FY2015 Study for Ministry of the Environment Japan

FY 2015

Feasibility Study on Joint Crediting Mechanism Project For Realization fo a Low-Carbon Society in Asia

Promotion of Decarbonizing of Municipal Waste Management and Ecological Industrial Town in Rayong Province

Report

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Kitakyushu Asian Center for Low Carbon Society
NTT Data Institute of Management Consulting
Institute for Global Environmental Strategies
EX Research Institute Ltd.
Amita Corporation

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Chapter 1

Project Background & Objectives

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1.1 Overview of Rayong Province

(1) Basic information

Rayong Province is a province in the eastern region of Thailand. Rayong Province is located next to Chonburi Province and Chanthaburi Province, with the Gulf of Siam to the south. The province is separated from Bangkok by about 200 km, which is about two and one-half hours away by car. The province has a tropical climate, with a rainy season (June to October) and a dry season (November to May), and is hot and humid throughout the year. According to statistics at the end of 2009, the 3,552 km^2 area is home to about 610,000 people. The population density is 171 people per 1 km^2, and it is a relatively quiet area in in Thailand.

(2) Major industries

The major industries in Rayong Province are agriculture, tourism, and manufacturing. The province is a leading industrial prefecture in Thailand as a result of the successive development of large-scale industrial estates since 1990 in areas near the Map Ta Phut district, as well as Chonburi Province to the north.

(3) Industrial estates in the province

Like Chonburi Province, Rayong Province is a region in the eastern part of Thailand that is the target of vibrant investment from foreign companies and is a driving force behind the regional economy in the east. There are 13 industrial estates in Rayong Province, with a total of 352 factories located in these industrial complexes. Industrial estates in Rayong Province are located separately in the north and south of the province and are largely divided into estates on the coast facing the Gulf of Siam and its hinterlands towards the south of the province, and estates on the border of Chonburi Province to the north.

A petrochemical complex that uses natural gas is located in the southern part of

Rayong Province, which has become a heavy chemical industrial zone. The northern part of the industrial area is adjacent to industrial estates in Chonburi Province, and is the most important industrial zone in Thailand with the advantage of being located close to Laem Chabang Port. This area, the Eastern Seaboard Industrial Estate (Rayong), is referred to as the “Detroit of the East.” It is a central area for the automotive industry and the destination for the entry of a number of major assembly manufacturers and related parts manufacturers from Japan and Europe into the local market.

1.2 Greenhouse gas emission reduction policies of the Thai Government

The Thai Government has laid out a target of “achieving a happy society with equity, fairness, and resilience” in the 11th National Economic and Social Development Plan (2012-2016), in which the mission of the nation is defined as the development of an environmental foundation to develop knowledgeable human resources and ensure the safety of natural resources. As a strategy for economic development and improvement of environmental issues, the Thai Government has mapped out a plan for the management of resources and the environment in order to achieve the sustainability of society. In the fine print, the following strategies have been spelled out, targeting a “paradigm shift to an environmentally-sustainable, low-carbon economy and low-carbon society.”

- Improvement of technology for low-carbon development of industries with large GHG emissions
- Review of policies that could be advantageous for low-carbon industries
- Promotion of a balance between communities and industries through the systematic recycling of waste and development of eco-industrial towns to provide raw materials.

Based on this plan, ten “Eco-Industrial Towns” in locations throughout Thailand were selected under the guidance of the Ministry of Industry (MOI) and with the Department of Industrial Works (DIW) and Industrial Estate Authority of Thailand (IEAT) playing a central role. In these eco-industrial towns, environmentally-friendly industrial estate projects that are integrated with the surrounding communities are being implemented over the next five to ten years. Rayong Province has been set as the stage for the promotion of initiatives that aim at the development of eco-industrial towns. For details, see section *1.3 Initiatives and challenges of Rayong Province in reducing greenhouse gas emissions.*

Figure 1. Excerpts of concepts from the 11th National Economic and Social Development Plan that relate to low-carbon development

1.3 Initiatives and challenges of Rayong Province in reducing greenhouse gas emissions

IRPC Industrial Estate, which is located in Rayong Prefecture (Rayong City), is one of the eco-industrial towns being promoted by DIW. The Map Ta Phut Industrial Estate (Map Ta Phut City) has been designated by the national government as an eco-industrial town that is being promoted by IEAT.

(1) Initiatives by DIW

DIW defines eco-industrial towns as “towns or cities with major manufacturing industries that enable sustainable growth and have a balance between social development and the living environment.” The DIW currently has formulated a master plan to develop nine industrial estates into eco-industrial towns, including the IRPC Industrial Estate. In the future, DIW aims to “develop and improve necessary legal systems” and “develop the capacity of persons responsible in target areas” in the creation of specific projects, as well as formulate responses to problems related to transportation, securing water resources, and the centralized treatment of industrial waste in the long term, starting with policies, such as the 3Rs (recycle, reuse, reduce) for industrial waste in the immediate future.

(2) Initiatives by IEAT

The Eco-Industrial Town concept of IEAT includes the objective of changing 15 industrial estates into eco-industrial towns between 2010 and 2013 and changing all of the industrial estates in Thailand into eco-industrial towns by 2019. Of these, nine policies were determined for the development of the Map Ta Phut Industrial Estate in Rayong Province as an eco-industrial town. These nine policies were determined after Kitakyushu and IEAT signed an MoU in 2014.

Based on the concepts that have been developed, the project has found that there are some that have started off as actual projects. However, there are also some that are still pending. IEAT has requested support for the implementation of specific projects, and of the nine issues, support is being offered within the potential framework under this project in areas that are expected to be feasible as JCM projects.

1.4 Cooperative relationship between Rayong Province and Kitakyushu City

In order to promote the Eco-Industrial Town concept, Kitakyushu, the Thai Department of Industrial Works (DIW) and IRPC signed a memorandum of cooperation on 4 December 2014. The stated mission of this MoU is to promote a balance between the industrial estate and surrounding communities, and promote the shift to an environmentally-friendly industrial estate. The signing ceremony for this MoU was attended by Mr. Kenji Kitahashi, Mayor of the City of Kitakyushu, Mr. Pasu Loharjun, Director General of DIW, and Mr. Sukrit Surabotsopon, Director/Executive Director/President of IRPC, under the supervision of Dr. Atchaka Sibunruang, Deputy Permanent Secretary of the Thai Ministry of Industry.

In August 2014, prior to the signing ceremony, Kitakyushu concluded a memorandum of cooperation with the Industrial Estate Authority of Thailand (IEAT) on the Map Ta Phut Industrial Estate in Rayong Province (or to be more precise, an industrial complex). The Eco-Industrial Town concept requires that the industrial estate have an environmental balance with surrounding municipalities, such as Rayong City, which is where the IRPC Industrial Estate is located (population of about 60,000), and Map Ta Phut City, which is where the Map Ta Phut Industrial Estate is located (population of about 45,000), and Rayong Provincial Administrative Organization (PAO, population of about 660,000), which is a wide-area municipality that includes these two cities. Kitakyushu has already developed a network with related municipalities, including Rayong PAO, and has organized workshops to improve waste management for the staff of these local governments using a project by The Overseas Human Resources and Industry Development Association (HIDA) on the development of a plan to improve the urban environment in Map Ta Phut City, Rayong City, and Rayong Province in the Kingdom of Thailand (November 2014 to July 2015).

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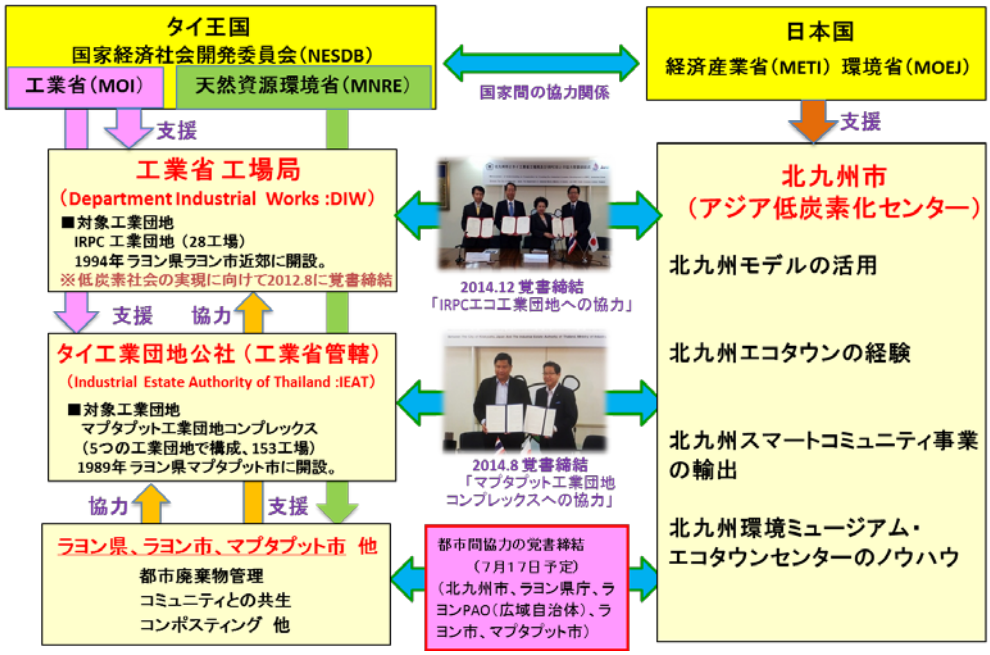

1.5 Project objectives and overview

This project was implemented on the foundation of cooperation between the City of Kitakyushu, Thai Department of Industrial Works (DIW), Industrial Estate Authority of Thailand (IEAT), Rayong Province, Rayong City, Map Ta Phut City, IRPC Industrial Estate, and Map Ta Phut Industrial Estate.

Studies on the following seven themes were carried out to confirm the possible application of Japan's technologies in the IRPC and Map Ta Phut industrial estates that will be developed as eco-industrial towns.

Potential technologies	Overview
1) Collection/development and practical application of databases	Detailed waste-related data on Map Ta Phut and IPRC industrial estates was compiled in fiscal 2014. From fiscal 2015, it is likely that efforts to reduce the amount of waste sent to landfills, in particular, will become more active with the use of the analysis and analysis results. It may be possible to apply Japanese advanced technologies in each of the stages of collection/development and application of databases.
2) Use of sludge as raw materials for cement	Sludge from 24 IRPC factories, for example, is currently sent to landfill for treatment. In order to promote the concept of "zero landfill," the use of sludge from these factories is being promoted as raw materials for cement.
3) Use of organic waste and organic sludge to produce alternative fuel (Bio-beat)	At present, there are plans to compost organic waste at waste treatment facilities in Rayong Province, for example. There is potential to use organic waste and sludge as an alternative fuel for boilers in existing plants with the use of Japanese advanced organic waste technologies for Bio-beat.
4) Waste-to-energy	In the future, there is potential to newly construct and increase the number of waste generation facilities. In addition to waste-to-energy technologies, there is also potential for the application of Japan's superior exhaust gas control technologies.
5) Technologies that effectively use water-saving technologies	As a measure to address shortages of industrial water in the future, IRPC and other companies want to work to ensure sound water conservation. The water balance data of the 24 IRPC factories contained a report on "Evaporation" of about 40% of water volume. By clarifying the water balance of each factory, there is potential to apply various types of water-saving technologies, including the improvement of piping from which water leakage occurs.
6) Emission control measures for power generation facilities and boilers	There are a number of cases where companies located in the Map Ta Phut and IRPC industrial estates have facilities that generate exhaust gas, such as power generation facilities and boilers. This requires strict environmental measures, such as the reduction of NOx and SO_2. As Japan possesses some of the world's most preeminent exhaust gas countermeasure technologies, there is potential to apply these technologies to control emissions from these facilities.
7) Energy-saving and distributed power generation technologies, including heat transfer	Since the target is an industrial estate, there is potential to introduce distributed power systems for the effective use of unused energy, including heat transfer between factory groups, without having to halt energy-saving measures in individual factories. A past study carried out by NEDO suggested the

	possibility of energy savings of about 28% by theoretically performing heat transfers in the Map Ta Phut Industrial Estate. There is potential to apply technologies for energy savings, application of unused heat, and distributed power generation that is being advanced in Japan.

Chapter 2

Energy Sector:

Project for Waste Heat Recovery, the Introduction of Decentralized Power Supply Systems, Energy Conservation and Water Conservation on Industrial Estates

NTT DATA Institute of Management Consulting, Inc.

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2.1 Objectives of the Feasibility Study and the Organizational Structure for the Implementation of the Study

2.1.1 An Outline of the Project (The Objectives and the Scope of the Study)

(1) Objectives

In this project, we conducted a study for the possibility of developing urban environment infrastructure businesses at the two major industrial estates for heavy and chemical industries in Thailand, by utilizing the environmental technologies of companies from Kitakyushu City. The two industrial estates are: the IRPC Industrial Estate (in Rayong Province) which is designated as one of the Eco-Industrial Towns promoted by the Department of Industrial Works (DIW); and the Maptaphut Industrial Estate (in Rayong Province) which is designated as one of the Eco-Industrial Towns promoted by the Industrial Estate Authority of Thailand (IEAT). The Eco-Industrial Town scheme aims to achieve a low-carbon society through cooperation between industrial estates and local communities. The scheme focuses on energy conservation, new energy sources and local resident participation, in addition to the promotion of resource circulation and recycling.

(2) The Scope of the Study

Through the studies conducted up to the previous fiscal year, it was confirmed that energy conservation measures have been taken to a certain extent, at individual factories on the two industrial estates which are to be developed into Eco-Industrial Towns. In this study, we explored the possibility of improving energy use efficiency, through the utilization of currently unused energy by groups of factories and the introduction of decentralized power supply systems in order to utilize unused energy, after conducting simple surveys of energy conservation at individual factories in order to reconfirm the previous studies' results. We also looked into the applicability of various water conservation technologies which have not been fully explored in the past, which range from simple technologies such as leak detection systems to advanced water conservation technologies.

① Measures for Exhaust Gases from Power Generation Systems, Boilers, etc.

Many of the companies located on the Maptaphut Industrial Estate and the IRPC Industrial Estate have facilities which emit exhaust gases such as power generation systems and boilers. They are required to reduce NOx emissions and SO2 emissions as environmental measures. Therefore, we conducted surveys on the introduction of Japanese technologies for exhaust gas

control measures, as Japan has the preeminent exhaust gas control technologies and they could be used on the industrial estates.

② Energy Conservation and Decentralized Power Supply Technologies Including Heat Sharing

As the proposed project includes energy conservation for industrial estates, the project could go beyond energy conservation measures for individual factories and conduct heat sharing among groups of factories, etc. in order to utilize currently unused energy, as well as introducing decentralized power supply systems in order to enable the utilization of unused energy. The past study conducted by NEDO (the New Energy and Industrial Technology Development Organization) suggests that heat sharing on the Maptaphut Industrial Estate, etc. could theoretically save about 28% of the energy currently being used. Therefore, we considered that Japanese advanced technologies for energy conservation, unused heat utilization and decentralized power supplies are applicable at the industrial estates.

2.1.2 Applicable Technologies and Relevant Legislation

(1) Applicable Technologies

The following technologies were selected as candidate technologies to be considered by the project, based on the results of field surveys at the factories, business facilities, etc. situated on industrial estates in Rayong Province.

Table 1 Applicable Technologies

Category	Facility	Applicable technology
	Warehouses at a petrochemical plant	Photovoltaic (PV) systems
	A food factory	Cogeneration systems
Business facilities	An office at a petrochemical plant	Highly efficient chillers, a PV system and highly efficient lighting
	Eco Center building	Highly efficient chillers

(2) Relevant Legislation

Regarding laws related to energy conservation in Thailand, the Energy Conservation Promotion Act B.E.2535 was enacted in 1992 and put into force in 1998. The law was revised in

2007.

In 2011, the Thai government published the Thailand 20-Year Energy Efficiency Development Plan (2011-2030), which sets the target of reducing energy intensity (energy use per unit of GDP) by 25% by 2030, when compared to the 2005 level.

Although the above national energy efficiency target has been set, individual companies are not necessarily required to meet specific energy efficiency targets. Energy conservation awareness in each company tends to be low, as Thailand is rich in resources and electricity is inexpensive.

2.1.3 The Organizational Structure for the Implementation of the Study

The following shows the organizational structure for the implementation of the study project.

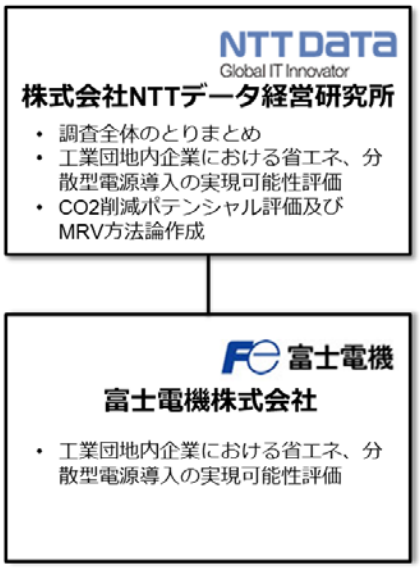


Fig. 1 The Organizational Structure for the Implementation of the Study

In addition to the above-mentioned companies, we asked air-conditioning equipment companies, refrigeration equipment companies, etc. for cooperation, when proposing energy conservation measures for each facility.

2.1.4 The Study Method and the Schedule

(1) The Study Method

The study project was conducted in four steps as shown below.

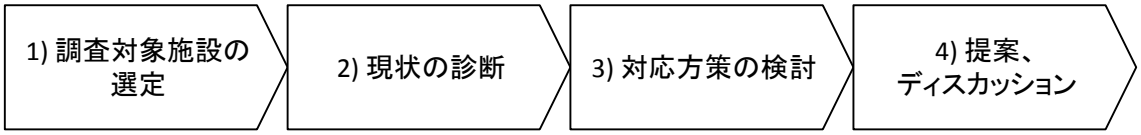


Fig. 2 Project Procedures

In “1) The selection of facilities to be studied,” we selected factory facilities on industrial estates managed by the DIW and the IEAT in Rayong Province. More specifically, we conducted surveys of factories on the IRPC Industrial Estate and the industrial estates in the Maptaphut Complex. As a way of approaching companies, we held workshops on some industrial estates

and explained the Joint Crediting Mechanism (JCM) as well as the purpose of the study in order to raise interest. We then visited companies, which were interested in the JCM and our study, individually to conduct the surveys.

In “2) Auditing the current situation,” we studied current energy consumption through on-site interviews and walk through surveys at facilities, as well as collecting energy data and information on equipment.

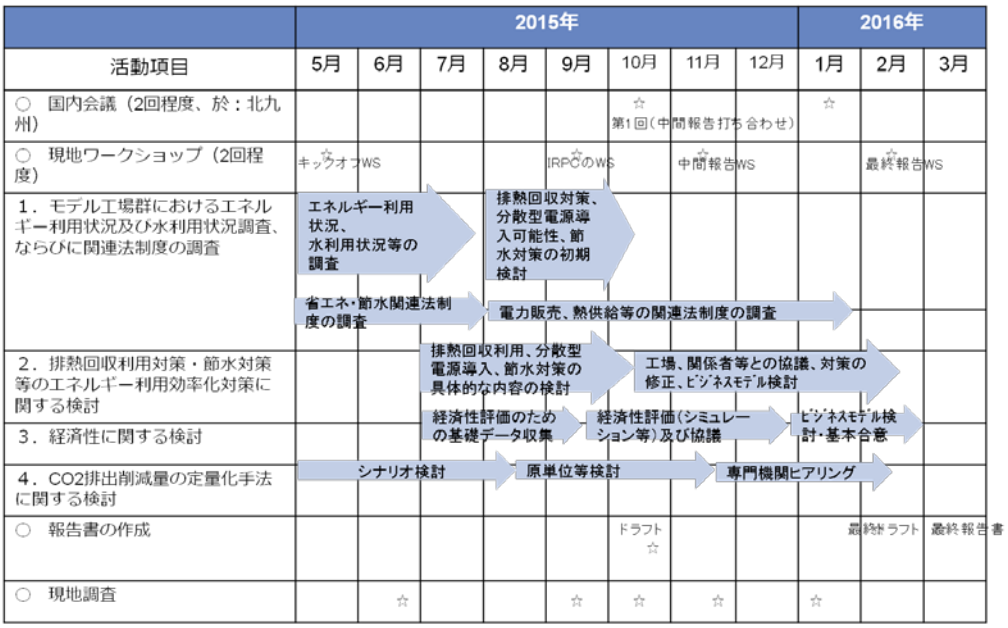
In “3) Consideration of the measures to be taken,” we considered energy conservation measures, etc. that are thought to be feasible based on the results of “2) Auditing the current situation,” with the cooperation of relevant equipment manufacturers, etc.

In “4) Proposals and discussions,” we had discussions with people in charge of the matter at each facility regarding the auditing results and the proposals we made, and considered how to proceed.

(2) The Schedule

The study was conducted in accordance with the following schedule.

Table 2　The Study Implementation Schedule



2.2 Results of the Feasibility Study

2.2.1 A Summary of the Field Surveys

In this project, we conducted field surveys targeting companies on the IRPC Industrial Estate and the Maptaphut Complex, in May, June, September, October, November and January. We interviewed a total of nine local companies. We also held four workshops to introduce the JCM scheme to companies on some industrial estates, with the aim of selecting potential companies for the creation of JCM projects. The following explains the results of the interview surveys of local companies which may have the potential to become JCM project partners, as well as the results of the four workshops.

2.2.1.1 Interview Surveys of Local Companies

(1) Petrochemical Plant (Company A)

We had on-site discussions with the company at its petrochemical plant on the IRPC Industrial Estate on four occasions, regarding the energy conservation-related issues that the company faces. About eight issues were laid on the table during the discussions, but the company has already taken considerably advanced energy conservation measures for some of the issues, and many of the remaining issues involved the need to improve the manufacturing process efficiency. We closely examined the remaining topics as some of them would not necessarily lead to CO2 reductions even if measures were taken. We then narrowed down the topics to three, and considered the possibility of the creation of a JCM project for each topic. The following explains a summary and the results of the discussions on each topic.

(1)-1 The Utilization of Waste Heat from Cogeneration Systems

The company wanted to utilize waste heat from the five cogeneration systems it operates. We considered how the waste heat could be utilized while interviewing them. We considered the introduction of waste heat recovery power generation systems, but the amount of waste heat that can be recovered is small and therefore the systems are expected to generate only a small amount of power. In addition, the system configuration will become complex and it will reduce economic efficiency. Therefore, the decision was left pending.

(1)-2 Eco-Warehouses

We considered turning warehouses on company A's premises into eco-warehouses by installing PV systems on the roofs of the warehouses. There was the possibility of installing a mega solar power plant if we could use all the warehouse roofs which totaled approx. 70,000 m^2. However, as a result of studying the feed-in tariff (FIT) system in Thailand, it turned out that the

Thai government will not apply the fix-price purchase policy to electricity derived from PV systems from the 2016 fiscal year onwards. Therefore, it was decided that the eco-warehouse project would not be implemented as it had become clear that it would be difficult to recover the investment needed for the introduction of large-scale PV systems with the main purpose being to sell electricity.

(1)-3 Eco-Building

The idea was to install a PV system on the roof of an office building on company A's premises as well as replacing the current air-conditioning equipment in the building with highly efficient energy saving equipment, in order to reduce CO2 emissions. Although the installation of a PV system was excluded from consideration for the reason explained in (1)-2, we still see the possibility of replacing the air-conditioning equipment and we are continuing to investigate the idea. We will select energy efficient equipment with the same cooling capacity based on the model numbers and other information on the currently used cooling units.

IRPC工業団地の航空写真

(2) Food Additives Plant (Company B)

It is a Japanese-affiliated company and is a tenant in the Maptaphut Complex in Rayong Province.

Future demand for electricity and steam is expected to increase at the company, and therefore it wants to supply both power and steam through the introduction of cogeneration systems, so that it can ensure a stable power supply as well as reducing carbon emissions through a reduction in the operating hours for the existing boilers and a reduction in the amount of grid electricity

purchased. The company is also considering the introduction of energy efficient equipment including chillers, compressors and lighting in a new plant, in order to make it an energy efficient plant.

(3) Iron Material Manufacturing Plant (Company C)

It is a Japanese-affiliated company and is a tenant in the Maptaphut Complex in Rayong Province. It could achieve low-carbon heat and power supplies through the introduction of cogeneration systems, as it uses large amounts of electricity and steam in the manufacturing process. It was decided that the company will continue to have in-house discussions in order to identify projects that may be feasible.

(4) Automobile Parts Plant (Company D)

The company is a tenant on the Amata City Industrial Estate in Chonburi Province. We introduced the company to the JCM scheme and interviewed them regarding their current energy conservation needs at the plant in September, but their interest in energy conservation was low as the plant does not consume a large amount of energy.

(5) Automobile Parts Plant (Company E)

The company is a tenant on the Hemaraj Eastern Industrial Estate in Rayong Province. They manufacture automobile parts. We introduced them to the JCM scheme and interviewed them regarding their current energy conservation needs at the plant in September. It was decided that the company will continue to have in-house discussions in order to identify projects that may be feasible.

(6) Cement Plant (Company F)

The company is interested in the introduction of a waste heat recovery power generation system for the cement kiln at its cement plant in Saraburi Province. Therefore, we launched discussions with an eye to the creation of a JCM project.

(7) Chemical Plant (Company G)

The company is located in Rayong Province. They currently use tanker trucks to supply the product raw materials to the plant, but they are considering the construction of pipelines for the supply of the raw materials for safety and efficiency reasons. With an eye to making it into a JCM project, the company is currently making estimates on CO2 emissions reductions through a

reduction in the raw material transportation distance by tanker trucks which will be enabled by the construction of pipelines.

(8) Petrochemical Plant (Company H)

The company is located on the IRPC Industrial Estate. They are interested in the JCM scheme and are currently checking whether they have any projects that could be appropriate for the scheme.

(9) Chemical Plant (Company I)

The company is located on an industrial estate in Rayong Province. They are interested in the renewal of their air-conditioning equipment.

(10) The Eco Center to Be Built by the IEAT

We started to investigate the possibility of installing energy efficient air-conditioning equipment, etc. in the Eco Center building to be constructed by the IEAT. The IEAT aims to establish the center in around May 2017, and it will be used for environmental education purposes.

2.2.1.2 Reports on the Workshops Held on Industrial Estates

We held workshops to explain the JCM scheme at the four locations shown below, in order to introduce companies to the JCM scheme and to select companies that are interested in energy conservation efficiently.

(1) The Workshop Hosted by the IEAT in June 2015

We held a workshop targeting companies on the Maptaphut Industrial Estate. We explained the Financing Programme for JCM Model Projects and gave brief explanations on past energy conservation projects to the 30 companies which participated in the workshop. We then looked for companies which were interested in conducting similar projects.

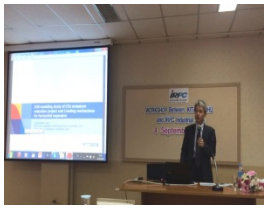
	
We gave presentations on the JCM scheme and project examples.	The workshop venue

(2) The Workshop on the IRPC Industrial Estate in September 2015

We held a workshop targeting companies on the IRPC Industrial Estate. We explained the Financing Programme for JCM Model Projects and gave brief explanations on past energy conservation projects to about 60 companies that are tenants on the industrial estate. We then looked for companies which were interested in conducting similar projects. The workshop gave us the opportunity to launch discussions regarding the eco-building and the eco-warehouses on the IRPC Industrial Estate mentioned above.

The workshop proceeded in accordance with the following schedule.

Time schedule	Contents	Speaker
9:20-9:30	Opening Speech (Thai-side)	Mr.Woravuth Sivapertranart
9:30-9:40	Opening Speech (Japan-side)	Kitakyushu City Government
9:40-10:00	Kitakyushu's approach to Eco-Industrial Town	Kitakyushu City Government
10:00-10:30	Introduction of F/S on formation of JCM project	NTT DATA Institute of Management Consulting
10:30-10:40	Q&A	
10:40-10:50	Break	
10:50-11:50	Efforts in various areas	
	(1) Energy Sector	NTT DATA Institute of Management Consulting
	(2) Waste Sector	Amita Corporation
11:50-12:00	Closing	

			
Mr. Woravuth, the Executive Vice President, Technology and Operational Excellence, IRPC	Presentation by the Kitakyushu City Government	Presentation by the NTT DATA Institute of Management Consulting	The workshop venue

(4) The Explanation Meeting on the Financing Programme for JCM Model Projects for the Chonburi Rayong Japanese Association in Thailand in October 2015

We held a workshop targeting Japanese-affiliated companies that are members of the Chonburi Rayong Japanese Association in Thailand. We explained the Financing Programme for JCM Model Projects and gave brief explanations on past energy conservation projects to the workshop participants. We then looked for companies that were interested in conducting similar projects. As of today, none of the companies have expressed interest in the scheme or projects.

	
We gave brief explanations of the JCM scheme and past examples.	The workshop venue

(5) The Explanation Meeting for the Pinthong Japanese Association in November 2015

We gave brief explanations on the JCM scheme and energy conservation technologies for the Pinthong Japanese Association which is an association of Japanese-affiliated companies on Pinthong Industrial Estates 1-3 in Chonburi Province. Many companies on the industrial estates are dissatisfied with the unstable power supply. Therefore, we proposed a project for the introduction of a large-scale cogeneration system through cooperation between multiple factories, and we are waiting for reactions from the companies which participated in the workshop.

	
We gave a brief explanation on the JCM scheme.	The workshop venue

2.2.2 The Possibility of Reducing Greenhouse Gas Emissions (CO2 Emissions from Energy Consumption in Particular)

We examined the possibility of CO2 emissions reductions for four technologies that may be feasible for JCM projects at this point.

Table 4 The Technologies Which May Be Feasible For JCM Projects

Category	Facility	Applicable technology
Factories	Petrochemical plant A	Waste heat recovery power generation systems
	Cement plant	
	Warehouses in petrochemical plant A	PV systems
	Food factory	Cogeneration systems
Business facilities	Office in petrochemical plant A	Highly efficient chillers

① Waste Heat Recovery Power Generation Systems

They recover waste heat which would otherwise be unused, and use it to generate power. The introduction of the technology will enable a reduction in the amount of grid electricity which needs to be purchased as the power generated by the systems will replace it.

The expected greenhouse gas (GHG) emissions reductions are calculated as follows.

[The electricity output from the waste heat recovery power generation systems] × [the emission factor for the grid in Thailand]

Here we only explain the calculation method for GHG gas emissions reductions, as this fiscal year's study has not estimated the specific electricity output.

② The Introduction of PV Systems

The introduction of PV systems will enable a reduction in the amount of grid electricity which needs to be purchased as the power generated by the PV systems will replace it.

We estimated the possible electricity output at petrochemical plant A, with the cooperation of a PV system manufacturer. The results were as follows.

The annual output from PV systems at company A: approx. 9,427 MWh

Therefore, the expected GHG emissions reductions can be calculated as follows.

[Electricity output] × [the emission factor for the grid in Thailand] = 9,427 MWh × 0.5113 tCO2/MWh = 4,820 tCO2

③ The Supply of Heat and Power through the Introduction of Cogeneration Systems

The introduction of the technology will enable a reduction in the amount of grid electricity which needs to be purchased as the power generated by the cogeneration systems will replace it. The technology will also enable a reduction in CO2 emissions from combustion in the boilers, as part or all of the steam currently being generated by the boilers will be supplied by the cogeneration systems.

The expected GHG gas emissions reductions are calculated as follows.

[The amount of grid electricity to be purchased] × [the emission factor for the grid in Thailand] + [fuel consumption when generating steam using the boilers] - [fuel consumption when using the cogeneration systems]

Here we only explain the calculation method for GHG gas emissions reductions, as this fiscal year's study has not estimated the specific electricity output.

④ The Renewal of Air-conditioning Equipment

The introduction of the technology will enable a reduction in grid electricity consumption which is equivalent to the amount of electricity saved through the renewal of the air-conditioning equipment.

The expected GHG gas emissions reductions are calculated as follows.

[The amount of electricity saved] × [the emission factor for the grid in Thailand]

Here we only explain the calculation method for GHG gas emissions reductions, as this fiscal year's study is still investigating this topic and has not estimated the specific energy conservation effects.

2.2.3 The MRV Methodology and the Organizational Structure for Monitoring

(1) Binary Cycle Power Generation

As binary cycle power generation is a type of waste heat recovery power generation, we are currently considering the MRV methodology as shown below, by referring to ID_AM001 “Power Generation by Waste Heat Recovery in Cement Industry” which is a methodology approved in Indonesia.

1) Eligibility Criteria

ID_AM001 stipulates the eligibility criteria as shown below. We need to revise Criteria 1, 2 and 4 in order to make them suitable for waste heat recovery from exhaust gases, as they are currently specifically for waste heat recovery from cement plants.

Table 5 Eligibility Criteria Set in ID_AM001

Criterion 1	The project utilizes waste heat from the cement production facility by waste heat recovery (WHR) system to generate electricity.
Criterion 2	WHR system consists of a Suspension Preheater boiler (SP boiler) and/or Air Quenching Cooler boiler (AQC boiler), turbine generator and cooling tower.
Criterion 3	WHR system utilizes only waste heat and does not utilize fossil fuels as a heat source to generate steam for power generation.
Criterion 4	WHR system has not been introduced to a corresponding cement kiln of the project prior to its implementation.
Criterion 5	The cement factory where the project is implemented is connected to a grid system and the theoretical maximum electricity output of the WHR system, which is calculated by multiplying maximum electricity output of the WHR system by the maximum hours per year (24 * 365 = 8,760 hours), is not greater than the annual amount of the electricity imported to the cement factory from the grid system: ➢ During the previous year before the validation, if the validation of the project is conducted before the operation of the project, or ➢ During the previous year before the operation of the project, if the validation of the project is conducted after the operation of the project.
Criterion 6	The WHR system is designed to be connected only to an internal power grid of the cement factory.

2) Parameters to Be Fixed *Ex Ante* (Prior to the Application for Project Registration)

Regarding the parameters to be fixed *ex ante* (prior to the application of project registration), we will think about the following parameters: the emission factor for electricity; and the total maximum rated capacity of the waste heat recovery power generation systems (after excluding the self-consumption by the waste heat recovery power generation systems). Regarding the emission factor for grid electricity, we could use the latest emission factor set by the Thai government or the Joint Committee (JC).

3) Establishment and Calculation of Reference Emissions

Regarding the establishment and calculation of reference emissions, ID_AM001 provides the following method.

$RE_p = EG_p * EF_{grid}$

Where,

RE_p	Reference emissions during a given time period *p*	(tCO_2/p)
EG_p	The quantity of net electricity generation by the WHR system which replaces grid electricity import during a given time period *p*	(MWh/p)
EF_{grid}	CO_2 emission factor for an Indonesian regional grid system, from which electricity is displaced due to the project during a given time period *p*	(tCO_2/MWh)

Determination of EG_p

$EG_p = EG_{SUP,p} - EC_{AUX,p}$

$EG_{SUP,p}$	The quantity of the electricity supplied from the WHR system to the cement production facility during a given time period *p*	(MWh/p)
$EC_{AUX,p}$	The quantity of electricity consumption by the WHR system except for the direct captive use of the electricity generated by itself during a given time period *p*	(MWh/p)

Determination of $EC_{AUX,p}$

$EC_{AUX,p} = EC_{CAP} * 24(hours/day) * D_p$

EC_{CAP}	The total maximum rated capacity of equipments of the WHR system which consumes electricity except for the capacity of equipments	(MW)

	which use the electricity generated by itself directly	
D_p	The number of days during a given time period p	(day/p)

4) Calculation of Project Emissions

Project emissions are zero according to ID_AM001. This is because, as stipulated in Criterion 3, waste heat recovery power generation systems utilize only waste heat and do not utilize fossil fuels as a heat source to generate steam.

Project emissions are not assumed in the methodology as the WHR system utilizes only waste heat and does not utilize fossil fuels as heat source to generate steam for power generation, which is prescribed in the eligibility criteria 3.
Therefore, the following formula is used to express the project emissions:

$PE_p = 0$

5) Setting the Monitoring Method

The introduction of binary cycle power generation systems will enable power generation using heat which would otherwise be wasted. The in-house utilization of the power generated from the systems will enable a reduction in the amount of grid electricity that needs to be purchased. CO2 emissions reductions achieved through the introduction of the systems are calculated by multiplying the reduction in the amount of purchased grid electricity by the emission factor for the grid. Therefore, monitoring is conducted using watt meters which monitor the electricity output from the binary cycle power generation systems.

<u>The Organizational Structure for Monitoring</u>

We are considering the following organizational structure for monitoring. Monitoring will be conducted mainly by the on-site staff. Japanese companies that become consortium members will support the monitoring activities where necessary. The staff will conduct daily data collections. A person in an administrative position or higher will be responsible for checking the data and the monitoring procedures. The director of operations at the relevant factory will conduct the project planning, the implementation, the compilation of the monitoring results and the reporting.

(2) The Introduction of PV Systems

Regarding the introduction of PV systems, we are currently considering the MRV methodology as shown below, based on MV_AM001 “Displacement of Grid and Captive Genset

Electricity by Solar PV System" which is a methodology approved in the Maldives.

1) Eligibility Criteria

MV_AM001 stipulates the following eligibility criteria.

Criterion 1	The project installs solar PV system(s).
Criterion 2	The solar PV system is connected to the internal power grid of the project site and/or to the grid for displacing grid electricity and/or captive electricity at the project site.
Criterion 3	The PV modules have obtained a certification of design qualifications (IEC 61215, IEC 61646 or IEC 62108) and safety qualification (IEC 61730-1 and IEC 61730-2), and have fulfilled the requirements of IEC 61701.
Criterion 4	The equipment to monitor output power of the solar PV system and irradiance is installed at the project site.

2) Parameters to Be Fixed *Ex Ante* (Prior to the Application for Project Registration)

Parameter	Description of data	Source
EF_{RE}	The reference CO_2 emission factor of grid and captive electricity, calculated based on the power generation efficiency of 49% using diesel fuel as the power source. The default value for EF_{RE} is set to be 0.5113 tCO_2/MWh. *The efficiency of the most efficient diesel engine is close to but below 49%.	Additional information The default emission factor is derived from the result of the survey on the new high-efficient engines using diesel fuel as a power source. The default value should be revised if necessary from the survey result which is conducted by the JC or project participants every three years.

3) Establishment and Calculation of Reference Emissions

In MV_AM001, reference emissions are calculated as follows.

$$RE_p = \sum_i EG_{i,p} \times EF_{RE}$$

RE_p : Reference emissions during the period *p* [tCO_2/p]

$EG_{i,p}$: The quantity of the electricity generated by the project solar PV system *i* during the period *p* [MWh/p]

EF_{RE} : The reference CO_2 emission factor of grid and captive electricity [tCO_2/MWh]

4) Calculation of Project Emissions

Project emissions are zero according to MV_AM001.

$PE_p = 0$ PE_p : Project emissions during the period *p* [tCO_2/p]

5) Setting the Monitoring Method

MV_AM001 does not provide parameters that need to be monitored.

The Organizational Structure for Monitoring

We are considering the following organizational structure for monitoring. Monitoring will be conducted mainly by the on-site staff. Japanese companies that become consortium members will support the monitoring activities where necessary. The staff will conduct daily data collections. A person in an administrative position or higher will be responsible for checking the data and the monitoring procedures. The director of operations at the relevant office will conduct the project planning, the implementation, the compilation of the monitoring results and the reporting.

(3) The Supply of Heat and Power through the Introduction of Cogeneration Systems

Regarding CO2 emissions reductions through the introduction of cogeneration systems, there is no approved methodology for the JCM scheme, as of February 2016. Therefore, we are considering the MRV methodology by referring to approved methodologies for the Clean Development Mechanism (CDM), etc.

1) Eligibility Criteria

The following eligibility criteria are under consideration.

Criterion 1	The cogeneration system is made up of a gas turbine and a boiler which uses waste heat from the gas turbine. The cogeneration system supplies electricity and heat (steam). The supplied electricity replaces electricity supplied from the grid.
Criterion 2	The electricity generated by the gas turbine is not fed to the grid (not sold) and is consumed in-house.
Criterion 3	The power generation efficiency of the gas turbine to be introduced by the project is ○% or higher (on a LHV basis) according to the test data or estimates made at the time of shipment by the manufacturer.

2) Parameters to Be Fixed *Ex Ante* (Prior to the Application for Project Registration)

Regarding data and parameters to be fixed *ex ante*, the following data and parameters are under consideration.

Parameter	Description of data	Source
EF_{elec}	CO2 emission factor for consumed electricity 0.5113*[tCO2/MWh] (for grid electricity in Thailand) The latest data available from the source at the time of validation will be stated in this table.	
CEF	The default value for carbon content in natural gas 15.3 tC/TJ	2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Table1.4

3) Establishment and Calculation of Reference Emissions

Regarding the establishment of reference emissions, the following approach is under consideration.

① Electricity purchased from the grid ② Fuel consumption for the generation of steam by the boiler Reference emissions = ① + ②

4) Calculation of Project Emissions

Regarding the calculation of project emissions, the following approach is under consideration.

① Natural gas consumption by the cogeneration system ② Energy consumed by auxiliary machinery for the cogeneration system Project emissions = ① + ②

5) Setting the Monitoring Method

<u>The Organizational Structure for Monitoring</u>

We are considering the following organizational structure for monitoring. Monitoring will be conducted mainly by the on-site staff. Japanese companies that become consortium members will

support the monitoring activities where necessary. The staff will conduct daily data collections. A person in an administrative position or higher will be responsible for checking the data and the monitoring procedures. The director of operations at the relevant office will conduct the project planning, the implementation, the compilation of the monitoring results and the reporting.

(4) The Renewal of Air-conditioning Equipment

Regarding the renewal of air-conditioning equipment, we are currently considering the MRV methodology as shown below, by referring to ID_AM002 "Energy Saving by Introduction of High Efficiency Centrifugal Chiller" which is a methodology approved in Indonesia.

1) Eligibility Criteria

ID_AM002 stipulates the following eligibility criteria.

Criterion 1	Project chiller is a centrifugal chiller with a capacity of less than 1,250 USRt. * 1 USRt = 3.52 kW
Criterion 2	COP for project chiller *i* calculated under the standardizing temperature conditions* ($COP_{PJ,tc,i}$) is more than 6.0. $COP_{PJ,tc,i}$ is a recalculation of COP of project chiller i ($COP_{PJ,i}$) adjusting temperature conditions from the project specific condition to the standardizing conditions. $COP_{PJ,i}$ is derived in specifications prepared for the quotation or factory acceptance test data at the time of shipment by manufacturer. [equation to calculate $COP_{PJ,tc,i}$] $\mathbf{COP_{PJ,tc,i} = COP_{PJ,i} \times [(T_{cooling-out,i} - T_{chilled-out,i} + TD_{chilled} + TD_{cooling}) \div (37 - 7 + TD_{chilled} + TD_{cooling})]}$ $COP_{PJ,tc,i}$: COP of project chiller *i* calculated under the standardizing temperature conditions* [-] $COP_{PJ,i}$: COP of project chiller *i* under the project specific conditions [-] $T_{cooling-out,i}$: Output cooling water temperature of project chiller *i* set under the project specific condition [degree Celsius] $T_{chilled-out,i}$: Output chilled water temperature of project chiller *i* set under the project specific condition [degree Celsius] $TD_{cooling}$: Temperature difference between condensing temperature of refrigerant and output cooling water temperature 1.5 degree Celsius set as a default value [degree Celsius]

	$TD_{chilled}$: Temperature difference between evaporating temperature of refrigerant and output chilled water temperature, 1.5 degree Celsius set as a default value [degree Celsius] *The standardizing temperature conditions to calculate $COP_{PJ,tc,i}$ Chilled water: output 7 degree Celsius input 12 degree Celsius Cooling water: output 37 degree Celsius input 32 degree Celsius
Criterion 3	Periodical check is planned more than four (4) times annually.
Criterion 4	Ozone Depletion Potential (ODP) of the refrigerant used for project chiller is zero.
Criterion 5	Plan for not releasing refrigerant used for project chiller is prepared. In the case of replacing the existing chiller with the project chiller, refrigerant used for the existing chiller is not released to the air.

2) Parameters to Be Fixed *Ex Ante* (Prior to the Application for Project Registration)

Regarding the parameters to be fixed *ex ante*, ID_AM002 stipulates the following parameters.

Parameter	Description of data	Source
EF_{elec}	CO_2 emission factor for consumed electricity. When project chiller consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project chiller may consume both grid electricity and captive electricity, the project participant applies the CO_2 emission factors for grid and captive electricity proportionately. Proportion of captive electricity is derived from dividing captive electricity generated by total electricity consumed at the project site. The total electricity consumed is a summation of grid electricity imported ($EI_{grid,p}$) and captive electricity generated ($EG_{gen,p}$)* during the monitoring period. * Captive electricity generated can be derived from	[Grid electricity] The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Emission Factors of Electricity Interconnection Systems", National Committee on Clean Development Mechanism Indonesian DNA for CDM unless otherwise instructed

<table>
<tr><th>Parameter</th><th>Description of data</th><th>Source</th></tr>
<tr><td></td><td>metering electricity generated or monitored operating time ($h_{gen,p}$) and rated capacity of generator (RC_{gen}).

[CO_2 emission factor]
For grid electricity: The most recent value available from the source stated in this table at the time of validation
For captive electricity: 0.8* [tCO_2/MWh]
*The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.</td><td>by the Joint Committee.
[Captive electricity]
CDM approved small scale methodology: AMS-I.A</td></tr>
<tr><td>$COP_{RE,i}$</td><td>The COP of the reference chiller i is selected from the default COP value in the following table in line with cooling capacity of the project chiller i.

$COP_{RE,i}$<table><tr><th>Cooling capacity /unit (USRt)</th><th>x<300</th><th>300≦ x<450</th><th>450≦ x<500</th><th>500≦ x<700</th><th>700≦ x<1,250</th></tr><tr><td>$COP_{RE,i}$</td><td>4.92</td><td>5.33</td><td>5.59</td><td>5.85</td><td>5.94</td></tr></table></td><td>Specifications of project chiller i prepared for the quotation or factory acceptance test data by manufacturer.

The default COP value is derived from the result of survey on COP of chillers from manufacturers that has high market share. The survey should prove the use of clear methodology. The $COP_{RE,i}$ should be revised if necessary from survey result which is conducted by JC or project</td></tr>
</table>

Parameter	Description of data	Source
		participants every three years.
$COP_{PJ,i}$	The COP of project chiller *i* under the project specific condition.	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by manufacturer
$T_{cooling-out,i}$	Output cooling water temperature of project chiller *i* set under the project specific condition.	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by manufacturer
$T_{chilled-out,i}$	Output chilled water temperature of project chiller *i* set under the project specific condition.	Specifications of project chiller *i* prepared for the quotation or factory acceptance test data by manufacturer
RC_{gen}	Rated capacity of generator, where applicable.	Specification of generator for captive electricity

3) Establishment and Calculation of Reference Emissions

Regarding the establishment and calculation of reference emissions, ID_AM002 provides the following method.

$$\mathbf{RE_p} = \sum_{\mathbf{i}} \left\{ \mathbf{EC_{PJ,i,p}} \times \left(\mathbf{COP_{PJ,tc,i}} \div \mathbf{COP_{RE,i}} \right) \times \mathbf{EF_{elec}} \right\}$$

RE_p : Reference emissions during the period *p* [tCO_2/p]

$EC_{PJ,i,p}$: Power consumption of project chiller *i* during the period *p* [MWh/p]

$COP_{PJ,tc,i}$: COP of project chiller *i* calculated under the standardizing temperature conditions

[-]

$COP_{RE,i}$: COP of reference chiller *i* under the standardizing temperature conditions [-]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

4) Calculation of Project Emissions

ID_AM002 stipulates the following formula for the calculation of project emissions.

$$\mathbf{PE_p} = \sum_{\mathbf{i}} \left(\mathbf{EC_{PJ,i,p}} \times \mathbf{EF_{elec}} \right)$$

PE_p : Project emissions during the period *p* [tCO_2/p]

$EC_{PJ,i,p}$: Power consumption of project chiller *i* during the period *p* [MWh/p]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

5) Setting the Monitoring Method

ID_002 does not provide parameters that need to be monitored.

The Organizational Structure for Monitoring

We are considering the following organizational structure for monitoring. Monitoring will be conducted mainly by the on-site staff. Japanese companies that become consortium members will support the monitoring activities where necessary. The staff will conduct daily data collections. A person in an administrative position or higher will be responsible for checking the data and the monitoring procedures. The director of operations at the relevant office will conduct the project planning, the implementation, the compilation of the monitoring results and the reporting.

2.2.4 Estimated Project Costs and Cost-effectiveness

(1) Estimated Project Costs

① Waste Heat Recovery Power Generation Systems

We are continuing to examine the detailed project costs in preparation for the next fiscal year.

② The Introduction of PV Systems

The initial investment amount (estimates): The cost of PV systems Approx. 220 million yen (excluding installation costs)

③ The Supply of Heat and Power through the Introduction of Cogeneration Systems

We are continuing to examine the details in preparation for the next fiscal year.

④ The Renewal of Air-conditioning Equipment

We are continuing to examine the details in preparation for the next fiscal year.

(2) Cost-effectiveness

① Binary Cycle Power Generation

We are continuing to examine the details in preparation for the next fiscal year.

② The Introduction of PV Systems

The cost-effectiveness was calculated using the following formula with the premise that the service life for the PV systems will be 15 years.

[The initial investment cost (with an expected subsidy rate of 50%] ÷ [annual CO2 emissions reductions (tCO2)] × [15 year service life]

The results are shown below.

4,820 tCO2 × 15 years ÷ 110 million yen = approx. 1,521 yen/tCO2

③ The Supply of Heat and Power through the Introduction of Cogeneration Systems

We are continuing to examine the details in preparation for the next fiscal year.

④ The Renewal of Air-conditioning Equipment

We are continuing to examine the details in preparation for the next fiscal year.

2.2.5 Co-benefits

(1) Binary Cycle Power Generation

The generation of power using waste heat will reduce the amount of power which needs to be purchased via the grid. The reduction of load on the grid is expected to reduce the emission of air pollutants such as soot, dust, SOx and NOx from coal-fired power plants which are the source of the grid electricity. The reduction of load on the grid is also expected to contribute to a stable power supply and a reduction in power outages.

(2) The Introduction of PV Systems

The introduction of PV systems on the roofs of warehouses and offices is expected to have heat-blocking effects. This could make the air conditioning in the warehouses and offices more efficient.

(3) The Supply of Heat and Power through the Introduction of Cogeneration Systems

The introduction of in-house power generation systems such as cogeneration systems will enable the stable supply of power and increase productivity, particularly in areas with an unstable power supply.

(4) The Renewal of Air-conditioning and Lighting Equipment

Taking energy conservation measures will reduce the amount of power which needs to be purchased via the grid. The reduction of load on the grid is expected to reduce the emission of air pollutants such as soot, dust, SOx and NOx from coal-fired power plants which are the source of the grid electricity. The reduction of load on the grid is also expected to contribute to a stable power supply and a reduction in power outages.

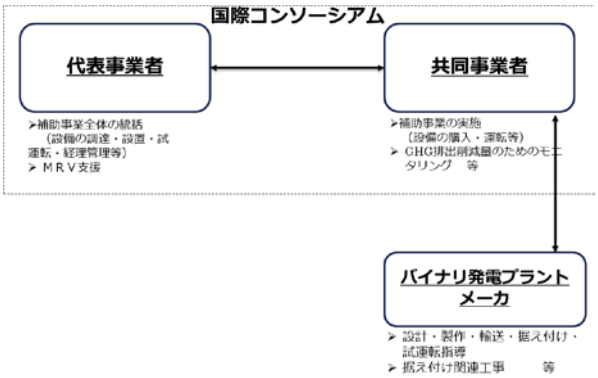
2.3 Investigation toward a JCM Project

2.3.1 Planning for the Establishment of Projects (the Organizational Structures for Implementation, the Financial Support Schemes, Schedules for Establishing Projects, etc.)

(1) Binary Cycle Power Generation

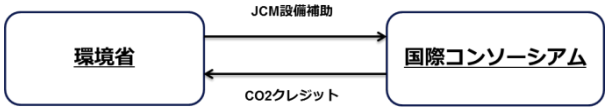
① The Organizational Structure for Implementation

The currently planned organizational structure for implementation is shown below.



② The Financial Support Scheme

We plan to use the Financing Programme for JCM Model Projects. The diagram below shows the planned financial support scheme for the implementation of the JCM project.



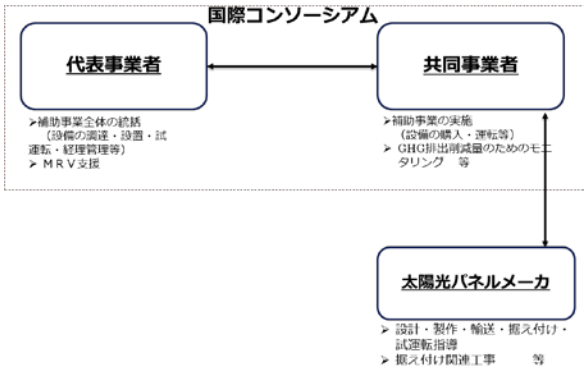
③ The Schedule for Establishing the Project

We will consider whether or not to conduct the project, by selecting equipment, examining economic efficiency and calculating the specific CO2 emissions reduction value before the end of this fiscal year. Based on the above results, we will consider applying for the Financing Programme for JCM Model Projects for the 2016 fiscal year or later, if the program's public invitation schedule meets the schedule of the company (which is considering the introduction of equipment) for securing a budget, etc.

(2) The Introduction of PV Systems

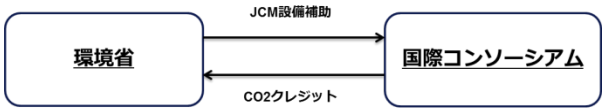
① The Organizational Structure for Implementation

The currently planned organizational structure for implementation is shown below.



② The Financial Support Scheme

We plan to use the Financing Programme for JCM Model Projects. The diagram below shows the planned financial support scheme for the implementation of the JCM project.



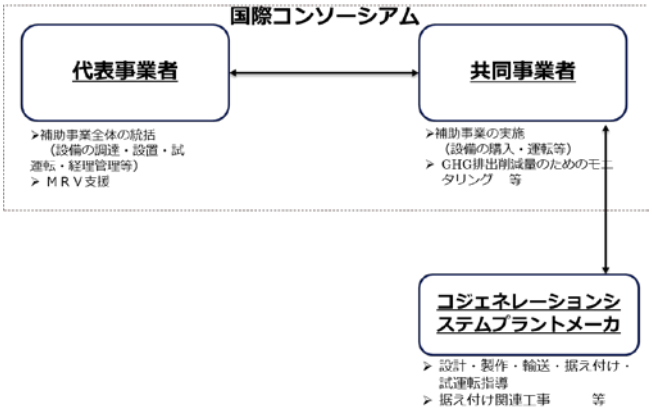
③ The Schedule for Establishing the Project

We will select equipment, examine the economic efficiency and calculate the specific CO2 emissions reduction value before the end of this fiscal year. Based on the above results, we will consider applying for the Financing Programme for JCM Model Projects for the 2016 fiscal year or later, if the program's public invitation schedule meets the schedule of the company (which is considering the introduction of equipment) for securing a budget, etc.

(3) The Supply of Heat and Power through the Introduction of Cogeneration Systems

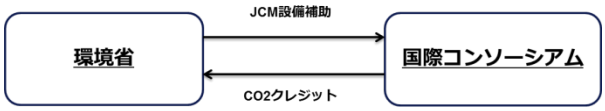
① The Organizational Structure for Implementation

The currently planned organizational structure for implementation is shown below.



② The Financial Support Scheme

We plan to use the Financing Programme for JCM Model Projects. The diagram below shows the planned financial support scheme for the implementation of the JCM project.



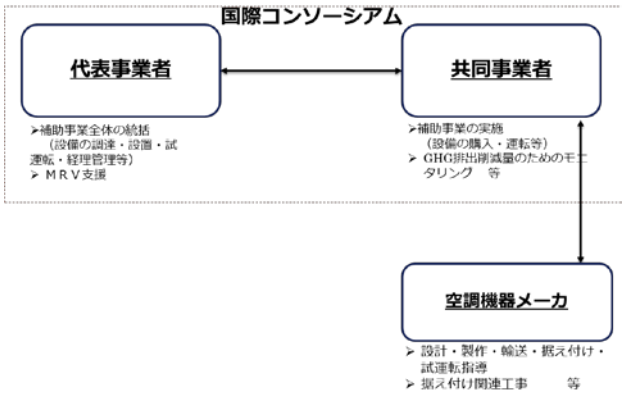
③ The Schedule for Establishing the Project

We will select equipment, examine the economic efficiency and calculate the specific CO2 emissions reduction value before the end of this fiscal year. Based on the above results, we will consider applying for the Financing Programme for JCM Model Projects for the 2016 fiscal year or later, if the program's public invitation schedule meets the schedule of the company (which is considering the introduction of equipment) for securing a budget, etc.

(4) The Renewal of Air-conditioning Equipment

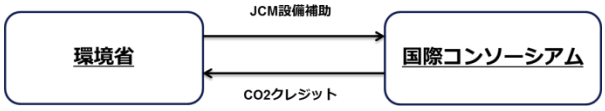
① The Organizational Structure for Implementation

The currently planned organizational structure for implementation is shown below.



② The Financial Support Scheme

We plan to use the Financing Programme for JCM Model Projects. The diagram below shows the planned financial support scheme for the implementation of the JCM project.



③ The Schedule for Establishing the Project

We will select equipment, examine the economic efficiency and calculate the specific CO2

emissions reduction value before the end of this fiscal year. Based on the above results, we will consider applying for the Financing Programme for JCM Model Projects for the 2016 fiscal year or later, if the program's public invitation schedule meets the schedule of the company (which is considering the introduction of equipment) for securing a budget, etc.

2.3.2 Challenges for the Establishment of the Project

Some of the companies which are currently considering the establishment of JCM projects have entered the phase of making final decisions on the implementation of JCM projects. When examining the financial details for the projects in order to make decisions on investments, we need to consider the timing for subsidy applications. The issue here is that there is not always enough time for full deliberations when trying to meet the deadline for applications. When we work on the establishment of JCM projects in the future, we will need to approach candidate companies as early as possible.

In the study, we considered the introduction of PV systems. Although companies were interested in the idea in general, there are several issues which discourage companies from investing in JCM projects to install PV systems: many companies already have in-house power generation systems; electricity charges are relatively inexpensive; and the Thai government decided that the FIT system will not apply to PV systems from the 2016 fiscal year onwards.

2.3.3 Future Schedule

We will continue to examine the possibility of establishing JCM projects, while considering applying for the Financing Programme for JCM Model Projects for the 2016 fiscal year (public invitations start in April 2016), if the schedule of the company (which is considering the introduction of equipment) for securing a budget, etc., meets the program's public invitation schedule.

Chapter 3

Waste Sector

“Low Carbon and Recycle of the Whole Waste from Industrial Parks”

NTT Data Institute of Management Consulting, Inc.
AMITA Corporation

Chapter 3 Table of Contents

3.1 Purpose and Implementing System of Project Feasibility Study

3.1.1. Outline of the Project (Purpose and Applicable Field)

In two industrial parks that aim at an ecological and industrial town, the types and amounts of wastes from the plants are surveyed toward no refuse to bury (zero landfill). Sludge is landfilled, while study of how to compost organic waste goes on. Moreover, there is a waste-to-energy plan. These show that various plans are made independently but their strategies are not always the effective use of waste or zero landfill.

In this project, we work on a mechanism of preventing any waste from being landfilled or burned and producing fuel from it by letting a third party organize data on a variety of scraps generated in an industrial park and researching for the optimal matching of them (see the figure on the next page). We also investigate the organization style and members of the third party and ask an ASP to collect such data through daily waste control tasks.

If we can find the optimal matching of various wastes generated in the industrial park and make fuel from them on the premises to a possible extent, it is expected not only to realize zero emissions thanks to the effective use of resources but also to contribute greatly to low carbon through a significant reduction in waste conveyance distance from the park to the outside and the prevention of methane gas from being emitted at landfills.

The third party organizes and manages waste data collected by the ASP through daily waste control tasks, which is a concept similar to plant-by-plant outsourcing of waste control. It is helpful for the plant operator to manage waste efficiently, to keep the transparency, and to carry out risk management.

The figure on the next page shows concrete activities planned in this fiscal year.

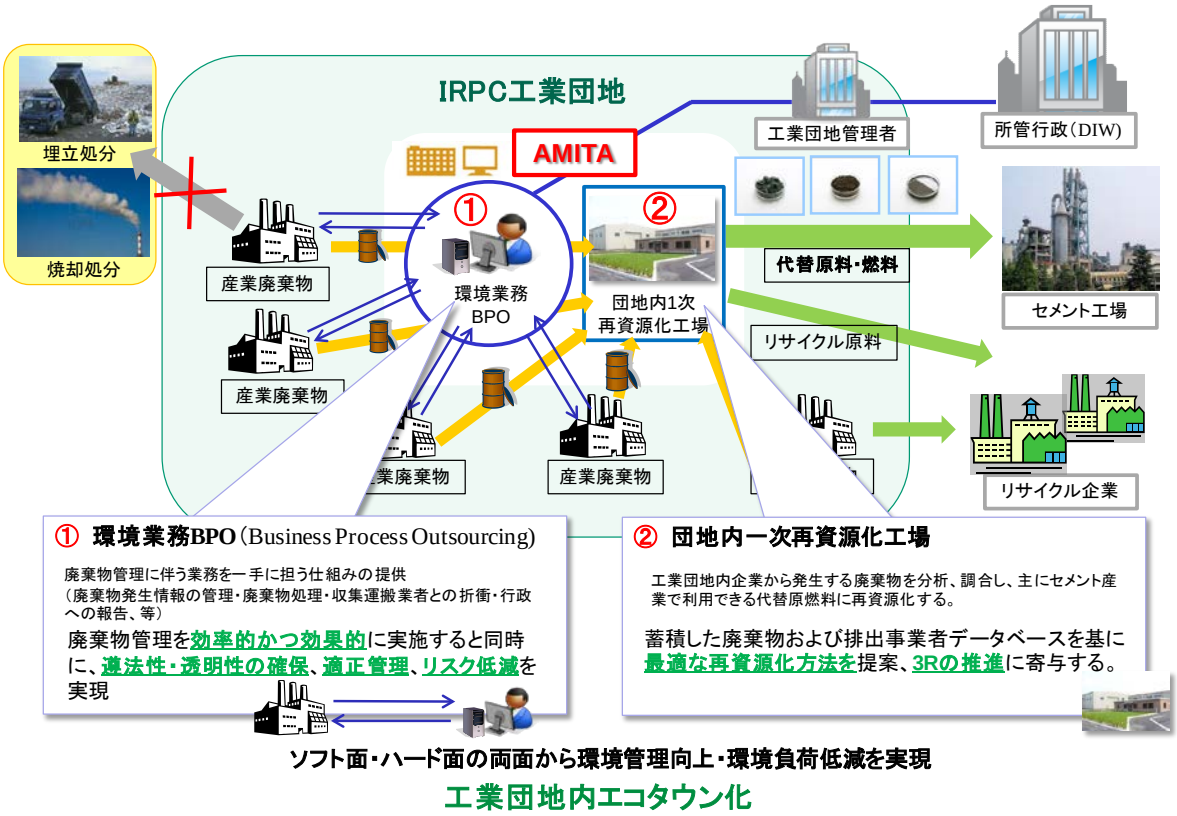


Figure: Sustainable waste management system as a model (schematic diagram)

3.1.2. Applicable Technologies and Related Legal Systems

Regarding the disposal of industrial waste, the Ministry of Industry issued a No. 6 notice (1997) to show the features and characteristics of four different harmful wastes and in-depth procedures for disposing of them. These wastes are prohibited from being delivered with no permission from the Department of Industrial Works, Ministry of Industry, and any authorized person is obliged to submit an annual report to the department to indicate in-depth data on the type, quantity, feature, storage method, conveyance, treatment, and disposal of waste.

In addition, the ministry issued a No. 7 notice (1998) of waste disposal to specify that owners of plants that discharge harmless waste set forth in the last provision of the notice shall dispose of it according to the regulations and shall not deliver it to the outside of the site without no permission from the Department of Industrial Works.

3.1.3. Implementing System

The accompanying figure shows the implementing system. Receiving administrative support from Kitakyushu, Rayong, and Map Ta Phut Cities, AMITA Corporation makes a joint investigation with two local industrial parks: IRPC and Map Ta Phut. In Japan, the company offers services for making raw fuel from industrial waste and controlling refuse.

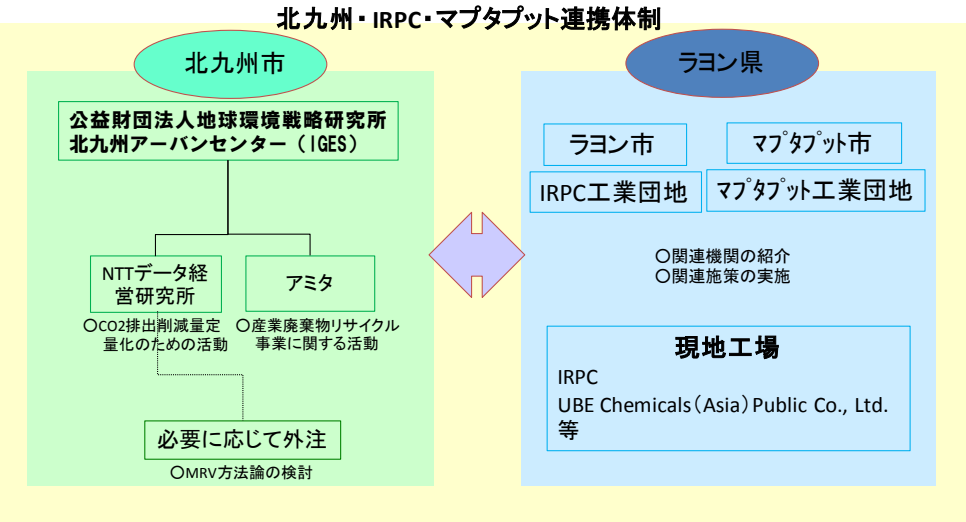


Figure: Investigation implementing system

3.1.4. Investigating Method and Schedule

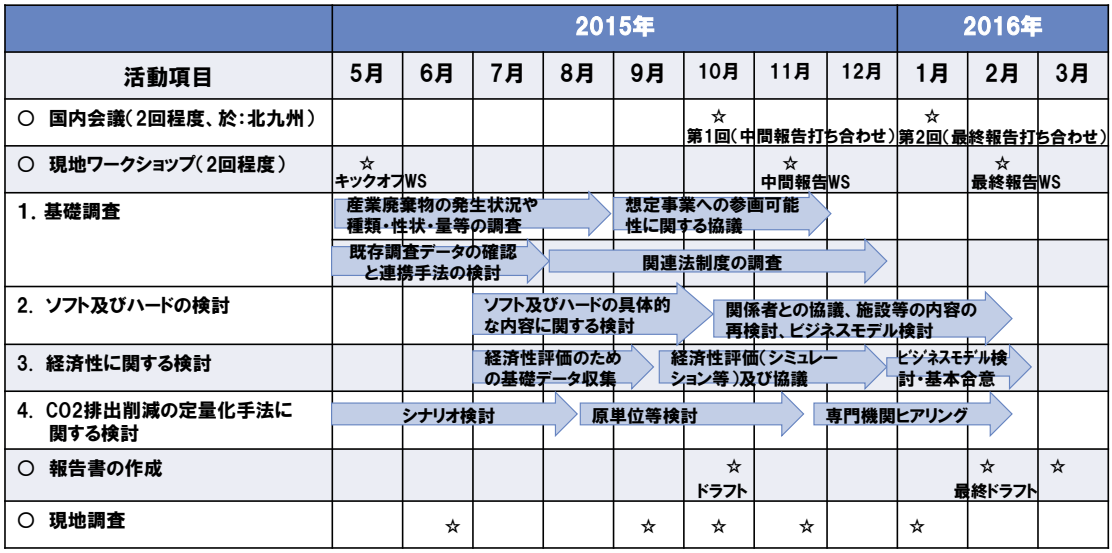
(1) Investigating method

The accompanying table shows survey methods. We conduct four activities basically by looking over literature, giving a hearing to companies, and making a field survey.

Activity	Methods
1. Surveying waste generating states in detail and checking related legal systems	○ Giving a direct hearing to each plant to grasp the generating status, types, nature, and amounts of industrial waste as well as intentions to join the project in question. ○ Checking out the results of existing surveys already made to work on how to use the data and to carry on data collection continuously. ○ Grasping related legal systems by looking over the results of existing surveys, analyzing disclosed information, and giving a hearing to related experts and the regulatory authorities concerned.
2. Working on software and hardware	○ Working on basic software concepts including customizing by giving a direct hearing to each plant and organizing requirements for software related mainly to electronic manifests used in the country. ○ Letting the joint applicant take the initiative in an internal investigation of raw fuel production plants according to the results of Activity 1, and finding what optimal matching should be to make raw fuel from the whole waste generated in the industrial park. ○ Developing a business model with plant-by-plant requirements in mind by talking with the plant directors about the results of the activities above and reviews as necessary.
3. Investigating the economic efficiency	○ Working on the economic efficiency (project's profitability) according to the results of Activities 1 and 2. ○ Checking out the raw fuel price in Rayong Province, Thailand, and its surrounding area by giving questions directly to the local government.
4. Researching for how to quantify CO_2 reduction	○ Working on reference and project scenarios for an industrial waste-to-fuel program, the unit consumption for estimating CO_2 emissions, and what to monitor from the viewpoint of the application of JCM. ○ Referencing to the survey results of similar projects under way if available.

(2) Implementing schedule

The accompanying figure shows the implementing schedule. We conduct the activities to submit a final report in February 2016.



3.2 Results of the Project Feasibility Study

3.2.1. Summary of the Field Survey Results

1. Occurrence and characteristics of waste

The tables on the next two pages list companies located and wastes (partial ones) generated in the IRPC industrial park. The companies are various, for example, oil refiners and chemical product manufacturers, so they discharge a wide variety of wastes.

	排出元	排出品	cal/g(dry)	水分(%)	ph	SiO2(%)	Al2O3(%)	Fe2O3(%)	CaO(%)	Cl(%)
1	A社	汚泥	7931.0	0.8	7.0	0.597	5.010	0.589	5.500	0.095
2	A社	廃油	5155.0	-	12.5	5.432	2.336	2.632	0.726	0.017
3	A社	汚泥	5387.0	87.0	7.0	0.517	1.380	0.845	1.310	0.083
4	A社	焼却灰	7319.0	27.0	-	0.301	0.035	0.859	0.008	-
5	A社	汚泥	-	1.2	7.0	35.100	45.000	1.330	0.181	0.025
6	A社	汚泥	3582.0	33.5	7.0	12.700	21.100	0.440	0.124	0.039
7	A社	廃アルカリ	-	-	7.0	0.057	0.008	0.641	0.122	0.002
8	A社	汚泥	-	-	12.5	0.011	0.622	0.015	0.012	3.864
9	B社	汚泥	4593.0	90.0	7.0	0.451	0.959	0.808	0.446	0.034
10	B社	廃アルカリ	332.0	-	8.0	0.070	0.451	0.001	0.005	0.000
11	B社	汚泥(アルミ含む)	2082.0	83.0	-	2.210	42.400	0.913	0.447	0.078
12	C社	汚泥	1749.0	-	6.0	0.100	0.078	0.000	0.004	0.025
13	C社	汚泥	7542.0	6.3	7.0	0.430	0.297	0.006	0.002	0.001
14	C社	汚泥	6989.0	41.8	7.0	0.271	0.119	0.010	0.017	0.002
15	D社	汚泥	11275.0	-	7.0	0.153	0.853	0.029	0.007	0.001

From the wastes currently incinerated or landfilled, we selected typical ones according to the available data, visited the companies to get the samples, and analyzed them to make sure whether they were suitable to fuel production.

Table: Companies in the IRPC industrial park

Company Name	Location site in IRPC Zone	Abb. Name	Industrial Code	Production
Thai ABS Co.,Ltd.	South	EPS	ข 3-44-1/43 รย	Expandable Polystyrene (EPS)
Thai ABS Co.,Ltd.	South	ABS	ข 3-44-2/34 รย	ABS และ AS
Thai ABS Co.,Ltd.	South	NanoChemical	ข3-48(2)-1/56 รย	(NANO ANTI BACTERIA)
Thai ABS Co.,Ltd.	North	PS	ข 3-53(5)-2/41 รย	(Polystyrene)
Thai ABS Co.,Ltd.	South	CCM	ข 3-53(5)-56/51 รย	Compounding Plastic
IRPC Polyol Co.,Ltd.	South	TPU	ข 3-44-2/43 รย	Polyurethane Elastomer, PU Coating Resin, PU Adhesive Unsaturated Polester
IRPC Public Company Limited	South	PTK	ข 3-42(1)-1/41 รย	PTK Catalyst
IRPC Public Company Limited	North	EBSM	ข 3-42(1)-2/41 รย	Ethylbenzene Styrene Monomer
IRPC Public Company Limited	South	ETP	ข 3-42(1)-3/41 รย	(Ethylene)
IRPC Public Company Limited	South	BTX	ข 3-42(1)-4/41 รย	Benzene Toluene Xylene
IRPC Public Company Limited	South	HA1	ข3-42(1)-11/53รย	HA1 (Catalyst)
IRPC Public Company Limited	South	PRP	ข3-42(1)-4/55รย	Propylene
IRPC Public Company Limited	South	HDPE	ข 3-44-1/25 รย	HDPE, LLDPE, Ethylene Copolymer, Ethylene
IRPC Public Company Limited	South	PP	ข 3-44-1/34 รย	Polypropylene
IRPC Public Company Limited	South	ACB	ข 3-48(6)-1/45 รย	ผลิต Acetylene Carbonblack
IRPC Public Company Limited	South	COND	ข 3-49-1/41 รย	(Condensate Residue), Condensate Plant
IRPC Public Company Limited	South	REFY	ข 3-49-1/43 รย	(Refinery)
IRPC Public Company Limited	South	DCC	ข 3-49-2/41 รย	(Combined Gas Oil) , Cracked Naptha Propylene)
IRPC Public Company Limited	North	LBOP	ข 3-50(4)-1/41 รย	(Lube Base Oil Plant)
IRPC Public Company Limited	South	CD-1	ข 3-53(5)-55/51 รย	Compounding Plastic
IRPC Public Company Limited	South	PW	ข 3-88-1/36 รย	(Power Plant)
IRPC Public Company Limited	North	UT-IP	ข 3-90-4/50 รย	Water Treatement Plant
IRPC Clean Power Co.,Ltd.	North	CHP II	ข 3-88(2)-91/57 รย	Utility Plant
TPI Concrete Co.,Ltd.	North	Concrete	ข 3-58(1)-10/38 รย	Concrete Plant
TPI Concrete Co.,Ltd.	North	Concrete	ข3-58(1)-1/40รย	Concrete Plant
TPI Concrete Co.,Ltd.	North	Concrete	ข3-58(1)-88/50รย	Concrete Plant
Thai Incinerate Service Co.,Ltd	South	TIL	ข 3-102-1/50 รย	Utility Plant
Thainitrate Company Co.,Ltd.	South	TNC	ข 3-42(1)-1/39 รย	Nitric Acid and AmmoniumNitrate
Thai Synthetic Rubbers Co.,Ltd.	South	TSL	ข 3-44-2/40 รย	Synthetic Rubber
Diapolyacrylate Co.,Ltd.	South	DIAP	ข 3-44-1/36 รย	PMMA
Millcon Steel Co.,Ltd	North	Mill Con Steel	ข 3-59-1/41 รย	Iron
UBE Chemicals (Asia) Public Company Limite	South	UCHA	ข 3-44-1/39 รย	Capolactum and Ammonium Sulphate
UBE Chemicals (Asia) Public Company Limite	South	UCHA	ข 3-44-1/40 รย	Nylon
UBE Chemicals (Asia) Public Company Limite	South	UCHA	ข 3-53(5)-1/45 รย	Compounding
TPI Polene Co.,Ltd.	South	LDPE	ข 3-44-1/33 รย	LDPE
Rayong Acetylene Co.,Ltd	South	RAC	3-89-4/41รย	Acethylene Gas

Table: Wastes generated in the IRPC industrial park (partial excerption)

Wase Generator	Waste cod	Type of waste	Quantity (k	Disposal company name	PLANT	Month	TYPE	Type	Disposal code	Disposal Metho	Compar
DIWG054800289	16 08 03	Fine catalyst (alumina)	12,880	Taurus pozzolan (ทรอรัส)	DCC	1	Routine	NHZW	049	Recycle	IRPC
DIWG054800198	19 08 12	Bio Sludge	10,510	BWG	WT	1	Routine	NHZW	071	Landfill	IRPC
DIWG054800198	19 08 14	waste water sludge	10,510	BWG	WT	1	Routine	NHZW	071	Landfill	IRPC
DIWG054800289	16 08 01	Spent catalyst	17,600	PROWASTE	DCC	4	Non-routine	NHZW	042	Recovery	IRPC
DIWG054800198	19 08 14	waste water sludge	3,270	BWG	WT	1	Routine	NHZW	071	Landfill	IRPC
DIWG054800198	19 08 14	waste water sludge	3,270	BWG	WT	1	Routine	NHZW	071	Landfill	IRPC
DIWG054800198	19 08 14	waste water sludge	11,010	BWG	WT	7	Routine	NHZW	071	Landfill	IRPC
DIWG054800289	16 10 02	Cleaning Water	29,360	TARF	DCC	7	Non-routine	NHZW	042	Recovery	IRPC
DIWG114800055	16 10 02	process wastewater (น้ำจากกระบวนการผลิต)	31,140	Siam Envi(สยามเอนวาย)	WT3	7	Non-routine	NHZW	066	Other	IRPC
DIWG114800055	16 10 02	process wastewater (น้ำจากกระบวนการผลิต)	31,370	Siam Envi(สยามเอนวาย)	WT3	7	Non-routine	NHZW	066	Other	IRPC
DIWG054800198	19 08 12	Bio Sludge	9,205	BWG	WT	8	Routine	NHZW	071	Landfill	IRPC
DIWG054800198	19 08 14	waste water sludge	9,205	BWG	WT	8	Routine	NHZW	071	Landfill	IRPC

In addition, we gave a hearing to IRPC to know the status of using electronic manifests. The following shows key answers and an e-manifest operation flow.

[About the e-manifest]

- IRPC centralizes wastes from the tenants. It receives about 1,000 manifests annually.
- To control the total amount of wastes, the park operator carries out manifest-based management that is not limited to harmful refuse.
- It is necessary to submit a summary to DIW once a year. The summary is developed easily by printing out the data registered in the database via the Internet and putting a sign on the print.
- The figure below shows how to manage the manifests currently. The management is based on a combination of paper and the Internet. The management system does not work well because the low performance of the DIW server causes a bad connection.

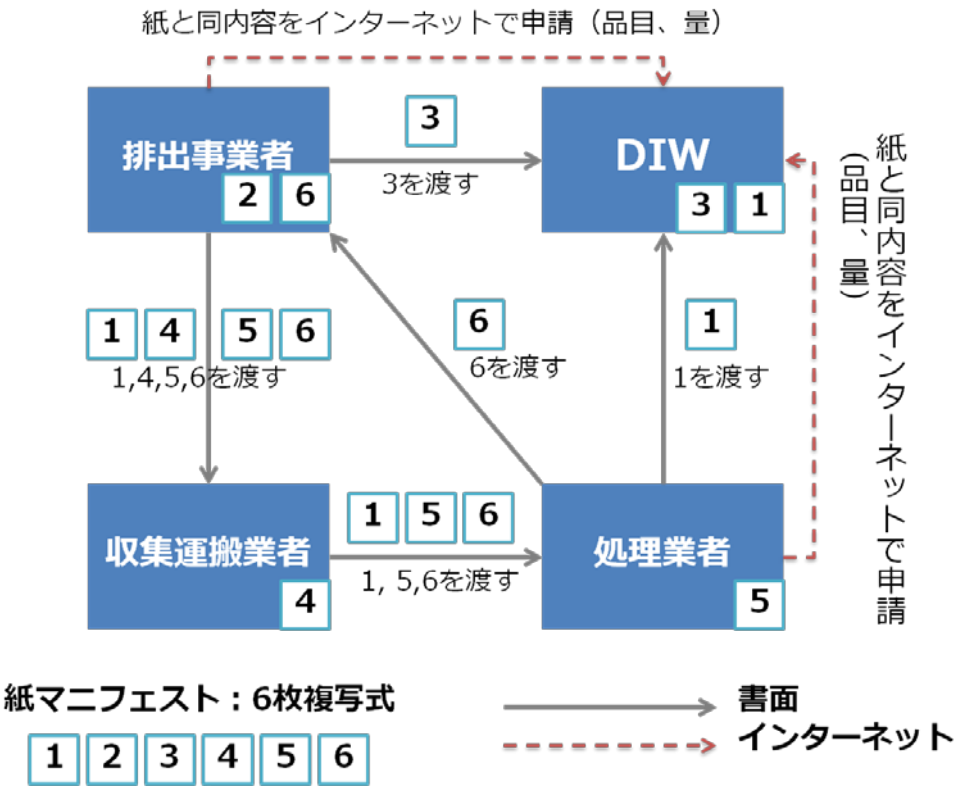


Figure: Flow of using e-manifests

3.2.2. Possibility of Reducing Greenhouse Gas Emissions (Particularly Carbon Dioxide Emitted from Energy Generation)

To check whether this project has the possibility of CO_2 reduction, we have worked on the following four scenarios:

1) Making raw fuel derived from industrial waste alternative to coal used in cement plants
2) Replacing simple combustion of industrial waste with recycling
3) Improving the ratio of biomass
4) Reducing the transportation distance

1) Making raw fuel derived from industrial waste alternative to coal used in cement plants

Carbon dioxide emitted during cement production is broken down as follows: about 40 and 60 percent are from the fuel combustion and calcination processes respectively. To check the possibility of CO_2 reduction by material change, we focused on the chemical reaction of the ingredients of the material in the latter process and compared two cases where the alternative material was used or not while seeing the CDM methodology—ACM005: Consolidated Baseline Methodology for Increasing the Blend in Cement Production.

In principle, the work above requires data on carbon density based on the analysis of the components of the alternative raw fuel and monitoring them. However, it was difficult to get such data, so we concluded that the estimation was impossible.

Moreover, assuming that the alternative raw fuel has a caloric value equivalent to that of coal used in an existing cement plant, the former caloric value or input increases, resulting in no CO_2 reduction during combustion.

2) Replacing simple combustion of industrial waste with recycling

In the reference scenario, we assumed that given part of waste was burned simply and that the project reduced CO_2 emitted from the simple combustion. To estimate the reduction, we introduced the ratio of the part burned simply to the total amount of industrial waste generated as a parameter.

Our survey paid attention to how to define the ratio conservatively, but we could not get any quantitative data on the ratio from a hearing.

3) Improving the ratio of biomass to avoid methane emissions at disposal sites (and CO_2 reduction by improving the biomass-to-energy ratio during power generation with exhaust

heat recovery)

In Thailand, buyers basically deal with industrial biomass waste as valuable to use it effectively, so small part of such landfilled waste may contribute to methane fermentation. Accordingly, this scenario may not result in CO_2 reduction.

4) Reducing the transportation distance

In the reference scenario, waste, which currently moves from Rayong Province to the final disposal site, is sent to the cement plant. Therefore, we have worked on its CO_2 reduction effect.

3.2.3. MRV Methodology and Monitoring System

Methodology to be Proposed to JCM

A. Title

Making Solid Fuel Alternative to that in Cement Production by Recycling Industrial Waste

B. Terms and Definitions

Term	Definition
Industrial waste	Residue from business activities.
Harmful waste	Dangerous and toxic refuse. It is a residual material that contains a substance regarded as dangerous and toxic from the viewpoints of its nature, density, and total content and that pollutes or destructs the environment directly or indirectly, or that poses a risk to the environment, the health, and the sustainable life of living things including human beings through business or other activities. The features include explosiveness, inflammability, reactivity, toxicity, infectiousness, and corrosiveness.
Organic waste	Refuse derived mainly from animals or plants, which includes paper, kitchen garbage, wood, bamboo, fiber, sludge, floral and faunal residues, and animal excreta.

Preparation technology	Resource recycle method that consists of precisely analyzing for components, caloric value, and repellent presence, working on preparations that meet product standards for alternative raw fuels, and checking for blending and conformance.
Alternative solid fuel	Fuel derived from cement raw material (CRM). It is used as an alternative fuel for cement production and made by mixing industrial solid wastes, such as sludge, embers, and ash dust to meet user's specification.

C. Outline of the Methodology

Action	Description
GHG reduction	In this methodology, fossil fuel consumption is reduced by recycling industrial solid waste containing harmful and organic materials in the technical preparation and adjustment processes to make an alternative fuel for cement production. Moreover, promoting resource circulation prevents GHG from being emitted from the simple incineration and reclamation of industrial waste. This means that the former emits CO_2 while the latter generates methane gas because the organic content of the waste is discomposed under anaerobic conditions at a disposal site, so both gases stop being emitted into the air by the circulation. Fossil fuel consumption is further reduced by making the transportation distance from industrial waste collection spots to recycle and cement plants shorter than that to incinerators or landfills.
Calculation of the reference emission	1. If no alternative fuel derived from industrial waste is used, CO_2 is emitted by coal fuel consumption for cement production. [1 Alternative to coal] 2. If no industrial waste is recycled, CO_2 is emitted by the simple incineration of waste containing fossil resource-derived carbon. [2 Alternative to simple incineration]

	3. If no industrial waste is recycled, methane gas is generated by the biological breakdown of organic carbon from landfilled refuse under anaerobic conditions at a disposal site. [3 Avoidance of methane] 4. If no industrial waste is recycled, CO_2 is emitted by fossil fuel consumption during movement from waste collection to treatment and disposal. [4 Reduction in conveyance distance] 5. The project is expected to reduce energy consumption at a waste disposal site because of a reduction in the amount of industrial waste delivered to the site. However, this methodology does not take this point into consideration.
Calculation of the project emission	1. CO_2 is emitted by fossil fuel consumption during movement from industrial waste collection spots to a recycle plant and delivery of alternative fuel from the latter to a cement plant. 2. CO_2 is emitted by power and fossil fuel consumption in a recycle plant where industrial waste is prepared. 3. CO_2 is emitted by burning the fossil resource-derived content of alternative fuel made from industrial waste during cement production.
Monitoring parameters	1. Amount of industrial waste delivered from collection spots to a recycle plant 2. Amount of alternative fuel delivered from the facility above to a cement plant 3. Power and fuel consumption in the recycle plant

	4. Quantity, composition, and caloric value of the alternative fuel used for cement production

D. Eligibility criteria

This methodology is applicable to projects that satisfy all the following criteria.

Criterion 1	The project must conduct the intermediate processing of industrial waste which is currently not treated for disposal after it is collected. The project must then utilize alternative fuel which will be obtained by recycling industrial waste through intermediate processing.
Criterion 2	The industrial waste to be recycled by the project through intermediate processing must meet one of the following conditions: if the project is not conducted, the industrial waste will be incinerated and emit CO2 through the combustion of waste which contains carbon derived from fossil resources; the industrial waste will be dumped in landfills at waste disposal sites and emit methane gas through biodegradable organic carbon biodegrading under anaerobic conditions at the waste disposal sites; or, the industrial waste will cause CO2 emissions through the use of fossil fuels for long-distance transportation.
Criterion 3	The intermediate processing used in the project must be the recycling of industrial waste into fuel for cement manufacturing which is of a specific quality, through the use of the industrial waste blending techniques.
Criterion 4	The blending techniques used in the project must include the following processes: component analysis of the collected industrial waste; consideration of the blending rates and combinations which meet the fuel product specifications; blending; and the analysis of product samples.
Criterion 5	The facilities and equipment to be introduced and used through the project activities must be new. They must not be converted or improved facilities and equipment which were or are being used for other activities.
Criterion 6	The project activities must not reduce the amount of industrial waste which would have been recycled if the project activities did not take place.

E. Emission sources and GHG types

Reference emissions

Emission sources	GHG types
Coal fuel consumption at cement plants	CO_2
Combustion of carbon components derived from fossil resources through the industrial waste incineration process	CO_2
Methane emissions from the anaerobic decomposition of organic waste at waste disposal sites	CH_4
Fossil fuel consumption through the collection of industrial waste and its transportation to incineration plants and landfill sites	CO_2
Project emissions	
Emission sources	GHG types
Grid electricity consumption in the recycling process	CO_2
Fossil fuel consumption in the recycling process	CO_2
Consumption of components derived from fossil resources in the alternative fuel at cement plants	CO_2
Fossil fuel consumption through the collection of industrial waste and its transportation to the recycling plant, as well as through the transportation of alternative fuel products from the recycling plant to the cement plants.	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated based on: the amount, composition and calorific value of the alternative fuel to be inputted for cement manufacturing; the percentage of industrial waste incinerated with no other treatment and the percentage of industrial waste dumped in landfill sites; the amount and distance for industrial waste transported to the recycling plant; etc.

F.2. Calculation of reference emissions

$RE_y = RE_{C,y} + RE_{INC,y} + RE_{CH4,y} + RE_{TR,y}$

RE_y Reference emissions in year y [tCO2/y]

(1) $RE_{C,y}$ Emissions from the consumption of coal fuel at cement plants in year *y* [tCO2/y]

(2) $RE_{INC,y}$ Emissions from the incineration process in year *y* [tCO2/y]

(3) $RE_{CH4,y}$ Methane emissions released from waste disposal sites in year *y* [tCO2/y]

(4) $RE_{TR,y}$ Emissions from the collection of industrial waste and its transportation to incineration plants or landfill sites in year *y* [tCO2/y]

(1) $RE_{C,y} = \Sigma_i Q_{ALFi,y} \times (CV_{ALFi} / CV_C) \times EF_{C,y}$

$Q_{ALFi,y}$ Consumption of alternative fuel type *i* by the project activities in year *y* [kl, ton/y]

CV_C The lower heating value of coal in year *y* [kcal/kl, t, 1000Nm^3]

CV_{ALFi} The lower heating value of alternative fuel type *i* in year *y* [kcal/kl, t, 1000Nm^3]

$EF_{C,y}$ CO2 emission factor for coal fuel in year *y* [tCO2/tCoal]

(2) $RE_{INC,y} = EFF_{INC,y} \times 44/12 \times \Sigma_j (R_{INC,y} \times W_{j,y} \times FCC_{j,y} \times FFC_{j,y})$

$EFF_{INC,y}$ The incineration efficiency of incineration equipment in year *y*

$R_{INC,y}$ The percentage of industrial waste to be incinerated with no other treatment in year *y*

$W_{j,y}$ The amount of industrial waste j to be inputted in the recycling plant in year *y* [ton/y]

$FCC_{j,y}$ The percentage of all carbon contained in industrial waste j in year *y* [tC/t]

$FFC_{j,y}$ The percentage of carbon derived from fossil resources out of all carbon contained in industrial waste j in year *y*

(3) $RE_{CH4,y} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F_{CH4} \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^{y} \sum_{j,\ell} R_{LF,x} \times W_{j,x} \times F_{\ell,x} \times DOC_\ell \times e^{-k\ell(y-x)} \times (1 - e^{-k\ell})$

φ_y Adjustment factor for uncertainty in year *y*

f_y The percentage of methane to be flared/combusted/used out of the recovered methane in year *y*

OX Percentage oxidized

F_{CH4} The percentage of methane in gases emitted at waste disposal sties

$DOC_{f,y}$ The percentage of degradable organic carbon which will decompose in year *y*

MCF_y Methane correction factor in year *y*

$W_{j,x}$ The amount of industrial waste j to be inputted in the recycling plant in year *x* [ton/y]

$R_{LF,x}$	The percentage of industrial waste to be dumped in landfill sites in year *x*
$F_{\ell,x}$	The percentage of organic waste type ℓ contained in industrial waste *j* in year *x*
DOC_{ℓ}	The percentage of degradable organic carbon in organic waste ℓ
k_{ℓ}	Decomposition speed for organic waste ℓ
ℓ	Organic waste
x	The year in which the waste was dumped in landfill sites (the value *x* could vary from the year when the dumping in the landfills started (x=1) to the year when the methane emissions are calculated (x=y).)
y	The year when the methane emissions are calculated

(4) $RE_{TR,y} = \Sigma_j \{R_{INC,y} \times W_{j,y} \times D_{INC} \times Ef_t\} + \Sigma_{j,n} \{R_{LF,y} \times W_{j,y} \times D_{LF} \times Eft\}$

$W_{j,y}$	The amount of industrial waste j to be inputted in the recycling plant in year *y* [ton/y]
D_{INC}	The distance from the industrial waste emission point to the incineration plant [km]
D_{LF}	The distance from the industrial waste emission point to the landfill site [km]
EFt	CO2 emissions per unit of productive activity for each type of vehicle in year *y* [tCO2/ton-kilometer]

G. Calculation of project emissions

$PE_y = PE_{ALT,y} + PE_{EC,y} + PE_{FC,y} + PE_{TR,y}$

PE_y Project emissions in year *y* [tCO2/y]

(1) $PE_{ALT,y}$ Emissions from the consumption of alternative fuel at cement plants in year *y* [tCO2/y]

(2) $PE_{EC,y}$ Emissions from the consumption of grid electricity by the project activities in year *y* [tCO2/y]

(3) $PE_{FC,y}$ Emissions from the consumption of fossil fuels by the project activities in year *y* [tCO2/y]

(4) $PE_{TR,y}$ Emissions from the collection of industrial waste and its transportation to the recycling plant, as well as the transportation of alternative fuel products from the recycling plant to the cement plants in year *y* [tCO2/y]

(1)-1 When measuring the emission factor for alternative fuel:

$PE_{ALT,y(1)} = \Sigma_i Q_{ALFi,y} \times EF_{ALTi}$

$Q_{ALFi,y}$ Consumption of alternative fuel *i* by the project activities in year *y* [kl, ton/y]

EF_{ALTi} The CO2 emission factor for the alternative fuel *i* [tCO2/tALT]

(1)-2 When calculating emissions from the composition of the alternative fuel and an assumed combustion efficiency:

$PE_{ALT,y(2)} = EFF_{COM,y} \times 44/12 \times \Sigma_i (Q_{ALFi,y} \times FCC_{i,y} \times FFC_{i,y})$

$EFF_{COM,y}$ The combustion efficiency of cement firing equipment in year *y*

$Q_{ALFi,y}$ Consumption of alternative fuel *i* by the project activities in year *y* [kl, ton/y]

$FCC_{i,y}$ The percentage of all carbon contained in alternative fuel *i* in year *y* [tC/t]

FFCi,y The percentage of carbon derived from fossil resources out of all carbon contained in alternative fuel *i* in year *y*

(2) $PE_{EC,y} = EC_{PJ,y} \times EF_{EL,y} \times (1 + TDL_y)$

$EC_{PJ,y}$ Grid electricity consumption by the project in year *y* [MWh]

$EF_{EL,y}$ The CO2 emission factor for grid electricity in year *y* [tCO2/MWh] (Calculate EFgrid,CM,y defined by the applicable version of the CDM methodological tool the "Tool to calculate the emission factor for an electricity system," and use it as the parameter.)

TDLy Average transmission and distribution losses of grid electricity received by the project in year *y* (For this parameter, use the default value of $TDL_{j,y}$ provided by the applicable version of the CDM methodological tool the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption.")

(3) $PE_{FC,y} = \sum EC_{n,y} \times NCV_{n,y} \times EF_{n,y}$

$EC_{n,y}$ Consumption of fossil fuel type *n* by the project activities in year *y* [kl, t, $1000Nm^3$/y]

$NCV_{n,y}$ The net calorific value of fossil fuel type *n* in year *y* [GJ/kl, t, $1000Nm^3$]

$EF_{n,y}$	The CO2 emission factor for fossil fuel type *n* in year *y* [tCO_2/GJ]

(4) $PE_{TR,y} = \Sigma_{j,p} \{W_{j,y} \times D_{AMT} \times Eft\}$
$+\Sigma_{j,p} \{Q_y \times D_{CEM} \times Eft\}$

$W_{j,y}$	The amount of industrial waste j to be inputted in the recycling plant in year *y* [ton/y]
Q_y	The amount of alternative fuel shipped by the project activities in year *y* [ton/y]
D_{AMT}	The distance from the industrial waste emission point to the recycling plant [km]
D_{CEM}	The distance from the recycling plant to the cement plant [km]
$EF_{p,y}$	CO2 emissions per unit of productive activity for each type of vehicle in year y [tCO2/ton-kilometer]

H. Calculation of emissions reductions

$ER_y = RE_y - PE_y$

ER_y	GHG emission reductions in year *y* [tCO_2]
RE_y	Reference emissions in year *y* [tCO_2]
PE_y	Project emissions in year *y* [tCO_2]

It is theoretically possible to calculate CO2 emissions reductions using the above described calculation methodology, but in reality it is difficult to obtain data for many of the parameters used in the methodology. Therefore, in this report, CO2 emissions reductions were estimated using the following method.

$ER_y = RE_y - PE_y$

= (1. CO2 emissions reductions through the replacement of coal at cement plants) + (2. CO2 emissions reductions through the replacement of incineration without other treatment) + (3. Methane emissions from disposal sites) – (4. CO2 emissions from electricity and fuel consumption at the recycling plant) + (5. CO2 emissions reductions through the reduction of the transportation distance)

The values for “1. CO2 emissions reductions through the replacement of coal at cement plants” and “3. Methane emissions from disposal sites” are zero, based on the results of the scenario analysis explained above.

Regarding “2. CO2 emissions reductions through the replacement of industrial waste incineration without other treatment,” it is not possible to calculate the CO2 emissions from incineration because the composition of the B3 waste currently being incinerated is unclear. If it is assumed that 60% of the B3 waste is plastic based on the data for general waste (from the calculation example in Surabaya[1]), the annual CO2 emissions reductions are estimated to be approx. 1,100 tons.

“4. CO2 emissions from electricity and fuel consumption at the recycling plant” can be calculated as follows if the CO2 emissions per unit of productive activity at the Amita Corporation’s plants in Japan are used: 0.009 (tCO2/ton shipped) × 24,000 tons (shipped) = 216 tons per year.

Concerning “5. Delivery distance reduction,” the distance to the final disposal site (Akkhie Prakarn Public Company Limited that has a record of collecting waste from IRPC and that is based in Samut Prakarn) is almost equal to that to the cement plant in Saraburi. Therefore, we have regarded the reduction as zero.

From the above, the resultant CO_2 reduction is given as follows:

ER_y = RE_y -PE_y

= “1. Alternative to coal in cement pant” + “2. Alternative to simple incineration”
+ “3. Methane emission from disposal site”
- “4. Power and fuel consumption in recycle plant”
+ “5. Delivery distance reduction”

= 0 + 1,100 + 0 - 216

= 884 tons/year

Accordingly, 884 tons of CO_2 is decreased annually.

[1] The 2014 Fiscal Year Promotion of Projects for the Development of the Japanese Recycling Industry Overseas “Power Generation from Municipal Solid Waste in Surabaya, Indonesia”

3.2.4. Estimated Project Cost and its Effectiveness

Assuming that the recycle plant has a CRM production capacity of 24,000 tons/year, the project is expected to cost 225 million yen. We set the statutory useful life at 17 years.

The planned cost effectiveness of CO_2 reduction (with no equipment subsidies from JCM) is shown below.

225 million yen ÷ (884 tons × 17 years) ≈ 16,635 yen/ton

3.2.5. Co-beneficial Effects

This project is expected to have a variety of co-beneficial effects by promoting waste recycling.

The first effect is fossil fuel reduction by the use of Suramix®. The second benefit is CRM-derived fuel that contributes to natural resource reduction because it can be not only alternative to fuel thanks to high caloric value but also used as a cement material alternative to clay.

Our preparation technology aims at 100-percent recycling of waste, that is to say, the total alternative raw fuel for cement production is consumed in the manufacturing process, resulting in no occurrence of secondary residue. The process is clear and makes it possible to guarantee the proper and transparent treatment of waste. Accordingly, compared with simple incineration and reclamation that are mainstream but implemented in an unclear disposal state, the technology is expected to have good effects, such as reducing environmental loads and promoting good environment control. Now that companies affiliated by foreign countries including Japan tackle issues with the proper and clear treatment of waste and the improvement of the recycle ratio, the project will solve them and increase investments from the countries.

In addition, preventing waste and ash after simple incineration from being buried prolongs the life of the final disposal site. In Japan, a report shows that after the cement industry increased the rate of accepting wastes and by-products to about 28.5 million tons/year in FY 2012, the life of the final disposal site would extend by eight years, resulting in contribution to a reduction in environmental load. Prolonging the life also contributes to a reduction in methane gas emission and in load put on the environment around the final disposal site.

3.3 Investigation toward a JCM Project

3.3.1. Project Planning (Implementing System, Grant-in-Aid Scheme, and Schedule)

We work on a scheme in which a local carrier—as partner—collects and delivers waste generated in the IRPC industrial park, and an cement manufacturer uses alternative fuel that is made from harmful part of the delivered in the interim treatment.

The park operator already carries on reuse and recycling, so the annual amount of waste incinerated or landfilled is about 5,000 tons.

This means that the feasibility of the project is low only in the IRPC industrial park, so it is necessary to expand the project to other industrial complexes in Rayong Province. Because about 300,000 tons of harmful waste is generated in the province, the wider area makes the feasibility high. Note that the project uses no JCM grant-in-aid scheme.

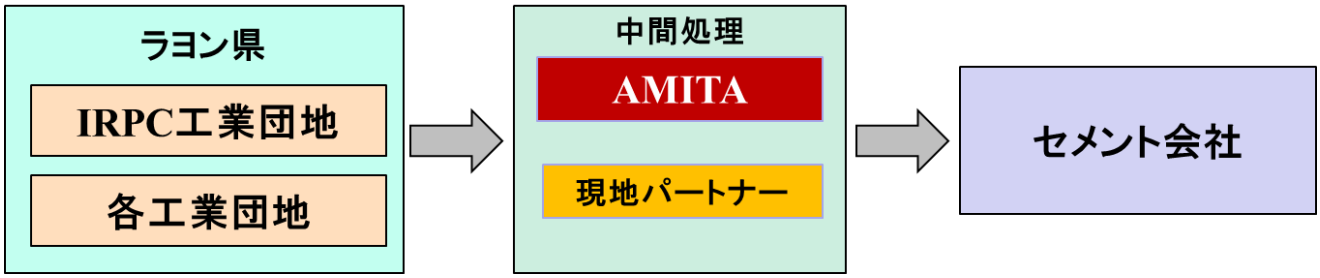


Figure ：Project operation system

3.3.2. Issues with Project Operation

In Thailand where waste-to-fuel for cement production already goes on, many cement manufacturers compete with each other to receive raw material derived from waste.

Most of plants operated by them are located in Saraburi District about 300 km far from Rayong Province. Therefore, after the interim treatment in the province, the resulting alternative fuel requires long-range conveyance to the cement plant, which is a problem to be addressed.

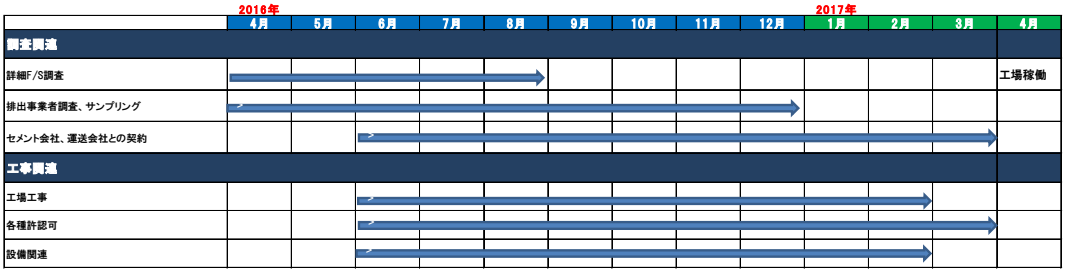
3.3.3. Future Schedule

FY 2016:

- Selection of a partner
- In-depth feasibility study
- Survey of waste dischargers and sampling
- Talk with the cement manufacturer about requirements for supplying alternative raw fuel
- Precise survey of an investment in on-site facilities
- Agreement with the authorities concerned and acquisition of permission
- Earthwork and plant construction

FY 2017:

- Start of the service



Chapter 4

Municipal Waste sector

“Waste-to-Energy Project”

EX Research Institute Ltd.

Chapter 4 Table of Contents

4.1 Purpose and Implementing System of Project Feasibility Study

4.1.1. Outline of the Project (Purpose and Applicable Field)

The project subjected to this survey aims to generate electric power from waste heat by using a municipal waste incinerator planned by Global Synergy Power Public Company Limited (hereinafter called GPSC), an affiliated company of Thai Public Oil Corporation (hereinafter called PTT) in the Rayong Province-operated Overall Waste Treatment Center located in the province. The project operator GPSC plans to generate an electric power of up to 9.9 MWh[1] from waste heat developed by burning combustible materials separated from municipal waste collected in the province at a rate of 500 ton/day (at the start). Up to 8.0 MWh[1] will be sold to Provincial Electricity Authority (hereinafter called PEA) to be alternative to power fed through the national grid and to contribute to a reduction in carbon dioxide emitted from energy generation. The researcher, which consists of Kitakyushu City, Nippon Steel & Sumikin Engineering Co., Ltd. (NSENGI), and EX Research Institute Ltd., studies the feasibility of running the project as one listed in JCM to introduce a high-efficiency municipal waste-to-power generator owned by NSENGI. Figure 1 shows the outline of the project that applies to the energy supply field.

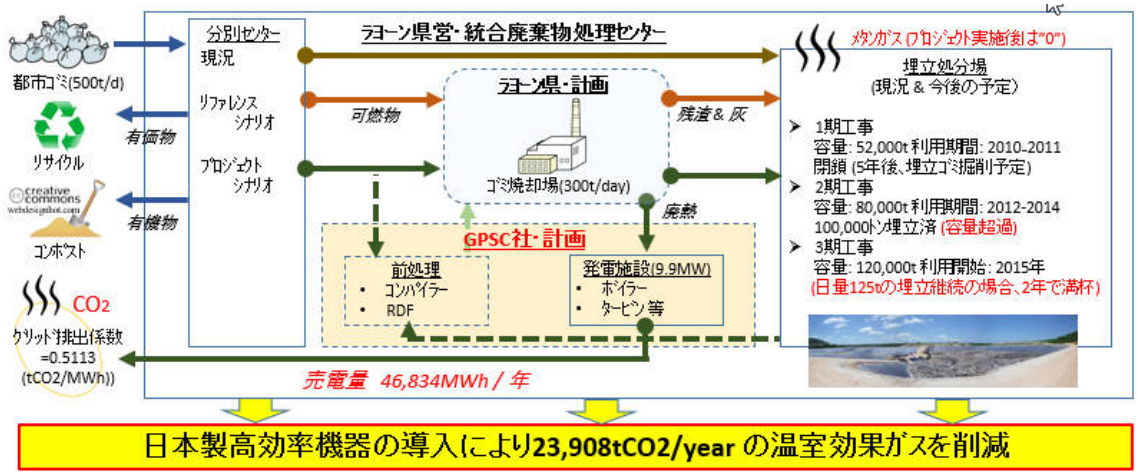


Figure 1: Outline of the project

4.1.2. Applicable Technologies and Related Legal Systems

(1) Applicable technologies

Facilities to be introduced in the project fall into two types: one is a facility for selecting

[1] Capacity of the power plant shown in PQ.

municipal waste, and the other is a plant for burning waste to generate power. GPSC has the same recognition, so it decides to let two subsidiaries operate the respective plants. The waste selecting plant requires a waste receiving pit, a crane that carries waste to the selection line or a heavy machine that has the same function, a belt conveyor, a trommel, and a magnetic separator. If it is necessary to dehydrate, dry, and compost organic waste as an additional operation, the corresponding equipment is mandatory. These units are regarded as a pre-treatment facility of the waste incineration and power plant.

Selection line in the Rayong Province-operated Treatment Center (photo taken by the researcher in June 2015)

The other plant to be introduced in the project includes a waste incinerator, a boiler, an exhaust gat treatment unit, various joints for system connections, system management and measurement devices, and accessories. In the project, we position a waste-to-power generation system as the core that consists of a stoker-type incinerator, a high-temperature and high-pressure boiler, and a steam turbine. NSENGI, which has the incinerator, aims to supply some machines including it. The turbine will be a high-efficiency product manufactured by a Japanese-affiliated company. In addition, we will adopt high-efficiency exhaust gas treatment technology cultivated by the company, so the project will be able to prevent Thailand from facing environmental pollution and contribute to the improved living environment of local residents.

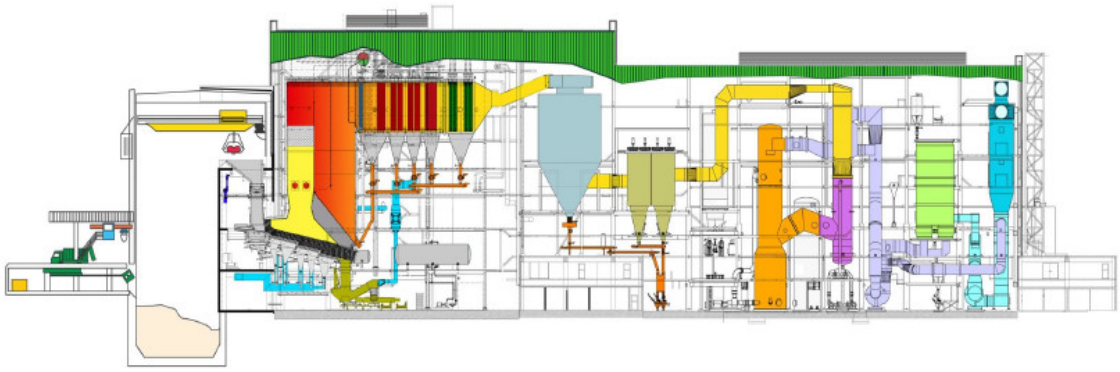


Figure 2: Stoker-type incinerator made by NSENGI
Source: Nippon Steel & Sumikin Engineering Co., Ltd.

NSENGI delivers the incinerator to about 500 sites including its overseas subsidiaries all over the world. The track record of the incinerator delivered shows that it can run continuously for 330 days a year. It is said that the operating rate of general incinerators ranges from 80% to 85%, so the NSENGI's one has a relatively high rate and we expect that a rise in rate will improve the profitability of the power generation service[2]. Furthermore, the Japanese manufacturer attains a power generation efficiency of 25-30 percent by conducting activities, such as making the boiler resistant to high temperatures and pressure, selecting optimal materials for the superheater, reducing the (combustion) air ratio, decreasing the exhaust gas temperature, and reducing the discharge pressure of the turbine. Through a JCM project survey made separately, we confirm that a Japanese-affiliated manufacturer has a steam turbine to be combined with the incinerator and boiler, and that its power generation efficiency is about 2 percent higher than that of turbines normally employed in the host country[3]. A reduction in operating rate requires the construction of a large-scale waste burning plant and work on how to treat waste properly during the stop of the incinerator. The NSENGI's incinerator, which features a high annual operating rate, meets needs the local area have because it faces difficulty in keeping landfill. The high efficiency of power generation results directly in the profitability, so we can easily think that a combination with the high-performance steam turbine increases the efficiency, which will be welcomed by the local government that has a financial problem with waste treatment. In addition, the incinerator made by NSENGI has structure that makes it easy to change the fire grade—easy maintenance—which allows the local company to run the machine stably for a long time.

(2) Related legal systems

In the project, we have made a survey of power generation with municipal waste and found that a variety of laws apply. Table 1 summarizes laws related to the project in the host country. Section 4.2.1 describes them in detail.

[2] Checks are necessary because of the maintaining work of the machines including the steam turbine.
[3] The results of a survey made in other countries in the Asian area show that the energy conversion efficiency of reaction-type steam turbines with 2D blades made in India and Malaysia is a little less than 24 percent, while that of Japanese products is about 26 percent.

Table 1: Laws related to the project in the host country[4]

Category	Law	Governing authority	Summary
Municipal waste	Buddhist Year 2535 Public Health Law	Ministry of Public Heath	General rules of solid and liquid wastes
	Buddhist Year 2535 Law for Promoting National Environment Conservation	Ministry of Natural Resources and Environment	National Environment Council, environmental funds, environmental standards and rules, and environmental policy planning
	Buddhist Year 2535 Harmful Substance Law		Import, production, storage, export, and transportation of harmful substances
	2002 MPH's ordinance on costs for collecting and delivering general waste	Ministry of Public Heath	Rules of upper service cost limits for the collection of municipal waste carried out by the local government
Energy	Buddhist Year 2535 National Energy Policy Council Law	Ministry of Energy (Secretariat)	Establishment of National Energy Control Council and rules of its authority
	Buddhist Year 2550 Energy Industry Law	-	Establishment of Energy Management Council and rules of its authority

4.1.3. Implementing System

The figure below shows the system for making this survey. Kitakyushu City takes the initiative in establishing the whole investigating framework between Rayong Province and GPSC as well as in confirming survey policies. EX Research Institute makes a basic survey of project operation and an investigation based on the policy. NSENGI, as a technical advisor, gives opinions to Kitakyushu City and EX Research Institute as well as conducts various activities for promoting the introduction of its own high-efficiency equipment (see Figure 3: Investigating system).

[4] Except general laws (e.g. commercial act) necessary to projects and their operation in the host country.

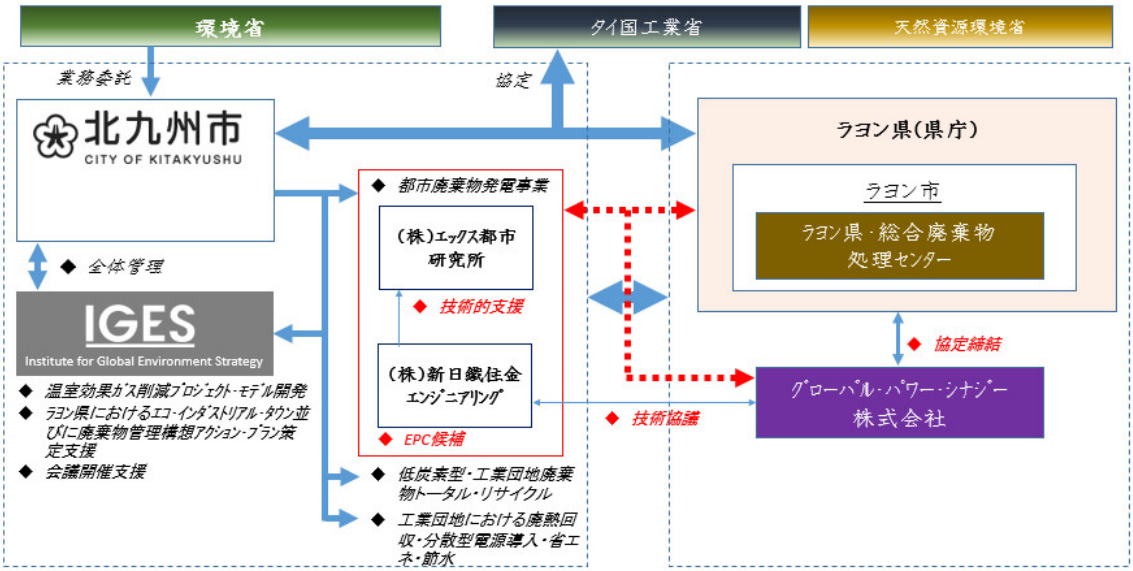


Figure 3: Investigating system

4.1.4. Investigating Method and Schedule

(1) Investigating method

Confirming what to survey

Table 2: What to survey, issues, and survey methods lists what to survey and issues on a category basis. In this survey, we have identified them by (i) collecting and organizing basic information necessary to the project and its operation as well as studying the participation of Japanese-affiliated companies, and (ii) checking out requirements for registering the project in JCM. The table also includes survey methods on an issue basis.

Table 2: What to survey, issues, and survey methods

Category	What to survey	Issues	Survey method
1	Project operation survey		
1)	Compatibility with the host country's laws and policies as well as the project plan	Organizing various measures for municipal waste and energy as well as checking them for compatibility	Looking over documents announced by the government of the host country and giving a hearing
2)	Current state of the host country	Checking the current state	Same as above

3)	Project plan	Checking and surveying the project operator, project plan, and permission	Giving a hearing to GPSC
4)	Environmental standard	Check the standard associated with the project	Looking over documents announced by the government of the host country and giving a hearing
2	JCM listing survey		
1)	Possibility of greenhouse gas reduction by the project	Estimating greenhouse gas reduction expected by the project	Estimating the reduction according to various JCM manuals, CDM methodologies, IPCC guidelines
2)	Methodology and MRV	Working on methodologies and MRV implementing systems applicable to the project	Conducting the work according to various JCM manuals, CDM methodologies, IPCC guidelines
3)	Project feasibility	Checking the JCM project for profitability	Estimation by NSENGI

4.2 Results of the Project Feasibility Study

4.2.1. Summary of the Field Survey Results

(i) Project-related laws, measures, and policies in the host country

Municipal waste

Thailand controls and supervises municipal waste in accordance with the Public Health Law (Buddhist Year 2535) enforced as a governing act in 1992, a variety of ministerial ordinances issued by the Ministry of Public Health under the control of the competent minister appointed as per PHL, Article 5, and government ordinances issued by local governments that receive authority as per PHL, Article 18. The law permits the local government to entrust the control of municipal waste and sewage (Article 18) and prohibits the unauthorized collection, delivery, and treatment of them (Article 19). Article 20 gives the local government the right to issue an ordinance for waste and sewage management. Concerning service costs to be defined in a

ministerial ordinance from the authorities concerned in accordance with PHL, Article 20(4), the Ministry of Public Health issued an ordinance for service costs for collecting and delivering general waste to specify the upper limit of domestic waste at 40 baht/month in 2002.

Energy including renewable one

The National Energy Policy Council Law, as its name suggests, is an act for establishing the council as a supreme decision-making organization for energy administration in Thailand. It was enforced in 1992 (Buddhist Year 2535) and modified in 2007 and 2008. In addition to the establishment of the council and its members including the prime minister as the chairperson, the law specifies the following council rights:

- Developing national energy policies and submitting them to the Cabinet
- Drawing national energy control and development plans and submitting them to the Cabinet
- Making rules for setting the energy price based on the policy and plan above
- Checking whether governmental organs, national enterprises, and energy-related private companies conduct their duties in accordance with the national policy, coordinating with and supporting them, and promoting the compliance
- Evaluating the results of implementing the policy and plan above

The Energy Industry Law enforced in 2007 (Buddhist Year 2550) specifies the establishment of the Energy Control Council, rights and obligations granted to the council, the types of business permits required on the basis of energy-related companies.

(ii) National policies and measures in Thailand

Municipal waste

Concerning the treatment of waste in Thailand, the National Environment Council established in accordance with the Law for Promoting National Environment Conservation draws up mid- to long-term policies and plans for 20 years to improve the national environment. The present policy and plan, which were developed in 1997, will be complete in 2016. Therefore, the Ministry of Natural Resources and Environment is preparing a mid- to long-term plan from 2017. The National Peacekeeping Council, which started in May 2014, approved the roadmap of treating waste including harmful one in Thailand drafted by the ministry at the Cabinet in August 2014. The roadmap shows strategies for (1) how to treat municipal solid waste delivered to existing landfills, (2) how to treat municipal solid food waste, (3) rules and standards for waste treatment, and (4) how to make regulations and give an education to the people to make

treatment sustainable.

Renewable energy

- Power source development plan (2015 to 2036)

In May 14, 2015, the National Energy Policy Council [5] approved the power source development plan, an energy development scheme for the next 21 years from 2015 to 2036. The plan, which was finalized through six public hearings after August 2014, consists of three criteria: national energy security, ecology, and economy resulting from the consideration of power demand reduction associated with the review of the GDP growth rate (4.41% → 3.94%) due to an economic recession, energy and power saving plans, and alternative energy development. The chapters of national energy security and ecology describe the promotion of using renewable energy to double the goal (ratio of renewable energy to the total power) defined in the previous plan approved in 2010 from 8 percent in FY 2030 to 16 percent in FY 2026.

- FIT

In January 23, 2015, the Thai Energy Control Council issued an official gazette to tell that as a result of working on the purchase of electric power generated from renewable energy (except solar one) in FY 2015 at the No. 147 conference held on December 15, 2014, the Thai government approved guidelines for a switch from ADDER to FIT and issued a notice to that effect on January 21, 2015. The table below shows power buying prices on the basis of renewable energy types attached to the gazette.

Table 3: Attachment 1 of the gazette issued by the Energy Control Council

Service type and capacity (MW)	FIT (baht/unit)			Contract period (years)	FIT premium (baht/unit)	
	FiT_F	$FiT_{V.2560}$	FiT (1)		Project for using biofuel (8 years)	Southern part premium (2) (in the period)
1. Municipal waste						
Plant's capacity ≤ 1 MW	3.13	3.21	6.34	20	0.70	0.50
Plant's capacity = 1 to 3 MW	2.61	3.21	5.82	20	0.70	0.50
Plant's capacity > 3 MW	2.39	2.69	5.08	20	0.70	0.50
2. Landfill waste	5.60	-	5.60	10	-	0.50

[5] Council established as par the National Energy Policy Council Law in Buddhist Year 2535. It has the rights to submit national energy policies and national energy management and development plans to the Cabinet.

3. *Biomass (direct incineration)*						
Plant's capacity ≤ 1 MW	3.13	2.21	5.34	20	0.50	0.50
Plant's capacity = 1 to 3 MW	2.61	2.21	4.82	20	0.40	0.50
Plant's capacity > 3 MW	2.39	1.85	4.24	20	0.30	0.50
4. Biogas (derived from sewage/solid waste	3.76	-	3.76	20	0.50	0.50
5. Biogas (derived from biomass	2.79	2.55	5.34	20	0.50	0.50
6. Small hydraulic power						
Plant's capacity ≤ 200 kW	4.90	-	4.90	20	-	0.50
7. Wind power	6.06	-	6.06	20	-	0.50

Source: Gazette issued by the Tai Energy Control Council (translation by the researcher)

(2) Current state of the host country

Municipal waste

Thailand enforced the Law for Promoting National Environment Conservation (LPNEC) in 1992 to establish the National Environment Council whose chairperson was the prime minister and which had the rights to draw up national environment conservation policies and plans, to make environmental standards, and to check and approve plans for managing environmental standards. The minister in charge of environmental administration is the vice-chairperson, its permanent secretary works as a member and secretary, and the Ministry of Natural Resources and Environment fulfills its duties. The law specifies not only the establishment of an environmental fund and the development of standards environmental but also the setup of a pollution control committee whose chairperson is the Vice Minister of Natural Resources and Environment and which consists of members including the heads of the authorities concerned, the deputy mayor of Bangkok, and the head of the Pollution Control Department working also as the secretary (Article 52). LPNEC, Article 53, paragraph 9 obliges the Pollution Control Department to submit an annual report on environment to the National Environment Council, so the former develops and announces an environmental white paper annually in accordance with the paragraph. The FY 2013 Environmental White Paper consists of five chapters and eight attachments, and Chapter 2 reports the current state of waste as follows:

The Pollution Control Department, Thai Ministry of Natural Resources and Environment, gives a questionnaire about municipal waste to 2,274 cities including Pattaya (specific city) 7,782 local administrative offices (LAO[6]) including 5,508 sub-district administrative offices

[6] Local Administrative Office

(SAO[7]), and Bangkok Metropolitan Administration (BMA), and statistically summarizes the resulting data on the generation, collection, delivery, and final disposal of municipal waste. Thailand has 26.8 million tons of municipal solid waste, so the generation of waste per person is 1.15 kg/day. From an area-by-area point of view, Bangkok holds an about 16% share of the total volume, and the remaining cities and the others command 38% and 46% shares respectively. Of 7,782 LAOs, 4,179 offices (54%) offer a municipal waste treatment service to collect and deliver 14.4 million tons of waste (53.8%) annually. Of the whole waste collected, 52 percent (7.421 million tons) is delivered to authorized treatment facilities, while 48 percent (6.938 million tons) is dumped in old-fashioned disposal pits or undeveloped spaces. There are 2,490 waste disposal sites all over Thailand. Of them, 446 sites are authorized but 2,024 sites are unauthorized. The recycle ratio of municipal waste is 19 percent (5.152 million tons). Recycling consists of (1) material production (3.935 million ton, 76%), (2) composting or biogas collection (1.114 million tons, 22%), and heat generation (0.103 million tons, 2%).

Renewable energy (waste to energy)

Thailand promotes the introduction of renewable energy based on plans made according to the national energy policy mentioned above and the national energy management and development scheme. Of such plans, the key one is the alternative energy development plan announced by the Department of Alternative Energy and Efficiency Improvement.

The key plan initially showed 10-year activities from 2012 to 2021, but the term was changed to 22 years from 2015 to 2036. The new goals of renewable energy in 2036 are set at 19,634.4 MW and 18% share, which are 2.6 times and about 2.5 times greater than actual records (7,490.4 MW and 7% share) in 2015 respectively. Waste-to-energy (WtE) is 65.7 MW in 2015, but the goal in 2036 is set at 500 MW. Therefore, we expect that the development and operation of public-private projects will accelerate.

3) Project plan

(1) Project operator

The project operator is Global Power Synergy (GPSC)[8], a subsidiary wholly owned by PTT that makes an investment directly and indirectly. The profile of GPSC is shown below.

Company name	Global Power Synergy Public Limited Company (GPSC)
Head office	555/2 Energy Complex Building B, 14th Floor, Vibhvadi – Rangsit Road,

[7] Sub-District Administrative Office

[8] In May 18, 2015, GPSC was listed in the Stock Exchange of Thailand. Before it, PTT released 374.57 million hot stocks.

	Kwaeng Chatuchak, Khet Chatuchak, Bangkok 10900.
Establishment	January 10, 2013
Capital	14,983 million baht
Main stockholders	PTT PLC PTT Global Chemical PLC Thai Oil Thai Oil Power
Sales and net profit	23,673 million and 1,798 million baht
Employees	-
Key business	Energy and water supply
Main investment destinations	Rachaburi Power (RPCL): 15% Combined Heat & Power Producing: 100% Thai Solar Renewable: 40% Bang Pa In Co-Generation: 25%

As shown above, we think that GPSC has a competence high enough to make an investment in, plan, and operate the run in question in view of its parent company, capital, and business.

(2) Project planning history

PTT, the parent company of GPSC, develops and operates the IRPC industrial park in Rayong Province, so both parties build a close relationship of cooperation. Now that public attention is put on environmental issues in Thailand, particularly Rayong Province where the petrochemical industry dominates, PTT's desires agree with Rayong Province's thoughts because the former wants to show measures against environmental problems taken by the PTT group, while the latter aims to address municipal waste problems. Therefore, both parties sign off on a contract on municipal waste treatment. The outline of the contract is shown below (including partial information collected from the stakeholders through a hearing).

- Contract on a waste-to-energy project using heat from the incineration of municipal waste
- Contract date: September 18, 2014
- Contract period: 28 years including construction
- In the project, GPSC cooperates with Rayong PAO in developing clean energy and building a mechanism friendly to the environment and surrounding residents.
- Rayong PAO supplies municipal waste to GPSC at a rate of 500 tons/day.
- Rayong PAO pays a tipping fee of 100 baht/ton to GPSC.

- Rayong Province provides a site and building (waste selection).
- GPSC operates the waste selection plant in advance, which will start at the end of 2015.
- The waste incinerator and power plant will start at the end of 2017.

(3) Planned project site

The site subjected to a JCM project survey is the Rayong Province-operated Integrated Waste Treatment Center (whose site area is 0.69 km^2) situated in Nong Taphan, Rayong District, Rayong Province, Thailand. The center, which Rayong PAO started to build in 2009, began its operation in November 2011. It consists of three final landfills under control, a municipal waste selection plant, a management building, and related equipment.

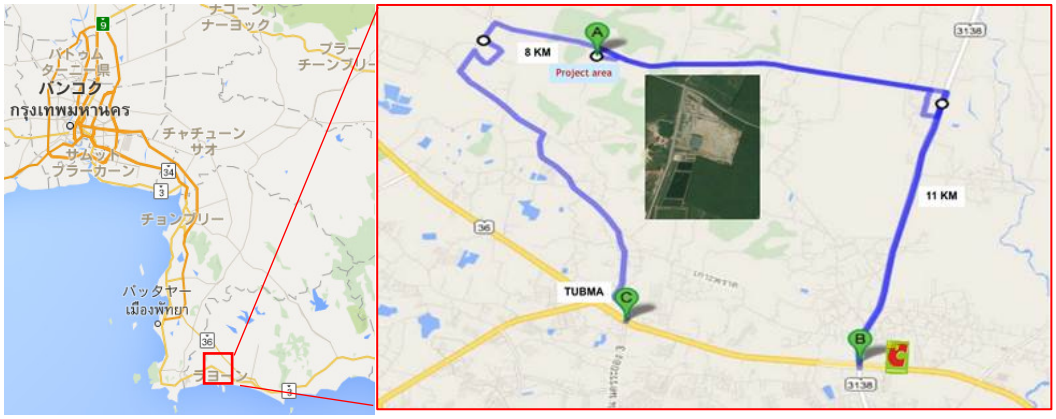


Figure 4: Location of Rayong Province-operated Integrated Waste Treatment Center (A on the map)

Rayong Province-operated Integrated Waste Treatment Center (photos taken by the researcher on August 21, 2015)

(4) Heat source for power generation (municipal waste)

As mentioned in (2) Project planning history, in September 18, 2014, the operator GPSC signed off on a contract with Rayong PAO to run a waste-to-energy project that uses heat from the incineration of municipal waste. The latter plans to supply the waste to the former at a rate of

more than 500 tons/day. In this survey, we analyzed the quality and amount of waste because guaranteeing the quality and amount of fuel has a direct and significant impact on the feasibility of the project.

i. Amount of waste

Rayong PAO collects municipal waste from 23 of 65 districts in the province and delivers it to the Province-Operated Integrated Waste Treatment Center. The amount of waste collected and delivered is about 350 tons/day in June 2015. The office commits GPSC to a daily supply of 500 tons, so we have given a hearing to the person in charge in Rayong PAO to put a question about how to procure the difference (150 tons/day), and known that the office negotiates with 45 districts that deliver no municipal waste to the center as of June 2015 to ask them to do it. The official is confident that Rayong PAO can achieve the goal because the daily amount of municipal waste collected and delivered is 105 tons only in Rayong District[9], and the tipping fee is lower than that shown by other local governments. Moreover, he shows a plan in which Rayong PAO will keep 725 tons of waste a day in the first phase by collecting it from the whole area of Rayong, Ban Khai, Ban Chen, and Nikhom Pattana Districts, and will treat municipal waste collected from the whole province in the center in the second phase. The amount of municipal water from the 45 districts that deliver no waste to the center is about 560 tons.

Garbage truck owned, controlled, and operated by each local government (photo taken by the researcher in the final landfill)

ii. Quality of waste

In consideration of the various conditions of Thailand and planned project site, we analyzed

[9] The Department of Environment, Rayong Province, announces 100 tons/day.

the quality of waste.

Number of analyses	2 times
When	Early in October and middle of November
Period	1 week each

Sampling

Figures 5, 6, and 7, and Table 4 show sampling points, the number of samples on a point basis, and sampling methods.

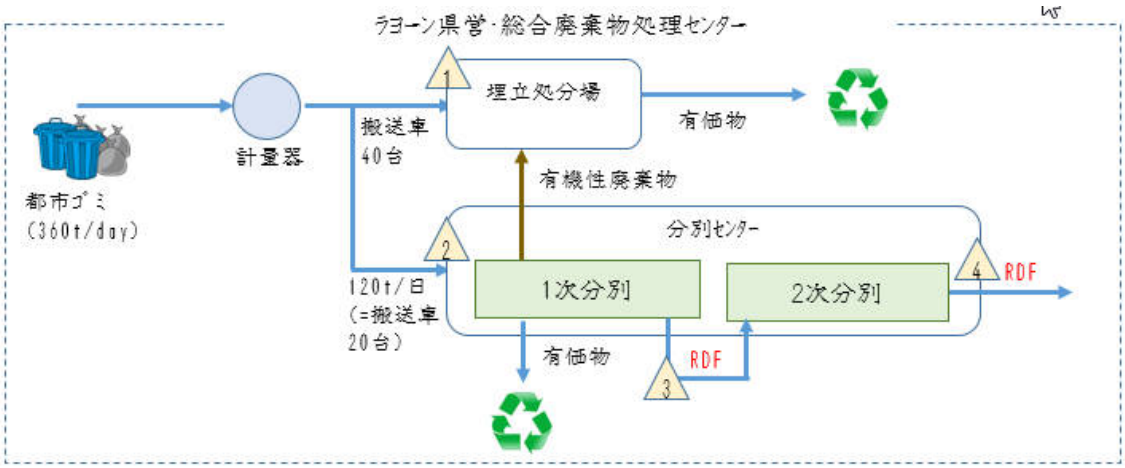


Figure 5: Sampling points in a survey of waste quality

Table 4: Sampling points and the number of samples in a survey of waste quality

Sampling points[10]		No. of samples
1	Landfill (food waste receiving yard)	7
2	Food waste receiving yard of the selection center (Monday to Friday)	5
3	Combustible waste collection yard of the selection center (Monday to Friday)	5
4	Combustible waste collection yard of the selection center (Saturday or Sunday)	2

[10] The numbers in the leftmost column of the table correspond to ones in triangles in Figure 5.

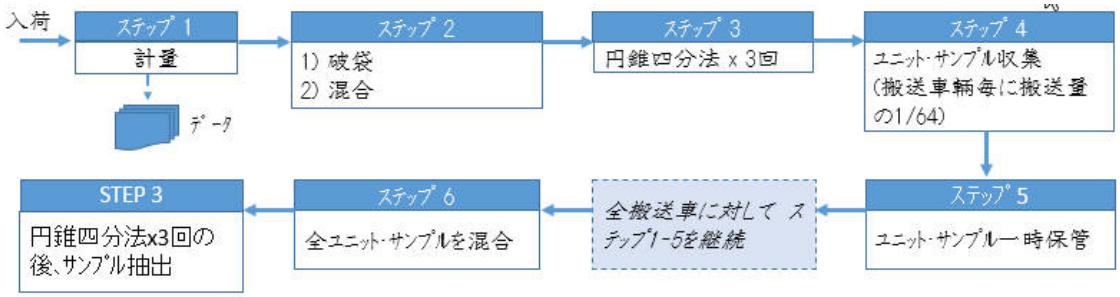


Figure 6: Method of sampling food scraps

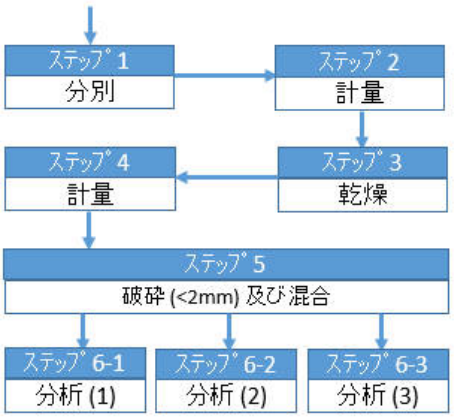
Figure 7: Method of sampling RDF

For what and how to analyze

GPSC plans to separate plastics from food scraps and to make RDF (Refuse Derived Fuel) from them. Table 5 and Figure 8 show for what and how to analyze on a sampling basis.

Table 5: For what to analyze on a sampling point basis

Sample		For what to analyze				
Sampling point	Quantity	Three components	Composition	Caloric value	Chlorine	Sulfur
1	7	○	○	-	-	-
2	5	○	○	-	-	-
3	5	○	○	○	○	○
4	2	○	○	○	○	○



ステップ	分析項目	分析対象・分析方法
1	組成分析、並びに 3成分 (含水率)	(1) 厨芥 (2) 紙類 (3) 繊維類 (4) 木竹類 (5) プラスティック (6) ゴム・皮革 (7) 金属 (8) 不燃物 (ガラス/石) (9) その他
3		105℃ ± 5℃ 3-5日間
6-1	3成分 (灰)	800℃ 2時間
6-2	低位発熱量	ASTM E711-87 (2004)
6-3	塩素	ASTM E776-87
	硫黄	ASTM E775-87

Figure 8: Sample types, for what to analyze, procedures, and methods

Analyzing results

The first and second surveys indicated that the average amount of waste delivered was 203 and 283 tons/day respectively. These values were greatly different from that (360 tons) promised by Rayong PAO, so we asked the office a question. The reason was that Map Ta Phut City did not daily deliver 70 tons of municipal waste to the disposal site in both survey periods. If the city does it, the daily amount of waste is 270 to 350 tons, which is similar to the figure planned by Rayong PAO. The following tables show the results of analyzing the waste for three components, composition, and elements.

Table 6: Three components

Component		Minimum	Maximum	Average
Combustible material	Wet	32.24	42.83	39.46
	Dry	71.04	87.66	81.21
Ash	Wet	5.92	13.38	9.06
	Dry	12.34	28.96	18.79
Moisture content	Wet	47.29	55.80	51.48
	Dry	-	-	-

Table 7: Composition (dry types)

Component	Minimum	Maximum	Average
Daily amount of waste			
Garbage	24.51 (14.19)	37.11 (28.29)	30.29 (21.22)
Paper	7.26 (7.79)	14.31 (18.27)	10.79 (11.79)
Fiber	1.37 (3.08)	11.82 (14.50)	6.77 (8.25)

Tree and plant	2.29 (4.22)	14.99 (10.96)	9.26 (7.15)
Plastics	23.12 (31.91)	29.43 (39.49)	26.63 (34.55)
Rubber and leather	0.08 (0.52)	2.87 (5.52)	0.96 (2.23)
Metal	0.461 (1.30)	1.37 (3.32)	0.81 (2.09)
Mottle and glass	1.50 (3.98)	4.59 (9.40)	2.81 (6.20)
Other	4.52(4.55)	10.77(9.79)	7.04 (6.52)

Table 8: Elements

Element	Average	Minimum	Maximum
Carbon	46.05 (67.90)	38.30 (64.49)	51.56 (70.59)
Hydrogen	8.41 (12.39)	6.96 (11.48)	9.51 (13.02)
Nitrogen	0.35 (0.52)	0.30 (0.49)	0.39 (0.55)
Oxygen	6.74 (10.02)	5.31 (7.26)	9.16 (13.20)
Chlorine	1.29 (1.88)	0.72 (1.04)	2.99 (4.20)
Sulfur	0.05 (0.07)	0.04 (0.06)	0.06 (0.08)

(5) Project permission and its status

The project finally burns waste and generates electric power simultaneously, so it requires two permits (contracts): one is related to waste treatment and the other is associated with the operation of power generation. Concerning the former, GPSC signs off a waste treatment contract with Rayong PAO that has the right to treat municipal waste in the province. The latter generally requires the following permits. Table 9 lists them and the status of GPSC receiving them.

Table 9: Permits necessary to the project and the status of GPSC receiving them

		Authority concerned	Status
1	Agreement to use the site	Village office	Complete
2	Check on compatibility with the national land use plan	Ministry of Interior	Complete
3	Plan operation license	Ministry of Industry	Complete
4	Electricity selling and buying contract	PEA	Negotiating
5	Electric power generation permit	National Energy Control Council	Under review
6	Application for the approval of projects exceeding a	Cabinet	Under review

	given scale[11]		

(6) Feasibility of the project

The project operator expects that the project will have an internal earning rate of 12 percent. The profit consists of power selling income and waste treatment cost as shown above. The latter is a total expenditure for the operation and maintenance of the waste incineration and power generation facilities. The ordinary profit is given by subtracting the selling and ordinary costs from the gross income.

Income

- Unit price

No.		Funds	Unit	Unit price
1	Income given by selling power to PEA Unit price at more than 3 MW during migration to FIT (food waste in Table 3)			
	1)	Fixed purchase price	kWh	2.39
	2)	Variable purchase price (which varies depending on fuel procurement cost = core inflation rate)	kWh	2.69
	3)	Premium (8 years)	kWh	0.70
2	Municipal waste treatment cost		THB/ton	100.-

- Quantity

No.		Funds	Unit	Quantity
1		Energy sold to PEA[12] (6.78 MWh - 1.0 MWh) x 24 hours/days x 330 days	MWh/year	45,777
2		Amount of municipal waste treated 500tons/day x 365days	Tons/year	182,500

Expenditure

- Costs for operating and maintaining the facilities (which are estimates in the first year and which vary after the next year)

No.	Funds	Unit	Total

[11] During check

[12] The energy generated and sold has an increasing possibility in the future, but the present estimate is based on a minimum supply of 500 tons/day committed y Rayong Province.

1		Labor cost	THB 1,000/year	18,000
2		Utilization (e.g. consumables) and management costs	THB 1,000/year	25,000
3		Maintenance cost	THB 1,000/year	60,000

If the core inflation rate is 6 percent and it applies to the variable purchase price (fuel procurement cost), facility operation cost, and maintenance cost included in the power selling price, the cash flow in the project period is shown below.

事業性評価(BAU)

単位: THB1,000

事業年度		0	1	2	3	4	5	6	7	8	9	10
年		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
初期投資		-1,560,000										
収益	売電益	0	310,507	319,178	328,368	338,111	348,437	359,384	370,987	383,286	358,719	372,538
	ﾁｯﾋﾟﾝｸﾞ･ﾌｨｰ	0	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250
	計(1)	0	328,757	337,428	346,618	356,361	366,687	377,634	389,237	401,536	376,969	390,788
支出	人件費	0	18,000	19,080	20,225	21,438	22,725	24,088	25,533	27,065	28,689	30,411
	消耗品費	0	25,000	26,500	28,090	29,775	31,562	33,456	35,463	37,591	39,846	42,237
	維持管理費	0	60,000	63,600	67,416	71,461	75,749	80,294	85,111	90,218	95,631	101,369
	計(2)	0	103,000	109,180	115,731	122,675	130,035	137,837	146,107	154,874	164,166	174,016
営業利益	計(1)－計(2)	0	225,757	228,248	230,888	233,686	236,652	239,796	243,129	246,662	212,803	216,772
ｷｬｼｭﾌﾛｰ		-1,560,000	225,757	228,248	230,888	233,686	236,652	239,796	243,129	246,662	212,803	216,772

事業年度		11	12	13	14	15	16	17	18	19	20	計
年		2,028	2,029	2,030	2,031	2,032	2,033	2,034	2,035	2,036	2,037	
初期投資		0	0	0	0	0	0	0	0	0	0	-1,560,000
収益	売電益	387,187	402,715	419,174	436,621	455,115	474,718	495,497	517,524	540,872	565,620	8,184,558
	ﾁｯﾋﾟﾝｸﾞ･ﾌｨｰ	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	18,250	365,000
	計(1)	405,437	420,965	437,424	454,871	473,365	492,968	513,747	535,774	559,122	583,870	8,549,558
支出	人件費	32,235	34,169	36,220	38,393	40,696	43,138	45,726	48,470	51,378	54,461	662,141
	消耗品費	44,771	47,457	50,305	53,323	56,523	59,914	63,509	67,319	71,358	75,640	919,640
	維持管理費	107,451	113,898	120,732	127,976	135,654	143,793	152,421	161,566	171,260	181,536	2,207,135
	計(2)	184,457	195,525	207,256	219,692	232,873	246,845	261,656	277,356	293,997	311,637	3,788,916
営業利益	計(1)－計(2)	220,980	225,440	230,168	235,179	240,492	246,122	252,091	258,418	265,125	272,234	4,760,642
ｷｬｼｭﾌﾛｰ		220,980	225,440	230,168	235,179	240,492	246,122	252,091	258,418	265,125	272,234	3,200,642

IRR 12 %

但し
1) 維持管理費には減価償却費を含まない
2) 維持管理(保守保全費)には大規模補修を含まない

Now, GPSC says that no information about a planned investment is disclosed due to the period of preparing bidding materials, but the tables above suggests a maximum investment of about 1,560 million baht.

4) Project to be surveyed and environmental standards

In this survey, we focus on the project for generating electric power by using waste heat from the incineration of municipal refuse. The continuous operation and maintenance of the incinerator—heat source—is mandatory to the project, so we have checked out not only wastewater and noise criteria but also environmental standards for exhaust gasses from plants including incinerators. Exhaust gas standards defined for incinerators have three categories: general, harmfulness, and infectiousness. Different wastewater standards are set for discharge

sources and destinations. The wastewater standard for plants applies to this project. Concerning noise, the Ministry of Labor issues an ordinance to show the noise standard, which applies to the project.

4.2.2. Possibility of Reducing Greenhouse Gas Emissions (Particularly Carbon Dioxide Emitted from Energy Generation)

In the project, the operator GPSC constructs a power plant additionally at the general waste treatment site, which is operated and managed by Rayong Province and where a waste incinerator plans to be introduced. The purpose of the former facility is to produce electric power from waste heat given by refuse incineration and feed it to the national power transmission network to make the waste-to-energy alternative to grid power, resulting in a reduction in green gas emissions. In BAU, CH4 is generated when food waste landfilled is fermented anaerobically. The project is expected to prevent the gas from being emitted and to reduce greenhouse gases. However, we do not count such a reduction in the project because it is out of the purpose of JCM.

1) Estimation method

(1) Greenhouse gasses to be estimated

In the project subjected to this survey, we evaluate the following greenhouse gases:

Emission category	Action category	GHG type	Evaluation and remarks
Reference emission	Power generation	CO_2	GHG emitted assuming that a power source connected to the national grid supplies electric power instead of the project
Project emissions	On-site use of fossil fuel	CO_2	GHG emitted by using equipment operation and auxiliary fuels in the power plant
	On-site power consumption	CO_2	GHG emitted by using electric power in the power plant
	Use of fossil in the pretreatment of waste	CO_2	GHG emitted by using fossil fuel in the pretreatment process of waste to get output power necessary to the operation of the power plant
	Use of power in the pretreatment of waste	CO_2	GHG emitted by consuming electric power in the pretreatment process of waste to get output power necessary to the operation of the power

			plant
	Use of extracted waste as RDF	CO_2	GHG emitted by burning RDF made from extracted waste to generate electric power

(2) Reference emission

$$\text{RE} = EG_p \times EF_{grid} \qquad \text{Equation (1)}$$

where

RE_p = Reference emission (t-CO_2) in the period *p*

EGp = Power (MWh) generated in the period *p* in the power plant with the waste incinerator

EF_{grid} = Grid's emission factor (t-CO_2/MWh)

(3) Project emissions

The following shows an equation for estimating the project emissions quantitatively.

$$PE_p = PE_{elec,plant,p} + PE_{FF,plant,p} + PE_{elec,pre-t,p} + PE_{FF,pre-t,p} + PFalt,p$$

where

PE_p = Project emission (t-CO_2) in the period *p*

$PE_{elec,plant,p}$ = GHG emission (t-CO_2) by power consumption in the power plan in the period *p*

$PE_{FF,plant,p}$ = GHG emission (t-CO_2) by fossil fuel consumption in the power plan in the period *p*

$PE_{elec,pre-t,p}$ = GHG emission (t-CO_2) by power consumption in the pretreatment of general waste in the period *p*

$PE_{FF,pre-t,p}$ = GHG emission (t-CO_2) by fossil fuel consumption in the pretreatment of general waste in the period *p*

PEFalt,p = GHG emission (t-CO_2) by alternative fuel combustion in the power plant in the period *p*

$$PE_{elec„plant,p} = EL_{plant,p} \times EF_{grid}$$

where

$EL_{plant,p}$ = Grid power (MWh) of power consumption in the power plant in the period *p*

EF_{grid} = Grid's emission factor (t-CO_2/MWh) in the host country

$$PE_{FF,plant,p} = FF_{plant,p} \times NCV_{FFi} \times EF_{FF,i}$$

where

$FF_{plant,p}$ = Fossil fuel consumption (tons) in the power plant in the period *p*

$NCV_{FF,i}$ = Lower caloric value (Gj/ton) of the fossil fuel *i*

$EF_{FF,i}$ = GHG emission factor (t-CO_2/ton) of the fossil fuel *i*

$$PE_{elec„pre-t,p} = EL_{pre-t,p} \times EF_{grid}$$

where

$EL_{pre-t,p}$ = Grid power (MWh) of power consumption in the pretreatment facility in the period *p*

EF_{grid} = Grid's emission factor (t-CO_2/MWh) in the host country

$$PE_{FF,pre-t,p} = FF_{pre-t,p} \times NCV_{FFi} \times EF_{FF,i}$$

where

$FF_{pre-t,p}$ = Fossil fuel consumption (tons) in the pretreatment facility in the period *p*

$NCV_{FF,i}$ = Lower caloric value (Gj/ton) of the fossil fuel *i*

$EF_{FF,i}$ = GRG emission factor (t-CO_2/ton) of the fossil fuel *i*

$$PE_{Falt,p} = \quad F_{alt,dry,p} \times TC_{pla} \times FCF_{pla} \times OF_{pla}$$

where

$F_{alt,dry,p,}$ = Power consumption (MWh) in the power plant in the period p

TC_{pla} = Carbon content (%) of all plastics

FCF_{pla} = Fossil fuel-derived carbon content (%) of the total carbon of plastics

OF_{pla} = Oxidation ratio (%)

(4) Reduction in emission

The resultant reduction is given by subtracting the project emission from the reference emission as follows:

$$ER_p = RE_p - PE_p \qquad \text{Equation (3)}$$

where

ER_p = GHG reduction (t-CO_2) in the period p

2) Estimating a reduction in emission

The project subjected to this survey is expected to reduce GHG emissions because power generated by heat energy from waste incineration is alternative to grid power. We can quantify the GHG reduction by measuring the resulting power after the project is complete. If estimating it before the project starts, as shown above, we need to use materials obtained until the submission of a proposal, such as incinerator's specs, the caloric value of general waste to be delivered to the facility, and data the proposer has. The most possible conditions viewed from the current state are shown below.

<u>Outline of the project site (specifications necessary to calculation)</u>

- Amount of food waste treated: 500 tons/day

- Combustible content: 25%
- Incinerator's capacity: 300 tons/day
- Fuel's lower caloric value: 4,000 kcal/kg[1]
- Plant running period: 330 days
- Plant's power generation efficiency: 28%
- Plant's power consumption: 1.0 MWh

(1) Reference emission

The reference emission—GHG emitted by grid power generation instead of the project—is given by equation (1). The table below lists the parameters of the equation and their values.

Parameter	Unit		Remarks
EG_p	MWh	Measured value	
EF_{grid}	t-CO_2/MWh	Default value	0.5113 announced by DNA of the host country

According to the specifications above, the annually generated energy is 53,697 MWh, the facility's power consumption is 6,887 MWh, and the grid-supplied power is 46,834 MWh. As a result, the reference emission forecast is 23,908 t-CO_2/year.

(2) Project emissions

In the project subjected to this survey, a power plant is constructed additionally next to a municipal waste incinerator that has been investigated so far. Therefore, GHG reduction activities in the latter facility go on regardless of the project. The project emissions include GHG emitted by fossil fuel and power consumption during the operation of the power plant as well as GHG emitted by fossil fuel and power consumption in the pretreatment process if it is necessary to adjust the caloric value for the smooth operation of the power plant. They are given by equation (2), the breakdown of which is shown in Section 4.2.2, paragraph 1)(3).

The table below lists the in-depth parameters of the equation.

Parameters	Unit	Value	Remarks
$EC_{plant,p}$	MWh	Measured value	
$EC_{pre-t,p}$	MWh	Measured value	
EF_{grid}	t-CO_2/MWh	Default value	0.5113 announced by DNA of the host country

$FF_{aux,i,p}$	L	Measured value	
$FF_{pre-t,,i,p}$	L	Measured value	
NCV_{FFi}	GJ/ton	Default value	*i* = Light oil (43.3) IPPC's default value
EF_{FFi}	t-CO_2/GJ	Default value	*i* = Light oil (0.0748). IPPC's default upper limit
TC_{pla}	%	Default value	IPPC's default value (85)
FCF_{pla}	%	Default value	IPPC's default value (100)
OF_{pla}	%	Default value	IPPC's default value (100)

Power consumed in the power plant and pretreatment process is generated in the former except when it stops. Accordingly, the power consumption is necessary only to maintaining work and the office building. The auxiliary fuel is a fossil type, which is used only when the power plant stops and the emergency generator runs during a power failure. To find GHG emissions, we will actually measure the power and fossil fuel consumption through monitoring after the project is complete. The current forecast is 75,400 kWh/year including energy necessary to maintaining work for 35 days—the suspension period of the power plant.

(3) Reduction in emission

According to the preceding paragraphs (1) and (2), the annual GHG reduction is 23,908 t-CO_2.

4.2.3. MRV Methodology and Monitoring System

1) Methodology

In the project subjected to this survey, the operator generates power from heat given by burning combustible materials separated from municipal food waste collected and delivered by the wide-area alliance of district governments in Rayong Province. The province, which makes a contract on municipal waste treatment, faces a problem of final landfill being nearly full. In the near future, there is a possibility of restoring the existing landfill by digging up waste and of generating power by using heat from combustible materials separated from the refuse. Not only the area in question but also quite a lot of other provinces in Thailand are in the same situation, so in consideration of it, we have worked on methodologies (draft) as follows:

(1) Considering eligibility requirements

	Eligibility requirements	Reasons for setup

1	The project shall generate electric power by using heat from municipal waste burned in the incinerator.	Most of combustible materials contained in municipal waste are made from plastics, so if the project includes incineration, it may emit GHG whose emission factor is larger than that of the grid.
2	If heat sources used in the project contain combustible materials (e.g. RDF and RPF) derived from extracted waste, 1) The operator shall build up a system for monitoring the input of the combustible material correctly. 2) The operator shall not use the combustible material beyond a upper limit. 3) The GHG emission factors (IPCC in 2006) of burning waste made from plastics are shown below. - Carbon content = 0.85 - Ratio of fossil fuel-derived carbon to carbon content = 1.00	The purpose of burning RDF derived from extracted waste is to keep heat for power generation, so the resulting GHG emission is regarded as one of project emissions.
3	The waste incinerator, which is used as a heat source, shall have a food waste capacity of 300 tons, a thermal shrinkage ratio of less than 5 percent, and a power generation efficiency of not less than 28 percent.	The performance of the incinerator is the most important. It is necessary to conduct a benchmark test to measure the efficiency of the project, the correctness of the operation, and the stability of incineration.
4	If the project includes the construction of a waste incinerator, it is essential to prove that an waste-to-energy project is added to the construction plan or that there is a plan in which municipal waste is treated without the use of waste heat including power generation in case the project does not run.	This methodology applies to power generation projects using waste heat from incineration, so it is necessary to prove that the heat is supplied now or in the future.

(2) Considering the quantification of GHG reduction

See Section 4-2-2. Possibility of Reducing Greenhouse Gas Emissions.

(3) Considering the guarantee of maintainability

Grid's emission factor announced by Thai DNA

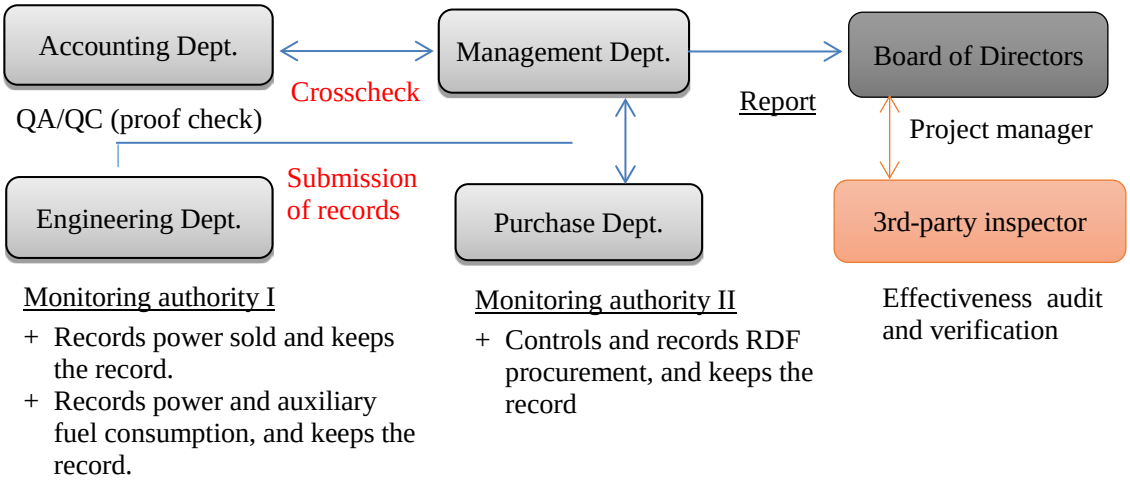
As clearly shown in the power source development plan, Thailand announces a definite policy of increasing carbon-neutral power sources, such as renewable energy, hydraulic power, and atomic power. Therefore, we think that the grid's emission factor announced by Thai DNA has a high reducing possibility in the future. To guarantee the maintainability, we will review the emission factor during monitoring and reflect the ex post one in a monitoring report.

2) MRV

To run this project, the operator GPSC establishes a subsidiary. Concerning MRV, the departments in charge in the subsidiary will conduct monitoring activities as part of its daily duties and make a report for certification. They will make crosschecks on the report internally and send a certification request to a third-party organization.

Implementing system

The MRV implementing system expected in the project is shown below.



Monitoring method

The following shows expected tasks that range from monitoring to third-party body's certification and report submission to the joint committee.

- As part of daily work, the person in charge in Engineering Department that controls the operation of the power plant monitors (1) power sold and purchased, (2) RDF consumption, (3) auxiliary power and fuel consumption to record the measured values in a given form.
- The departmental head checks the form daily, keeps it in a given file, and regularly submits it to Management Department.
- Management Department compares the record with books received from Accounting and RDF Purchase Departments, and converts the form to an electronic file.
- The monitoring authorities transcribe data accumulated during the monitoring period in a spreadsheet set forth in the project design statement, and submit it as a report to the Board of Directors having the highest responsibility for the project.
- The board submits the report to the third-party body, and after receiving a certificate, sends the certified report to the JCM Joint Committee.

Monitoring devices

Efforts shall be made to guarantee the correctness of measured values by selecting devices whose emission measurement error is within 5 percent as shown in the JCM System Regulations and by calibrating them regularly.

4.2.4. Estimated Project Cost and its Effectiveness

We take action to the extent that we can make an application for equipment subsidies, but NSENGI discloses no information because it contains confidential one related to business.

4.2.5. Co-beneficial Effects

Contribution to sustainable development in the host country

As mentioned before, the host country tends to increase municipal waste slightly, depending on change in people's consuming activities associated with economic growth. Moreover, landfills in use are nearly full and the people raise awareness of environment, so the waste administration is in a period of transition. Like other countries, the administration faces a difficulty in keeping equilibrium between income and expenditure, but the sustainable treatment of waste requires it. Implementing the project in question contributes to the sustainable development of the host country by (i) reducing municipal waste now landfilled and making them harmless to solve the landfill problem, and (ii) selling power generated from waste heat to address the financial

equilibrium issue.

4.3 Investigation toward a JCM Project

4.3.1. Project Planning (Implementing System, Grant-in-Aid Scheme, and Schedule)

The project operator GPSC has ample funds and plentiful know-how about power selling services, so it has a competence high enough to establish an operating subsidiary with its own funds and to let it operate and manage the project. In addition, GPSC intends to plan and run the project with its own funds. Registering the project in JCM as a grant-in-aid one requires establishing an international consortium with a Japanese-affiliated enterprise. At the fourth conference held on October 12, GPSC showed EX Research Institute (researcher) its intention to talk about the foundation of such a consortium. We will hold in-depth meetings including the conference while paying attention to the progress of this survey.

2) Financial support scheme

As mentioned above, GPSC plans to raise funds including ones from financial institutes in its own fashion.

3) Schedule

At the fourth conference held on October 12, we received the following schedule from GPSC.

When	Planned action
End of Dec. 2015	Notification of prior review results and public announcement of bidding
End of Apr. 2016	Notification of bidding results
End of Dec. 2017	Start of power selling service

4.3.2. Issues with Project Operation

As mentioned so far, GPSC has made preparations for the project in silence, so it has no problem. Because GPSC is an affiliated and listed company of PTT, the provider (EPC) makes a decision whether to list the project in JCM after the project operator conducts a preliminary test for qualification and tenders for the project with qualified companies according to its in-house rules. As a result, it is difficult to carry on the project in conventional steps expected as a JCM grant-in-aid project: (i) letting the operator select a provider and then (ii) making an application for JCM subsidies. NSENGI, the candidate of EPC, shows the intention of requiring GPSC to place an order to itself (if the request is unsuccessful, the candidate withdraws an application for

the grant-in-aid project). Due to these problems including an issue of information disclosure having the risk of hindering fair competition between the temporary and other bidders, negotiation between the parties concerned is stagnant.

4.3.3. Future Schedule

1) Project operator

As shown in Section 4.3.1, paragraph 3, the project plan is about two months behind the initial schedule. Bidding will be announced in the second half of December and the winner will be determined at the end of April in the next year.

2) Researcher

As mentioned above, we applied for the secondary grant-in-aid equipment project in FY 2015 and submitted documents, but withdrew it because the bidding specification was unclear, resulting in limitations on cost estimation, and the Global Environment Center Foundation gave us advice. We will have continuous talks with the parties concerned about the possibility of a reapplication in the next fiscal year.

Chapter 5

Supporting Institutional Arrangements for JCM Development and Replication on Decarbonising of Municipal Waste Management and Ecological Industrial Town in Rayong Province (Kitakyushu – Rayong Cooperation Project)

Institute for Global Environmental Strategies

Table of Contents

5.1 Summary of the Section

The main targets of the JCM Feasibility Study (FS) under the city-to-city collaboration between the City of Kitakyushu and Rayong Province are the IRPC Industrial Estate which is managed by the Department of Industrial Works (DIW) and the Map Ta Phut Industrial Estate which is managed by the Industrial Estate Authority of Thailand (IEAT), both of which are in Rayong Province. Kitakyushu City has signed a Memorandum of Understanding (MoU) to cooperate on low-carbonisation of industrial estates with DIW and IRPC, and IEAT, respectively. As part of the activities under these MoUs, there have been some requests to Kitakyushu City to assist with the development of relevant policies. The current study was conducted in order to identify potential linkage between these policies and the JCM.

In the current FS, necessary assistance was provided for the development of the Eco Industrial Town Key Performance Indicator (KPI) for DIW, and the Master Plan on Eco Industrial Town for the Map Ta Phut Industrial Estate Complex (hereafter, Master Plan) for IEAT, respectively, in collaboration with Kitakyushu City.

Once the KPI of DIW takes effect, the industrial estates managed under the authority of DIW will have to make efforts to enhance energy savings and other measures by following the indicators. This is likely to trigger the identification of JCM candidate projects. On the other hand, the main objective of the Master Plan is to secure safety and environment conservation of the industrial estates and the communities. The plan did not contain concrete numerical targets for low-carbonisation, so the potential use in relation to JCM is likely to be limited.

A series of workshops have been organised in Japan and in Thailand, respectively, in order to share the contents and progress of the FS and to discuss on necessary matters among relevant stakeholders. The first workshop in Japan was held on 14 May 2015 (in Tokyo) and the next one organised for 16 December 2017 (in Kitakyushu City). The workshops in Thailand have been organised for 19 and 20 May 2017 (in Bangkok) and for 19 and 20 January 2018 (in Bangkok), respectively.

5.2 Assistance for Institutional Arrangements

5.2.1 Assistance for Development of the Eco Industrial Town Key Performance Indicators (for DIW)

5.2.1.1 Background and Objectives

DIW is the subsidiary agency of the Ministry of Industry of Thailand. DIW is responsible for the operation of industrial estates and also regulates chemicals and hazardous substances. It is currently

implementing the Eco Industrial Town Project which aims to achieve both economic growth of industries, and improved environment and quality of life in the communities surrounding the industrial estates in six designated provinces, namely, Rayong, Prachin Buri, Phra Nakhon Si Ayutthaya, Pathurn Thani, Saraburi, and Chon Buri Provinces.

One of the objectives of the project is to develop Eco Industrial Town Key Performance Indicators (KPI) which are to be applied to areas and industrial estates that are managed by DIW. A draft of the KPI is currently under development.

Kitakyushu City signed a MoU with DIW and IRPC to cooperate on low-carbonisation of industrial estates in 2014 and there was a request from DIW to Kitakyushu City to assist the development of the KPI as part of activities under the MoU. The current study was conducted in order to seek for potential linkage between the KPI and the JCM.

5.2.1.2 Methods and Schedule

(1) Schedule

The current study first reviewed the draft KPI prepared by DIW and provided comments and information mainly on Kitakyushu City and other cases in Japan. A consultation meeting was then held and followed by participation at a seminar on KPI for the Eco Industrial Town organised by DIW. The overall schedule of the study is provided in Figure 1.

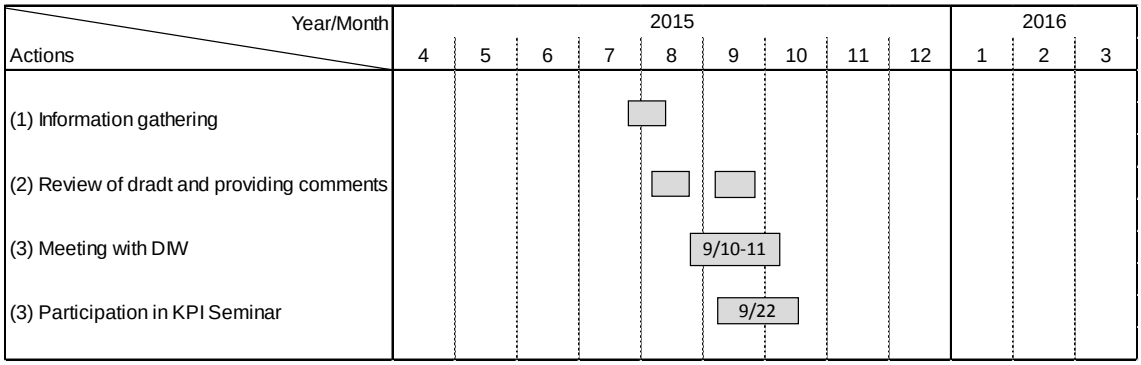


Figure 1. Action items and schedule on assistance for development of Eco Industrial Town Key Performance Indicators.

(2) Review of draft KPI and providing comments

The development of KPI continued according to the following procedure: (i) Preparation of draft KPI by DIW; (ii) Inviting comments on draft KPI from experts in other countries; (iii) Presentation and discussion at the Seminar on Key Performance Indicators (see "(4) Participation for seminar");

and (iv) Updating the draft KPI based on the comments received in the seminar by DIW.

From Japan, Prof. Toru Matsumoto of the University of Kitakyushu who is an expert on eco towns and was nominated by Kitakyushu City joined as an expert. IGES supported Kitakyushu City and Prof. Matsumoto in developing the KPI.

I. Outline of draft KPI

- The first draft KPI were developed by DIW based on a review and analysis of the information on eco industries and/or eco towns in about ten different countries. The draft indicators were then compiled and updated by the local consultant in Thailand (Management System Certification Institute).
- DIW has been developing draft KPI since 2012 in order to evaluate the progress of the Eco Industrial Town Master Plans developed by DIW in six provinces, respectively, under the responsibility of DIW. Among them, the Eco Industrial Town Master Plan of Rayong was finalised in 2015.
- The characteristics of the KPI are that they seek to evaluate not only the industrial estate but the entire town (= province).
- Draft KPI consist of the following five levels and ten indicators. The main target of Levels 1-2 is the industrial estate; Levels 3-4 is the community and town; and Level 5 is achieving the overall objective.
  - Level 1: Implementing in accordance with the law
  - Level 2: Maintaining the level of safety and environmental standards for industrial enterprises
  - Level 3: Resource consumption and energy efficiency
  - Level 4: Improving the economy and quality of life
  - Level 5: Achieving low-carbon society

II. Information and comments

Initially, there was a request from Kitakyushu City and Prof. Matsumoto to provide comments to the draft KPI from a technical perspective. In response to that request, relevant information mainly from Kitakyushu City and other cases in Japan was collected and organised aiming to provide objective reference material. The organised cases and findings, such as indicators which are apparently difficult to achieve, suggested indicators to be added, and other findings, were submitted to DIW (Appendix 5-1).

III. Meeting with DIW

DIW and the local consultant who developed the draft KPI visited Japan to explain and discuss the Seminar on Key Performance Indicators (see "(4) Participation to seminar") so the following meeting was held (travel expenses were covered by DIW).

DATE/TIME 15:00-17:00, 10 September 2015; 10:00-14:00, 11 September 2015
LOCATION Prof. Matsumoto's laboratory, the University of Kitakyushu
PARTICIPANTS Total 7

- Participants from Thailand (2): Pattamawan Khunprasert (DIW), Usasiri Sirisukha (Management System Certification Institute)
- The University of Kitakyushu (2): Prof. Toru Matsumoto, graduate student
- Kitakyushu City (2): Junichi Sono, Yasuhito Takatsuka
- Institute for Global Environmental Strategies (IGES) (1): Kohei Hibino

SUMMARY OF DISCUSSION

- Background and objectives of development of the KPI. (DIW)
- Explanation about the Seminar on KPI on 22 September 2017. (DIW)
- Review of each draft indicator and comments on the appropriateness. (Kitakyushu City, Prof. Matsumoto)
- It was confirmed that comments on the draft indicators will be submitted to DIW by filling out the form prepared by DIW by 17 September 2017.

(4) Participation at seminar

The "Seminar on Defining Key Performance Indicators for Thai Eco Industrial Towns" was organised in Bangkok by DIW. A case study of an eco-town in Kitakyushu City was presented by Prof. Matsumoto of the University of Kitakyushu as one of the invited resource persons (funded by DIW) and a discussion took place on the draft indicators of KPI based on the comments provided in advance. A summary of the seminar is as follows:

DATE/TIME 9:00-12:30, 22 September 2015
LOCATION Golden Tulip Sovereign Hotel Bangkok
PARTICIPANTS Total approx. 100

- Participants from Japan (2): University of Kitakyushu (Prof. Toru Matsumoto), IGES (Kohei Hibino)
- Other resource persons (2): UNIDO (Jan Dictus), German International Cooperation (Robert Himmler)
- Local participants: Relevant government agencies (DIW, IEAT), Provincial government, Industrial estate, research institutions, etc.

AGENDA

1. Welcome notes
2. Background of KPIs' Eco Industrial Town Development in Thailand (Dr. Patsaraporn Plubcharoensuk, DIW)
3. Lessons learnt and Key Performance Indicators for Eco Industrial Town
   - Prof. Toru Matsumoto, University of Kitakyushu
   - Dr. Robert Himmler, German International Cooperation
   - Mr. Jan Dictus, UNIDO
4. Open comments on Key Performance Indicators of Thai Eco Industrial Town (Moderator: Dr. Supriya Wongswan)

SUMMARY OF DISCUSSION

Open comments and discussion took place on each level (i.e., 1-5) of the draft KPI after the presentations. The outline of the discussion is as follows:

Level 1: Implementing in accordance with the law

- Eco towns target special industrial estates so a target of 80% on legal compliance is low – the target should be 100%.
- Reporting for EIA is mandatory so the target should be 100%.

Level 2: Maintaining the level of safety and environmental standards for industrial enterprises

- There are other safety features that need to be taken into account including environment aspects such as heat and dust, work conditions aspects, and safety aspects such as prevention of accidents and deaths.
- There should be indicators other than compliance such as status of maintenance and frequency of accidents.
- The suggested 80% monitoring sample should specifically indicate in what conditions the indicator will be applied.
- The standard for compliance and the standard for environment emissions should be clearly separated given the difference in character.
- The standard for effluent should be 100% but it would be difficult to meet the standard for emissions, so these should be dealt with separately.

Level 3: Resource consumption and energy efficiency

- The type of information needed for evaluation, how to evaluate, availability of data, which agency have the data, etc. should also be understood.
- The availability of data is an important factor for the indicators and data should be something that could be collected within a realistic timeframe and cost as well as

being measurable.

- Who is going to collect the data? Each agency and industrial estate is collecting data but there needs to be an organisation that collects and consolidates data, otherwise Level 3 will not proceed.
- The indicator on water consumption should include water consumption of factories.

Level 4: Improving the economy and quality of life

- The average household income should specify if it is for overall areas or specific areas. Other indicators such as employment /unemployment rate, infrastructure, networks, etc. should also be included. A long life does not necessarily indicate that the quality of life is also high, so the indicator on average age should be reconsidered.
- Indicators such as community participation and information disclosure are also important and worth considering.
- Q. What is the target of the evaluation – overall area or specific area? – A. Initially, it will target some specific small areas on a trial basis and gradually expand the coverage to include other provinces. The extent of coverage depends on budget availability. (DIW)
- Some industrial estates have many old factories thus the selection of indicators should carefully consider differences in types, etc. of the factories.

Level 5: Achieving low-carbon society

- There were no comments.

Wrap-up and other matters

- The targets and indicators for measurement were mixed up so it is important to consider whether the indicators are measurable and whether data is available. It would be a good idea to designate an organisation to collect and consolidate all the data. It is also important to clarify the cost of operation. It was suggested to conduct a test run for about half a year and decide whether the indicators are feasible or not.
- It took nine months for DIW to develop a Master Plan, thus it is expected to take some time when dealing with a new area. (DIW)
- Q. An inquiry counter at the agency should be established in the province where the pilot project will be implemented. – A. Next year, staff will be sent to the provinces where the pilot projects will be conducted. It is not certain whether whole provinces will be covered but staff will certainly be sent to Rayong Province. (DIW)
- The draft indicators will be reviewed based on comments provided at the seminar and pilot projects will be implemented. (Moderator)

Seminar on Defining Key Performance Indicators for Thai Eco Industrial Towns (9/22).

Welcome notes delivered by Dr. Pasu Loharjun, Director General of DIW, at the opening of the Seminar

5.2.1.3 Results and Achievements

The draft KPI were to be updated by DIW based on the comments received at the Seminar. However, a concrete schedule for updates or a due completion date were not mentioned (completion has not been identified as of February 2016). Tentative draft KPI at the time of the Seminar are available in Annex 5-1.

5.2.1.4 Potential of Institutionalisation and Linkage with JCM

(1) Potential and challenges toward institutionalisation

The draft KPI developed by DIW is one of the main activities of the Eco Industrial Town Project which is the Thai national policy and therefore it is highly likely that it will be realized. As noted at the seminar however, KPI may be developed gradually through implementation of pilot testing targeting specific areas, thus a practical application to all six target provinces is considered to take some time. As also noted at the seminar, it will take some time to complete an implementation structure including designation of organisation to collect and consolidate the data, clarify the roles and responsibilities of the relevant agencies, and establish inquiry counters in all provinces.

(2) Relevance and potential application to JCM

The current assistance has focused on providing objective information and comments on draft KPI. There were also various comments provided at the Seminar. It is not clear at this moment how these comments will be reflected in the KPI until the final version is issued. On the other hand, as the target of KPI includes all industrial estates and communities within the six target provinces which DIW manages, these bodies will be obliged to pursue the set indicators in KPI once they are

formalised. Thus, it is expected that it will be an influential tool regardless of how the comments are taken in the draft.

Regarding the linkage with JCM, particularly Level 3 (Resource consumption and energy efficiency) and Level 5 (Achieving low-carbon society) are considered to be most relevant (Table 1).

Table 1. The list of indicators in Level 3 and Level 5 of the draft Eco Industrial Town Key Performance Indicators of DIW which were considered most relevant to JCM. (Tentative draft as of September 2015).

Levels of indicators	Draft key performance indicators
Level 3: Resource consumption and energy efficiency	• 80 percent of industrial waste from specified factories has been recycled • The ratio of the electricity consumption to GDP of the industry decreases (compared to the base year) • The rate of generating household waste is not more than 0.9kg/capita/day • The average water consumption per capita is not more than 150 litres/day • 10 percent of factory operators continuously increase development of eco-efficiency or come under the category of Eco Factory
Level 5: Achieving low-carbon society	• Carbon emissions (equivalent) of the Eco Industrial Town must not be more than 5 tons-C per 1 million baht of GDP • 20 percent of energy use is from alternative energy • Carbon emissions (equivalent) from all activities must not be higher than the global average

Once these targets on energy consumption and CO_2 reduction are set, the industrial estates in the target provinces at least will be obliged to work toward the targets and it will create motivation to introduce energy efficient systems and hence increase the possibility of identifying candidate JCM projects. The JCM would be a useful scheme to support the introduction of new systems for industrial estates and factories that are keen to enhance energy savings so it is important to continue disseminating information on the JCM to DIW as well as to industrial estates that are under its jurisdiction.

5.2.2 Assistance for Development of the Map Ta Phut Industrial Estate Complex Master Plan (for IEAT)

5.2.2.1 Background and Objectives

IEAT is the subsidiary public corporation of the Ministry of Industry of Thailand. It is responsible for the development and establishment of industrial estates ensuring that the factories for various industries are orderly and systematically clustered together. IEAT manages 58 industrial estates in 18 provinces with 11 directly managed by IEAT and the remaining 47 operated through joint ventures with the private sector (from IEAT provided material as of May 2015).

Kitakyushu City and IEAT exchanged a MoU on enhancing low-carbonisation of Map Ta Phut Industrial Estate Complex in 2014. In the MoU, four areas were stipulated as the focus for implementation over the initial three years (2014-2016). These are: (i) Master Plan Eco Industrial Model, (ii) Eco Centre, (iii) Waste Recycling Complex, and (iv) Capacity Building. IEAT has been developing an individual master plan for each industrial estate and the current development of the Master Plan is included in the (i) cooperative activity.

The Map Ta Phut Industrial Estate Complex is a flagship presence among industrial estates of IEAT and has an important status as a model for other industrial estates. The current study was conducted to seek possible linkage between the Master Plan and the JCM by assisting Kitakyushu City in its support for IEAT on the development of the Master Plan.

5.2.2.2 Methods and Schedule

(1) Schedule

The current study reviewed the draft Master Plan prepared by IEAT, conducted gathering and organising of relevant information, and provided comments as inputs. A consultation meeting was then held with IEAT. The overall schedule of the study is provided in Figure 2.

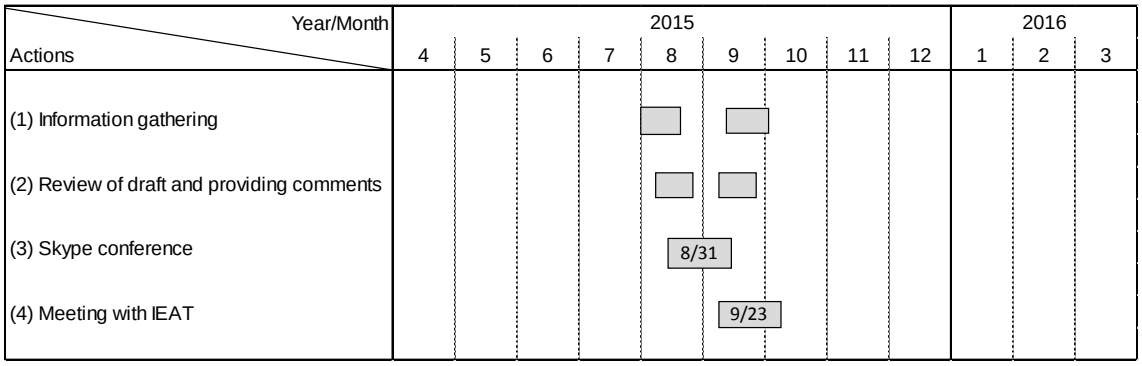


Fig. 2. Action items and schedule on assistance for development of the Master Plan on Eco

Industrial Town for the Map Ta Phut Industrial Estate Complex.

(2) Skype Conference

A Skype conference was organised to clarify the needs of IEAT in terms of what kind of assistance is needed from Kitakyushu City for the development of the Master Plan and how to proceed.

DATE/TIME 17:30-18:30, 31 August 2015; 10:00-14:00

LOCATION IGES-KUC meeting room (and IEAT headquarters)

PARTICIPANTS Total 6

- IEAT side (3): IEAT (Jariya Sukhapan, Husana Rattanabhibal), EX Research Institute (Satoshi Takagi)
- Kitakyushu City side (3): Kitakyushu City (Junichi Sono, Yasuhito Takatsuka), IGES (Kohei Hibino)

SUMMARY OF DISCUSSION

- Kitakyushu City explained the comments sent to IEAT prior to the Skype conference (see "(3) Review of draft Master Plan and providing comments").
- IEAT explained the background, development and status of the Master Plan (see "(4) Gathering and organising information").
- Both parties confirmed the status that no progress has been made in the work since IEAT sent a request to Kitakyushu City in January 2015 due to miscommunication.
- Kitakyushu City requested IEAT to prioritise the actions in the draft Master Plan by sorting out the actions into those already in operation and those needing assistance.
- IEAT is planning to introduce an EV bus for the second action item in the draft Master Plan which is "transportation". Kitakyushu City responded that it can assist by providing information and case studies from Kitakyushu. The city can also provide operational know-how and can dispatch the experts. IEAT has expressed its interest to submit the proposal for FY2017 IEAT budget request.
- There was a discussion on how to incorporate renewable energy into Eco Champion, an IEAT-led incentive and awarding programme to commend industrial estates that are advanced in enhancing eco-friendly activities. Both parties agreed to discuss further at the next opportunity when Kitakyushu City visits Thailand.
- Both parties agreed to discuss in more detail in September in Bangkok.

(3) Review of draft Master Plan and providing comments

Based on the discussion with IEAT, the draft Master Plan was reviewed and comments were provided. Table 2 shows a summary of comments on Action #8 "Waste Management" and Action

#9 “Energy Management” which are considered to be most relevant to JCM.

Table 2. An outline of Action #8 “Waste Management” and Action #9 “Energy Management” in the Master Plan on Eco Industrial Town for the Map Ta Phut Industrial Estate Complex and a summary of comments provided by the Kitakyushu City to IEAT (as of August 2015).

	Outline of the draft Master Plan	Summary of the comments provided
8. Waste Management	1. Development of material flow for the industrial waste 2. Establishing of a network of surveillance to prevent illegal dumping 3. Promotion of municipal waste management by separation of household waste	• Decreasing waste generation from household should be the responsibility of the municipality while decreasing of waste from industrial estate should be the responsibility of IEAT • Promoting the use of recycle products should be through joint efforts by the municipality and IEAT • Illegal dumping is often conducted by collecting, transporting and treatment companies and not by the companies that generate the waste • In order to prevent illegal dumping, enhanced recycling of waste and strict surveillance are needed (Information on Kitakyushu City’s prevention measures was provided separately).
9. Energy Management	1. Promotion of alternative energy use 2. Feasibility study for introducing solar cells in the household 3. Campaign for reducing electricity consumption in households	• Promotion of renewable energy (solar cell, wind power, cogeneration, etc.) • Promotion of a subsidy system to install renewable energy system including FIT • Installing energy saving type equipment, e.g., LED system • Establishing surplus energy supply system to surrounding areas including residents • Installation of solar cell systems on the roof of factories • Promotion of subsidies for installation of systems (e.g., JCM) to the tenant companies in the industrial estates

(4) Gathering and organising information

The background and status of the Master Plan development which was recognised through consultation with IEAT is summarised below:

- The development of Master Plans for industrial estates is prescribed in several ongoing national policies, including the 11th National Economic and Social Development Plan

(2012-2016) which is developed by the National Economic and Social Development Board (NESDB), the Prime Minister Policy, Ministry of Industry Strategic Plan. IEAT has been implementing the development in line with this guidance.

- The Eco Industrial Estate and Networks scheme which IEAT has been promoting defines specification of standards and criteria which consists of 5 aspects and 22 areas and each Master Plan of the industrial estate is developed following these specifications (Figure 3).
- IEAT set its key performance indicator to develop at least four master plans for the individual industrial estates starting from 2013 and has completed developing 19 master plans as of September 2015.
- In FY2014 (Thai fiscal year which starts from October), master plans for the Map Ta Phut Industrial Estate Complex and other four industrial estates (outside of Map Ta Phut) have been developed but the one on Map Ta Phut Industrial Estate Complex could not be completed within FY2014. It was therefor included in the list of cooperation actions of the MoU with Kitakyushu City
- In FY2015 (Thai fiscal year), in total of four master plans including RIL and Map Ta Phut IE in Map Ta Phut Industrial Estate Complex and other two industrial estates (in Ayutaya Province) were developed and finalized. The Master Plan for the Map Ta Phut Industrial Estate Complex was also completed within FY2015with assistance from Kitakyushu City (Figure 4).

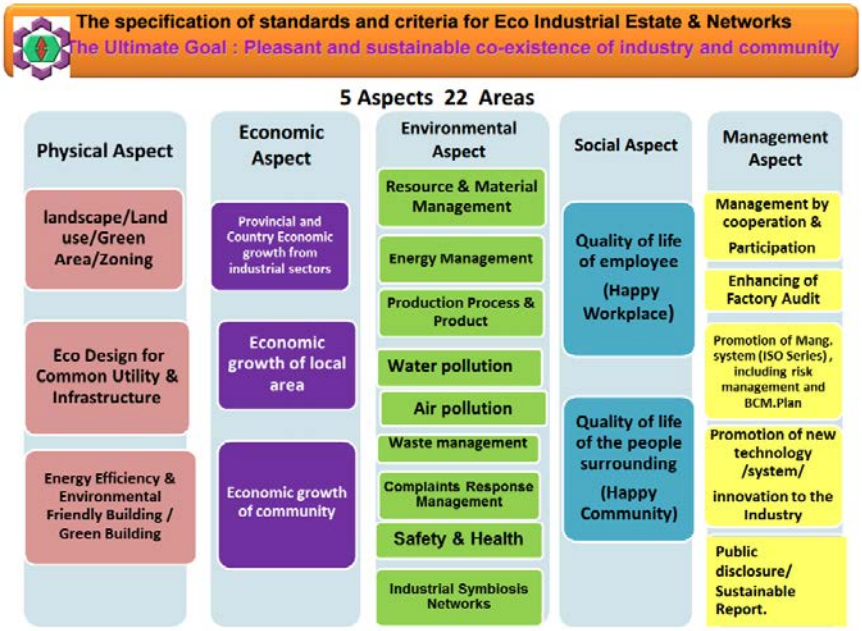


Figure 3. The specification of standards and criteria for Eco Industrial Estate and Networks of IEAT which consists of 5 aspects and 22 areas. [1]

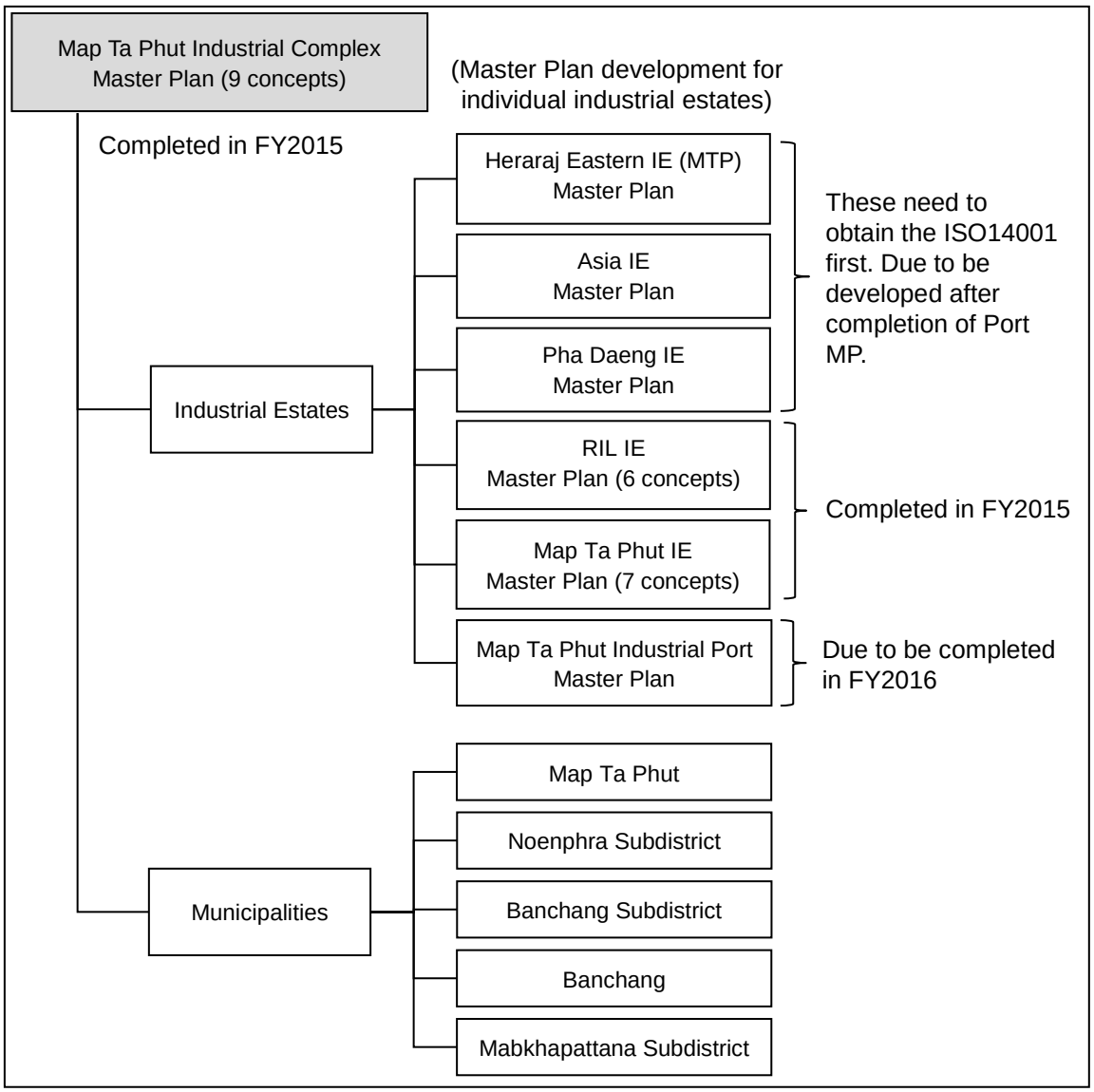


Figure 4. Structural chart and progress of development of the Map Ta Phut Industrial Complex Master Plan and other master plans of individual industrial estates within the complex (Developed based on the information from the meeting with IEAT on 9/23).

(5) Meeting with IEAT

A consultation meeting was held with IEAT on the development of Master Plan and the possibility of utilising JCM scheme.

[1] ECO INDUSTRIAL ESTATE and networks Development towards ECO TOWN and Eco-cities: http://www.unido.or.jp/files/20131020_10_Thailand.pdf

DATE/TIME 10:30-15:30, 23 September 2015

LOCATION IEAT headquarters

PARTICIPANTS Total 3

- IEAT (2): Jariya Sukhapan, Husana Rattanabhibal
- IGES (1): Kohei Hibino

SUMMARY OF DISCUSSION

Background and status of Master Plan

- IEAT explained the background and status of the Master Plan development (summarised in "(4) Gathering and organising information").

Possible use of JCM

- A brief concept, status of signing of the JCM bilateral agreement between the Governments of Thailand and Japan, and the process of JCM was explained. (IGES)
- In the next 12th National Economic and Social Development Plan, it is expected that the concept of Smart Community Development will be stipulated with energy efficiency and low-carbonization of industrial estates becoming important issues. This coincides well with the focus of the cooperation MoU between IEAT, NESDB and JICA (Note that JICA also concluded a similar MoU with DIW) and the KPI which DIW is currently developing. It also matches with the focus of the cooperation MoU between IEAT and Kitakyushu City, so it makes sense for IEAT to promote low-carbonisation of industrial estates using the JCM scheme. (IEAT)
- It would be good if the EV bus system and other eco transportation and logistics as well as renewable energy projects which were discussed at the earlier Skype conference could also utilise JCM scheme under the MoU with Kitakyushu City. (IEAT)
- IEAT wishes to organise a JCM workshop involving technical experts from the industrial estates to identify the target. (IEAT)

Eco transportation

- There is a need to enhance energy efficiency for a wide range of transportation and logistics (e.g., train, monorail, logistical transportation of factories, and transportation of workers in the factories) in Map Ta Phut Industrial Estate Complex other than the EV bus system. It was suggested to start from feasible actions and gradually approach larger projects. (IEAT)
- It is considered that the EV bus system would be an ideal initial target to start with, considering the scale. In order to submit a proposal for FY2017 (Thai fiscal year) IEAT budget, the proposal should be ready by December 2015. (IEAT)

Renewable energy, energy efficiency

- IEAT has been conducting the Eco Champion programme every year as a means to enhance energy saving in the industrial estates. The current indicators do not contain renewable energy (e.g., PV, wind power, etc.) so it was suggested to incorporate a feasible target at first and gradually increase the target. (IEAT)
- The current status of installation of renewable energy in the industrial estates is unknown. Thus, it was suggested to conduct a status survey and set indicators based on the result of the survey. (IEAT)
- IEAT would like to also consider applying JCM to IEAT's office buildings and street lighting in the industrial estates aside from installation of PV and energy saving systems in factories. IEAT would prefer projects that could benefit the entire industrial estate and for which IEAT will be the primary applicant from the standpoint of fairness. (IEAT)

5.2.2.3 Results and Achievements

The Master Plan was adopted and finalised by IEAT after Kitakyushu City provided comments. The finalised Master Plan was 330 pages in total (in Thai) and was not attached to this report as an Annex. However a copy of the cover page is displayed in Figure 5. The timing of issuance which is stipulated as January 2015 (2558 in Buddhist calendar) indicates the procedural timing by which the document was supposed to be finalised in IEAT.

Figure 5. Cover page of the Master Plan on Eco Industrial Town for the Map Ta Phut Industrial Estate Complex.

5.2.2.4 Potential of Institutionalisation and Linkage with JCM

(1) Potential and challenges toward institutionalisation

The Master Plan was finalised, Kitakyushu City having providing assistance. However, the reflection of comments was limited. There has been no particular request from IEAT in the development of individual Master Plans for industrial estates, but given that the individual Master Plans of industrial estates have been developed based on key performance indicators of IEAT to develop at least four per year, it is considered that steady development could also be expected hereafter.

(2) Relevance and potential application to JCM

The main objective of the Master Plan is to secure safety and environment conservation for the industrial estates and communities. The plan did not contain concrete numerical targets for low-carbonisation, so the potential use in relation to JCM is likely to be limited.

On the other hand, IEAT is interested in JCM and there is a possibility of identifying candidate JCM projects from IEAT's buildings and/or energy savings for entire industrial estates, as stated by

IEAT. Promising candidate projects pointed out by IEAT are those such as energy saving of IEAT buildings, energy saving of entire industrial estates, eco-transportation of industrial estates, and renewable energy.

5.3 Organising Workshops

In order to share information and understanding the contents and progress of the study and to ensure smooth operation of the work, the current JCM city-to-city collaboration FS was expected to organise two workshops, one at the beginning of the study, and the other one at the end of the study, in both the Japanese host municipality and the local host municipality, respectively.

5.3.1 Workshop in the Japanese Host Municipality

Regarding the workshop in Japan, the first workshop (kick-off workshop) could not be organised in Kitakyushu City due to conflict of schedule among participants. So the first workshop was held in conjunction with the first progress reporting meeting in Tokyo on 14 May 2015 having received consent from the Ministry of the Environment. The second workshop (reporting workshop) which was to share the progress of the study was organised in Kitakyushu City on 16 December 2015.

(1) First workshop in Japan (Kick-off workshop)

DATE/TIME 13:00-14:00, 14 May 2015

LOCATION 2nd Laurel Building, Tokyo

PARTICIPANTS Total 9

- Ministry of the Environment (3): Teppei Yamaga, Tomoki Uematsu, Shuichi Ozawa
- Joint-business partners (6): Kitakyushu City (Junichi Sono), NTT DATA Institute of Management Consulting (Motoshi Muraoka), EX Research Institute (Masato Ohno, Satoshi Takagi), Amita Corporation (Teruo Yamazaki), IGES (Shiko Hayashi).

SUMMARY OF DISCUSSION

Overall Matters

- Thailand is in the final process of signing the JCM bilateral agreement with Japan and therefore the application to JCM Model Projects will be dealt equivalent to that of the signatory countries. (Ministry of the Environment)
- Kitakyushu City is planning to exchange MoU with Rayong Province/Rayong City/Map Ta Phut City aside from MoUs with IEAT and DIW/IRPC. This will enable a holistic approach, with approaches from both the industrial estate and from the community, to support the Eco Industrial Town scheme. (Kitakyushu City)
- The Eco Industrial Town scheme is hosted by DIW and IEAT both of which are under the Ministry of Industry. Both agencies have competitive awareness and

Kitakyushu City has exchanged a MoU with both agencies. A workshop in Thailand will also be held separately. (Kitakyushu City)

Energy Sector (Annex 5-2)

- The study will be focusing on energy saving and exhaust heat recovery in industrial factories and aims to identify candidate projects.
- The industrial estates in Thailand could be achieving exhaust heat recovery in a large scale.

Waste-to-energy (Waste Management Sector) (Annex 5-3)

- The waste-to-energy project for the municipal waste in Rayong Province is assuming a joint implementation structure of the local company (Company A) and the Japanese engineering company.
- The JCM Model Projects will only be applied to systems that will contribute to CO_2 reduction, so the actual subsidy rate is expected to be about 25%.

Recycling of industrial waste (Waste Management Sector) (Annex 5-4)

- A basic research will be conducted to investigate the status of waste generation, type of waste, needs, processing cost, as well as the waste processing companies.

Support for Institutionalisation of Relevant Policies (Annex 5-5)

- Both IRPC Industrial Estate and Map Ta Phut Industrial Estate are developing the Eco Industrial Town Master Plans, and it is anticipated that action plans will be developed thereafter. Therefore the study will investigate possible linkage between the action plans and the JCM.

(2) Second workshop in Japan (Reporting workshop)

DATE/TIME 13:00-13:50, 16 December 2015

LOCATION International Village Centre, Kitakyushu City

PARTICIPANTS Total 13

- Kitakyushu City (3): Kengo Ishida, Junichi Sono, Yasuhiko Takatsuka
- NTT DATA Institute of Management Consulting (3): Motoshi Muraoka, Tomomi Hoshiko, Maria Yamakawa
- EX Research Institute (1): Masato Ohno
- Amita Corporation (3): Katsuhiko Sugie, Hiroshi Mekaru, Teruo Yamazaki
- IGES (3): Yatsuka Kataoka, Shiko Hayashi, Kohei Hibino

SUMMARY OF DISCUSSION

Waste-to-energy (Waste Management Sector) (Annex 5-6)

- The project proposal to conduct waste separation, generation of RDF, and waste-to-energy was explained to Company B which is conducting waste collection

in Rayong Province.

- Company B is applying a competitive bidding process and fulfilling the necessary conditions for bidding. Forming an International Consortium remains to be a challenge. The project is however preparing a submission to the secondary call for applications for JCM Model Projects.

Recycling of industrial waste (Waste Management Sector) (Annex 5-7)

- Two study projects, including the Business Process Outsourcing to effectively conduct recycling of industrial waste and to construct a primary processing facility in the industrial estate for recycling of industrial wastes were explained.

Energy Sector (Annex 5-8)

- An explanatory workshop on the JCM was organised for local companies in the industrial estates, Japanese society, and industrial estates composed mainly of Japanese companies, respectively. Individual study was conducted for those that expressed an interest.
- The status of survey on the candidate projects, including installation of roof-top PV panels on factories, cogeneration in the industrial estates, boilers in the factory, installation of pipelines, and power generation by heat recovery, were explained.

Support for Institutionalisation of Relevant Policies (Annex 5-9)

- Progress on assisting the development of the Master Plan for IEAT and KPI for DIW was explained and updated.

5.3.2 Workshop in the Local Host Municipality

Regarding workshop in local host municipalities; the first workshop (kick-off workshop) was organised before initiating the FS (19 and 20 May 2015 in Bangkok) to share the plans and schedules of the FS, while the second workshop (reporting workshop) was organised after the FS by presenting and discussing the achievements of the FS (19 and 20 January 2016 in Bangkok). As Kitakyushu City had exchanged MoU with both IEAT and DIW & IRPC, a joint committee meeting based on the MoU were organised concurrently with the JCM workshops. A practical meeting was also held after each joint committee meetings.

(1) First workshop in Thailand (Kick-off workshop)

I. Joint Committee Meeting with IEAT

DATE/TIME 9:40-12:00, 19 May 2015

LOCATION IEAT headquarter, Room 205

PARTICIPANTS Total 34

- IEAT side (21): IEAT Governor (Dr. Veerapong Chaiperm), Deputy Governor, Office of Natural Resources & Environmental Policy and Planning (ONEP), DIW,

Rayong Province, IEAT staffs, others

- Japan side (13): Kitakyushu City (Kengo Ishida, Junichi Sono, Yasuhiko Takatsuka, Hiroshi Yasutake), National Institute for Environmental Studies (Minoru Fujii), NTT DATA Institute of Management Consulting (Motoshi Muraoka, Maria Yamakawa), Amita Corporation (Teruo Yamazaki), Fuji Electric (Yutaka Fueki), EX Research Institute (Satoshi Takagi), IGES (Toshizo Maeda, Pharot Tubkrai, Kohei Hibino)

AGENDA

1. Promotion of low-carbon industries (National Institute for Environmental Studies) (Annex 5-10)
2. JCM modelling study of CO_2 emissions reduction project and Creating mechanisms for horizontal expansion (NTT DATA Institute of Management Consulting) (Annex 5-11)
3. Smart Community Business (Fuji Electric) (Annex 5-12)
4. Project to Support the Large-Scale Formation of Joint Crediting Mechanism Programs to Realize Low Carbon Societies in Asia (Amita Corporation) (Annex 5-13)
5. Discussion on Action Plan

SUMMARY OF DISCUSSION

- IEAT hopes to discuss and determine the details of how to carry forward the nine concepts of the Map Ta Phut Eco Industrial Town scheme and the four activities in the MoU, and to discuss the progress and impact in the next meeting. (IEAT)
- Q. Are there any plans to conduct survey targeting the communities? – A. The main target of the survey is energy efficiency and waste management in industrial estates but the survey on municipal solid waste will be targeting Rayong Province, Map Ta Phut City, and Rayong City.
- Q. What are items that could be implemented for renovation from the perspective of the entire industrial estate other than improvement of production process and update of systems? – A. This will be discussed in detail at a later practical meeting.
- There was a request to disseminate information to the communities on achievements such as reduction of CO_2 and waste. (IEAT)

The first JCM workshop in Thailand (Joint Committee Meeting) with IEAT (5/19).

II. Practical meeting with IEAT

DATE/TIME 13:30-16:00, 19 May 2015

LOCATION IEAT headquarter, Room 205

PARTICIPANTS Total 12

- IEAT side (5): Jariya Sukhapan, others
- Japan side (7): Kitakyushu City (Junichi Sono, Yasuhiko Takatsuka, Hiroshi Yasutake), NTT DATA Institute of Management Consulting (Motoshi Muraoka, Maria Yamakawa), Amita Corporation (Teruo Yamazaki), Fuji Electric (Yutaka Fueki)

SUMMARY OF DISCUSSION

- Q. How are the JCM FS related to the four activities under the MoU between Kitakyushu City and IEAT? – A. The energy and waste management projects are related with the Eco Industrial Town scheme (1st action) and waste recycling complex (3rd action). Furthermore, these are also related to the 8th concept (waste management) and the 9th concept (energy management) among the 9 concepts in the Map Ta Phut Eco Industrial Town Master Plan.
- An overall schedule for the study is needed and it is requested that the schedule will coincide with the activity period of Master Plan development. (IEAT)
- Q. What is the concept of the projects? – A. The current study is a feasibility study and the results of the study might reveal that the project cannot be implemented as described in the concept.
- It was requested to submit details of the study including schedule, objective of visit, participants from Japan, and the target local companies when any on-site study is conducted. (IEAT)

III. Joint Committee Meeting with DIW & IRPC

DATE/TIME 13:00-15:00, 19 May 2015

LOCATION DIW headquarter

PARTICIPANTS Total approx. 24

- DIW & IRPC side (15): DIW Director General (Dr. Pasu Loharjun), IRPC President (Mr. Sukrit Surabotsopon), DIW staffs, IRPC staffs, others
- Japan side (9): Kitakyushu City (Kengo Ishida, Junichi Sono), National Institute for Environmental Studies (Minoru Fujii), NTT DATA Institute of Management Consulting (Motoshi Muraoka, Maria Yamakawa), EX Research Institute (Satoshi Takagi), IGES (Toshizo Maeda, Pharot Tubkrai, Kohei Hibino)

AGENDA

1. Remarks and presentation by DIW
2. Remarks and presentation by IRPC
3. Remarks and presentation by Kitakyushu City

SUMMARY OF DISCUSSION

Due to time limitations, the discussion session was omitted. Instead, a press interview was conducted.

IV. Practical meeting with DIW & IRPC

DATE/TIME 10:30-13:00, 20 May 2015

LOCATION DIW headquarter

PARTICIPANTS Total approx. 20

- DIW & IRPC side (8): DIW Director (Thaned Juntakin), DIW staffs, IRPC staffs
- Japan side (11): Kitakyushu City (Kengo Ishida, Junichi Sono, Yasuhiko Takatsuka, Hiroshi Yasutake), National Institute for Environmental Studies (Minoru Fujii), NTT DATA Institute of Management Consulting (Motoshi Muraoka, Maria Yamakawa), Amita Corporation (Teruo Yamazaki), EX Research Institute (Satoshi Takagi), MI Consulting (Takeshi Soga, Kyomi Shiraishi), IGES (Kohei Hibino)

AGENDA

1. Promotion of low-carbon industries (National Institute for Environmental Studies) (Annex 5-10)
2. JCM modelling study of CO_2 emissions reduction project and Creating mechanisms for horizontal expansion (NTT DATA Institute of Management Consulting) (Annex 5-11)
3. Smart Community Business (Fuji Electric) (Annex 5-12)
4. Project to Support the Large-Scale Formation of Joint Crediting Mechanism Programs to Realize Low Carbon Societies in Asia (Amita Corporation) (Annex

5-13)

5. Discussion

SUMMARY OF DISCUSSION

- Q. What is the relationship between JCM and CDM; is there any overlap? – A. The CDM and JCM are different schemes but they are in a complementary relationship. Energy savings are not included in the target of CDM but they are in the target for JCM.
- Q. How is food waste being treated in Japan? – A. Some plants are generating methane gas by anaerobic digestion and generating electricity.
- Q. What kind of energy saving measures are anticipated in petroleum processing? – A. In countries where energy saving is not advanced, there is room for improvement in the refinement process. But it is considered that IRPC is already advanced in energy saving so the remaining measure could be collaborative use of excess energies (e.g., heat, steam) among factories.
- Q. It is requested to survey petroleum processing as the amount of energy generation from the process is high. – A. Any areas where there is a possibility of improvement will be surveyed.
- Since IRPC Industrial Estate and Map Ta Phut Industrial Estate have different governing laws and regulations, any matters that require collaboration between IEAT and IRPC (DIW) will be considered separately. (DIW)

The first JCM workshop in Thailand (Joint Committee Meeting) with DIW & IRPC (5/19).

The practical meeting with DIW & IRPC (5/20).

(2) Second workshop in Thailand (Reporting workshop)

I. Joint Committee Meeting with IEAT

DATE/TIME 9:30-13:00, 19 January 2016

LOCATION IEAT headquarters, Room 205

PARTICIPANTS Total 19

- IEAT side (10): IEAT Deputy Governor (Somchint Piloik), IEAT staffs
- Japan side (9): Kitakyushu City (Kengo Ishida, Junichi Sono), NTT DATA Institute of Management Consulting (Motoshi Muraoka, Maria Yamakawa), EX Research Institute (Satoshi Takagi), Amita Corporation (Teruo Yamazaki), Nippon Steer & Sumikin Engineering (Takeshi Nimura), Pacific Consultants/JICA expert (Yasuo Kannami), IGES (Kohei Hibino)

AGENDA

1. Opening remarks
2. Result of Cooperation Framework for Creating Map Ta Phut Eco Industrial Town in 2015
   - Introduction about JCM (Joint crediting mechanism) (NTT DATA Institute of Management Consulting) (Annex 5-14)
   - MSW management & Promotion of Low Carbonisation at Ecological Industrial Town in Rayong Province (EX Research Institute) (Annex 5-15)
   - Energy savings in industrial estate (NTT DATA Institute of Management Consulting) (Annex 5-16)
   - Recycling industrial wastes with low-carbon emission project (Amita Corporation) (Annex 5-17)
3. Cooperation Framework for Creating Map Ta Phut Eco Industrial Town between the City of Kitakyushu and IEAT in 2016
   - Evaluation of Map Ta Phut Eco Industrial Town Master Plan
   - Eco Centre
   - Seminar for Eco-Town Managers (SETM) Training
   - Transportation Master Plan (Ideas for activities and Initial project proposal of EV bus system)
   - Co-Branding Between Kitakyushu City and IEAT

SUMMARY OF DISCUSSION

Due to time limitations, discussion on the results of JCM FS did not take place in the workshop, while there were some discussion points that could be related to JCM within the IEAT – Kitakyushu cooperation activities for 2016 onward, as follows:

- Regarding the evaluation of Map Ta Phut Eco Industrial Town Master Plan, it was suggested to determine specific targets such as for energy saving and air pollution according to the specification of standards and criteria for Eco Industrial Estates and Networks of IEAT which consist of 5 aspects and 22 areas.

- With regards to the Transportation Master Plan, discussion took place on the eco logistics for workers, visitors and material flow for entire industrial estates. It was suggested to consider the possibility of applying JCM to energy saving for the Eco Centre and the EV bus system.

II. Practical Meeting with IEAT

DATE/TIME 14:00-15:45, 19 January 2016

LOCATION IEAT headquarters

PARTICIPANTS Total 10

- IEAT side (3): Jariya Sukhapan、Parichad Boonsuan、Husana Rattanabhibal
- Japan side (7): Kitakyushu City (Kengo Ishida, Junichi Sono), NTT DATA Institute of Management Consulting (Motoshi Muraoka, Maria Yamakawa), Amita Corporation (Teruo Yamazaki), Pacific Consultants/JICA expert (Yasuo Kannami), IGES (Kohei Hibino)

SUMMARY OF DISCUSSION

Discussion related to JCM included the followings:

Evaluation of Map Ta Phut Eco Industrial Town Master Plan

- The meeting agreed that relevant policy documents need to be translated into English for Kitakyushu City to assist the development of evaluation for the Master Plan. IEAT will consider translating three relevant materials: (i) specification of standards and criteria for Eco Industrial Estate and Networks, (ii) Master Plan, and (iii) Eco Champion.
- It was suggested to consider introducing a mechanism that the communities recognise the benefit of industrial estates; otherwise the communities will not evaluate the industrial estates positively. (Kitakyushu City)

Transportation Master Plan (Eco logistics)

- A basic survey should be conducted first as the status of material flow and human movement is not well recognised. (Kitakyushu City)
- The meeting agreed that Kitakyushu City and IEAT will continue discussing on what funding scheme may be approached in order to develop the Transportation Master Plan and how the plans will be operationalised.

Eco Centre and EV bus

- Regarding a plan to introduce an EV bus system for transporting visitors to the Eco Centre, the meeting noted that the proposal document should be ready by September 2016 in order to submit an application for the IEAT's FY2019 budget considering

the due completion timing of the Eco Centre (spring of 2019).

The second JCM workshop in Thailand (Joint Committee Meeting) with IEAT (1/19).

III. Joint Committee Meeting and Practical meeting with DIW & IRPC

DATE/TIME 9:30-14:00, 20 January 2016

LOCATION DIW headquarters, Room 503

PARTICIPANTS Total 13

- DIW (6): Decha Pimpisut, Apichin Jotikasthira, Kanatid Gueadclai, Anchalee Oumpancharoen, Saranyu Iamrahong, Tiwaporn Chaimongkol
- IRPC (3): Awrapin Ketratanakul, Nattawadee Wuttijak, Parichart Junlapan
- Japan side (4): Kitakyushu City (Junichi Sono), NTT DATA Institute of Management Consulting (Maria Yamakawa), EX Research Institute (Satoshi Takagi), Amita Corporation (Teruo Yamazaki)

AGENDA

1. Opening remarks
2. Introduction about JCM (Joint crediting mechanism) (NTT DATA Institute of Management Consulting) (Annex 5-14)
3. Energy savings in industrial estates (NTT DATA Institute of Management Consulting) (Annex 5-16)
4. Recycling industrial waste with low-carbon emission project (Amita Corporation) (Annex 5-17)
5. Discussion

SUMMARY OF DISCUSSION

About JCM scheme

- Q. Regarding the relationship between subsidy and credit, does the amount of credit to be transferred need to be more than 50% even if the funding rate was 30%? – A. Yes, past results suggest so.

- Q. Can JCM be applied to already introduced systems? – A. The contract can only be executed after applying to the public offering and then adopted. So it cannot be applied to already introduced systems.

Energy sector

- Discussions took place on the energy efficiency of water treatment systems.
- A system to recover the off gas for binary cycle generation was suggested.
- It was concluded that the status of energy efficiency is very high in IRPC Industrial Estate and the remaining issues are not necessarily relevant to CO_2 reduction, suggesting that it would be difficult to pursue the possibility of JCM application. Meanwhile, it was suggested that individual companies in the IRPC Industrial Estate may have some issues that are worth consideration.

E-manifest (Waste management sector)

- Possibility and issues of introducing the e-manifest system were discussed.
- It was pointed out that the e-manifest system should be established at the national level in order to function successfully.

Cement raw materialisation (Waste management sector)

- The results of analysing 8 waste samples taken from IRPC were explained. It indicated that the calorific value is high and it would be possible to accept it as raw material. (Amita Corporation)
- Q. Has the result of analysis been able to clarify the ratio of variability of the constituents? – A. More detailed analysis is needed toward realisation of the project.
- Q. Can the cement raw materialisation be applied to the JCM? – A. The process of cement materialisation itself does not contribute much to CO_2 reduction so it is considered difficult to apply to the JCM.

The second JCM workshop in Thailand (Joint Committee Meeting) with DIW & IRPC (1/20).