R activity.

1. Hold many public meetings for explanation of separation and recycling system.

2. Charge waste management fee for raising citizen's concerning.
3. Set different price between kitchen garbage and recyclables.

※These 2 methods are "Kitakyushu's Challenges", so we can not prove whether it will be applicable or not in Thailand now.

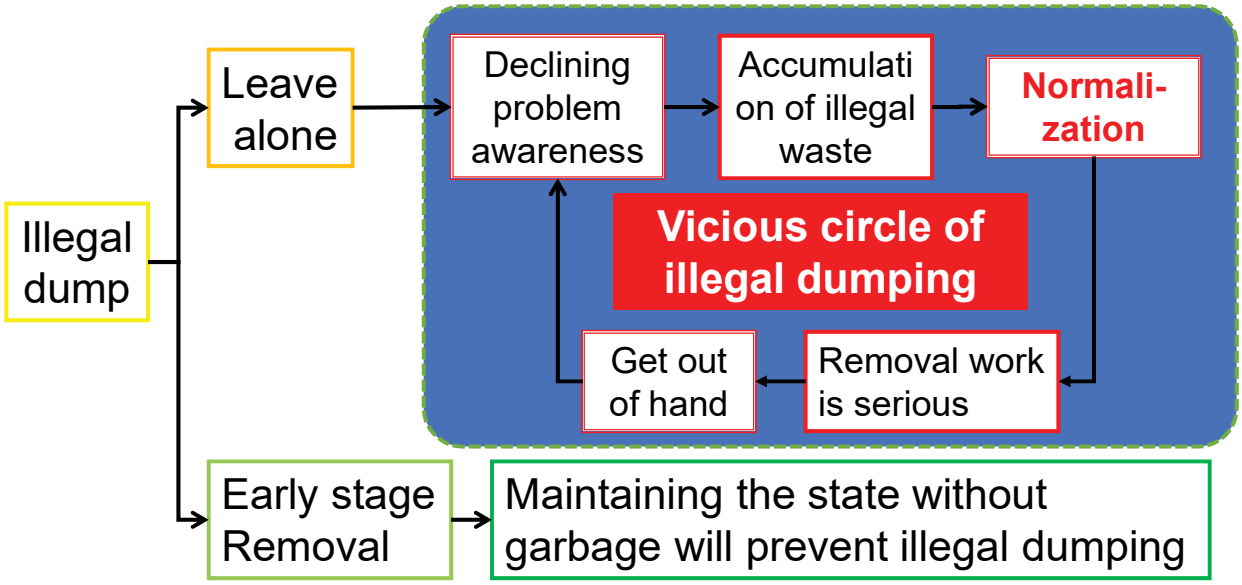
However, raising citizen's cost consciousness for waste is very important !!
Proper separation should be given some incentive compared to no separation!!

45 liter	50 ¢	45 liter	20 ¢
25 liter	33 ¢	25 liter	12 ¢

Gather information on illegal dumping

Significance of information gathering

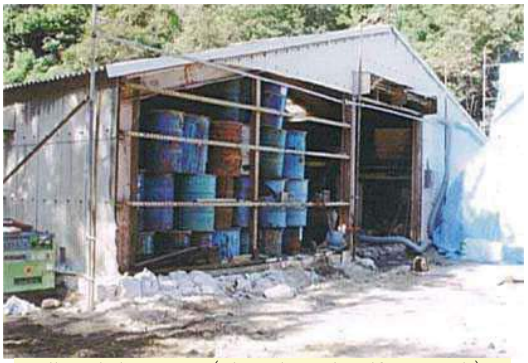
We collect information on illegal dumping as soon as possible and remove it early so as to prevent prolonged or expanded.



Examples of Illegal dumping

Illegal dumping

Improper disposal (excessive storage amount)



Illegal dumping (abandoned sulfate pitch)

Illegal dumping (sulfate pitch spill)

Sulfate pitch: tar-like substance generated in the process of illegal (tax-evading) production of diesel oil from heavy oil and kerosene. Being strongly acidic, this mixture of waste oil and sulfate sometimes eats through the container (metal barrel) and seeps out. Photo: "Industrial waste in Japan 2005," the Ministry of the Environment

18

Illegal dumping Patrol

Name	outline	Execution	Achievements In 2016
Weekday patrol	Implemented along with on-site inspection of authorized dealers con-cerning industrial waste	Main office	**587**
		Center	**1,658**
Night / Saturday patrol	Patrolled at closing office day and time zone	Main office	**115**
Holidays Patrol		Center	**89**
Late night / early morning patrol	Patrol of illegal dumping addiction	Private consign-ment	**200**
Total			**2,649**

Main office：Industrial Waste Management Division、
Center：Simmoji, Hiagari, kougasaki Environment Center

Illegal dumping reporting person

	Term of office (year)	Number of people
lst	2000~2002	73
2nd	2003~2005 (Added in FY 2005)	97 191(-3、+97)
3dr	2006~2007	185
4th	2008~2009	175
5th	2010~2011	164
6th	2012~2013	96(Company14)
7th	2014~2015	92 (Company14)
8th	2016~2017	65 (Company17)
		Request area：5

Status of appointment ceremony

	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16
Illegal dumping	425	547	371	240	160	208	133	194	146	151	128	81
Illegal incineration	14	13	6	6	0	3	2	-	-	-	-	-
Othiers	109	95	55	58	54	100	65	108	79	119	77	36
total	548	655	432	304	214	311	200	302	225	270	205	117

Illegal dumping surveillance cameras

Currently 30 installed in the city
(actual and fake cameras)

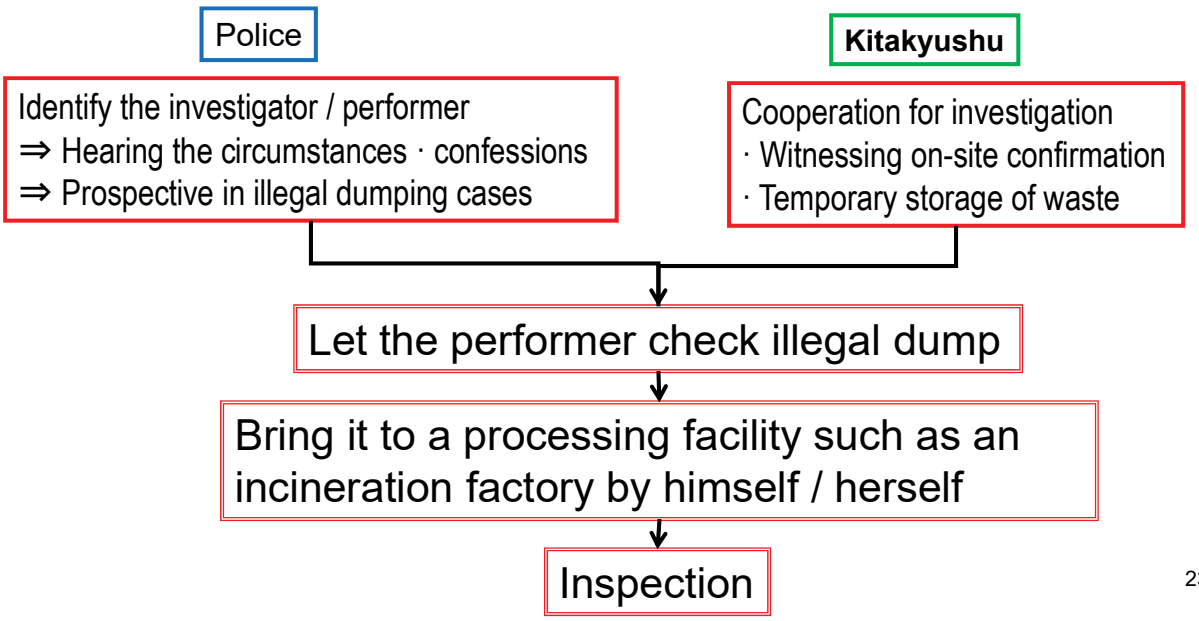
Signboard of Illegal Dumping Ban

Experience of Illegal dumping prevention surveillance cameras (example)

✓ Illegal dumping [household garbage about 10 kg], such as a rice cooker, a microwave oven, a frying pan, a cassette cylinder, empty cans

Collaboration with the police against illegal dumping cases

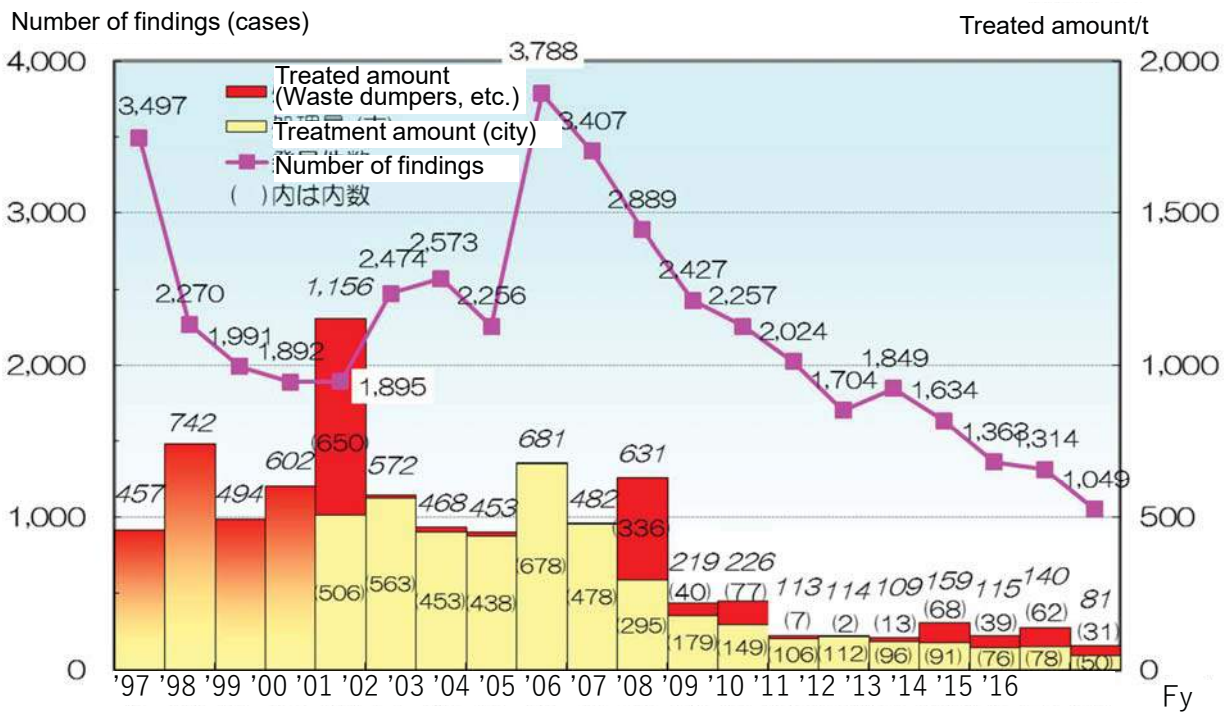
The contents of illegal dumps, images of surveillance cameras, cases that can specify executors are dealt with in cooperation with the police



Report with police case (2016FY)

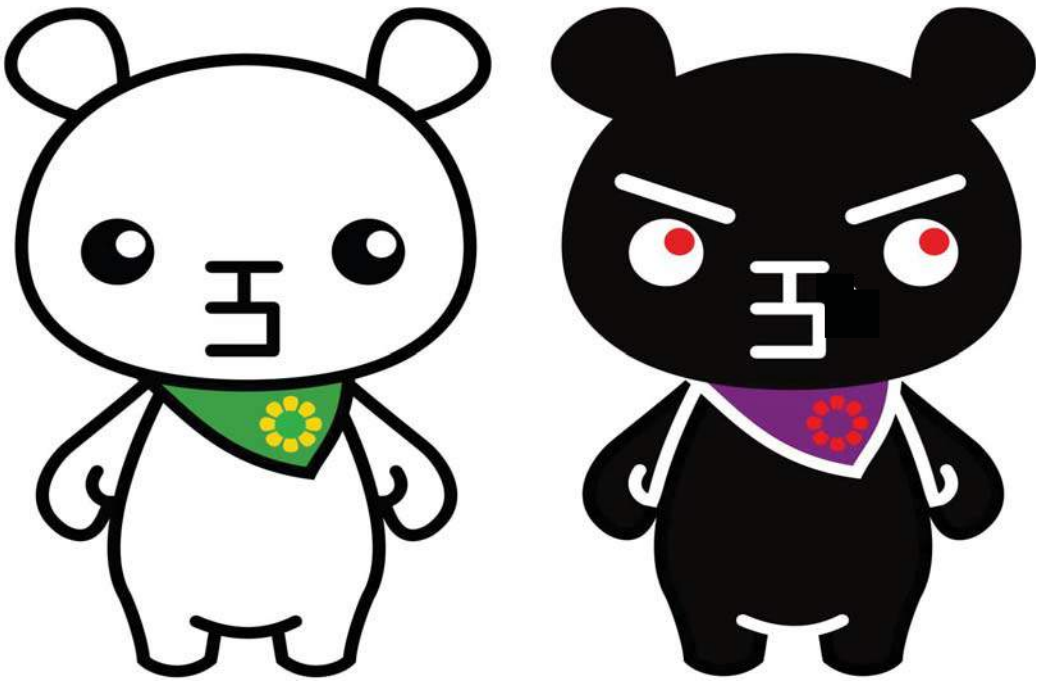
Year.month	Illegal dump waste	Place	Result
2016.6	General waste	Kokuraminam Yukawa	Fine 300,000 yen
2016.6	Household garbage 【Cam】	Yahatanishi Honjo	Collect reason statement
2016.6	General waste	Kokuraminami Yoshida	Collect reason statement Proper handling by the actor
2016.7	Bulky garbage	Kokurakita Sunatsu	Collect reason statement Proper handling by the acto
2016.8	Bulky garbage	Kokuraminami Fujimi	Collect reason statement Proper handling by the acto
2017.1	Household garbage	Moji Yanagimachi	Usually arrested, Prosecutors' office · Suspect prosecution
2017.1	General waste	Wakamatsu Otomaru	Fine 300,000 yen
2017.2	Waste tires	Kokurakita Katano	Fine 200,000 yen
2017.2	Household garbage 【Cam】	Yahatanishi Honjo	Collect reason statement

Current state of illegal dumping Kitakyushu (2016FY)



The increase in treated amount (dumpers etc.) at '01 and '07 are associated with illegal dumping of industrial waste.

Thank you for your attention
khob khun krab!!



Introduction of Anaerobic Digestion

By Dr. Chatchawan Chaichana
Chief of Green Energy Technology Research Center
Faculty of Engineering, Chiang Mai University

- What is biogas ?
- biogas generation process
- composition of biogas
- biogas utilization
- ปัจจัยที่มีผลต่อการผลิตก๊าซชีวภาพ
- waste processing technologies (anaerobic digestion technology)

What is biogas ?

biogas is clean energy generated from waste, for example, any kind of animal dung, waste water from farm, waste water from factories, waste, and/or residues from agricultural related activities, ใช้ทางการเกษตรมาผ่านกระบวนการหมักเพื่อให้เกิดการย่อยสลายสารอินทรีย์ เมื่อสภาวะแวดล้อมเหมาะสม จะได้ก๊าซชีวภาพที่สามารถนำมาใช้เป็นพลังงานไฟฟ้า หรือความร้อนได้

กระบวนการผลิตก๊าซชีวภาพ

กระบวนการผลิตก๊าซชีวภาพเป็นกระบวนการแบบไม่ใช้อากาศ ประกอบด้วยปฏิกิริยา 4 ขั้นตอนหลัก ซึ่งรวมเรียกว่า Anaerobic digestion ซึ่งมีรายละเอียดของปฏิกิริยาแต่ละขั้นตอน ดังนี้

1. Hydrolysis

- เป็นขั้นตอนที่ย่อยสลายสารโมเลกุลสารประกอบอินทรีย์เชิงซ้อนขนาดใหญ่ให้ เปลี่ยนไปอยู่ในรูปที่ละลายน้ำได้ มีความซับซ้อนน้อยลง และขนาดโมเลกุลเล็กลง

2. Acidogenesis

- ขั้นตอนนี้จะย่อยสลายสารที่ได้จากขั้นตอนแรกให้เป็นกรดอินทรีย์ชนิดโมเลกุลเล็ก

กระบวนการผลิตก๊าซชีวภาพ

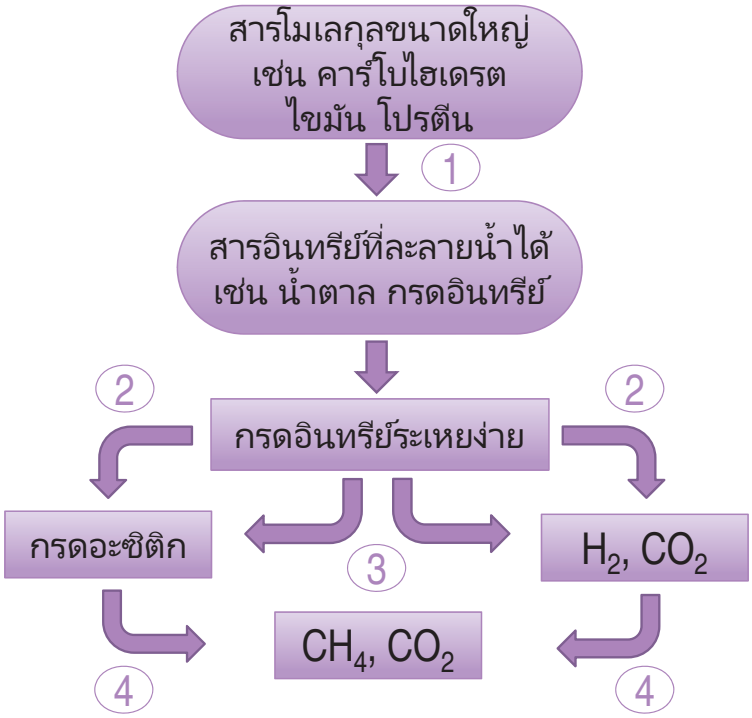
3. Acetogenesis

- ขั้นตอนนี้จะย่อยสลายสารประกอบต่อ ให้เป็นกรดไขมันระเหยง่ายที่มีอะตอมไม่เกินสองอะตอม

4. Methanogenesis

- เป็นขั้นตอนที่เปลี่ยนผลิตภัณฑ์ที่ได้จากการย่อยสลายในขั้นตอนที่ผ่านมาให้เป็นก๊าซชีวภาพ

กระบวนการผลิตก๊าซชีวภาพ



ขั้นตอนที่ 1 2 และ 3 ขั้นตอนสร้างกรดเกิดในบ่อกรด

ขั้นตอนที่ 4 สร้างมีเทน เกิดในถัง UASB

องค์ประกอบของก๊าซชีวภาพ

ประโยชน์ของก๊าซชีวภาพ

ประโยชน์ของก๊าซชีวภาพ

1. <u>ประโยชน์ด้านพลังงาน</u>

เนื่องจากก๊าซชีวภาพมีก๊าซมีเทน เป็นส่วนประกอบหลัก จึงทำให้มีคุณสมบัติ จุดติดไฟได้ดี และยังสามารถนำไปใช้เป็นพลังงานในรูปต่างๆ ได้ เช่น

- เผาเพื่อใช้ประโยชน์จากความร้อนโดยตรง เช่น ใช้กับเครื่องกกลูกสุกร และ หม้อต้ม ไอน้ำ (Steam Boiler) เป็นต้น
- เผาเพื่อให้ความร้อนและใช้ในการขับเคลื่อนเครื่องจักรกลต่างๆ เช่น ใช้กับเครื่องยนต์เบนซินและเครื่องยนต์ดีเซล เป็นต้น
- เผาเพื่อให้ความร้อน และใช้ในการผลิตพลังงานไฟฟ้า

อัตราการทดแทนการใช้พลังงานของก๊าซชีวภาพ 1 ลบ.ม. (ที่มีก๊าซมีเทน 60%)

- ก๊าซหุงต้ม (LPG) 0.46 กิโลกรัม

- น้ำมันดีเซล 0.60 ลิตร

- น้ำมันเบนซิน 0.67 ลิตร

- น้ำมันเตา 0.55 ลิตร

- ฟืนไม้ 1.50 กิโลกรัม

- ผลิตกระแสไฟฟา 1.2-2.5 kWh

ประโยชน์ของก๊าซชีวภาพ

2. ประโยชน□ด□านการเกษตร

สำหรับเกษตรกรและฟาร□มทั้งหลาย สามารถใช้กระบวนการผลิตก๊าชีวภาพ ให□เกิดประโยชน□ 2 ทาง ได□แก□ การทำเป□นปุ□ยและการทำเป□นอาหารสัตว์

ประโยชน์ของก๊าซชีวภาพ

3. ประโยชน□ด□านการอนุรักษ□สิ่งแวดล□อม

- กลิ่น - ลดกลิ่นรบกวนจากของเสียที่เกิดขึ้น
- แมลงวัน - ทำให้แมลงวันไม่สามารถใช้ของเสียและน้ำเสียเหล่านั้นเป็นแหล่งเพาะพันธุ์และแพร่ขยายเชื้อโรค
- น้ำเสียที่ผ่านการบำบัดแล้ว จะสามารถหมุนเวียนนำกลับมาใช้ และจะถูกปล่อยออก สู่แหล่งน้ำภายนอกโดยไม่มีปัญหาต่อสภาพ แวดล้อมอีกต่อไป
- การแพร่กระจายของก๊าซมีเทนลดลง

ปัจจัยที่มีผลต่อการผลิตก๊าซชีวภาพ

อุณหภูมิ (Temperature)

Psychrophilic

ย่อยสลายสารอินทรีย์ได้ดีในช่วงอุณหภูมิต่ำ (5-15 องศาเซลเซียส)

Mesophilic

ย่อยสลายสารอินทรีย์ได้ดีในช่วงอุณหภูมิปานกลาง (35-37 องศาเซลเซียส)

Thermophilic

•ย่อยสลายสารอินทรีย์ได้ดีในช่วงอุณหภูมิสูง (50-55 องศาเซลเซียส)

ปัจจัยที่มีผลต่อการผลิตก๊าซชีวภาพ

ความเป็นกรด-ด่าง (pH)

ช่วง pH ที่เหมาะสมต่อการเจริญเติบโตของแบคทีเรียอยู่ในช่วง 6.5-7.5 ถ้าต่ำากว่า 5 จะมีอันตรายต่อแบตทีเรียที่สร้างมีเทนแต่แบคทีเรียที่สร้างกรดอินทรีย์สามารถทนต่อสภาพเป็นกรดได้ต่ำถึง 4.5 โดยไม่เป็นอันตราย

อัลคาลินิตี้ (Alkalinity)

ค่าอัลคาลินิตี้ที่เหมาะสมต่อ ระบบหมักมีค่าประมาณ 1,000-5,000 มิลลิกรัม/ลิตร ในรูปของแคลเซียม คาร์บอเนต ($CaCO_3$)

ปัจจัยที่มีผลต่อการผลิตก๊าซชีวภาพ

กรดอินทรีย์ระเหยง่าย (Volatile Acid)

ปริมาณกรดอินทรีย์ระเหยง่ายในถังหมักไม่ ควรเกิน 2,000 มิลลิกรัม/ลิตร แต่อาจทนได้ถึง 5,000 มิลลิกรัม/ลิตร

สารอาหาร (Nutrients)

ซึ่งอัตราส่วนที่เหมาะสมในระบบควรมีอัตราส่วน COD:N:P เท่ากับ 100:2.2:0.4 หรือ BOD:N:P เท่ากับ 100:1.1:0.2

ปัจจัยที่มีผลต่อการผลิตก๊าซชีวภาพ

สารยับยั้งและสารพิษ (Inhibiting and Toxic Substances)

การสะสมของสารบางชนิด เช่น กรดอินทรีย์ระเหยง่าย แอมโมเนีย ซัลไฟด์ และโลหะหนักบางตัว เช่น โซเดียม โปแตสเซี่ยม สามารถทำให้การ ย่อยสลายในสภาพไร้ออกซิเจนหยุดชะงักได้

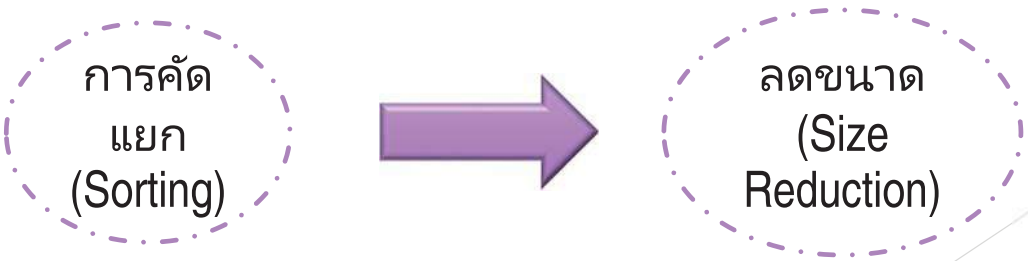
การกวน (Mixing)

การกวนผสมในถังหมักมีความสำคัญ เพราะจะทำให้แบคทีเรียมีโอกาสพบ อาหารได้ทั่วถึง และสารอาหารต่าง ๆ ที่แบคทีเรีย ขับออกจะเกิดการกระจาย ได้ดีขึ้น

เทคโนโลยีพลังงานขยะ (เทคโนโลยีย่อยสลายแบบไม่ใช้ออกซิเจน)

การใช้กระบวนการย่อยสลายแบบไม่ใช้ออกซิเจนในการจัดการขยะมูลฝอยชุมชน โดยทั่วไปสามารถแบ่งการทำงานออกเป็น 3 ขั้นตอน ประกอบด้วย

1. การบำบัดขั้นต้น (Pre-treatment/Front-end Treatment)



เทคโนโลยีพลังงานขยะ (เทคโนโลยีย่อยสลายแบบไม่ใช้ออกซิเจน)

ซึ่งโดยทั่วไประบบบำบัดขั้นต้นสำหรับเทคโนโลยีย่อยสลายแบบไม่ใช้ออกซิเจนสามารถแบ่งออกได้เป็น 2 แบบ คือ

Dry Separation Process

- ใช้ Rotary Screen เป็นอุปกรณ์สำคัญในการคัดแยกขยะมูลฝอยอินทรีย์
- ใช้ Shredder ในการบดย่อยขยะมูลฝอยอินทรีย์ให้มีขนาดเหมาะสำหรับการย่อยสลาย

Wet Separation Process

- ใช้หลักการคัดแยกสิ่งปะปนออกจากขยะมูลฝอยอินทรีย์โดยวิธีการจม-ลอย (Sink-Float Separation)
- มีอุปกรณ์สำคัญที่เรียกว่า Pulper ทำหน้าที่ในการคัดแยกและบดย่อยขยะมูลฝอยอินทรีย์

เทคโนโลยีพลังงานขยะ (เทคโนโลยีย่อยสลายแบบไม่ใช้ออกซิเจน)

2. การย่อยสลายแบบไม่ใช้ออกซิเจน (Anaerobic Digestion)

เป็นขั้นตอนการผลิตก๊าซชีวภาพจากขยะมูลฝอยอินทรีย์สำหรับนำไปใช้เป็นพลังงาน และเพื่อทำให้ขยะมูลฝอยอินทรีย์ถูกย่อยสลายเปลี่ยนเป็นอินทรียวัตถุที่มีความคงตัว ไม่มีกลิ่นเหม็น ปราศจากเชื้อโรคและเมล็ดวัชพืช

3. การบำบัดขั้นหลัง (Post-treatment)

เป็นขั้นตอนการจัดการกากตะกอนจากการย่อยสลายแบบไม่ใช้ออกซิเจนให้มีความคงตัวมากขึ้น

ขอบคุณครับ

2nd Seminar / Workshop
for

Integrated Waste Management in Chiang Mai

under city to city cooperation
between
Chiang Mai Province & City of Kitakyushu
(JCM project development study entrusted by the Ministry of Environment, Japan)

0. Review
(Summary of Seminar Aug 2017)

1. Baseline & Policy Review

1-1 Waste Flow & Management

Waste Generation Sources

Tambol	:	3
Community	:	19
Household	:	12,353
Business	:	85
Hospital	:	1
Clinic	:	50

General Waste
- Containers for Waste Disposal are set in front of each house
- No Waste Separation
- XX tons/day

Recycable Waste
- 0.X tons /day

Hazardous Waste
- 50 collecting sites (in front of shops) in municipality
- 0.X tons/month

Infectious Waste
- 0.X tons /day

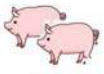
(11 units)

SANSAI Waste Disposal Site (Open Dump)

Final Disposal Site (Hort)

← Collection & Transport → ← Cost : THB11,319,150/y (FY2559) →
Services provided by the City ** Single Year Contract basis*

Organic Waste



Plastic Waste

Private Sector
Registered : x
Non Registered : xx

MRF(s)

Temporary Storage in communities (50 places 2 each = 38 places + Ga Station etc.)

Waiting for Instruction from CPO

SANSAI Hospital
150kg/day in average)

Private Sector

1-2 Waste Information

*** Chiang Mai Provincial Office together with the city of Kitakyushu in cooperation with Chiang Mai University and EX Research Institute will conduct waste analysis for waste generated in Mae Jo Municipality

1-3 Waste Management related Policy & Regulation at city level

Announcement of the City related to Set up Committee and Advisory Board for Waste Management
● Issued on May 11, 2017 ● In accordance with city's policy of make Mae Jo Municipality as comfortable city to live, with clean, less waste, good environment and safety then good health as per policy set up by the Government. ● The Ministry of Interior works to solve municipal solid waste issues at each places for realization of Clean Province by promoting 3Rs activities for short period of 1 year ● Committee will be set up and in charge of cleanliness program to reduce problems
BE2558 City Ordinance related to addition on the BE2552 City Ordinance related to Public Health (Addition II)
• 2nd addition after 1st addition prescribed by the BE2556 City Ordinance • Revision of Tariff for Waste related services (see Appendix 3 for more detail)
BE2552 City Ordinance related to Public Health
• Instruct house & building managing parties to set up waste disposal points and do not throw away places other than intended • Municipality will collect transport and treat in accordance with BE2535 Public Health Act and BE2545 Ministerial Order for Service Tariff for Waste Water and Municipal Solid Waste Management

Appendix 1. Households in the City

Community name	No of Household	Abandoned
* Independent (not belong to any community) *	406	63
Tao Hai 1	68	0
Tao Hai 2	133	0
Pabong	137	11
Huai Kiang	168	0
Pa Kham	252	0
Mae Jo	1,074	44
Sahakornnikom 1	103	1
Sahakornnikom 2	2,235	50
Thung Pa Ket	1,272	15
Thung Muen Noi	1,620	14
Kaset Mai	371	0
Rai Sahakon	664	17
Mae Jo Mai	633	10
Phae Pa Ha	354	7
Sri Sahakon	630	15
Mae Du	261	0
Nong Sai	308	0
Ling Muen	1,250	25
Phatthana Saikaeo	414	18
total	12,353	290

Appendix 2. Municipal Solid Waste Collection in the City (1/3)

Transporter	Area	Mon	Tue	Wed	Thu	Fri	Sat	Remarks
83-2363	Tao Hai 1, Tao Hai 2, Chiratchaya, Suwichada, Junction Sansai Hospital - Phrao Road,	×		×			×	
	Pabong		×			×		
	Rai Sahakon	×		×			×	
	Sansai Hospital		×			×		
	Wassana Place Hostel, Chom Doi village, Khru Phen Hostel				×			
82-7004	- Pa Kham, Onsirin4	×			×			
	- Huai Kiang, Mae Pa, Old landfill, Behind Mae Jo Garden, Srivichai Village		×			×		
	- Kaset Mai, Nattakamol village			×			×	
	- Onsirin11	×						
	- Phuet Rai			×				
82-5958	- Mae Jo community, Mae Jo school, Mae Jo market, Soi Krungthai Straight line	×	×	×	×	×	×	Daily / Direct Service
	- Mae Jo Mai, Lukkwat dorm, Side Market Mae Jo, Soi Steak Idea, Mon Mai, Accommodation behind Maejo University, Pramong Sai B		×			×		
	- Than Nam Thip village, Chanyawan		×					
	- Mae Jo Soi.1, Mae Jo village Straight line			×				
	- Wio Doi village, May Apartment, Phaya Lanna		×				×	
	- Wieng Thong Village				×			
82-0397	- Mar Jo University, Sri Sangwan School, Tobacco	×	×	×	×	×	×	Compact Garbage Truck
	- Sansai Wittayakom School		×		×		×	
	- Freshwater Fisheries Research and Development Center, Chiang Mai			×			×	

Appendix 2. Municipal Solid Waste Collection in the City (2/3)

Transporter	Area	Mon	Tue	Wed	Thu	Fri	Sat	Remarks
82-7704	- Thung Muen Noi	×	×	×	×	×	×	
	- Nonnipa village	×		×		×		
	- Golden Garden home village, Mae Jo Mansion Village				×		×	
	- Janya Wan village	×	×	×	×	×	×	
82-5934	- Sahakornnikom 1	×	×	×	×	×	×	Daily / Direct Service
	- Mae Jo Village, Pruk Siri Village, Piwich Inn					×		
	- Soi4 Straight lines all the way, Soi Tonngoen, Kwan Arun Kindergarten				×			
	- Sun Side Village, Mind shine, Setthi Village		×					
	- Thung Muen Noi Soi1 To every dorm	×			×		×	
	- Alongkon village			×				
	- Soi Om Mueang Kha Mai	×				×		
	- Ban Rong, Nutthanan Village		×					
83-3965	- Thung Pa Ket	×		×		×	×	Daily / Direct Service
	- Green View Village, Somwang Village, Chom Doi dorm		×		×		×	
	- Thongchai Village, Baan Duang Thida, Doi Kham Hillside House, Meesuk villa, Ban Thana Chai, Clapmake hotel	×		×		×		
	- Birse House dorm, essy mansion, U-to House, Inthanin Place, Pinthong Place, Kochakorn House, Doi Ngam Place, Pang Thong dorm, Deedee mansion, Sky and D.C apartment, Porn Sawan houseboat, Pracha Nikhom Restaurant, Porn Sawan Village		×		×		×	

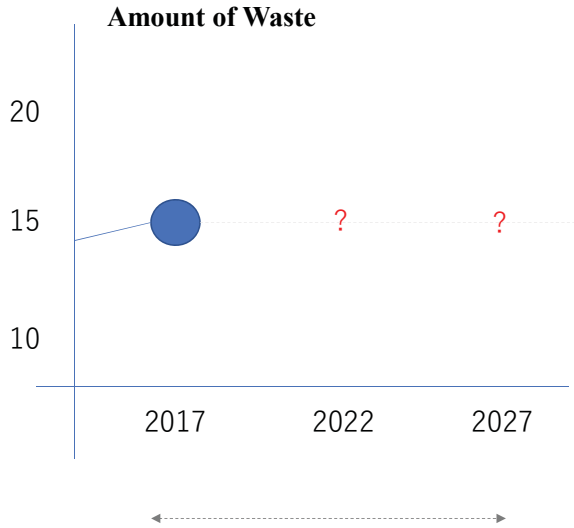
Transporter	Area	Mon	Tue	Wed	Thu	Fri	Sat	Remarks
83-3965	Intersection Mae Jo Police Station - Intersection Wat Mongkol Setthi, Dorm Soi Bangkhen - The old road	×		×		×		
	Nanta Thani Village		×				×	
	Thanthanan Village			×				
	Thanakit Animal feed – junction Thung Muen Noi - Company BETAGRO	×	×	×	×	×	×	Daily / Direct Service
	Dorm Soi4			×		×		
82-3108	Ling Muen (Straight lines every day)- Ruai Chok market	×	×	×	×	×	×	Daily / Direct Service
	Thanyakorn, Green Beach Home, Wanalee Village		×		×		×	
	Ban Lao Moo10		×		×	×		
82-1192	Mae Du, Phatthana Saikaeo, Nong Sai	×			×			
	Deeya Village, Karnkanok8		×			×		
	Duangdara Village, Ban BJ Hill, Ban Pongsakorn			×				
	Sri Sahakon, Ying Charoen Pillow House, Junction Phae Pa Ha to Wat Mongkol Setthi to Finlow Village, Fang dorm - Sahakon Soi2 - Mind House - Ran Rabb Thung Setthi - Phum Siri Dorm - Ban Udomsuk Garden - Banthoeng Bar	×		×		×		
	Phae Pa Ha - Onsiri1 - Soi Deva Sathan - Soi Yanyong - Sang Tawan Village, Soi Ban Thung		×				×	
	Sri Anan Mansion, Ban Nayok, Department of Lands	×			×			
	Onsiri1 - Ran Supnana	×	×	×	×	×	×	Daily / Direct Service
	Wang Bua Tong				×			
	Soi13 Ling Muen - Soi Ran Pratu Muan - Thaen Lueang shrine - Sahakon Soi5	×		×		×		

Appendix 3. Service Charge

No	Item	Fee (Baht)
	Charge rates for sewage and solid waste	
1.	Storage and handling of feces or sewage One time 1.1) Remnants of cubic meters or first cubic meters and cubic meters the next Per cubic meter 1.2) Not more than half a cubic meter (Half a cubic meter The figure equals 1 cubic meter)	 33 20
2.	The collection and transportation of solid waste monthly 2.1) The collection and transportation of solid waste monthly. The amount of waste a day does not exceed 500 liters. - One day not more than 20 liters per month - One day more than 20 liters but not more than 40 liters per month - One day more than 40 liters but not more than 60 liters per month - One day more than 60 liters but not more than 80 liters per month - One day more than 80 liters but not more than 100 liters per month - One day more than 100 liters but not more than 200 liters per month - One day more than 200 liters but not more than 300 liters per month - One day more than 300 liters but not more than 400 liters per month - One day more than 400 liters but not more than 500 liters per month 2.2) The collection and transportation of solid waste monthly. The amount of waste a day, 500 liters or more. - One day, no more than 1 cubic meter per month - One more than 1 cubic meter Store and transport every cubic meter or fraction of cubic meter Per cubic meter 2.3) Collection and disposal of solid waste from time to time. - Not more than 1 cubic meter - More than 1 cubic meter Store and transport every cubic meter or fraction of cubic meter Per cubic meter	 20 40 60 80 100 200 300 400 500 1,000 1,000 150 150
3.	License fee rate Undertake the collection and disposal of sewage and solid waste By doing business or by receiving benefits with a fee. 3.1) Sewage and solid waste collection 3.2) Get rid of sewage and solid waste.	 5,000 5,000

2. Forecasting Study

2-1. Concept of Forecasting Study



How to process &/or Dispose waste ???
(Disposal Site(s), Capacity available at Disposal Site(s), Technologies)

Factors and Variation of Amount of Waste

- Increase of Population
- Increase of Income
- Development Plan
- New Business Operation
- Changes of Life Style & Behavior

- Decrease of Population
- Revision of Laws & Regulation (Waste Management & Resource Conservation ETC.)
- Technology Innovation (High Durability, Biodegradable etc.)
- 3Rs Promotion
- Shut Down of Business Operation
- Changes of Life Style & Behavior

2-2. Forecasting Study in Mae Jo City

NOT AVAILABLE

3. Objective & Goal Setting

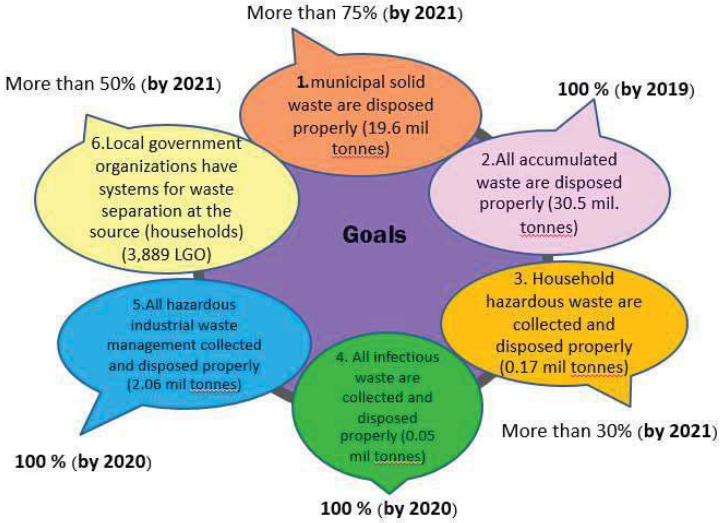
3-1. Targets consider to be newly set up in Waste Management Sector in Thailand

- Targets for waste management set up by the Central Government -

National Solid Waste Management Plan (2016-2021)

Presented by Pollution Control Department & Approved by the Cabinet on May 3rd, 2016

Framework
Encourage citizens, including children, and the private sector to reduce waste at the source by following the 3Rs concept (Reduce, Reuse, Recycle)
Establish proper disposal methods for municipal solid waste and household hazardous waste by using centralized facilities for clusters of municipalities emphasizing waste utilization and waste to energy methods
All relevant sectors participate in the management of solid and hazardous waste



3-2. Objectives & Goals set up in Waste Management Sector in Municipality

OBJECTIVE

To make Mae Jo Municipality as comfortable city to live, with clean, less waste, good environment and safety then good health as per policy set up by the Government.

TARGET(S)

No	National Policy	Target set up by the Municipality	Remarks
1	3Rs Promotion	To reduce 5% by BE2560	
2	Waste Separation at origins	To promote in the area	
3	Appropriate Disposal of Municipal Solid Waste (>75% by 2021)	*Completed (Transport to Sanitary Landfill in Hort District)*	
4	Appropriate Disposal of Hazardous Waste from domestic sector (>30% by 2020)		Waiting for answer from Chiang Mai Provincial Office
5	Appropriate Disposal of Infectious Waste (100% by 2020)		Need o find out solution
6	Introduction of proper processing &/or disposal technology at waste management center under clustering concept	To promote waste separation at generation points to be sold for material recycling (plastic waste)	
7	Appropriate treatment of accumulated old waste disposed in inappropriate sites (100% by 2019)	Completed (no such accumulated waste is existing in the area)	
8	Encouragement of all parties to participate in waste management	To conduct workshop & seminar with purpose of awareness raising & capacity development. To conduct 3Rs promotion	

4. Development Resource and Waste Management Strategies

Proposed Activities in Environmental Management including Waste Management in 2560-2561

	Project Name	Outline	Output
1	Sustainable Environmental Management (Seminar)	1. To let communities understand and manage community in sustainable way 2. To create concept of regulation cost management & rules in environmental management in the community. 3. To let community to continuously conduct environmental activities.	1. Management of the municipality, Member of city congress, responsible officers, leaders of communities understand and aware sustainable environmental management in the community. 2. Trainees can join with the community and set up regulations cost and value in environmental management in each community. 3. Environmental conditions in the community will be improved and continuously maintain for long time
2	Network Establishment against smog Issues	1. To create a community network to protect and solve the smog in the Maejo Town municipality area. 2. To raise awareness and conscious not to do open burning in agricultural land & weeds along the roads and motivate and promote conservation of natural resources and the environment. 3. To reduce patients suffering from diseases such as Respiratory system	1. Citizen will know and understand in prevention of having smog. 2. Networks in communities to solve and monitor open burning of waste in communities. 3. The rate of illness from respiratory disease decreased.
3	Mae Jo clean city to promote Cleanliness in municipality	1. To carry out the activities of community empowerment projects to reduce waste problems. 2. To activate and encourage people & authorities to cooperate in continuous solid waste reduction. 3. To make Mae Jo municipality as a clean city and to reduce cost & expenses for waste management of the municipality 4. In response to the government's policy to discipline people in the nation to maintain the cleanliness of the country.	1. Citizen will know as for waste separation at household 2. More citizen will support for solving waste problems and pay more attention in environmental in both household and community. 3. The amount of municipal solid waste must be processed & Stored in the community to be transported & reduced amount of waste. *Does this mean some recyclable waste can be recycle either as material recycle or thermal recycle shall be separated, processed and stored at warehouse in the community to create value ???*

	Project Name	Outline	
4	Green City 20 under Local Agenda LA 20 (Seminar)	1. To grow up environment leaders. 2. To develop the skills of thinking, analysis and planning in community development & capacity development of community. Parties in the area support for various projects & activities to encourage their daily life to be eco-friendly way with green consumption, including collaborative & balanced management of natural resources and local environmental in sustainable way. 3. To develop a model and mechanism for area development toward green city, green community and green society through cooperation by all parties. 4. To Encourage to know the value, including conservation of natural resources and environment in order to strengthen the local network for development to drive the green society 5. To publish the format, concepts and Knowledge for Sustainable Development to the Public	1. Community leaders and core leaders from other groups will well aware to participate in environmental program, change their daily life and eco-friendly consumption and cooperate in conservation of natural resources and environment in both balanced and sustainable way 2. There will be a sustainable development network. Which enable to drive the area to green society 3. The area has been developed to strengthen the implementation mechanism and upgrade to the model community level. Area will be comfortable to live for long and move forward to the green society through cooperation of many parties. 4. To have model, way of thinking and part of knowledge as for development of sustainable green society. Publish & distribute to members in LA 20 network and all level in public in order to build up cooperation, develop a model for further expansion
5	Research for biomass oriented organic fertilizer production for reduction of fog issues	1. To reduce the fragments of Natural materials, leaves, Twigs, Biodegradable waste, which cause smog problems in the area, if burn. 2. To avoid paying any expense to dispose natural materials, leaves, twigs, weed, Biodegradable waste at landfill. 3. To increase productivity by utilization of organic compost with mineral, which effect on growing plants for long time 4. To minimize problems, such as environmental impact caused by smog, and to reduce cost for production by less utilization of expensive chemical fertilizer. 5. Organic Compost enable to improve agricultural areas, gardens, landscape in municipality in terms of beautification. Improve agricultural land for better conditions. No chemical residue to reduce from the usage of chemicals and chemical fertilizers which might cause pollution in the community. To preserve nature and the environment	1. To reduce the open burning problem of fragments of natural materials, leaves, branches, weeds, which cause of smoke in the area, and to save cost in waste management, waste disposal of natural materials, leaves, branches, Weeds degraded at landfill. 2. To fertilize soil to increase productivity the agricultural areas, and save cost by reducing utilization of expensive chemicals. 3. The exchange of knowledge and experience of composting from natural remnants of the community. Contribute to the conservation of nature and the environment. In the development of quality of life and community development and reduce the problem of smoke in the area.

Current Situation (iv) Activities in Environmental Management including Waste Management in Past & Assessment

	Project Name	Objectives & Target	Assessment
1	Participation in TOYOTA GREEN TOWN contest	1. Energy (Electricity) Saving 2. Energy Saving in Transportation 3. Reduction of MSW 4. Increase Green Area in city	แพะป่าห้า community from Mae Jo city won 1st prize in community group
2			
3			
4			

5. Discussion (How to set up waste management plan for the area)

TARGET

5%

Reduction

1. What is the baseline for the target ???
(1) How many tons of Waste generated in your area ?
(2) How fluctuate amount of waste generated in the area ?
(3) Which year's date will be baseline ?

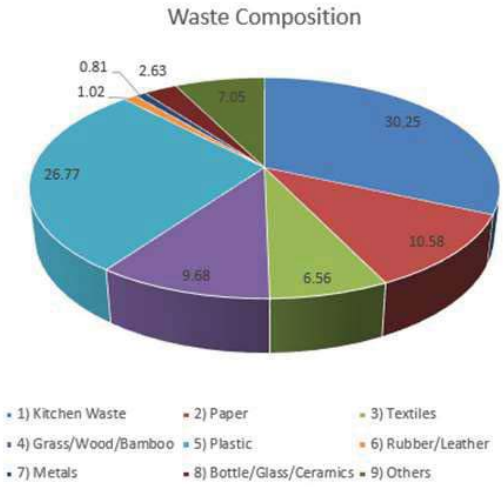
2. What is the exact amount for 5 percent (how many tons/day) ?

3. How to achieve the target (reduce the amount mentioned in 2 above) ?

4. How to measure & assess outcome from activities

5. How to continue to improve waste management

Options from Waste Data



Composition of Waste generated and transported to Rayon Integrated Waste Management Center
Source: EX Research Institute Limited

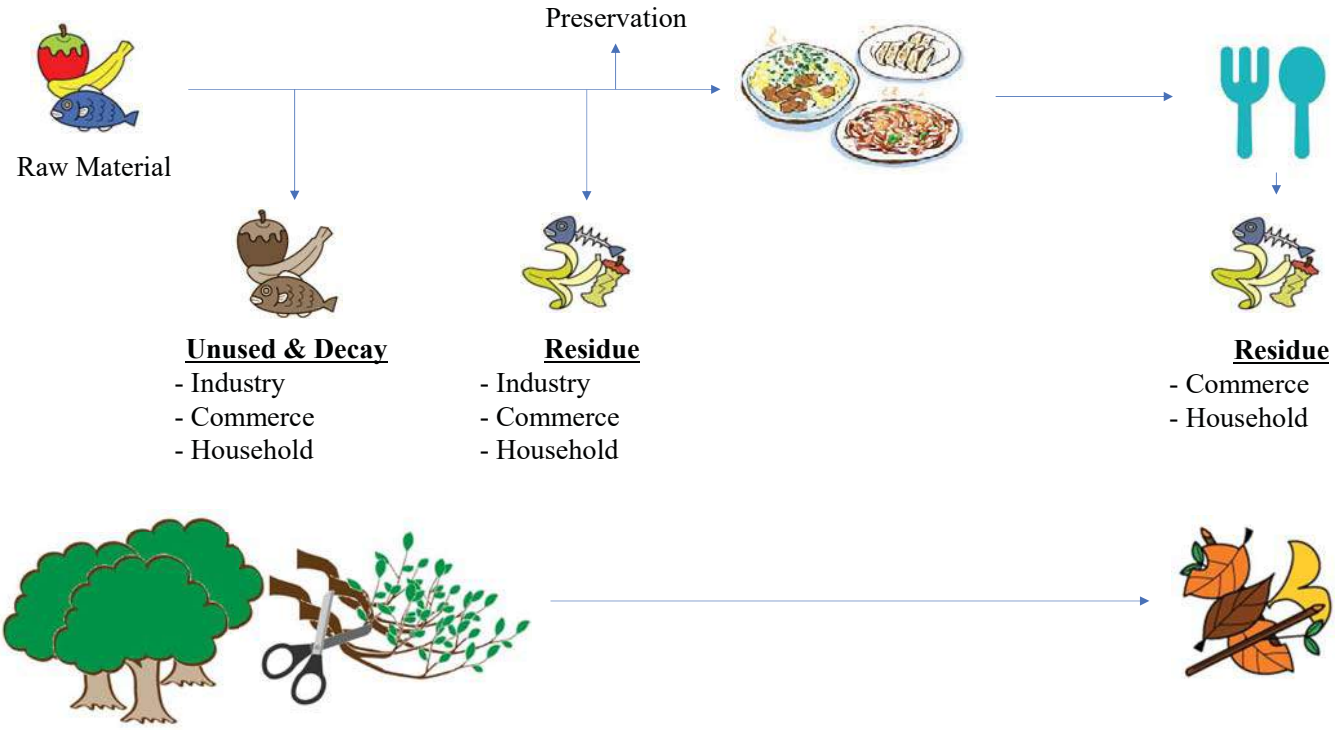
There are many options to reduce 5 percent of waste sent for landfilling ! Such as

(1) Reduction (Less cost & High Priority)
- Reduction of only 1/5 of Organic Waste (in Wet Weight)
- Reduction of 1/5 of Plastic Waste
- Reduction of ½ of Paper Waste
- Reduction of ½ of Biomass Waste
- Or mix up a few options mentioned above.

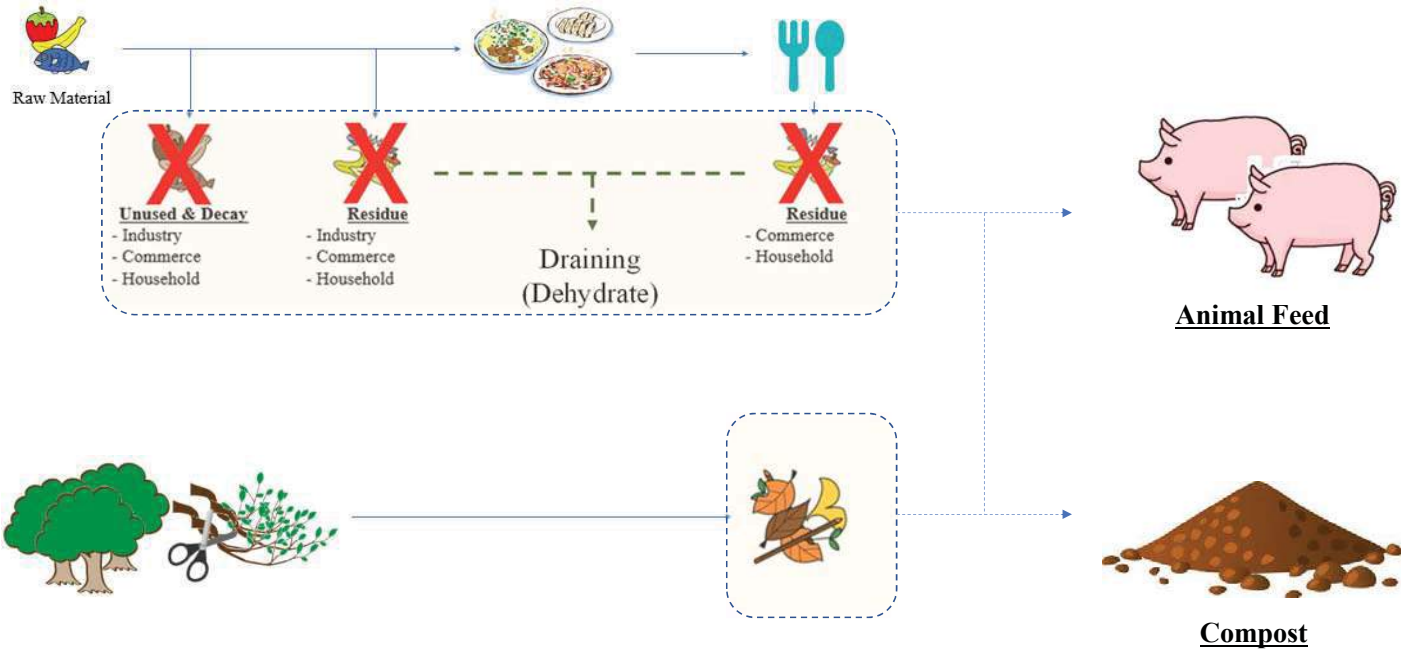
(2) Material & Thermal Recycle (more cost)
- Composting (Organic Waste & Biomass)
  Amount of Waste to be reduced to ½
- Anaerobic Digestion
  Amount of Waste to be reduced to 3/10
- RDF
  Amount of Waste to be reduced to 7/10
- WtE
  Amount of Waste to be reduced to5-10%

Case Study … How to reduce Organic Waste

How Organic Waste generate ?



Case Study … How to reduce Organic Waste…How to reduce Organic Waste ?



Case Study … How to reduce Organic Waste…How to realize Organic Waste reduction ?

1. Awareness Raising

2. Capacity Building
(1) Responsible Persons from Administrative Office
(2) Leaders from communities, schools, offices & companies
(3) Volunteers

3. Organization
(1) Assignment of environmental committee in each community / schools, offices & company
(2) Networking

4. System & Mechanism
(1) Monthly / Periodically Meeting
(2) Environmental Week / Month
(3) Surveillance & Monitoring
(4) Exhibition
(5) Seminar & Workshop

5. Tools
(1) Competition & Commendation
(2) Regulation, Guidebook & Penalties
(3) Economic Incentives
(4) Information Disclosure

Case Study … How to reduce Other types of Waste

How Other Waste to be generated ?

- Broken
- No Use

Case Study … How to reduce Other types of Waste

How to reduce other Waste to be generated ?

e.g. Plastic Waste

(1) Plastic shopping bag

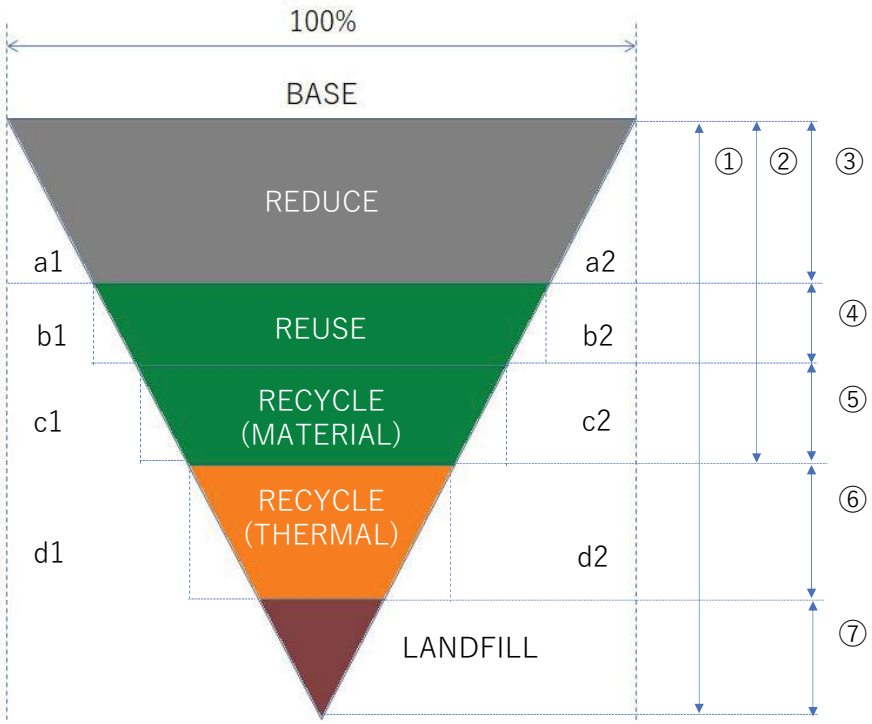
- Promotion of Eco Bag Utilization
- No Plastic Bag campaign at Convenience Stores, Grocery shops & Department Stores
- Plastic Bag for pay (stop free distribution)
- Point Program
- Introduction of biodegradable shopping bag

(2) Other plastic waste

- Quality Improvement (high durability)
- Quality Improvement (simple package with less plastic)
- Promotion of Refilling System with less plastic material
- Utilization of own lunch box, dish, bowl & other tableware
- Utilization with best care

Minimization

Waste Management Hierarchy & Basic Concept for Waste Management



Activities	Reduction
(1+2)+3	a1+a2
(1+2)+4	b1+b2
(1+2)+5	c1+c2
(1+2)+6	d1+d2

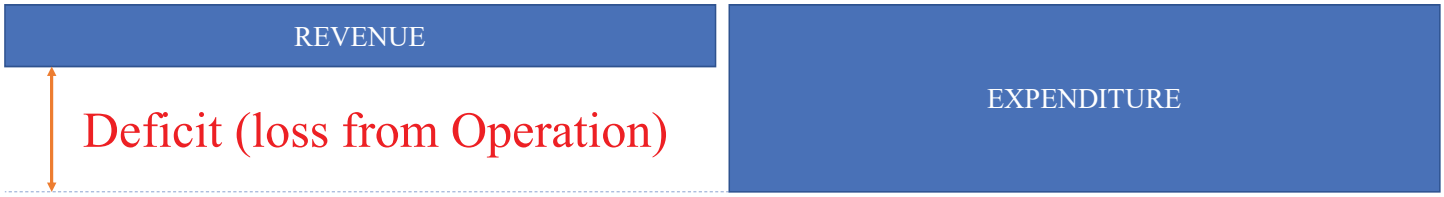
Activities in Waste Management by each stage

Stage	Activities
1	• Laws & Regulation • Guideline • Awareness Raising • Capacity Building (Administrators, Leaders from Communities, Organization & Volunteers) • Waste Management System Development • Planning • Financing • Changes of Lifestyle & Behavier
2	• 3Rs Promotion
3	• Reduction of waste by type promotion on utilization of ECO BAG for plastic waste reduction extra charge on plastic bag at shopping center introduction of bio degradable material for container and/or packing introduction of resource saving products introduction of high durability products promotion of utilization of eco products No food waste campaign Establishment of Sharing System
4	● Waste Exchange Center ● Free Market (exchange or buy-sell of unused items / products)

Activities in Waste Management by each stage

Stage	Activities
5	• Establishment of Material Recycle System Waste Bank (Software and Hardware) Exchange waste to daily necessaries • Involvement of Private Sector Material Recyclable Waste Collection System Development Material Recycle Factories and support for operation • Green Purchasing Campaign (Government & Private Sector) • ECO Mark
6	• Develop facilities, such as RDF/RPF manufacturing plant, Biogas digester with utilization unit, and/or WtE plant • Understanding on factors to develop such thermal recycle facilities and support for operation
7	• Appropriate Disposal dispose at either Sanitary Landfill, Engineered Landfill or Controlled Dump <50t/day (If local authorities need to have such facilities, should consider how let any partied to decide to develop the facilities & maintain its operation)
Others	• Efficiency / Economic Feasibility in Waste Flow & Environmental Impact Clustering & Integrated Waste Management Center / Transfer Station

Financial Assessment



Source of Loss Compensation
General Budget allocated to Local Authorities from the Central Government

How to make up the balance ???
(1) Increase Revenue
  1) Revision (Increase) of Service Charge
  2) Increase no of payer for service charge in the area
  3) Generation of additional Income (Material & Thermal Recycle)
(2) Reduce Expenditure
  1) Reduction of Amount of Waste to be processed and/or disposal for pay
  2) Reduction of unit cost for waste processing and disposal for pay
  3) improvement of efficiency in waste management, including collection & transportation

If Local Authorities could utilize cost & expenses currently spent on waste management for other purpose, such as education, social welfare or even conservation of environment, then citizen will be happy (support for the local government) or not ???

5. Others

Co-Relation among Activities in waste management by each administrative level in Thailand

Central Government

- Revision of Law
- Issuance of Notification (Clustering)
- Development of Data System
- Power Purchase from WtE power plants

→ Achievement of National Target in
1. Waste Management
2. Power Development

Contribution

Chiang Mai Province

Activities (including under the Project)
1. Awareness Raising
2. Capacity Building
   1) Planning / 2) Management
3. 3Rs Promotion
4. Development of Appropriate Waste Management Facilities

→ Realization of
1. Reduction of Waste
2. Material Sound Society
3. Clean city / province
4. Green city / province
5. Appropriate Waste Management

Proposal on cooperation among the parties concern, i.e., Local Authorities in Chiang Mai Province, City of Kitakyushu, Pollution Control Department and Japan International Cooperation Agency (JICA)

Technical Support for Municipal Solid Waste Management

Link & Co-Work ???

2018

- Knowledge Sharing (Level I) 2nd round
- Knowledge Sharing (Level II for 2nd group (xx LAs))
- Model Project Development (Mae Jo municipality)
- Model Project Expansion (xx LAs)
- Wide Area Processing
- JCM model project development study
- JCM Project Implementation

Support (subject to budget allocation by MOEJ)

北九州市 CITY OF KITAKYUSHU

2017

- Knowledge Sharing (Level I)
- Knowledge Sharing (Level II for 1st group (16 LAs))
- Model Project Development (Mae Jo municipality)
- JCM model project development study

THANK YOU

地方電力公社

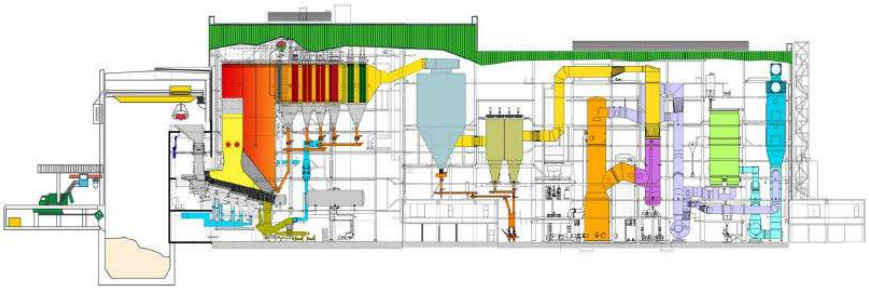
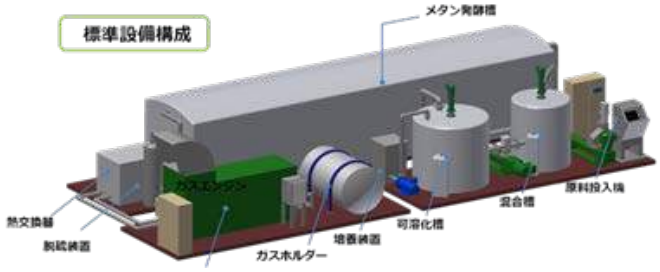
電気料金表

1030.92　　10.56

			一般家庭				小規模事業者		中規模事業者			大規模事業者			特定事業			非営利団体		
			150KWh未満	150KWh以上	22-33KV	22KV以下	22-33KV	22KV以下	69KV	22-33KV	22KV以下	69KV	22-33KV	22KV以下	69KV	22-33KV	22KV以下	69KV	22-33KV	22KV以下
一般料金	従量価格	15KWh迄	2.3488	3.2484			3.9086	3.2484	3.1355	3.1729	3.2009	3.1355	3.1729	3.2009	3.1355	3.1729	3.2009	3.4407	3.6107	2.8271
		16-25KW h	2.9882																	3.9177
		26-35KWh	3.2405																	
		36-100KWh	3.6237																	
		101-150KWh	3.7171																	
		151-400KWh	4.2218	4.2218				4.2218												
		401KWh以上	4.4217	4.4217				4.4217												
	サービス料		8.19	38.22	312.24	38.22	312.24	46.16	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24
	契約電力料(/kw)	ピーク							175.7	196.26	221.50	224.3	285.05	332.71	220.56	256.07	276.64			
		パーシャル	-	-	-	-	-	-				29.91	58.88	68.22				-	-	-
		オフピーク										0.00	0.00	0.00						
時間別料金	ピーク(/kwh)				5.1135	57,982	5.1135	5.7982	4.1283	4.2097	4.3555	4.1283	4.2097	4.3555	4.1283	4.2097	4.3555	4.1283	4.2097	4.3555
(ToU)	オフピーク(/kwH)				2.6037	2.6369	2.6037	2.6369	2.6107	2.6295	2.6627	2.6107	2.6295	2.6627	2.6107	2.6295	2.6627	2.6107	2.6295	2.6627
	サービス料(/m)				312.24	38.22			312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24	312.24
	契約電力料(kw)								74.14	132.93	210.00	74.14	132.93	210.00	74.14	132.93	210.00	74.14	132.93	210.00

Project Idea Note for the Study

Document release date	(17/03/2017)
Title of the proposed study	Introduction of high efficient waste processing facility under Integrated Waste Management in Chiang Mai, Thailand
The communication focal point entity etc. of the study	Name of contact entity etc: EX Research Institute Limited Name and position of contact person: Mr. Satoshi Takagi, Senior Consultant E-mail of contact person: s.takagi@exri.co.jp Phone number of contact person: +81-359567503 Address of contact entity etc: 17-22 Takada 2chome, Toshima-ku, Tokyo, Japan
Japanese participant[s] for the study	Name of participant: EX Research Institute Limited Roles: Total Coordination, Business Evaluation & JCM project development Name of participant: City of Kitakyushu Roles: Framework & promotion of JCM projects Name of participant: Nippon Steel & Sumikin Engineering Co., Ltd. Roles: Technical Provider
Thai participant[s] for the study	Name of participant: Chiang Mai Provincial Office Roles: Framework & support for the project (Name of participant: Chiang Mai Waste to Power 2 Co., Ltd. Roles:) Potential project owner (Name of participant: Roles:)
Brief summary of the study	**[Objective of the Study]**

Example: ➢ Objective of the study ➢ Location of the study ➢ Scale of investment including planned source of investment ➢ Technology[ies] to be adopted for the study, and brief description of the technology[ies] ➢ Project implementation scheme, and role of each participant ➢ Current status and progress of the study including planned timeline	This study will be conducted with purpose of materialize low carbon technology & low environmental impact based projects in the field of municipal waste management in Chiang Mai province **[Location of the Study]** Chiang Mai Province, Thailand **[Scale of Investment & Investor(s)]** Scale of Investment will be ranged from a ten million Thai Bath to billion Thai Baht depending on the type & scale of the project. **[Technologies to be employed with brief description]** Two type of technologies, landfilled old waste base WtE plant and anaerobic fermentation with high efficiency would be employed in the targeted projects in the study. The former will be provided by Nippon Steel & Sumikin Engineering Co., Ltd., (NSENGI) is a one of the leading Japanese Engineering Companies. According to NSENGI, one of their engineered facility has world highest record of 30.2% in energy conversion efficiency by combining various technologies, such as low-air ration combustion, high pressure & high temperature steam generation, steam extraction from turbine, to improve energy conversion efficiency at the facility. We expect to have facility with not less than 28% of energy conversion efficiency in Thailand.  Source: Nippon Steel & Sumikin Engineering Co., Ltd. The other technology would be employed is Anaerobic Fermentation with high efficiency, to be provided by Price Management Japan Co., Ltd. (PMJ), who is an owner of the international patent for rapid solubilizing of organic matter. According to PMJ, they have realized four time as much as methane gas collected from organic matter in comparison with conventional method. PMJ's technology is applicable for both large and small size, thus we expect to develop JCM project at many sites.  Source: Price Management Japan Co., Ltd.(PMJ)

	[Project Implementation Scheme & Role of each participant] EX Research Institute Limited will participate in International consortium for the project management as Japanese representative and will be a window to the Government of Japan for JCM subsidy as well as JCM project registration and other series of communication with JCM joint committee.
Rough estimation of expected GHG emission reductions (unit: tCO2/year)	There is a project, which Japanese Engineering Company under negotiation. The study implementation body regards the project with highest potentiality in the study. For the project, approximately 18,000tCO2/year of GHG will be reduced from project implementation.
(if any) Capacity building activity for the host country (cf. information sharing among stakeholders, organizing workshops, and/or study tour to Japan)	As the study will be conducted as a part of city-city cooperation between Chiang Mai province and the city of Kitakyushu, the project implementation body, in cooperation with the city of Kitakyushu will provide comprehensive support for realization of integrated waste management in Chiang Mai province, including holding workshop for 3Rs promotion.