FY2013 Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia

Final Report on Technical Assistance for Designing a Low Carbon City Plan in Surabaya, Indonesia

March 2014

Institute for Global Environmental Strategies

- Summary -

In August 2013, Japan and Indonesia agreed to promote the Joint Crediting Mechanism (JCM) to develop large-scale, concrete JCM projects. As part of this, this project studied the potential to reduce greenhouse gas (GHG) emissions in the main energy consumption fields in Surabaya. Target areas included the four sectors of energy, transportation, waste, and water resources. The project aimed to not only calculate potential CO_2 emissions in each sector, but to also confirm related data and strengthen a management system for this, support the development of plans to implement CO_2 emission reduction projects, and explore the potential to transfer technologies and management systems to achieve these targets.

Project Management	Institute for Global Environmental Strategies (IGES)
	City of Kitakyushu (Asian Center for Low Carbon Society)
Energy Sector	NTT Data Institute of Management Consultant, Inc.
Transportation Sector	Almec VPI Corporation
Waste Sector	Nishihara Corporation*
	Hitachi Zosen Corporation
	Amita Corporation
Water Resource Sector	Matsuo Sekkei Corporation
	(Cooperation: Water and Sewer Bureau, City of Kitakyushu)

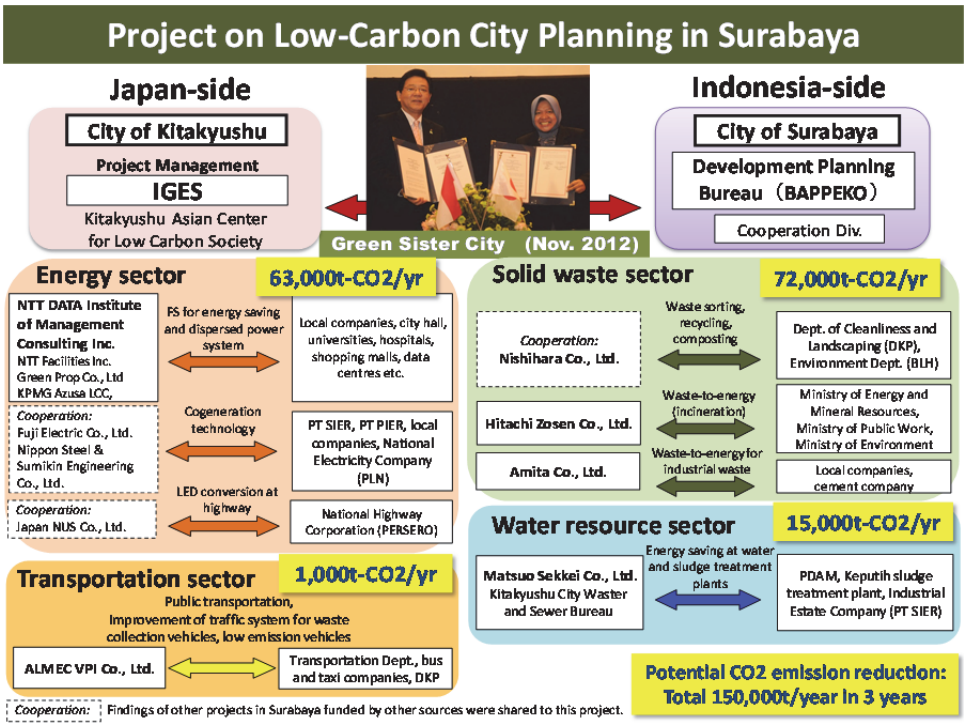


Figure 1 Implementation structure and potential CO2 emission reductions in each sector

In addition, this project was implemented in a format where the project results from existing

energy and waste management sectors were adopted under the framework of cooperation between Surabaya and Kitakyushu, which had concluded an agreement as green sister cities in November 2012 (See Figure 1).

Potential to Reduce CO_2 Emissions

As shown in Table 1, there is potential to reduce CO_2 emissions by approximately a total of 150,000 t-CO2/year when specified projects in all four sectors have been implemented. Reduction effects will also increase if projects can potentially be implemented in three years and then expanded. Of these project proposals, it is the energy and waste management sectors that can expect large-scale reductions with relatively short-term, local investments. This comprises about 90% of the potential overall reduction amounts for both sectors. In contrast, of the two remaining sectors, large-scale CO_2 reductions in the transportation sector require full-scale responses and long-term investments, including interest adjustments among a large number of stakeholders. The water resources sector is limited to purification plants and water distribution stations, and therefore, impacts are also limited.

Estimated project expenses and cost effectiveness

Table 2 gives an overview of the CO_2 emission cuts, estimated project costs and cost effectiveness of the above four sectors. The cost of reductions per 1t of CO_2 for energy-saving items and supply of heat and power in the energy sector are both JPY 100,000/t-CO_2/year. For the transportation sector (converting vehicles to CNG), it is about twice that amount; however, when adding infrastructure improvement, such as the CNG station, to this figure, the amount grows even higher.

Figures for the waste sector are overwhelmingly low when compared with other sectors: cost reductions for the raw materials for cement per 1t of CO_2 are only JPY 10,000/t-CO_2/year, followed by JPY 50,000/t-CO_2/year with the separation, recycling, and composting of general waste (intermediate treatment) and JPY 60,000 - 130,000/t-CO_2/year with the power generation from incineration.

In the water resources sector, the introduction of a discharge pressure control system for water distribution pumps is cost effective at JPY 70,000/t-CO_2/year, and is expected to also further reduce leakage rates. The effects of replacing aging water distribution pumps are well-understood; however, the cost for equipment is high and cost effectiveness is also high at JPY 300,000/t-CO_2/year. Costs for energy-saving measures at industrial wastewater treatment facilities and sludge treatment plants are even higher, and it is difficult to develop independently into a JCM project.

Implementation Plan for Project Applications

Table 2 shows a list of plans and their actual implementation and applications. The number of

projects that were studied this fiscal year need to be further examined and analyzed next fiscal year. After the studies are complete, the project will move ahead towards implementation after agreements with counterparts on project details and investment rates. Therefore, many proposed projects will be implemented after FY 2015. Of these, plans for energy savings in buildings is moving ahead relatively quickly in comparison with other projects, and within the next fiscal year, agreement with counterparts is expected to be reached, which means that it will be possible for the project to apply for equipment aid.

For projects with a scale of hundreds of millions of yen, applications will be submitted to the Ministry of the Environment for equipment aid, and to JICA overseas investment and financing for projects with a scale of several billion yen.

Table 1 Potential for CO2 Emission Reductions (based on F/S results and estimating an implementation period of three years)

Sector		Implementation details	Potential annual CO2 emission reductions (t-CO2/year)	Implementation costs	Cost effectiveness [t-CO2/year]	Secondary effects (Co-benefits)
Energy	Energy savings in buildings (LED lighting, air conditioning, BEMS, heat and power supply)	Hotel A	100	JPY 10 million	JPY 100,000	Reduces electricity costs
		Hotel B	4,000	JPY 360 million	JPY 90,000	
		Commercial facility A	4,100	JPY 470 million	JPY 120,000	
		Office building A	1,500	JPY 140 million	JPY 100,000	
	Heat and power supply to industrial estates (cogeneration)	SIER Industrial Estate (6MW, 20t/hr)	15,000	JPY 1.8 billion	JPY 120,000	Effective utilization of energy, natural gas use
		PIER Industrial Estate (16MW, 37t/hr)	38,000	JPY 3 billion – 4 billion	JPY 80,000 to 110,000	
Transportation	Conversion to CNG vehicles	Buses (30), taxis (150), (1 CNG station)	900	JPY 210 million (+JPY 400 million)	JPY 230,000 (+JPY 440,000)	Reduces air pollution, promotes use of public transport
Waste	Separation, recycling, composting	Treatment capacity of 150t/day Grouping of transportation vehicles	100 【+10,500】	JPY 500 million	JPY 5 million 【JPY 50,000】	Promotes recycling, reduces amount of waste sent to landfills
	Power generation from incineration	Treatment capacity of 500t/day Produces 9,330kW (4MPa×400℃)	30,200 【+15,000~70,000】	JPY 6 billion	JPY 200,000 【JPY 60,000-130,000】	Reduces amount of waste sent to landfills, effective use of resources
	Raw materials for cement from waste from business establishments	Liquid alternative fuel: 10,000t/year Raw materials for cement: 24,000t/year	14,000 18,000	JPY 340 million	JPY 10,000	Proper treatment and reuse of resources for waste from businesses

Water resources	Update water distribution pumps	Ngagel Water Purification Plant (systems I, II)	5,200	JPY 1.5 billion	JPY 300,000	Reduces electricity costs
	Adjustments to water distribution delivery pressure	Control deliver pressure of water distribution pumps	10,000	JPY 700 million	JPY 70,000	Lowers leakage rates
	Treatment of industrial waste, septic tank and sludge treatment	SIER Industrial Estate Keputhi Sludge Treatment Plant	100 30	JPY 500 million JPY 200 million	JPY 5 million JPY 7 million	Reduces electricity costs
Total			**150,000t-CO2/year**	**JPY 13 billion - JP 14 billion**		

【 】CO2 emission reductions through control of methane gas generated and resulting cost effectiveness

Table 2 Implementation plans for project applications

Sector		Implementation details	Implementation costs	FY 2014	FY 2015	FY 2016	Expected source of implementation budget
Energy	Energy savings in buildings	Hotels (2), commercial facility (1), office building (1)	JPY 1 billion	Project design, consensus building, application for equipment aid	**Demonstration project**	**Continued**	Ministry of Environment,: equipment aid
		New buildings (hospitals, office buildings, etc.)	JPY 1 billion	F/S	Contract, approval and authorization procedures, application for demo project		
	Heat and power supply to industrial estates (cogeneration)	SIER Industrial Estate (6MW, 20t/hr)	JPY 1.8 billion	Contract, approval and authorization procedures, application for demo project	EPC	**Demonstration project**	JICA overseas loans and financing
		PIER Industrial Estate (16MW, 37t/hr)	JPY 3 billion – 4 billion	F/S	Contract, approval and authorization procedures, application for demo project	EPC, **Demonstration project**	
Transportation	Conversion to CNG vehicles	Buses (30), taxis (150), CNG station (1)	JPY 210 million JPY400 million	F/S	Application for equipment aid, **demonstration project**	**Continued (expansion)**	Ministry of Environment: equipment assistance

Waste	Separation, recycling, composting	Treatment capacity: 150t/day	JPY 500 million	JICA project implementation, application for equipment aid	EPC, **Demonstration project**	**Continued**	Ministry of Environment: equipment assistance
	Power generation from incineration	Treatment capacity: 500t/day Power generation: 9,330kW (4MPa×400℃)	JPY 6 billion	F/S	Contract, approval and authorization procedures, application for demonstration project	EPC、**Demonstration project**	JICA overseas loans and financing
	Raw materials for cement from waste from business establishments	Liquid alternative fuel: 10,000t/year Raw materials for cement: 24,000t/year	JPY 340 million	F/S	Contract, approval and authorization procedures, application for demonstration project	EPC、**Demonstration project**	Ministry of Environment: equipment assistance
Water resources	Update water distribution pumps	Ngagel Water Purification Plant (systems I, II)	JPY 1.5 billion	F/S	Design	**Demonstration project**	JICA overseas loans and financing (Other support projects and cooperation through City of Kitakyushu)
	Adjustments to water distribution delivery pressure	Control deliver pressure of water distribution pumps	JPY 700 million	F/S	Design	**Demonstration project**	
	Treatment of industrial waste, septic tank and sludge treatment	SIER Industrial Estate Keputhi Sludge Treatment Plant	JPY 500 million JPY200 million	F/S	Design	**Demonstration project**	

EPC: Engineering, procurement, construction　　Shaded sections：New F/S expected for next fiscal year

Table of Contents

Chapter 1: Project Background and Objectives

1.1 Overview of the City of Surabaya

Surabaya, the capital city of East Java, is the second largest city in Indonesia with a population of about three million. Surabaya is located at the mouth of the Brantas River, and consists of 31 small zones and 160 towns. With a tropical climate, the rainy season lasts from November to May and the dry season from June to October. Surabaya has a mean annual rainfall of 1,500 mm.

The population density is 8,500 people/km^2, and urban growth is intense. With a population growth rate of 0.65% annually, the population is concentrated in urban centers, in particular. The number of people who travel to offices from the suburbs have increased, with the city supporting a daytime population of five million. With the inclusion of the population from surrounding areas, the total population of the city area reaches nine million.

Surabaya is located in the northeast area of Java, and occupies an important position in the land, sea, and air networks that connect the city to points both in and outside of Indonesia. Reachable from the capital city of Jakarta in one hour by plane, Surabaya can be easily accessed within several hours from cities in Southeast Asia. Both the Juanda International Airport and the Port of Tanjung Perak are located in Surabaya, and serve as an important gateway to East Java for the transportation of people, goods, and services. Surabaya has a number of offices and business centers, and has become an educational hub for students in Indonesia.

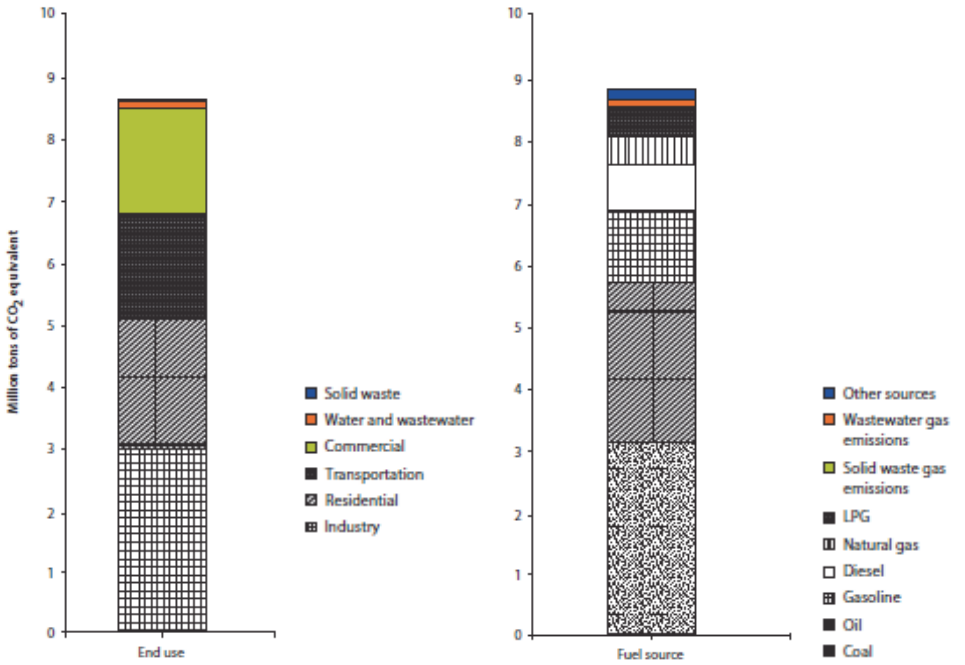
Receiving the Adipura Award[1] in 2011 and the ASEAN Environmental Sustainable City Award, Surabaya is known as a city that is actively promoting eco-friendly urban development.

Greenhouse gas emissions produced from energy consumption

According to a report by The World Bank,[2] the amount of energy consumed in Surabaya in 2010 totaled 39.2 PJ, broken down as follows: transportation consumed the most energy at 40%, followed by the industrial sector at 27%, households at 21%, private sector at 9%, and public services at 3%. Greenhouse gas emissions generated in the city can be converted to 860 million t-CO2, with the private sector and households accounting for the majority of emissions at 43%, followed by the industrial sector at 35%, and the transportation sector at 20%; the remainder is methane that is emitted by wastewater and landfilling of waste (Figure 1.1, left). In addition, fuel is broken down as follows: coal at 36% is the highest, followed by oil (29%), with the remainder made up of gasoline, diesel, LPG, and natural gas (31%) (Figure 1.1, right).

[1] Honor conferred on cities for eco-friendly urban development as part of a commendation system under the management of the Ministry of Home Affairs. The system has been in place since 1986.

[2] Ostojic, Dejan R., Ranjan K. Bose, Holly Krambeck, Jeanette Lim, and Yabei Zhang. 2013. Energizing Green Cities in Southeast Asia: Applying Sustainable Urban Energy and Emissions Planning. Washington, DC: World Bank. doi: 10.1596/978-0-8213-9837-1. License: Creative Commons Attribution CC BY 3.0



Note: CO_2= carbon dioxide; GHG = greenhouse gas; LPG = liquefied petroleum gas.

Figure 1.1. GHG emissions by final consumption sector and fuel source

(Source: The World Bank)

Air pollution

Air pollution in Surabaya is mainly caused by factory smoke and traffic.

Surabaya is home to Indonesia's largest industrial estate (SIER), where industrial activities are thriving. However, there are a number of factories that do not adequately treat smoke emissions, which then becomes a source of air pollution.

NOx, HC, CO, and other pollutants are emitted by the transportation sector. The causes of air pollution include the use of aging vehicles and poor quality fuel, an increase in the number of vehicles, and traffic congestion. The types of vehicles in operation in Surabaya include two-wheelers, which are quite high in number (over 1.3 million), in addition to private vehicles, taxis, and angkots (buses). Although the road network has improved overall, there is serious traffic congestion during commuting hours. This is a factor not only for commuting to Surabaya, but also at points enroute between neighboring cities. The public transportation network is not developed enough to support the population, and the number of users has been decreasing because of low service standards due to traffic congestion. The public transportation network has fallen victim to the vicious cycle that promotes the use of two-wheeled vehicles or privately-owned automobiles.

Waste

There is only one final disposal site in Surabaya. This site receives all the waste, including general household waste and waste from businesses. Leachate is only treated simply, which means that groundwater contamination may be getting worse. To date, Surabaya has achieved a reduction in the amount of organic waste in the city through the promotion of composting practices in households, and has been successful in greening and beautifying urban areas using compost. However, drastic measures are needed to address the issue of increased waste that has resulted from economic growth.

Water

PDAM Surabaya (a water supply company) produces and supplies drinking water for the city. PDAM is under the jurisdiction of the city, and about 70% of Surabaya's residents are able to access water services. However, some water service systems, such as piping, are aging, and equipment must be replaced.

The city's sewerage system has not been updated. Sewage treatment is available for every building, and household sewage is treated with septic tanks or putrefaction tanks. There are many areas in which industrial wastewater is either untreated or treatment is not adequate, and since these are discharged into the Surabaya river, which is the city's water source for drinking water, it is imperative that measures be put into place.

1.2 Measures in Surabaya that are relevant to Indonesia's National Action Plan to Reduce Greenhouse Gas Emissions

If greenhouse gas emissions in Indonesia that is undergoing remarkable economic growth continue to increase, by 2020, it is expected that there will be a striking increase in the amount of emissions in land use, land use change, forestry, and energy, in particular (Figure 1.2). To address this potential issue, Indonesia drew up a climate change mitigation action plan (RAN-GRK) in 2009, and is working out targets to achieve emission reductions by 2020 without reining in economic growth: 26% through self-efforts and 41% with international support.

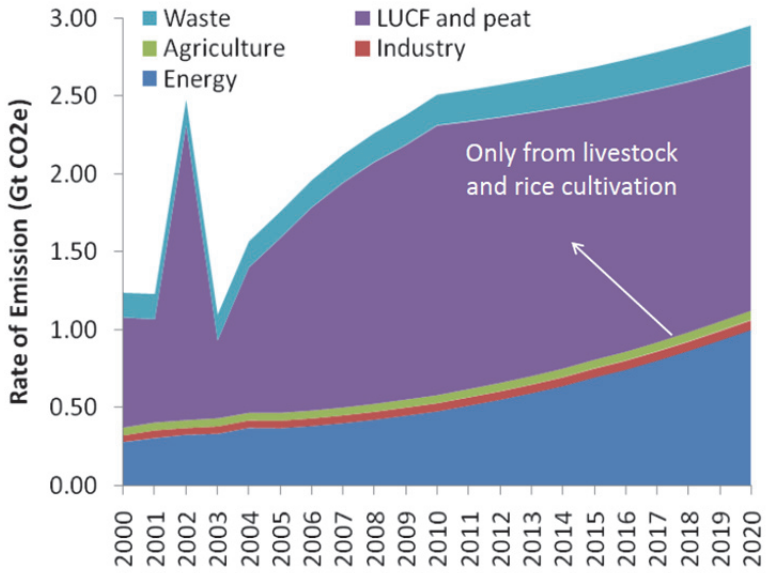


Figure 1.2. Transitions and future forecasts for GHG emissions by sector in Indonesia

(Source: National Council on Climate Change, Indonesia)

RAN-GRK requires that action plans (RAD-GRK) be developed at the state level as well. East Java, where Surabaya is located, announced their action plan in 2012 (No. 67/2012).[3]

In response to RAN-GRK and RAD-GRK in East Java, the planning agency for Surabaya (BAPPEKO) and the Surabaya College of Engineering jointly developed the "Grand Design Compilation Report on Reduction of Greenhouse Gas Emissions in Surabaya Municipality" in November 2013. The report documents the basic approaches when considering low-carbon plans, i.e., following existing plans, such as the long-term development plan of the area (RJPPD) and land-use plan of the state/local government (RTRWP/K), clarifying authority between the national, state, and city governments, and using city-level RAD-GRK to address priority urban issues.

In parallel, Surabaya is drawing up a Green City Master Plan, consisting of eight areas, and which aims to create a green city (Figure 1.3).

[3] BAPPEDA PROVINSI JAWA TIMUR, KOMITMEN PEMERINTAH PROVINSI JAWA TIMUR DALAM MENDUKUNG PENURUNAN EMISI GAS RUMAH KACA, Disampaikan pada acara Rapat Penurunan Emisi Gas Rumah Koca di BAPPEKO Surabaya, 10 Juli 2013.

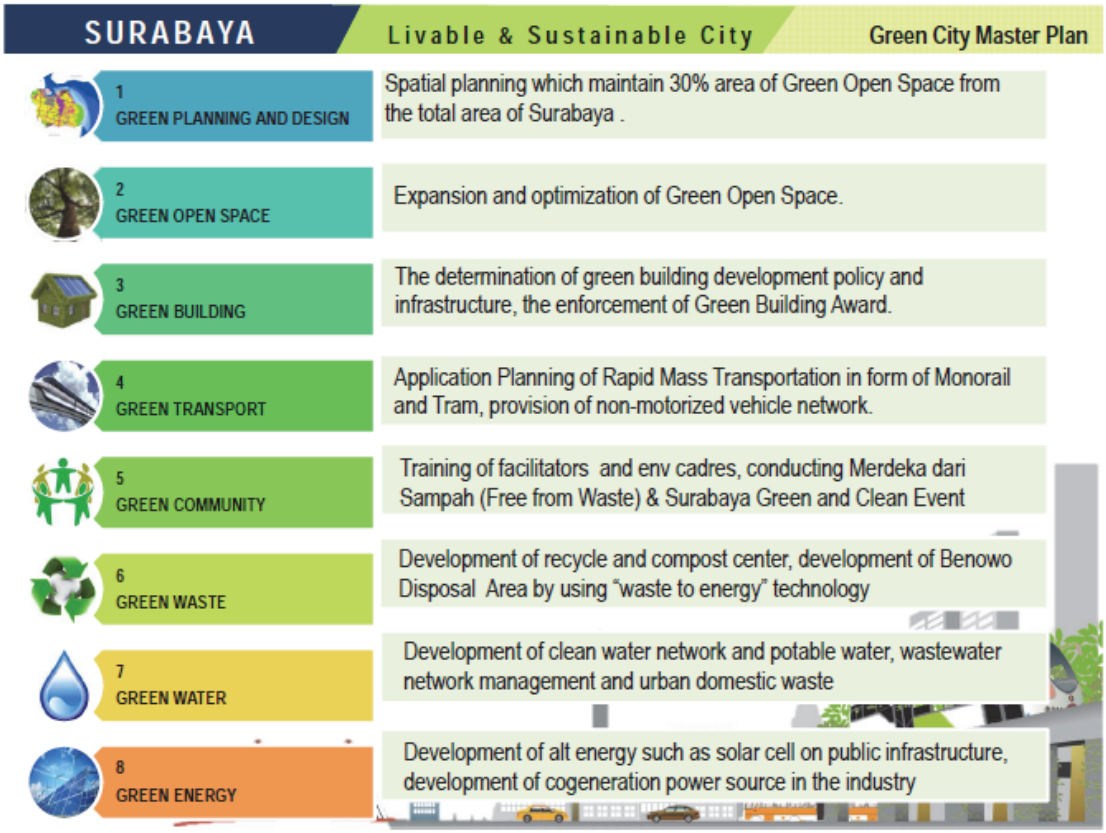


Figure 1.3. Overview of actions in 8 areas in the Surabaya Green City Master Plan[4]

1.3 Cooperation between Surabaya and Kitakyushu

The cities of Surabaya and Kitakyushu have maintained a cooperative relationship for over 10 years. In response to this, both cities agreed to continue to implement a number of cooperation projects as environmental sister cities in November 2012 (Figure 1.4). The cooperative relationship between these two cities is one feature of this project.

Various projects are implemented through the cooperative relationship of both cities with major results, including the expansion of compost activities in the city that started in 2004, which led to a 30% reduction in the amount of waste and contributed to beautifying and greening the city. The cities collaborated on projects to support capacity building for product quality management in the water sector (2007-2008), and a JICA project on the treatment of wastewater (2011-2013), as well as a cogeneration system (supply of heat and electricity) in the SIER industrial complex that is being promoted with the Japanese Ministry of Economy, Trade, and Industry in the energy sector.

[4] Anityasari, M., CLOSING REMARKS INTERIM MEETING OF "PROJECT ON LOWCARBON & ENVIRONMENTALLY SUSTAINABLE CITY PLANNING IN SURABAYA, INDONESIA. Interim Meeting for the Project on Low-Carbon City Planning in Surabaya, Indonesia, 20 Nov. 2013.

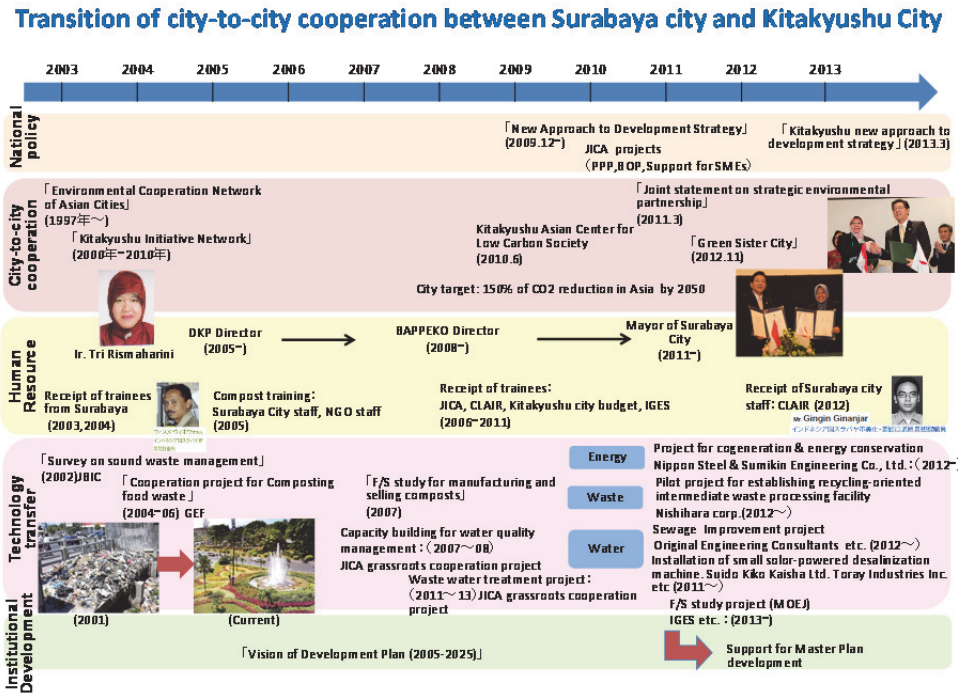


Figure 1.4 Transition of city-to-city cooperation between Surabaya and Kitakyushu

1.4 Project objective

In August 2013, Japan and Indonesia agreed to promote the Joint Credit Mechanism (JCM) to develop large-scale, concrete JCM projects. As part of this, this project studied the potential to reduce greenhouse gas (GHG) emissions in the main energy consumption fields in Surabaya. Target areas included the four sectors of energy, transportation, waste, and water resources. The project aimed to not only calculate potential CO_2 emissions in each sector, but to also confirm related data and strengthen a management system for this, support the development of plans to implement CO_2 emission reduction projects, and explore the potential to transfer technologies and management systems to achieve these targets.

Chapter 2: Project Scope, Process, and Implementing System

2.1 Project scope

The scope of the project targeted the four sectors of energy, transportation, waste, and water resources, in which energy consumption and GHG emissions are high.

The project examined the following issues: (1) in the energy sector, the project examined energy savings in buildings, and the supply of heat and power to industrial estates; (2) in the transportation sector, the project looked at improving the operation of public transportation and taxis, for example, as well as conversion to the use of efficient vehicles; (3) in the waste sector, the project investigated the separation, recycling, and composting of household waste, generation of power from incineration, and manufacturing of raw materials for cement from waste from business establishments; and, (4) in the water resources sector, the project investigated energy savings for purification plants and reduction of water leakage rates, and the energy savings potential for industrial wastewater treatment facility and septage treatment facility.

2.2 Project process

Companies in charge of each sector carried out project feasibility studies (F/S) in cooperation with counterparts in Surabaya, and outcomes were compiled and summarized by the Institute for Global Environmental Strategies (IGES).

As below, report meetings were held a total of five times (twice in Kitakyushu and three times in Surabaya), and aimed to develop cooperation between contract applicants, counterparts in Surabaya, and implementing organizations by sharing pertinent information. Meeting programmes, attendees, and summaries are detailed in Attachments 1-5.

2013

26 June (Fri) 1st Domestic Stakeholders Meeting (Kitakyushu) 【Attachment 1】

10 July (Mon) Inception Meeting (Surabaya) 【Attachment 2】

20 Nov (Wed) Mid-term Report Meeting (Surabaya) 【Attachment 3】

2014

31 Jan (Fri) 2nd Domestic Stakeholders Meeting (report of outcomes) (Kitakyushu) 【Attachment 4】

10 Feb (Mon) Report of Outcomes (Surabaya) 【Attachment 5】

2.3 Project implementing system

Companies and organizations in charge of this project, as well as counterparts in Surabaya are listed in Table 2.1.

Table 2.1. Project implementing system

Area	Japan	Indonesia (Surabaya)
Project management	Institute for Global Environmental Strategies (IGES), City of Kitakyushu (Asian Center for Low Carbon Society)	Development Planning Bureau (BAPPEKO) International Cooperation Division
Energy* Energy savings Cogeneration (heat/power supply)	NTT Data Institute of Management Consulting, Inc. (NTT Facilities, Inc.) (At Green Co., Ltd.)	Private companies (buildings, offices, hotels), city hall, universities, hospitals, commercial facilities, data centers SIER Industrial Estate, PIER Industrial Estate, National Electricity Company (PLN), private companies
Transportation	Almec VPI Corporation	Transportation Department (DisHub), bus company (DAMRI), taxi companies, park beautification department (DKP)
Waste	Nishihara Corporation**	Park beautification department (DKP), environment department (BLH)
	Hitachi Zosen Corporation	Park beautification department (DKP), environment department (BLH), Ministry of Energy and Mineral Resources, Ministry of Public Works (PU), national power company (PLN)
	Amita Corporation	Cement companies, private companies
Water resources	Matsuo Sekkei Co., Ltd. (Cooperation: Water and Sewer Bureau, City of Kitakyushu)	Surabaya water service public corporation (PDAM), SIER industrial estate, Keputih sludge treatment plant

* NTT Data Institute of Management Consulting was in charge of the energy sector, and a project was implemented in cooperation with NTT Facilities and Green Prop. In addition, with regard to the cogeneration project (supply of heat and power) under the energy sector from FY 2011-2013, basic studies were carried out for a project of the Ministry of Economy, Trade, and Industry (METI) on the export of infrastructure systems. Project outcomes were applied to this project in cooperation with Nippon Steel and Sumikin Engineering and Fuji Electric Co., Ltd., which were also project constituents.

** Nishihara Corporation had already carried out a JICA waste management project in Surabaya. IGES, as the project managing organization, and NTT Data Institute of Management Consulting, a JICA project consultant, examined the potential to develop this under the JCM.

In addition, this project was implemented in a format where the project results from existing energy and waste management sectors were adopted under the framework of cooperation between Surabaya and Kitakyushu, which had concluded an agreement as green sister cities in November 2012 (See Figure 2.1).

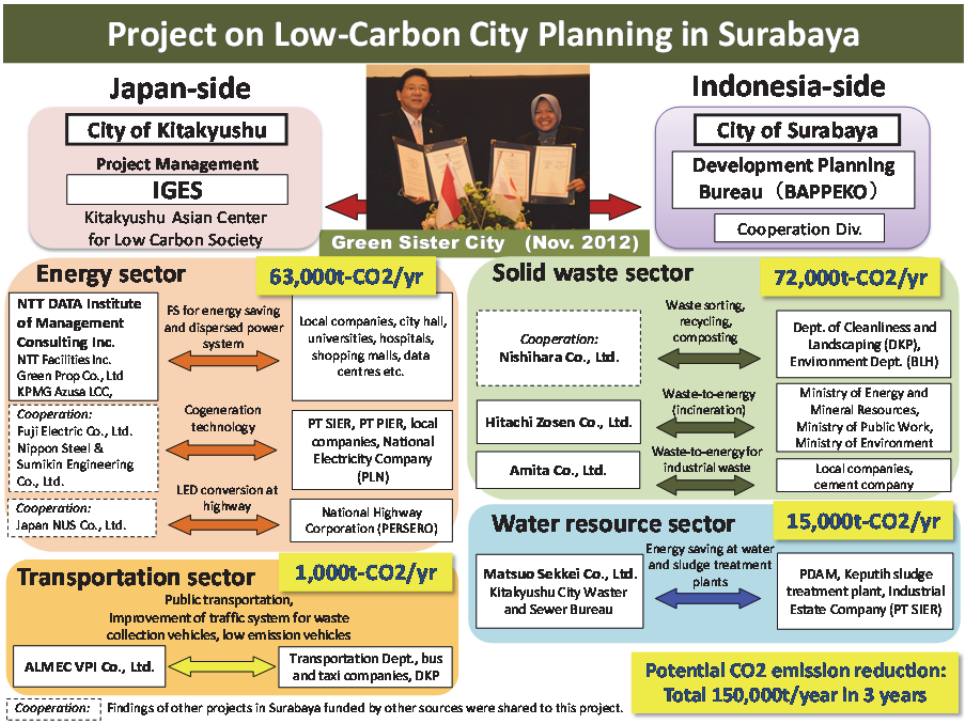


Figure 0.1. Project implementation system

Notes: KPMG Azsa LLC in the energy sector in the above figure implemented Eco-Action 21 outreach activities to promote energy-saving actions for small- and mid-sized companies in Surabaya. This project aims to share information and achieve a synergist effect with KPMG Azsa LLC, such as cooperating in local workshops. In addition, Japan NUS Co., Ltd. (JANUS) is working with the national highway public corporation (PERSERO) to convert lighting on the highway in Surabaya to LED lights, and information will also be shared with this company. Although both companies are not directly involved in the project, the direction and objective for reducing CO_2 emissions in Surabaya under the JCM is the same. Since there is potential for future collaboration, both companies have been added to the implementation system figure.

Chapter 3: Project Outcomes

3.1 Potential to reduce CO_2 emissions

As shown in Table 3.1, there is potential to reduce CO_2 emissions by approximately a total of 150,000 t-CO2/year when specified projects in all four sectors have been implemented. Reduction effects will also increase if projects can potentially be implemented in three years and then expanded (large-scale development).

However, of these, separation, recycling, and composting in the waste sector are not energy-derived CO_2 reductions and depends on controlling the generation of methane. However, energy-derived CO_2 reductions for power generation from incineration are 30,000 t- CO_2/year, and if methane gas is added, this will increase by 15,000 to 70,000 t- CO_2/year.

Of these project proposals, it is the energy and waste management sectors that can expect large-scale reductions with relatively short-term, local investments. This comprises about 90% of the potential overall reduction amounts for both sectors. In contrast, of the two remaining sectors, large-scale CO_2 reductions in the transportation sector require full-scale responses and long-term investments, including interest adjustments among a large number of stakeholders. The water resources sector is limited to purification plants and water distribution stations, and therefore, impacts are also limited.

3.2 Estimated project expenses and cost effectiveness

Energy

In the energy sector, the amount of capital investment for energy savings in buildings is about a total of JPY 1 billion, when looking at four institutions (two hotels, one commercial facility, one office building). The menu of energy-saving measures for this would be roughly divided into four areas: conversion to LED lighting, introduction of cogeneration system (for heat and power supply), shift to highly-efficient air conditioning equipment/system (change to chillers, pumps, cooling towers, etc.), and introduction of building energy management system (BEMS). Combinations differ for each target institution. Incidentally, approximately investment is roughly defined as follows:

Hotel A (LED lighting only): JPY 10 million

Hotel B (Cogeneration system, BEMS, air conditioning): JPY 360 million

Commercial facility (BEMS, air conditioning): JPY 470 million

Office building (BEMS, LED lighting, air conditioning): JPY 140 million

The average of the overall cost effectiveness is JPY 100,000/t- CO_2/year. When looking at each specific item, the overall cost effectiveness can be broken down as follows: LED lighting (JPY 100,000/t-CO_2/year), cogeneration (JPY 80,000/t-CO_2/year), air conditioning (JPY 90,000 to

270,000/t-CO_2/year), and BEMS (JPY 10,000-160,000/t-CO_2/year).

With regard to introducing a cogeneration system (for heat and power supply) in industrial estates, the amount of investment is estimated to be JPY 1.8 billion to supply a total of 6MW of power and 20t/h of steam heat to four companies in the SIER Industrial Estate, and a total of JPY 3 to 4 billion to supply a total of 16MW of power and 37t/h of steam heat to seven companies in the PIER Industrial Estate. Cost effectiveness is slightly better in the PIER Industrial Complex, as it is approximately JPY 12,000/t-CO_2/year in the SIER Industrial Complex, and about JPY 80,000-110,000/t-CO_2/year in the PIER Industrial Complex. Incidentally, the SIER Industrial Complex is located in the southern part of the city area in Surabaya, and the PIER Industrial Complex is located in Pasuruan state, which is about 50km south of Surabaya. There are a number of large-scale factories in the PIER Industrial Complex that require heat.

Transportation

In the transportation sector, 30 CNG buses (national bus company DAMRI) and 150 CNG taxis (private taxi company) will be introduced in the next three years. One CNG station is planned to be built and operated. Costs are estimated to be JPY 210 million for the vehicles (cost to convert diesel buses and gasoline-dependent cars to CNG vehicles: JPY 4 million/vehicle X 30 vehicles + JPY 600,000/vehicle X 150 vehicles), and JPY 400 million for the CNG station. The amount of CO_2 emissions for converting vehicles to CNG is a total of 900t-CO_2/year, i.e., 13t-CO_2/year/vehicle for buses (annual mileage of 75,600km and fuel consumption of 3.5km/l for diesel converted to 4.1km/m3 for CNG), and 3t-CO_2/year/vehicle for taxis (annual mileage of 72,000km and fuel consumption of 11.7km/l for gasoline converted to 14.0km/m3 for CNG). The cost effectiveness for CO_2 reduction is JPY 230,000/t-CO_2/year for vehicles only, and JPY 670,000/t-CO_2/year when the CNG station is added.

Waste

Currently, Nishihara Corporation is operating a waste separation and recycling facility (intermediate treatment) with a 10-15t/day treatment capacity in the Sutorejo area of Surabaya, and is also working on the construction of a composting facility with a 20-40t/day treatment capacity in the Wonorojo area with a JICA project. A new proposal to this project, the construction of a separation, recycling, and composting facility (super depo) with a treatment capacity of 150t/day has been added, and construction costs are estimated at about JPY 500 million. Through the operation of this facility, it is possible to cut emissions by about 10,000t-CO_2/year, and cost effectiveness would be about JPY 50,000/t-CO_2/year. However, the better part of this is controlling the generation of methane gas by reducing the amount of waste that is landfilled, and therefore, CO_2 emission cuts for

energy sources are 100t-CO_2/year through grouping and improving the effectiveness of vehicles for transport to the final waste disposal site. In considering this only, the cost effectiveness is JPY 5 million/t-CO_2/year.

This project also examines residual substances from separation, recycling, and composting facilities (super depo), and power generation from incineration for separated waste at other intermediate treatment facilities. The low calorific value of this waste is expected to be just under 2,000kcal/kg. Based on this estimate, the construction of a facility with a treatment capacity of 500t/day and power generating facilities of 9,330kW (steam conditions of 4MPa×400℃) is being proposed. Supposing that the facility consumes 2,580kW (about 28%) of the power produced through the operation of the facility and 6,750kW (about 72%) can be sold, the CO_2 emissions reduction effect as a fossil fuel alternative is 30,000t-CO_2/year (=6,750kW × 8,000hr/year × 0.56kg-CO_2/kWh). Design and construction costs for the facility are expected to be approximately JPY 6 billion at this time, which means that the cost effectiveness will be JPY 200,000/t-CO_2/year. If the amount of methane generated that is controlled by reducing the amount of final waste is added to this figure (estimated at 15,000-70,000t-CO_2/year depending on waste quality), cost effectiveness becomes JPY 60,000-130,000/t-CO_2/year.

Other than the above-mentioned household waste, the project also examined the potential for CO_2 emission reductions through use of business waste to produce the raw materials for cement. From interviews with companies in the industrial estate around Surabaya, it is estimated that it is possible to produce 10,000t/year of liquid alternative fuel (heat quantity of 3,350kcal/kg) and 24,000t/year of raw materials for cement (heat quantity of 1,800kcal/kg) using waste from these companies, and that Cement Indonesia, a company located in the city of Gresik to the west of Surabaya, can accept the raw materials for cement produced from this waste. It is possible to reduce CO_2 emissions of about 32,000t-CO_2/year by substituting about 13,000t/year of coal for fuel use (heat quantity of 5,700kcal/kg) that is needed for the production of cement by using the raw materials for cement. Construction costs for these production facilities are expected to be about JPY 340 million (not including land costs), which means that cost effectiveness will be about JPY 10,000/t-CO_2/year.

Water resources

As an energy-saving measure at water purification plants, power savings and reduction of leakage rates has been proposed by updating aging distribution pumps (Ngagel Water Purification Plant systems I and II constructed between 1920 and 1950) and introducing a discharge pressure control system for distribution pumps. Replacing seven (output of 1,500kW) of the total of 26 pumps at the Ngagel Water Purification Plant system I (output of 1,925kW) also reduces the amount of power used by about 20% by making the pumps of systems I and II more efficient. This is expected to

enable a CO_2 emissions cut of a total of 5,000t-CO_2/year (= 7,400MW×0.7kg-CO_2/kW). By reducing the discharge pressure for distribution pumps from 0.3MPa to 0.2MPa, it is estimated that the amount of power can be reduced by 2% and leakage rates by 3%, with an expected CO_2 emissions cut of a total of 10,000t-CO_2/year as a result. This is expected to enable CO_2 emission reductions of a total of 15,000t-CO_2/year. Facility investment costs for updating antiquated pumps is about JPY 1.5 billion, which means that the CO_2 emission reduction cost effectiveness is JPY 300,000/t-CO_2/year. The introduction of a discharge pressure control system for distribution pumps costs JPY 700 million, which means that CO_2 emission reduction cost effectiveness is JPY 70,000/t-CO_2/year.

This project also examined energy-saving measures at wastewater treatment facilities in the SIER Industrial Estate and the Keputhi Sludge Treatment Plant. Sludge and waste is treated through the oxidation ditch process (OD) at both facilities. Changing the aerator/agitating equipment (that consumes 70% to 90% of all power in each facility) from the existing horizontally-mounted mammoth rotor to an underwater propeller/oxygen diffusion plate is expected to improve oxygen supply efficiency and reduce power consumption. If the amount of power consumption cut is estimated at about 15%, power consumption reductions of about 150,000kWh/year and 39,000kWh/year can be expected, respectively, which when converted to CO_2 emission reductions becomes 110t-CO_2/year and 30t-CO_2/year, respectively. With capital investment in facilities and equipment estimated at about JPY 500 million and JPY 200 million, respectively, cost effectiveness for each facility is JPY 5 million/t-CO_2/year and JPY 7 million/t-CO_2/year, and there is no price advantage when compared with other candidate items.

Comparison of four areas

Table 3.1 gives an overview of the CO_2 emission cuts, estimated project costs and cost effectiveness of the above four sectors. The cost of reductions per 1t of CO_2 for energy-saving items and supply of heat and power in the energy sector are both JPY 100,000/t-CO_2/year. For the transportation sector (converting vehicles to CNG), it is about twice that amount; however, when adding infrastructure improvement, such as the CNG station, to this figure, the amount grows even higher.

Figures for the waste sector are overwhelmingly low when compared with other sectors: cost reductions for the raw materials for cement per 1t of CO_2 are only JPY 10,000/t-CO_2/year, followed by JPY 50,000/t-CO_2/year with the separation, recycling, and composting of general waste (intermediate treatment). However, the control of methane emissions makes up the majority of this figure, and is not an energy-derived CO_2 emissions cut. If looking at energy-derived CO_2 emission cuts only, cost effectiveness is JPY 200,000/t-CO_2/year; however, if power generation from

incineration also includes the control of methane gas generation, that figure falls to JPY 60,000 to JPY 130,000/t-CO_2/year.

In the water resources sector, the introduction of a discharge pressure control system for water distribution pumps is highly cost effective at JPY 70,000/t-CO_2/year, and is expected to also further reduce leakage rates. However, it is important to measure all aspects of the amount of distributed water and pressure at the water distribution pump discharge side and the end of the water distribution pipe; detailed inspections can take one to two years. The effects of replacing aging water distribution pumps are well-understood; however, the cost for equipment is high and cost effectiveness is also high at JPY 300,000/t-CO_2/year. Costs for energy-saving measures at industrial wastewater treatment facilities and sludge treatment plants are even higher, and it is difficult to develop independently into a JCM project.

3.3 Co-benefit effects

Although there are no co-benefit effects (secondary effects, environmental and social effects) from energy savings in buildings in the energy sector, suffice it to say, energy-saving measures raise people's awareness of energy conservation. However, more than that, the economic effects from direct reductions in energy bills are greater. In order to estimate the stability of power supply in comparison with unstable power systems and use natural gas as fuel, it has been pointed out that the environmental impacts from emitted gas are small.

Co-benefit effects from the spread of CNG vehicles in the transportation sector mean that CNG vehicles emit low levels of NOx, black smoke, and particulate matter (PM). This contributes to improving air quality. In addition, a modal shift by improving the image of public transportation and ridership rates by adopting CNG vehicles in public transport (buses) can also be expected to be combined with improvement of operation and management systems and measures to improve user rates for public transportation. Furthermore, secondary impacts, such as job creation and the development of human resources for associated businesses can be predicted with the spread of the use of CNG vehicles.

With regard to the waste sector, the amount of waste sent for final disposal can be streamlined using any measure, aiming at extending the life of final disposal sites and controlling the generation of methane gas. In addition, promoting the separation, recycling, and composting of waste (intermediate treatment) is expected to improve the awareness of households and businesses about waste, and using compost produced from organic waste in green areas and parks is expected to change people's ideas of resource circulation and their awareness of waste as a resource by using it as waste fuel. With regard to hazardous waste from businesses (B3), waste that until now was transported over 800km to a treatment facility in western Java, can now be treated nearby, which will

contribute to reducing fuel costs and air pollutants related to this transport. In addition, the provision of proper business waste treatment services can respond to the demand for compliance with waste management requirements by businesses.

In the water sector, it is expected that improvements in operating income as a result of reductions in electricity bills and leakage rates, as well as upgrades to water treatment facilities and improved services, will result in benefits for residents. Reductions in electric bills for industrial wastewater or sludge treatment facilities also serves as an aid for the operating income and expenditures of both facilities, and it can be expected to lead to improvements in services for customers.

Table 3.1. Potential for CO2 Emission Reductions (based on F/S results and estimating an implementation period of three years)

Sector		Implementation details	Potential annual CO2 emission reductions (t-CO2/year)	Implementation costs	Cost effectiveness [t-CO2/year]	Secondary effects (Co-benefits)
Energy	Energy savings in buildings (LED lighting, air conditioning, BEMS, heat and power supply)	Hotel A	100	JPY 10 million	JPY 100,000	Reduces electricity costs
		Hotel B	4,000	JPY 360 million	JPY 90,000	
		Commercial facility A	4,100	JPY 470 million	JPY 120,000	
		Office building A	1,500	JPY 140 million	JPY 100,000	
	Heat and power supply to industrial estates (cogeneration)	SIER Industrial Estate (6MW, 20t/hr)	15,000	JPY 1.8 billion	JPY 120,000	Effective utilization of energy, natural gas use
		PIER Industrial Estate (16MW, 37t/hr)	38,000	JPY 3 billion – 4 billion	JPY 80,000 to 110,000	
Transportation	Conversion to CNG vehicles	Buses (30), taxis (150), (1 CNG station)	900	JPY 210 million (+JPY 400 million)	JPY 230,000 (+JPY 440,000)	Reduces air pollution, promotes use of public transport
Waste	Separation, recycling, composting	Treatment capacity of 150t/day Grouping of transportation vehicles	100 【+10,500】	JPY 500 million	JPY 5 million 【JPY 50,000】	Promotes recycling, reduces amount of waste sent to landfills
	Power generation from incineration	Treatment capacity of 500t/day Produces 9,330kW	30,200 【+15,000~70,000】	JPY 6 billion	JPY 200,000 【JPY	Reduces amount of waste sent to

		(4MPa×400℃)			60,000-130,000】	landfills, effective use of resources
	Raw materials for cement from waste from business establishments	Liquid alternative fuel: 10,000t/year Raw materials for cement: 24,000t/year	14,000 18,000	JPY 340 million	JPY 10,000	Proper treatment and reuse of resources for waste from businesses
Water resources	Update water distribution pumps	Ngagel Water Purification Plant (systems I, II)	5,200	JPY 1.5 billion	JPY 300,000	Reduces electricity costs
	Adjustments to water distribution delivery pressure	Control deliver pressure of water distribution pumps	10,000	JPY 700 million	JPY 70,000	Lowers leakage rates
	Treatment of industrial waste, septic tank and sludge treatment	SIER Industrial Estate Keputhi Sludge Treatment Plant	100 30	JPY 500 million JPY 200 million	JPY 5 million JPY 7 million	Reduces electricity costs
Total			**150,000t-CO2/year**	**JPY 13 billion - JP 14 billion**		

【 】CO2 emission reductions through control of methane gas generated and resulting cost effectiveness

Chapter 4: Implementation Plan for Project Applications

Table 4.1 shows a list of plans and their actual implementation and applications. The number of projects that were studied this fiscal year need to be further examined and analyzed next fiscal year. After the studies are complete, the project will move ahead towards implementation after agreements with counterparts on project details and investment rates. Therefore, many proposed projects will be implemented after FY 2015. Of these, plans for energy savings in buildings is moving ahead relatively quickly in comparison with other projects, and within the next fiscal year, agreement with counterparts is expected to be reached, which means that it will be possible for the project to apply for equipment aid.

For projects with a scale of hundreds of millions of yen, applications will be submitted to the Ministry of the Environment for equipment aid, and to JICA overseas investment and financing for projects with a scale of several billion yen.

Table 4.2 shows the approaches to promote the actual implementation of projects and ideas to promote the introduction of Japanese technologies.

The implementation plans for project applications in each sector is below.

Table 4.1. Implementation plans for project applications

Sector		Implementation details	Implementation costs	FY 2014	FY 2015	FY 2016	Expected source of implementation budget
Energy	Energy savings in buildings	Hotels (2), commercial facility (1), office building (1)	JPY 1 billion	Project design, consensus building, application for equipment aid	**Demonstration project**	**Continued**	Ministry of Environment,: equipment aid
		New buildings (hospitals, office buildings, etc.)	JPY 1 billion	F/S	Contract, approval and authorization procedures, application for demo project		
	Heat and power supply to industrial estates (cogeneration)	SIER Industrial Estate (6MW, 20t/hr)	JPY 1.8 billion	Contract, approval and authorization procedures, application for demo project	EPC	**Demonstration project**	JICA overseas loans and financing
		PIER Industrial Estate (16MW, 37t/hr)	JPY 3 billion – 4 billion	F/S	Contract, approval and authorization procedures, application for demo project	EPC, **Demonstration project**	
Transportation	Conversion to CNG vehicles	Buses (30), taxis (150), CNG station (1)	JPY 210 million JPY400 million	F/S	Application for equipment aid, **demonstration project**	**Continued (expansion)**	Ministry of Environment: equipment assistance

Waste	Separation, recycling, composting	Treatment capacity: 150t/day	JPY 500 million	JICA project implementation, application for equipment aid	EPC, **Demonstration project**	**Continued**	Ministry of Environment: equipment assistance
	Power generation from incineration	Treatment capacity: 500t/day Power generation: 9,330kW (4MPa×400℃)	JPY 6 billion	F/S	Contract, approval and authorization procedures, application for demonstration project	EPC、**Demonstration project**	JICA overseas loans and financing
	Raw materials for cement from waste from business establishments	Liquid alternative fuel: 10,000t/year Raw materials for cement: 24,000t/year	JPY 340 million	F/S	Contract, approval and authorization procedures, application for demonstration project	EPC、**Demonstration project**	Ministry of Environment: equipment assistance
Water resources	Update water distribution pumps	Ngagel Water Purification Plant (systems I, II)	JPY 1.5 billion	F/S	Design	**Demonstration project**	JICA overseas loans and financing (Other support projects and cooperation through City of Kitakyushu)
	Adjustments to water distribution delivery pressure	Control deliver pressure of water distribution pumps	JPY 700 million	F/S	Design	**Demonstration project**	
	Treatment of industrial waste, septic tank and sludge treatment	SIER Industrial Estate Keputhi Sludge Treatment Plant	JPY 500 million JPY200 million	F/S	Design	**Demonstration project**	

EPC: Engineering, procurement, construction　　Shaded sections：New F/S expected for next fiscal year

Table 4.2. Approaches to promote actual implementation of projects

(Ideas to promote the introduction of Japanese technologies)

Sector		Approach
Energy	Energy saving in buildings	➢ Comparative analysis and recommendations for complementary measures for the Energy Efficiency Facilitation Fund, which the Indonesian Ministry of Finance (BKF) plans to promote capital investment (cooperation with JICA Indonesia office) ➢ Support for institutional design of the Green Building Awareness Award planned by Surabaya (collection of energy consumption data on large buildings and facilities) ➢ Access to customers and connection with equipment manufacturers through energy-saving diagnosis projects
	Heat and power supply to industrial estates (cogeneration)	➢ Negotiations on electricity purchasing prices with Indonesian Ministry of Energy and Mineral Development, national electric company (PLN) ➢ Price negotiations with natural gas supply company ➢ Cooperation and coordination with Japan METI, NEDO, JICA ➢ Appeals to customers with stable power supply
Transportation	Conversion of vehicles to CNG	➢ Pressure on Department of Transportation to promote CNG (CNG price preferential treatment, CNG station development/improvement, CNG conversion kit safety, vehicle compensation, creation of system for maintenance of CNG vehicles) ➢ Pressure to adopt CNG vehicles in public transportation ➢ Cooperation with public transport organization in Surabaya (MRT), next generation light rail train (LRT) plan ➢ Cooperation with Japanese leasing company, manufacturers, CNG conversion service companies, gas associations ➢ Host trainees on CNG in Japan, dispatch experts to field
Waste	Separation, recycling, composting	➢ Comparison with proposals from local governments outside of Surabaya on treatment commission expenses and facility construction aid ➢ Management of intermediate waste treatment facility (404/day capacity) under implementation in JICA project, and tied to proposal for large-scale facility.
	Power generation through incineration	➢ Negotiation of purchase price with Ministry of Energy and Mineral Development and national electric power company (PLN) ➢ Cooperation with Sumba Organic company which is commissioned for administrative work at the final disposal site

		➢ Negotiations on processing costs, proposal for wide-area treatment of waste
	Raw materials for cement from waste from business establishments	➢ Full enforcement of waste management methods (Ministry of Environment (KLH) is requested to strengthen waste management compliance to waste generating businesses) ➢ Negotiations with cement company, field study of waste generating businesses
Water resources	Update water distribution pumps	➢ Cooperation with water improvement projects in Surabaya started by Kitakyushu from FY 2014 (JICA grassroots technical cooperation project), and release of data on river quality (water source)
	Adjustments to water distribution delivery pressure	
	Treatment of industrial waste, septic tank and sludge treatment	➢ Cooperation with sewage promotional projects promoted by the Kitakyushu Water and Sewer Bureau in Surabaya

Energy

For energy savings in buildings, the project plans to submit an application for aid for equipment to the Ministry of the Environment because the project scale per proposal is several hundreds of millions of yen. The implementation structure may include the creation of an international consortium of companies from both Japan and Indonesia, which will function as the outlet for the distribution of equipment aid. The project is also examining the potential for establishing a local ESCO company and providing services for local businesses regarding the conversion to LED lighting.

As the project scale for heat and power supply projects are JPY 3 billion to JPY 4 billion, the project plans to establish a special purpose company (SPC) to accept funding from sources such as the JICA overseas investment and financing. In the future, it will be necessary to build consensus with stakeholders, and negotiate power purchasing prices with the national electric company (PLN), negotiate long-term gas supply contracts with the national gas supply company, negotiate investment ratios with investment companies in Japan and Indonesia, and negotiate contracts with heat and power suppliers.

In order to promote project implementation and application, the Indonesian Ministry of Finance (BKF) will advise on the design of the Energy Efficiency Facilitation Fund that is being planned in cooperation with the JICA Indonesia Office. This will become an outlet to promote the horizontal development of model projects which are supported with equipment aid. In addition, the project will support the institutional design of the Green Building Awareness Award that is being planned by Surabaya, and will collect energy consumption data for large buildings in Surabaya in accordance with the national master plan on energy saving, and appeal to building owners to promote energy

saving investments.

It is possible to tie the promotion of Japanese technologies to business talks, such as securing access to customers through energy-saving diagnostic projects and introducing Japanese manufacturers. The project also plans to emphasize the stability of power supply through the supply of heat and electricity onsite in order to expand projects.

Transportation

The transportation sector is carrying out a F/S next fiscal year on the small-scale introduction of CNG vehicles, and is examining the project potential and applicability of MRV methodologies to prepare for the shift to requests for equipment aid after FY 2015. By FY 2015, the transportation sector aims to have introduced 10 CNG buses and 50 CNG taxis. By FY 2016, this will increase by 20 vehicles and 100 vehicles, respectively, in addition to the construction and operation of a CNG station. In parallel, visits to Japan for training and dispatch of experts will be carried out, and support provided to develop an implementation system to strengthen capacity of stakeholders and expand activities.

The project implementation structure will involve the formation of an international consortium of representatives from businesses, Japanese automobile manufacturers, Japanese CNG station construction companies, local bus and taxi companies, with a representative company (Japanese trading/leasing company) leasing CNG vehicles to local businesses through the use of equipment aid.

To promote implementation, it is necessary for the project to request the Department of Transportation to develop policies to expand the use of CNG vehicles, such as with preferential pricing for CNG vehicles, assistance for the construction of CNG stations, establishment of a safe CNG conversion kit and compensation system for conversion vehicles, and a maintenance system for these vehicles. In addition, coordination with public transport organizations (MRT) and the next generation light rail train (LRT) plan promoted by Surabaya and request the adoption of CNG vehicles in public transportation (buses) in the city.

In addition, Japanese technology will be promoted through linkages with Japanese leasing companies, manufacturers, CNG conversion service companies, and gas associations in order to promote the introduction of Japanese technologies.

Waste

Intermediate treatment of general waste (separation, recycling, and composting) is currently being carried out at a treatment plant with a capacity of 10-15t/day, and a facility with a capacity of 20-40t/day is under construction as part of a JICA project. In FY 2014, the facility will be in operation. Based on the operating outcomes, another facility will be constructed with a treatment

capacity of 150t/day using equipment aid in FY 2015. MRV methodologies will be carefully reviewed in FY 2014 and monitoring will be performed by a project assessor.

In order to financially conclude a project, receipts for processing expenditures are required. In order to ensure this financial aspect of the project, negotiations will be carried out with Surabaya; at the same time, negotiations will also take place with other local governments in the surrounding area, and advantageous conditions, including the financing shares for facility construction costs, will be discussed.

Achieving power generation from incineration requires that a project feasibility survey be carried out next. Next fiscal year, the project will conduct a study on coordination with the Sumba Organic Company, potential for wide-area application, including neighboring local governments, and application conditions for MRV methodologies. In FY 2015, the project will get consensus on contract conditions with stakeholders, and prepare for approval and authorization procedures, and enter into engineering, procurement, and construction (EPC). In FY 2016, the project will aim to start the process of construction.

To secure profitability of the project, it is essential to secure preferential prices for sales (purchases) of electricity (to be negotiated with the national electric company, PLN) and processing expenditures. The project will conduct a survey on the situation of environmental impacts at the unsanitary final disposal site. It is necessary to carry out the groundwork to accept expenses for power generation from incineration, including a survey on the situation of environmental impacts at the current unsanitary final disposal and calculate the costs of converting the current site to a sanitary landfill site.

With regard to the raw materials for cement from waste from business establishments, the project will conduct a survey on the type, quantity, and composition of waste by continuing to interview businesses next fiscal year. The project will also check the conditions at the cement company for receipt of this waste, and carefully check facility construction costs. In order to promote the establishment of MRV methodology, the project aims at construction and operation by FY 2016 after obtaining agreement, contracts, and approval procedures with stakeholders in FY 2015.

In order to promote the implementation of projects, the actual conditions of waste treatment and commissions will be studied, and requests will be made to the Ministry of the Environment to check observance of waste treatment methods (full compliance by waste generators).

Water resources

Next fiscal year, each proposal in the water sector will continue to be studied to determine the

potential for implementation. Project design and construction will be planned for FY 2015 and put into operation from FY 2016. However, since it is difficult to continue feasibility studies under the JCM independently for water resources issues, the project aims to establish cooperation with local, related projects in Kitakyushu. A request for capacity training for staff has come from the Surabaya Water Services Public Corporation (PDAM), the relationship with PDAM will be maintained through the acceptance of trainees in related JICA trainings.

Sectoral Reports

Energy Sector (NTT DATA Institute of Management Consulting Inc.)
Transportation Sector (ALMEC VPI Corporation)
Solid Waste Sector （Nishihara Corporation, Hitachi Zosen Corporation, Amita Corporation）
Water Resource Sector (Matsuo Sekkei Corporation)

Energy Sector: NTT DATA Institute of Management Consulting Inc.

1. Background and purpose of this study

Surabaya, as a local government in Indonesia, is interested in building advanced low carbon society, and many activities for realization of low carbon in energy sector have been positively implemented. They include switching off unnecessary lights, installation of energy efficient lighting at city government buildings, and installation of LED (with PV) street lamps. Also, business feasibility study on combined heat and electricity supply service using CHP at SIER (Surabaya Industrial Estate Rungkut) which is the largest industrial estate in the city has been conducted sponsored by Japan's Ministry of Economy, Trade and Industry.

Although many activities toward low carbon have been conducted, there are still many issues remained. For example, CO2 reduction effect of those approaches has not been quantified. Because of lack of know-how needed to compose projects, Surabaya city's unique activities are remained at an experimental level. Energy saving potential and needs in the whole city have not been surveyed, strategic model projects based on those kinds of surveys are not generated, and business feasibility studies on ESCO project have not been conducted.

Therefore, this study aims to establish environment for "achieving low carbon society as a whole Surabaya city" from a perspective of JCM. In particular, doing a basic study on sectors whose basic surveys such as energy saving potential and needs survey predicted on CO2 reduction have not been done. Regarding activities whose CO2 reduction effect has been roughly quantified, we will develop MRV methodology with the aim of applying JCM. As for activities whose business model has been studied, a business expansion feasibility study to Surabaya city and surrounding areas will be done.

Two themes of this study are "Study on Combined Heat and Power in Industrial Estate" and "5. Study on Energy Savings and Dispersed Generation in Buildings."

2. Current situation of energy sector in Indonesia

In Indonesia, reduction of CO2 emission from electricity consumption is supposed to be an important issue to be solved. It is estimated that electricity consumption amount will increase by an average of 8.65 % per year between 2012 and 2021. Indonesia prioritizes increasing the ratio of using coal as power source in the future.

Resulting scenario in the future is that CO2 emission will significantly grow because CO2 emission increases and CO2 emission factor remains high due to an increase of electricity consumption associated with economic growth. Measures against this situation are: (1) Energy saving, (2) Low carbon energy, and (3) High efficient power

generation.

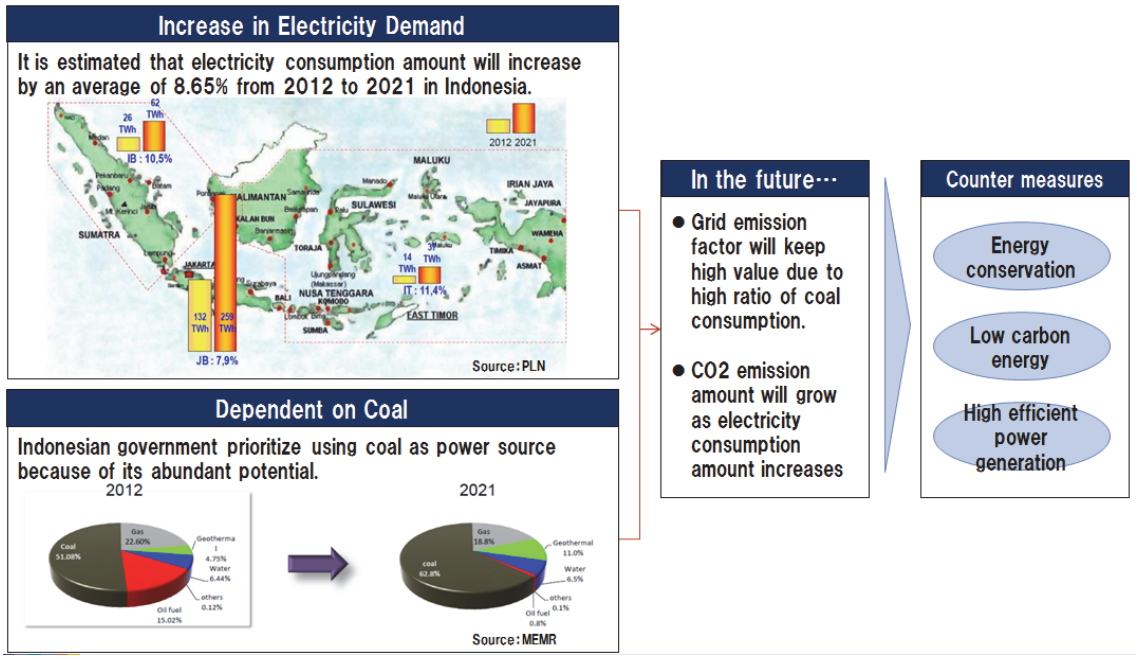


Figure 1 Current situation of energy sector

Utility cost tends to increase because power tariff was raised by an average of 15 % in 2013. With this background, the needs for energy saving on customers' side are growing and it is expected that approaches related to government's global warming policy will be expanded.

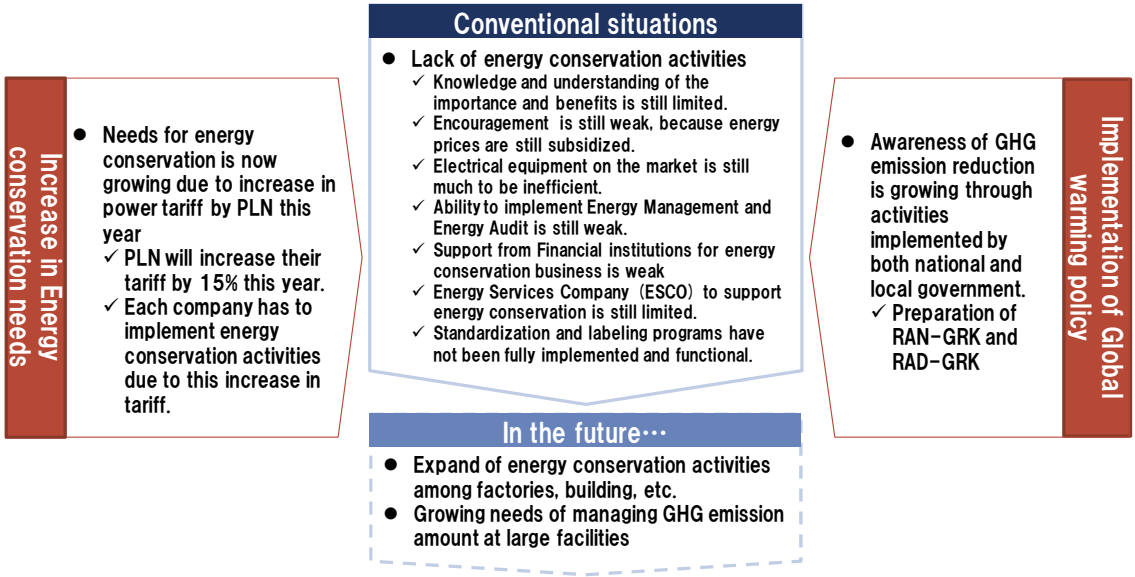


Figure 2 Supposed scenario in the future

3. Relation between our study items and CO2 emission in Surabaya

According to the report of an program “Sustainable Urban Energy Development” by The World Bank, CO2 emission in the whole Surabaya city is 8.6M tCO2. The total CO2 emission from Industrial sector and commercial sector accounts for more than 50 % of the whole CO2 emission in Surabaya.

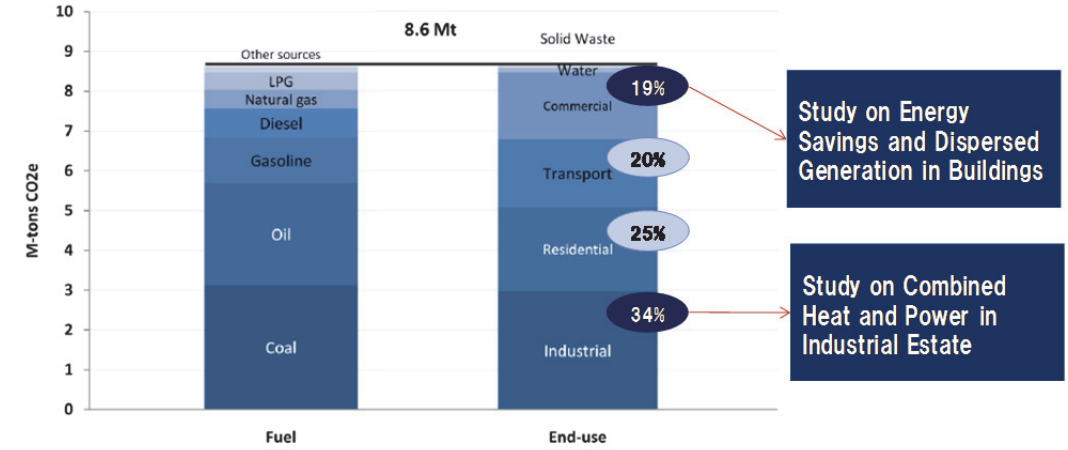


Figure 3 Relation between our study items and CO2 emission in Surabaya

4. Study on Combined Heat and Power in Industrial Estate

4.1. Development of MRV methodology

Regarding the project for introducing CHP into the largest SIER industrial estate in Surabaya city, which is separately being done by the Ministry of Economy, Trade and Industry, this study has developed MRV methodology toward JCM project.

Methodologies of other mechanisms which we referred to in considering our methodology include CDM Methodology AM0014, AM0048 and J-Credit Methodology EN-S-007.

The details of the developed methodology, which are spared in this summary, are described in a main report separately. The reference scenario consists of electricity from grid power (PLN) or off-grid power generators and steam supply from private boilers. As monitoring items, power and heat supply amount of CHP, steam temperature and steam pressure are designated.

4.2. Calculation of CO2 reduction

CO2 reduction of the considered system for SIER industrial estate whose maximum energy supply amount is 6 MW of electricity and 20 t/h of steam was calculated. The results of calculation are as follows:

Reference scenario

I. Steam

a. Steam supply amount of CHP per year: 323.2 TJ/year

b. Emission factor of natural gas: 15.3 tC / TJ

c. Boiler efficiency: 0.9

Amount of emission: a * b / c * (44 / 12) = 20144.5 tCO2/year - (1)

II. Electricity

d. Electricity supply amount of CHP per year: 42,700 MWh

e. Grid emission factor: 0.741 tCO2 / MWh

Amount of emission: d * e =31640.7 tCO2/year – (2)

III. Total

(1) + (2) = 51785.2 tCO2/year – (3)

Project scenario

f. Annual natural gas consumption amount of CHP: 646.5 TJ/year

g. Emission factor of natural gas: 15.3 tC / TJ

Amount of emission: f * g * (44 / 12) = 36269.1 tCO2/year – (4)

Amount of emission reduction

(3) – (4) = 15516.2 tCO2/year

4.3. Possibility of expansion for combined heat and power business

4.3.1 Study flow

This year's study started from candidate site selection from among the surrounding areas of Surabaya city, potential survey by hearing and questionnaire from each factory, and recognized preliminary needs.

In the first site selection, PIER industrial estate was selected as a major candidate of the study by hearing from related departments of the city government and web survey. At PIER industrial state, we visited six factories which used natural gas boiler, and verified the demand situation of electricity and heat, and the business needs for combined heat and power by hearing, etc.

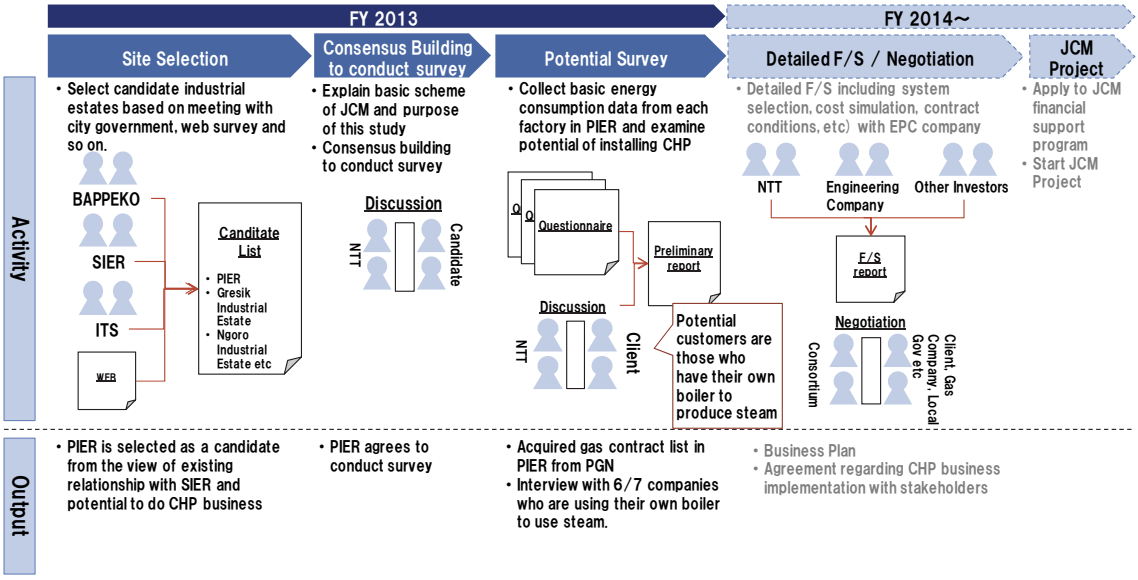


Figure 4 Study flow

4.3.2 Study result

The result of the study concludes that PIER industrial estate demands for steam at estimated 35 t/h and it is a prospective area for combined heat and power business expansion. Some companies think that the stability of grid power is an issue, hence, there are needs for stable power supply by their own operation.

	Boiler Capacity	Steam Demand	Interests
Factory A	20 t/h×1	16 t/h	• Cost reduction • Stability of power quality
Factory B	2 t/h ×3 4 t/h ×1	8 t/h	• Cost reduction
Factory C	0.75 t/h ×3 2 t/h×2	5 t/h	• Cost reduction • Stability of power quality
Factory D	Confirming		• Cost reduction • Stability of power quality
Factory E	2 t/h ×1	2 t/h	• Cost reduction
Factory F	2 t/h ×1	2 t/h	• Cost reduction
Factory G	1 t/h ×1	1 t/h	※ not visited in this study

* Estimation based on gas consumption amount

Fig. 5 Verified steam demand in SIER industrial estate

4.3.3 Next step

To realize combined heat and power business in PIER industrial estate, we are

planning to conduct detailed feasibility study and negotiate with related stakeholders of this project (customers, local governments, electricity company, gas company, operating company of industrial estate, etc). The detailed feasibility study includes acquiring the detailed energy demand data (energy data based on daily fluctuation, seasonal fluctuation, etc), considering implementation team for the projects, system selection based on detailed data, and economical evaluation.

5. Study on Energy Savings and Dispersed Generation in Buildings

5.1. Study flow

This year's study started from candidate site selection from among Surabaya city focusing on facilities consuming large amount of energy, then negotiation with candidate sites, energy diagnosis and primary recommendation for applying for JCM project.

In the first site selection, some facilities consuming large amount of energy were selected as a major candidate by hearing from related departments of the city government and web survey. Then, shopping mall, university, hospital, hotel, office building, etc were selected. Next, in negotiation with candidate sites, we explained the general meaning of this study such as the purpose of the study and JCM scheme, requested for cooperation, and attempted to build a consensus. As a result, we achieved a consensus with four facilities (one shopping mall, one commercial building and two hotels) as a major candidate for JCM project. In the energy diagnosis, we conducted a diagnosis at selected sites, and suggested recommended energy saving measures and application for JCM program by summarizing the result of the energy diagnosis. Regarding measures which have a need, we introduced companies which could implement them and gave primary recommendation for applying for JCM project.

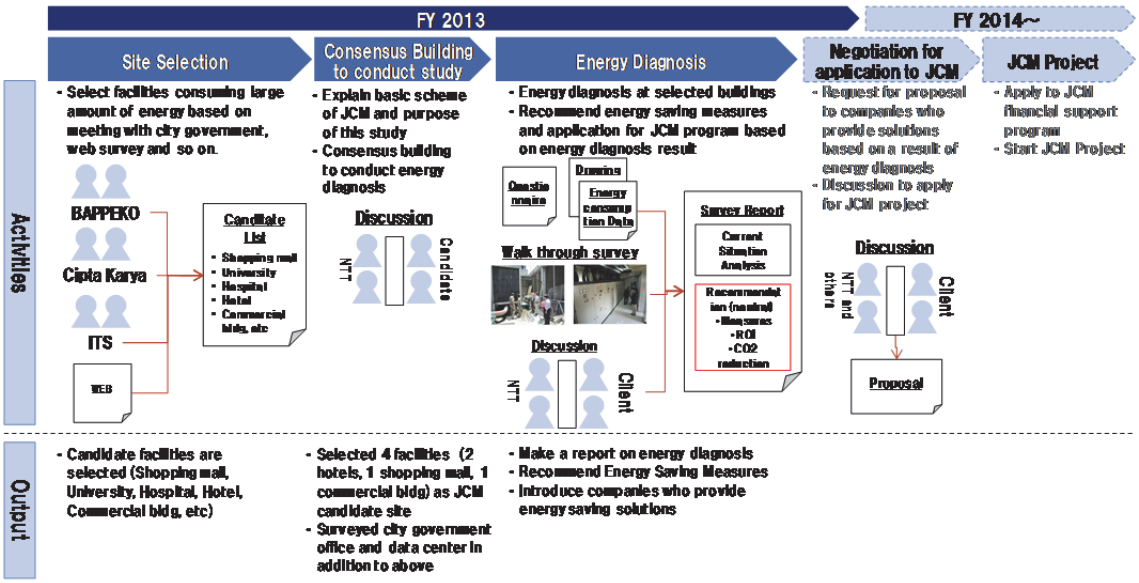


Fig. 6 Study flow

5.2. Outline of surveyed facilities

Two major hotels, one shopping mall and one commercial building in Surabaya city were objects of this study.

Hotel A, which is a member of US hotel chain, was completed in 1996. The owner is an Indonesian company. This hotel chain is interested in energy saving and has global energy saving target. Hotel A is a part of complex facility and supplied electricity and heat from Shopping mall A. Hotel B, which is managed by an Indonesia-company, was purchased from US hotel chain. It was completed in 1979 and renovated in 1993. It is a complex facility consisting of the hotel and two other commercial buildings on the premise. Heat and Power Source is located in Hotel B. Shopping mall A is the largest shopping mall in the city managed by an Indonesian company. This building was completed in 1986 and expanded three times in 1991, 1996 and 2001. Two fifty-floor-scale buildings on the premise are under construction. Commercial building A is one of the largest commercial buildings in the city. It is owned by one of the largest media companies in Indonesia and its head office is in the building. It is completed in 1997.

	Hotel A	Hotel B	Shopping mall A	
Outline	• Member of US hotel chain • Managed by Indonesian Company • Energy saving target as global chain	• Managed by Indonesian company • Consist of one hotel and two commercial buildings	• Largest shopping mall in Surabaya managed by Indonesian Company	• One of the biggest commercial building in Surabaya • Owned by one of the largest media companies in Indonesia
Year of Completion	1996	1979 (Renovated in 1993)	1986 (Extended in 1991, 1996, and 2001)	1997
Floor Area	35,000m²	25,500m²	125,000m²	25,000m²
Floors	28 Floors	27 Floors	6 Floors above ground, 1 Floor below	21 Floors

Fig. 7 Outline of surveyed facilities

5.3. Study result

5.3.1 Hotel A

At Hotel A, walkthrough survey and meetings were conducted on September 25th and October 29th in 2013. Also, summary documents of energy consumption data and introducing facilities were collected.

As measures for energy saving to be taken, the results of the diagnosis suggested replacement of existing laundry machines, installation of BEMS and installation of LED lightings, especially, the hotel was interested in LED lightings most. Estimated cost effectiveness is as follows.

	Outline	Estimated Amount of Initial Investment	CO2 Emission Reduction Amount	PBP*	Notes
Installation of LED lightings	• Replace existing 1,000 lightings with LED type (tentative)	• Rp 1.1 Billion	• 100 tCO2/yr	• 7.3 yrs • 3.6 yrs	• Request for profit share from Hotel A • Proposal to be prepared by lighting solution company

Fig. 8 Recommended energy saving measures for Hotel A

5.3.2 Hotel B

At Hotel B, walkthrough survey and meetings were conducted on September 23rd, 26th and October 28th in 2013. Also, summary documents of energy consumption data and introducing facilities were collected.

As measures for energy saving to be taken, the results of the diagnosis suggested (1) installation of CHP system, (2) installation of BEMS, (3) replacement of existing chillers and (4) replacement of existing pumps. Firstly, regarding (1) installation of CHP system, it is supposed that it can contribute cost saving because there are steam demand for hot-water supply to hotel rooms and laundry, and large electricity demand

for the hotel building and the two other commercial buildings on the premise. Although private power generator has already been installed, it can supply electricity only for some facilities in case of a power outage due to inadequate capacity. This problem can be solved by installing CHP system as well. Regarding (2) installation of BEMS, although BAS has already been installed at this time, it is not used because of breakdown. By taking this opportunity, energy saving is expected because it may be easier to recognize consumption situation of energy by installing BEMS. (3) Replacement of existing chillers has a major effect on energy saving for the whole facility because power consumption of chillers accounts for 50 % of the total consumption. (4) Replacement of existing pumps is also estimated to contribute energy saving with renewal high efficient type because they are deteriorated. Above-mentioned measures for energy saving and estimated cost effectiveness are summarized as follows.

	Outline	Estimated Amount of Initial Investment	CO2 Emission Reduction Amount	PBP*	Notes
Installation of Combined Heat and Power	• Install 1MW CHP and supply both power and heat to hotel and office	• Rp 24 Billion	• 2,900 tCO2/yr	• 7.2 yrs • 2.9 yrs	• Proposal to be prepared by EPC company
Installation of BEMS	• Install BEMS to manage energy consumption	• Rp 5.1 Billion	• 400 tCO2/yr	• 6.5 yrs • 3.2 yrs	• Proposal to be prepared by BEMS solution provider
Replacement of Existing Chiller	• Replace two existing chillers with latest high-efficient ones	• Rp 6.5 Billion	• 600 tCO2/yr	• 6.3 yrs • 3.1 yrs	• Proposal to be prepared by A/C equipment manufacturer (tentative)
Replacement of Existing Pump	• Replace four existing pumps with latest high-efficient ones	• Rp 1.2 Billion	• 100 tCO2/yr	• 6.5 yrs • 3.2 yrs	

* (Above)
• Not Supported
(Below)
• Financial Support from JCM Program
(50% of initial investment)

Fig. 9 Recommended energy saving measures for Hotel B

5.3.3 Shopping mall A

At Shopping mall A, walkthrough survey and meetings were conducted on September 24th, October 29th and December 5th in 2013. Also, summary documents of energy consumption data and introducing facilities were collected.

As measures for energy saving to be taken, the results of the diagnosis suggested (1) installation of BEMS, (2) replacement of existing chillers, (3) replacement of existing pumps, and (4) replacement of existing cooling towers. Regarding (1) installation of BEMS, old type BAS are installed at this time. The consumption situation of energy

has not been recognizable. The shopping mall is interested in installation of BEMS by upgrading BAS. Regarding (2) replacement of existing chillers, (3) replacement of existing pumps and (4) replacement of existing cooling towers, measures are urgent need because the power consumption of the cooling system accounts for more than 40 % of the total as well as every facility is deteriorated. Energy saving has been deemed to be possible by replacing those facilities with high efficient types. Above-mentioned measures for energy saving and estimated cost effectiveness are summarized as follows.

	Outline	Estimated Amount of Initial Investment	CO2 Emission Reduction Amount	PBP*	Notes
Installation of BEMS	• Replace existing BAS with BEMS	• Rp 15.9 Billion	• 900 tCO2/yr	• 4.2 yrs • 2.1 yrs	• Proposal to be prepared by BEMS solution provider
Replacement of Existing Chiller	• Replace five existing chillers with latest high-efficient ones	• Rp 23.5 Billion	• 2,300 tCO2/yr	• 6.9 yrs • 3.5 yrs	• Proposal to be prepared by A/C equipment manufacturer (tentative)
Replacement of Existing Pump	• Replace 18 existing pumps with latest high-efficient ones	• Rp 6.8 Billion	• 700 tCO2/yr	• 6.4 yrs • 3.2 yrs	
Replacement of Existing Cooling Tower	• Replace 8 existing cooling towers with latest high-efficient ones	• Rp 6.8 Billion	• 200 tCO2/yr	• 20.0 yrs • 10.0 yrs	

* (Above)
• Not Supported
(Below)
• Financial Support from JCM Program
(50% of initial investment)

Fig. 10 Recommended energy saving measures for Shopping mall A

5.3.4 Commercial building A

At Commercial building A, walkthrough survey and meetings were conducted on September 27th, October 28th and December 6th in 2013. Also, summary documents of energy consumption data and introducing facilities were collected.

As measures for energy saving to be taken, the results of the diagnosis suggested (1) installation of BEMS, (2) installation of LED lighting, (3) replacement of existing chillers, and (4) replacement of existing pumps. Firstly, regarding (1) installation of BEMS, any monitoring system such as BAS and BEMS has not been installed, and then operation and maintenance of the facilities is costly at this time. The consumption situation of each facility is not recognized correctly. Energy saving is expected by making energy consumption recognizable with installation of BEMS. Regarding (2) installation of LED lighting, many standard fluorescent lights are installed in this facility at this time, hence energy saving effect is expected with LED. Regarding (3) replacement of existing chillers and (4) replacement of existing pumps, ESCO model

which does not need initial cost is highly concerned. (3) Replacement of existing chillers has a major effect on energy saving for the whole facility because the power consumption of the chillers accounts for more than 50 % of the total. Energy saving has been deemed to be possible by enhancement with high efficient types because the facilities are deteriorated as well as (4) pumps. Above-mentioned measures for energy saving and estimated cost effectiveness are summarized as follows.

	Outline	Estimated Amount of Initial Investment	CO2 Emission Reduction Amount	PBP*	Notes
Installation of BEMS	• Install BEMS to manage energy consumption	• Rp 5.4 Billion	• 400 tCO2/年	• 11.0 yrs • 5.5 yrs	• Proposal to be prepared by BEMS solution provider
Installation of LED lightings	• Replace existing 1,000 lightings with LED type (tentative)	• Rp 1.1 Billion	• 100 tCO2/年	• 7.3 yrs • 3.6 yrs	• Request for profit share from Hotel A • Proposal to be prepared by lighting solution company
Replacement of Existing Chiller	• Replace three existing chillers with two latest high-efficient chillers	• Rp 6.0 Billion	• 900 tCO2/年	• 4.4 yrs • 2.2 yrs	• Proposal to be prepared by A/C equipment manufacturer (tentative)
Replacement of Existing Pump	• Replace nine existing pumps with 5 latest high-efficient pumps	• Rp 2.1 Billion	• 100 tCO2/年	• 13.5 yrs • 6.8 yrs	

* (Above)
• Not Supported
(Below)
• Financial Support from JCM Program
(50% of initial investment)

Fig. 11 Recommended energy saving measures for Commercial building A

5.4. Next step

We are planning to launch concrete negotiations toward applying JCM, specifically, selection of manufacturer for the facilities, negotiation with candidate sites and establishment of a consortium. We are also discussing activities for project expansion. To find new sites, we intend to conduct energy diagnosis of hospitals, universities, etc. Furthermore, we will examine possibility of collaboration with Green Building Awareness Award conducted by Surabaya city.

Transportation Sector: ALMEC VPI Corporation

1. Background of the Target Country / City

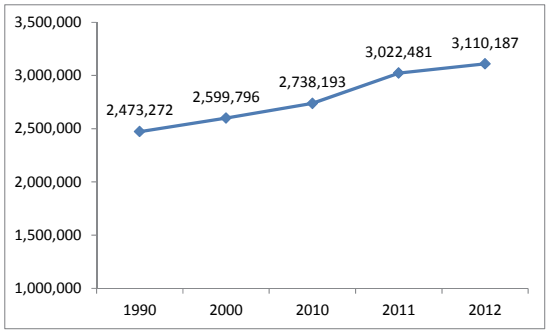
1.1 Outline of the Target City

(1) Present condition

Surabaya City has a population of about 3.1 million. It is positioned as the center of industry and commerce in East Java Province.

1) Population

The population of Surabaya has been increasing for 20 years. As results, the population density exceeds Tokyo and Osaka.



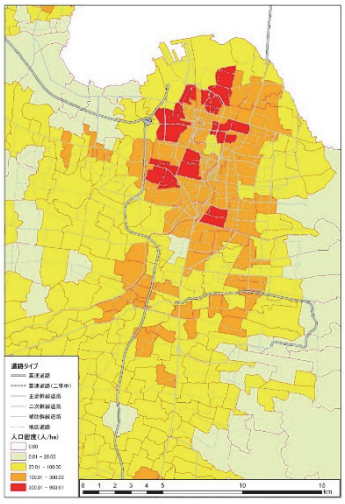


Figure 1.(1) Population of Surabaya

Source: Surabaya City Government (surabaya.go.id)

2) Vehicle Sales in Indonesia

The number of vehicle sales in Indonesia shows an increasing trend in recent years. Although the share of commercial vehicles increases, passenger cars still dominant.

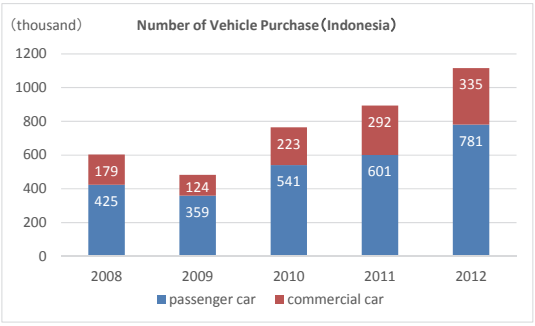


Figure 1.(2) Annual Vehicle Sales in Indonesia

Source: GAIKINDO

3) Road Traffic

The rapid increase in private car has caused heavy traffic congestion while it has forced road-based public transport to decline their service levels. Due to a one-way traffic system widely applied in the city's CBD, the mileage per vehicle must increase.

4) Public Transportation

In regard to available public transport services, there are city buses using main terminals while mini-buses, *angkot* and taxies serve using minor terminals.

Purabaya Bus Terminal located in the southern part of the city is always crowded. Regardless of congestion, taxies and private cars use the terminal and its surroundings. Most of buses and minibuses don't leave the terminal until passengers are fully onboard. It results in delayed bus service, congested terminal and no additional space for passengers who wait for buses at middle bus stops.

(2) Traffic Problems

Salient traffic problems in the city are:

- traffic congestion caused by increasing private cars;
- worsening of air pollution by traffic congestion; and
- lack of a hierarchical public transportation network

1.2 Transportation Plan

(1) Urban Transportation Plan

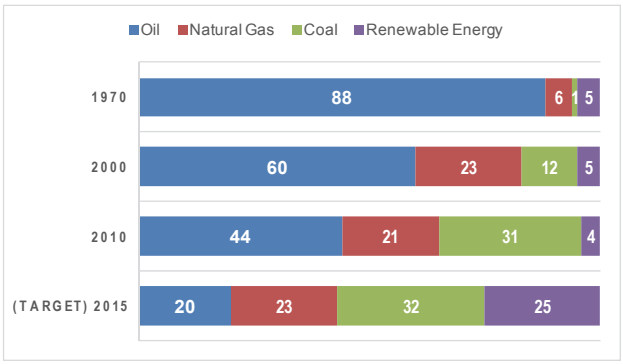
The JICA study in 2011 plans Mass Rapid Transit (MRT) and Bus Rapid Transit (BRT) to be operational in 2030.

Figure 1.(3) Urban Transportation Planning in 2030

Source: The Study on Formulation of Spatial Planning for GERBANGKERTOSUSILA (GKS) Zone in East Java Province in the Republic of Indonesia, 2011, JICA

(2) Energy Plan

In Indonesia, the energy strategy sets at using natural gas. Various low-pollution traffic systems are required from two purposes: implementing the energy strategy and protecting the environment. Introducing CNG vehicles can diversify transport fuel sources and thus improve energy security in compliance with the recent governmental policy.



Source: ESDM report

Figure 1.(4) Composition of Energy Sources in Indonesia

2. The Project

2.1 Project Directions

❑Long-term direction: Introduction of CNGV in line with BRT development

BRT can provide more punctual and frequent and larger capacity service than ordinary buses. The afore-mentioned JICA study plans to introduce BRT in Surabaya City in 2030. CNG BRT fleet will be assigned for the improvement of operation service in terms of environment, safety, and convenience.

Trans Jakarta

❑Short and mid-term direction: Introduction of CNGV for Bus and Taxi Services

As a step to assign CNG BRT fleet in the long-term, CNG vehicle, CNG station and CNG management system will be developed for bus and taxi service in the short and mid-term.

2.2 Applicable Technology

The main applicable technology is CNG vehicle and CNG station. CNG vehicle is the vehicle which stores natural gas in a gas bottle by high pressure (20MPa).

In CNG vehicle, there are two types. The first type is dedicated CNG vehicle, and the second is bi-fuel CNG vehicle. Bi-fuel CNG vehicle is to equip CNG conversion kit with a gasoline or diesel car.

In CNG station, there two types: pipeline system and mother-daughter system. The mother-daughter system use a trailer transporting gas fuel.

■ Cost of CNG conversion kit – in the case of gasoline vehicle to CNG vehicle

JAPAN	About 500,000 yen（FKmechanic , HKS） * including construction costs, by maker's HP, interview
ITALY	About 200,000 yen（Lovato） *not including construction costs, by interview with Auto Gas
CHINA	About 50,000 yen（Tianlan Gas） *by maker's HP

3. Study Method

3.1 Study Objective

The study is to assess potential environmental improvement and possible CO_2 emission reduction by way of introduction of low carbon vehicles and improvement of operation efficiency. For this purpose, some field surveys such as vehicle operation survey, CNG facility survey and stakeholders' interview, have been conducted to select a feasible project.

The target vehicles are bus, taxi, *angkot* and garbage collector in the study.

Public transportation			Garbage collector
Bus	Taxi	*Angkot*	
			

3.2 Study Workflow

Collection of operation data	Examination of operational situation	Traffic conditions survey
Method: use of GPS devices Target:40 vehicles (4 types X 10 vehicles) Output: route, travel speed, time	Method: interview Target: 4 operators Output: operation cost, management organization	survey of the traffic situation and infrastructure

↓

Selection : Identification of Project for FS (target vehicles and applicable technology)

↓

FS : Carrying out FS on the above-selected project

3.3 Project Organization

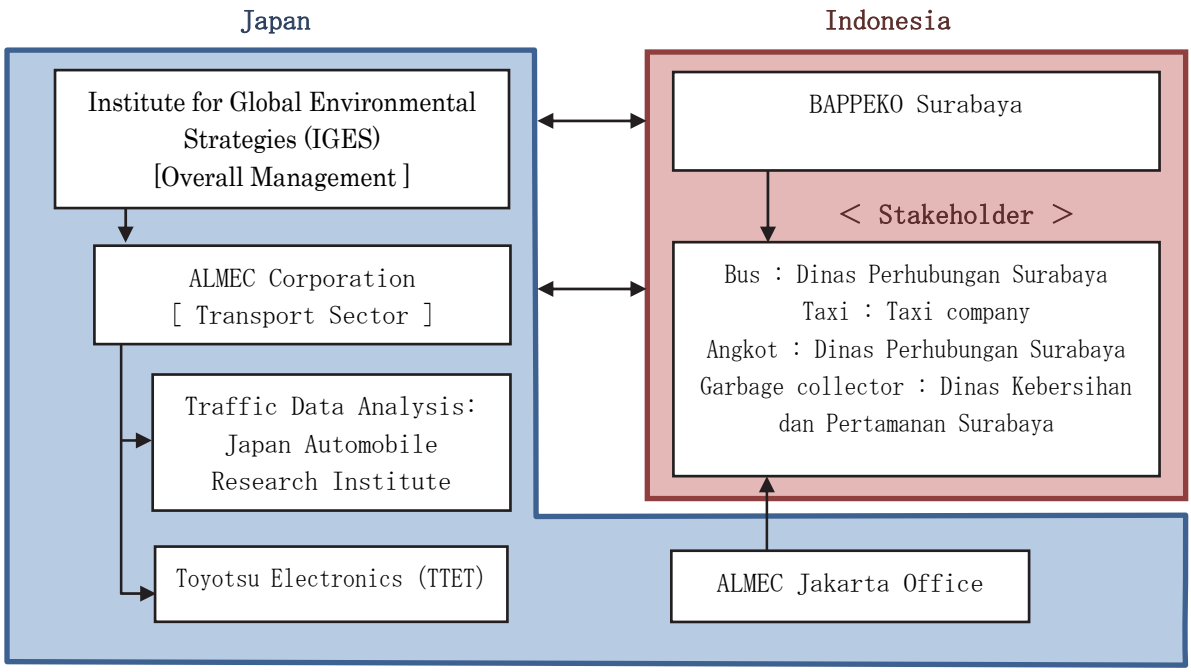


Figure 3.(1) Project Organization

4. Study Results

4.1 Result of Operation Data Survey

(1) Operation data（Travel time ratio）

- The travel time ratio of **Bus** is high (86%) but it is not considerably different in each vehicle.
- The travel time ratio of **Taxi** is a little high (60%) but it is not considerably different in each vehicle.
- The travel time ratios of ***Angkot*** and **Garbage Truck** are low (under 50%) and they are considerably different in each vehicle.

*Travel time ratio= travel time / operation time

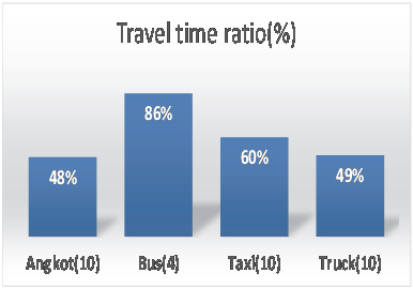


Figure 4.(1) Travel Time Ratio

(2) Characteristic of driving

＜**Idle time ratio**＞

- The idle time ratio of **Bus** is very high (60%) due to probably low average speed.
- The idle time ratio of **Taxi** is not high (27%) but it is not considerably different in each vehicle.
- The idle time ratios of ***Angkot*** and **Garbage Truck** are not high but they are considerably different in each vehicle.

* Idle time ratio = time of engine “ON” and speed “0”/ travel time

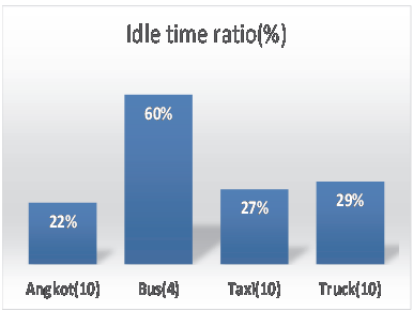
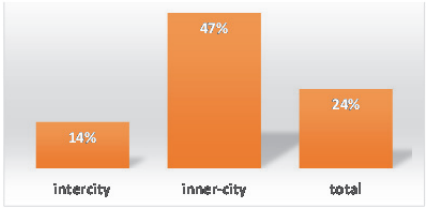


Figure 4.(2) Idle Time Ratio

In the Case of Japan



The idle time ratio of inner-city traffic: 47%

The idle time ratio of inter city traffic: 14%

Source: The Energy Conservation Center, Japan

Figure 4.(3) Idle Time Ratio in the Case of Japan

＜ **Speed distribution**＞

- ***Angkot*** recorded slow travel.
- The travel speed distribution of **Bus** and **Taxi** is large and thus eco driving effect may be considerable.

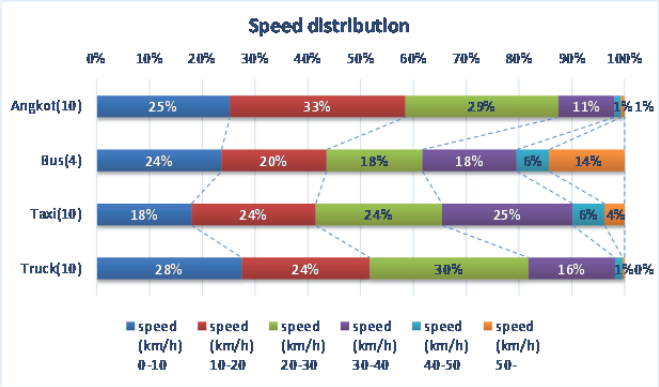


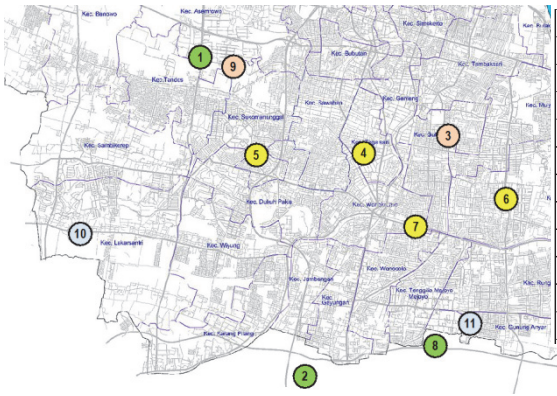
Figure 4.(4) Speed Distribution

4.2 Result of Interview Survey

Bus DAMRI	The number of vehicles owned：253（Mercedes 200，Hino 50，Hyundai 3） Average fuel consumption：3.48 km/L Average distance：6,268km/month（by fuel consumption data） Management system：by three divisions (every day/ every week/ every month), There is a maintenance training program.
Taxi O-RENZ TAXI	The number of vehicles owned：737（all TOYOTA LIMO,1500cc,gasoline） Average fuel consumption：11.68 km/L Average distance：5,579km/month（by fuel consumption data） Management system：There is a workshop. A car is workable for 5 years while 100 vehicles are replaced every year.
Angkot Organda	The number of vehicles owned：5,400 The number of routes：79（Organda 50, SPTI 29） Average fuel consumption：12 km/L（by interview, no data） Management system：Maintenance should be done by driver. No operation data is available.

Garbage Collector	Dinas Kebersihan dan Pertamanan Surabaya（DKP） The number of vehicles owned：119 (Arm roll: 92, compacter: 12, truck: 15) all diesel Average fuel consumption：5 km/L (by interview, no data) Management system：Easy maintenance and repair is done by themselves. Other repairing works are done by Astra Group, the vehicle supplier.

4.3 Result of Traffic Conditions Survey

CNG Station	There are 11 CNG Stations either in operation or under planned. 

No	Operator	Type	Status
1	CNE	pipeline	active
2	CNE	pipeline	active
3	CNE	mother-daughter	not active
4	CNE	mother-daughter	planning
5	CNE	mother-daughter	planning
6	CNE	mother-daughter	planning
7	CNE	mother-daughter	planning
8	Zebra	pipeline	active
9	Zebra		not active
10	-	mother-daughter	not active
11	-	pipeline	not active

CNG Conversion Engineering	AutoGas（CNG conversion company） PT. AutoGas in Surabaya has 2 engineers who converted 60 vehicles to CNG-V within one year (2013) PT. CNE in Surabaya provides similar service.

4.4 Evaluation of Technology

Based on the result of field survey, technical applicability as a JCM project is evaluated in terms of low carbon vehicle, improvement of operation efficiency and eco driving. In regard to low carbon vehicles, we select CNG vehicles since the Government of Indonesia promotes CNG vehicles and CNG stands as a national energy strategy.

	CNGV	**Improvement of operation efficiency**	**Eco driving**
Energy Security	It is along with the national energy strategy. .	Since it is not an alternative fuel, the effect to energy security is low.	(the same as left)
Environmental Improvement	CNGV rarely discharges NOx and PM. In the case of passenger car, CNG Vehicle can reduce CO_2 emission by 19%.	Large environment improvement can be brought about by taxi allocation control system and garbage collection system with intermediate depots.	Eco-driving may improve fuel consumption by 10%-20% but it depends on traffic situations.
Economic Aspect	CNGV is costly but it can enjoy lower fuel cost. So it is advantageous to long distance driving vehicles such as taxi or bus.	Bus companies and major taxi companies have already worked for the improvement of operation efficiency.	Eco-driving as a JCM project needs to collect and analyze monitoring data. Such project management cost must be considered.
Evaluation	○ CNGV is suitable to a JCM project since it match the national energy strategy and considerable environmental improvement is anticipated in project implementation.	△ Bus and taxi companies have already improved operation management at a high level. Garbage collection improvement with intermediate depots will be analyzed separately.	△ Eco-driving as a JCM project must require a sizable cost and some period of preparation. So it is better to encourage operators to practice eco-driving without project.

More precisely, the following effects are anticipated when introducing CNG vehicles:

(1) Government Policy for Improved Energy Security

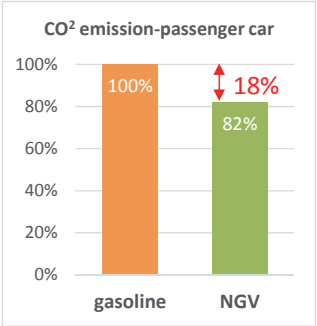
Introducing CNGV can diversify transport fuel sources and thus improve energy security in compliance with the recent governmental policy. Competitive and stable CNG price can be expected in the future.

(2) Environmental Improvement

CNGV can improve air conditions with less emission of pollutants such as

NOx and PM than conventional petrol vehicles.

In case of passenger cars, CNG vehicles can reduce CO_2 emission by 19%.



(3) Economical Improvement

The CNG unit price is less than half of gasoline, less than 60% of diesel. The fuel cost per km of CNGV is cheaper than that of gasoline or diesel car.

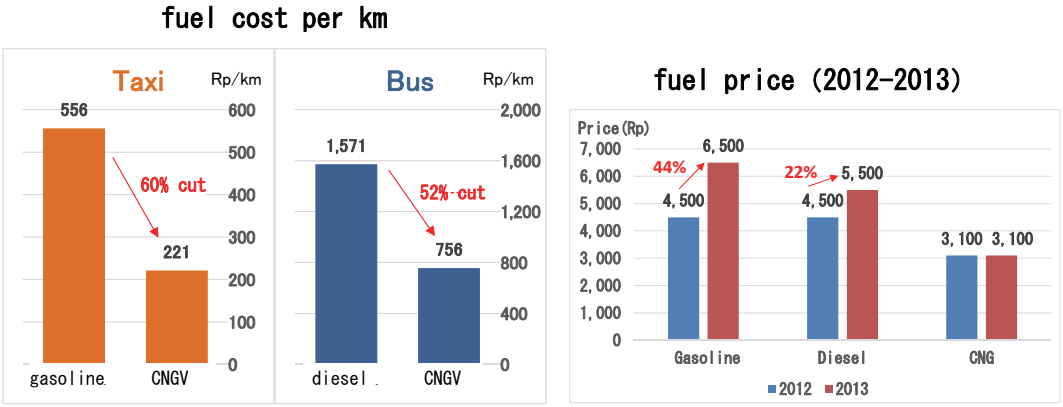


Figure 4.(5) Fuel cost per Km / Fuel Price [Pertamina price]

4.5 Identification of Project Target for JCM

Based on the result of field survey, “Introduction of CNGV for Bus and Taxi Services“ has been selected as a target JCM project in the transport sector subject to feasibility study. There are some local reasons affecting the project selection as follows:

- ✓ There are 11 CNG stations either in operation or under planned in Surabaya City area.
- ✓ Buses run on decided routes (DAMRI) while taxi operation areas are delineated (O-RENZ). It is advantageous to construction and operation of an efficient CNG station.
- ✓ Both the companies provide good fleet maintenance by workshop and training. They seem to have established safety management.
- ✓ Both the companies are positive to introduce CNGV under the situation that CNG stations are sufficiently distributed.

❑***Angkot***

- ✓ It is difficult to keep good maintenance of CNG and record daily operation due to individual business.

- ✓ CNG device must be physically separated from passenger space. However safety monitoring is difficult.
- ✓ The role of *angkot* in the overall urban transport system should be re-designated prior to the introduction of CNG vehicles.
- ✓ Because of *angkot*'s slow travel pattern, EV may be better suited than CNGV.

Dangerous setting !

Good practice !

❑**Garbage Collector**

- ✓ The current operation pattern can be modified with greater efficiency by intermediate depots.
- ✓ Beside solid waste management improvement, the garbage collection pattern with intermediate depots will be analyzed from a transport planning viewpoint such as CO_2 reduction effect.

5. The Way to JCM project

5.1 Implementation Organization

The proposed implementation organization is illustrated below. Under the JCM project mechanism, an implementing body can expect project subsidy which is up to 50% in the case of facility investment. If project subsidy could be mobilized, an implementing body would invest the remaining portion. In the case of a bilateral consortium between Japanese and Indonesian companies, for example, Japanese company will invest the reaming portion and Indonesian company will use the facilities to be invested by JCM subsidy and Japanese company and pay back as a leasing fee during a project period.

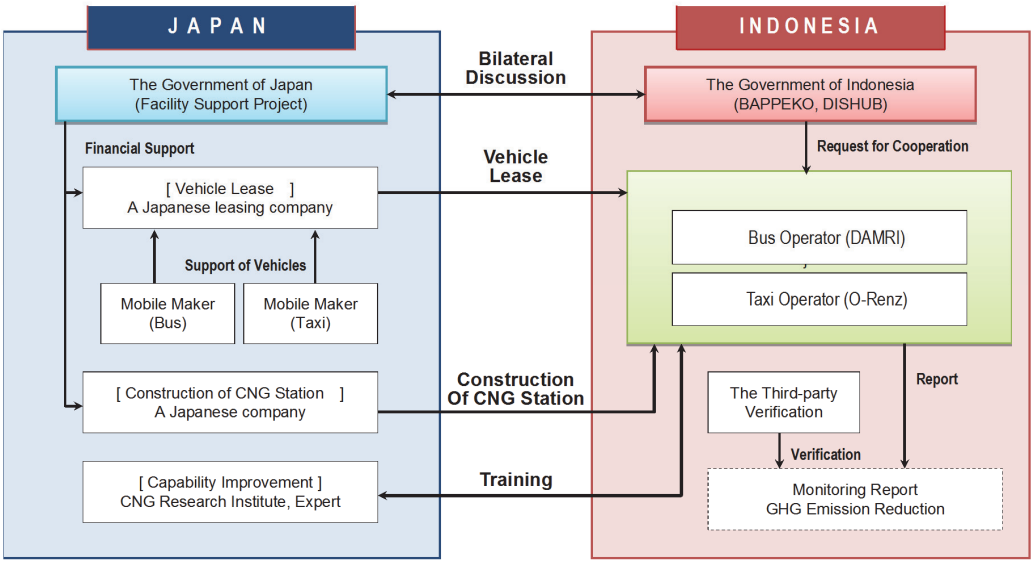


Figure 5.(1) Implementation Organization

5.2 Payback Period

Although CNG vehicle price is higher than gasoline or diesel car, a fuel cost is cheaper. So it is advantageous for long mileage vehicle like taxi or bus. High effect is expectable by bus and taxi which run long distance every day.

It is estimated that payback period is within 5 years in both the cases of bus and taxi.

Table 5.(1) Payback Period of Bus and Taxi

Taxi (Rp)

	a)gasoline	b)CNG	a-b	
vehicle price(Rp)	199,155,000	316,305,000	117,150,000	TOYOTA-HP、probox
fuel efficiency(km/L,m^3)	11.7	14.0		a)O-RENZ average、b)Tokyo Gas HP
fuel unit cost(Rp)	6,500	3,100		
fuel cost per km(Rp)	556	221		
distance (km/year)	72,000	72,000		O-RENZ average
fuel cost(Rp/year)	40,032,000	15,912,000	24,120,000	
payback period(year)			4.9	

Bus (Rp)

	a)diesel	b)CNG	a-b	
vehicle price(Rp)	800,000,000	1,100,000,000	300,000,000	DAMRI社ヒアリング
fuel efficiency(km/L,m^3)	3.5	4.1		a)DAMRI average、b)TTLC（Jakarta）
fuel unit cost(Rp)	5,500	3,100		
fuel cost per km(Rp)	1,571	756		
distance (km/year)	75,600	75,600		DAMRI average
fuel cost(Rp/year)	118,767,600	57,153,600	61,614,000	
payback period(year)			4.9	

5.3 Project Schedule

If the continuous feasibility study is carried out in the Japanese fiscal year of 2014, CNG vehicles will be introduced in a small-scale and the project scheme and MRV methodology proposed in this report will be evaluated. CNG stations will be developed in 2015 and later.

＜2014: Main contents of the continuous FS>

- To investigate an implementation plan and a financial plan
- To make consensus building among stakeholders
- To undertake small-scale introduction of CNG vehicles
- To monitor and report CO_2 reduction based on the MRV Methodology suggested in this report

＜2015 - 2016＞

In 2015, to ensure gas demand at already available CNG stations, CNG vehicle will be introduced as priority.

In 2016, the number of CNG vehicles will be expanded and one CNG station will be constructed. For example, all of O-RENZ Taxi vehicles are Toyota manufactured and they have replaced 100 vehicles every year. So in addition to bi-fuel CNG vehicle using conversion kit, dedicated CNG vehicles will be introduced at the time of replacement.

- To ensure gas demand, CNG vehicle will be introduced as priority in 2015.
- Introduction of CNG vehicle will be expanded and construction of 1 CNG station in 2016.
- Capability improvement training will be carried out.

Table 5.(2) Project Schedule

Project Year	CNG Vehicle		CNG Station	Capability Improvement
	Bus	Taxi		
2014	Feasibility Study			
2015	10	50	－	1st training
2016	20	100	1	2nd training
Total	30	150	1	

5.4 Estimation of CO_2 Reduction

The above proposed JCM Project (2014-2015) can reduce 885 tons of CO_2 based on the estimation below.

When CNG Vehicles are spread out to all taxi and bus fleets, we can expect to reduce 40 thousand tons of CO_2 under the year 2013 situations.

Table 5.(3) Estimation of CO_2 Reduction

Taxi	Units	Reference	Project	emission reductions
Referential fuel consumption of vehicle category i	L/km	0.0856	0.0518	
Net Calorific value of fuel type x	GJ/kl	32.8	50.5	
CO2 emission factor for fuel type x	tCO2/GJ	0.0693	0.0561	
Total drive distance	km/y	66,948	66,948	
Number of vehicles	unit	150	150	
CO_2 emission	**tCO_2/y**	**1,955**	**1,472**	**483**

Bus	Units	Reference	Project	emission reductions
Referential fuel consumption of vehicle category i	L/km	0.2874	0.2000	
Net Calorific value of fuel type x	GJ/kl	37.7	50.5	
CO2 emission factor for fuel type x	tCO2/GJ	0.0687	0.0561	
Total drive distance	km/y	75,216	75,216	
Number of vehicles	unit	30	30	
CO_2 emission	**tCO_2/y**	**1,679**	**1,278**	**402**
Total	**tCO_2/y**	**3,634**	**2,750**	**885**

5.5 Issue for the Project

Although the government distributed CNG conversion kits to the public transportation operator for free in 2011 and 2012, they did not be used. Raised issues are worth noting for the proposed JCM project:

- Lack of CNG stations: There are only 3 CNG stations which are in operation around Surabaya City. All of them are located far from the central area.
- Fluctuated CNG price: The operator concerns about CNG price hike in the future.
- Safety of CNG conversion kit and invalidation of vehicle guarantee: Installing a CNG conversion kit, an operator has two apprehensions. They are safety of CNG devise and vehicle manufacturer's guarantee which may be invalidated after conversion.

5.6 Policy for the Development

Taking the issues for the project into account, necessary government policies to implement the proposed JCM project and promote CNG vehicles broadly are identified as below:

Promotion of related infrastructure and facility	The government's support to CNG stations[*1], and BRT development.
Economic aspect	The government policy to stabilize CNG price [*2] and

	subsidy CNG vehicles.
Safety	The government policy to establish maintenance organization [*3] and keep the maker's vehicle guarantee after installing CNG conversion kit
MRV methodology	In addition to the MRV methodology about CNGV, a new MRV methodology about modal shift by BRT will be developed.

*1; In addition to the 3 operating stations, there are 4 stations waiting for permit from the local government. The 4 stations will be located near the central area, it is expected that using CNG will be spread over by these operation. As a CNG station needs a large amount of investment in construction, the MRU (Mobile Refueling Unit) system which carries and supplies CNG by truck from CNG station is worth considering for economic and convenient fueling service. Currently PT. CNE owns 2 MRU trucks.

*2; In order for a CNGV user to use CNG in comfort, it is required for the government to show a policy about a CNG price.

*3; Establishment of maintenance organization and capability improvement training will be carried out by the cooperation among CNG engineers, vehicle manufacturers, and counterpart agencies.

In order to encourage similar projects over the country, it is important to evoke CNG demand through this model project in Surabaya. After that, it is expected that CNG will be spread autonomously over various places. When CNG infrastructure will be ready by this project, it is also expected that it will benefit several sectors such as freight truckers and garbage collectors.

Solid Waste Sector

Solid Waste sector

As “Solid Waste Sector”, we will conduct Feasibility Study (F/S) about 1.MSW (Municipal Solid Waste) and 2.Industrial Waste in Surabaya City. The identification of GHG emission reduction under JCM scheme will be calculated as well. About 1.MSW, the scope of Nishihara Corporation is sorting of waste and composting of organic waste, the scope of Hitachi Zosen Corporation is waste-to-electricity. Amita Corporation aims to develop the business by waste generated alternative fuel, and materials to replace fossil fuel and natural resources used by Indonesia's cement manufacturers.

Companies	Target waste and Business
Nishihara Corp.	Target : MSW Business : Sorting of waste and Composting of organic waste
Hitachi Zosen Corp.	Target : MSW Business : Waste-to-electricity
Amita Corp.	Target : Industrial Waste Business: Alternative fuel, and materials for cement manufacturers.

About MSW, Composition survey will be conducted at Super Depo which was constructed by Nishihara Corp. in March 2013. Super Depo can sort 10-15tones/day of MSW. From the composition survey, they will consider the feasibility of business and calculate GHG emission reduction. The point will be the “residue” after sorting. The residue is transferred to Final dispose site. Nishihara Corp. will consider the feasibility on the assumption that they will be able to sort all the valuables (plastics, papers etc). Hitachi Zosen will conduct the F/S on the assumption that the residue will be utilized by the waste-to-energy method.

In Indonesia, industrial waste is categorized as “B3 waste”. As a result of the economic growth, the amount of such industrial waste is on the increase, but simple incineration and reclamation disposal are employed in most cases.

Amita Corporation will conduct the F/S on the assumption that they will establish a plant for recycling resources. The plant will manufacture waste generated alternative fuel and materials for cement manufacturers. They will calculate the amount of GHG emission reduction by the use of waste generated alternative fuel, and materials to replace fossil fuel and natural resources by Indonesia's cement manufacturers

Solid Waste Sector: Nishihara Corporation

Feasibility Study of the Recycle Business in Surabaya City, Republic of Indonesia

1. Introduction and Key Findings

1.1 Introduction

This study aims at analyzing and evaluating a recycle business model for MSW management in Surabaya city. The main subjects are (1) to consider a business model, (2) to conduct a composition survey of MSW and collect macro data of waste management, and (3) to estimate GHG reduction from study results.

1.2 Key Findings

The study shows the key findings as follows.

(1) Business model:

- Based on the calculation of sales profit and running cost, the net operating income will be Rp458 million per month, or Rp5.5 billion per year; and
- Even if we achieve that amount of net operating income above, it will be difficult for us to bear the initial cost independently in terms of business feasibility.

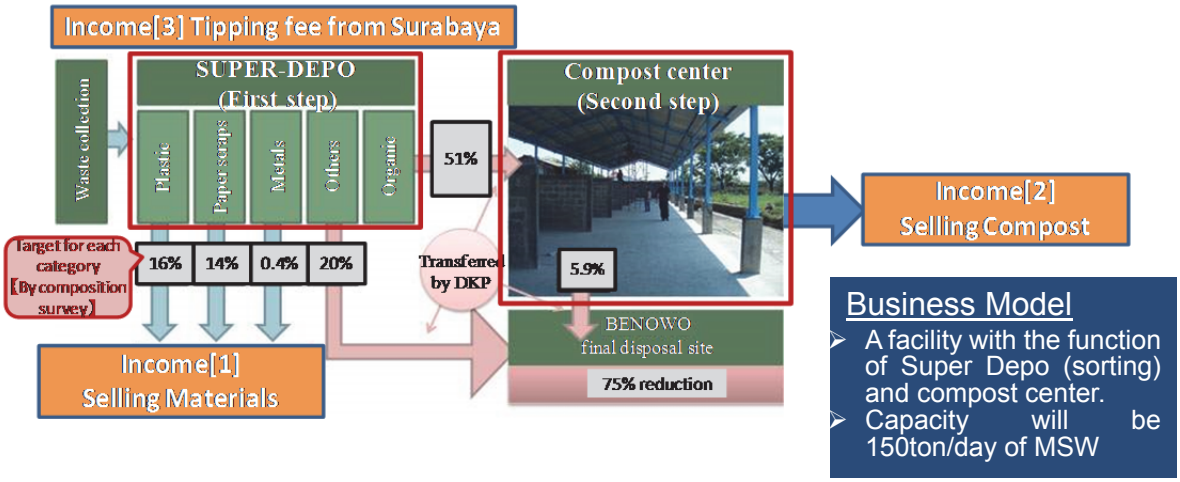
(2) Composition survey:

- 50% will be used for the compost and 30% will be suitable for the valuables (such as plastics and papers), out of the MSW at the Super Depo; and
- The potential of organic waste, which will be the target of composting, is estimated to be 1,855 t/day in Surabaya.

(3) GHG reduction

- Large facility with separation and composting x 1 10,500 t-CO2/year
- Large facility with separation and composting x 6 63,000 t-CO2/year
- Whole potential for compost in Surabaya 250,000 t-CO2/year

2. Business Model



2.1 Outline and Schedule

The outline of the business model is deploying treatment facilities consisting of sorting and composting functions to reduce, reuse and recycle waste. After collected, waste is selected and processed for composting and selling that produce income. Tipping fee for collection is also paid by Surabaya.

One Super Depo has already operated since March 2013 as a pilot project and treats 10 to15 t/day of MSW. As a demonstration and pilot of composting process, we are preparing for the construction of a composting center in Wonorejo in 2014, which can accepts 20 to 40 t/day of organic waste. Furthermore, large facility of waste separation and composting at a scale of 100 to 150 t/day will be constructed in 2016. This model aims at developing a self-sustaining business model in Surabaya and Indonesia supported by Japan, Indonesia and Surabaya.

2.2 Business Feasibility

In terms of the business feasibilities, the scale of facility will be "150 t/day of MSW". The net operating income of Rp458 million per month, or Rp5.5 billion per year, will be expected (not including the initial cost). The main income will be 1.selling valuables (compost, plastics, papers etc) and 2. tipping fee (Rp100/kg) from Surabaya

2.3 Issues of Business Model

Initial cost:

- We assume that initial cost of "Waste Separation and Composting Center", which accepts 150 t/day of MSW, will be approximately Rp5 billion.
- Net income will be around Rp5.5 billion/year, however, it is not realistic to prepare the initial cost from our own fund in consideration of the interest rate or tax; and
- We would like to consider the possibility of obtaining the public financial support for the early deployment of the business.

Profit of selling compost:

- We assume that fertilizer makers (Petro Kimia, etc) will buy our compost as materials of organic fertilizer; and
- To make sure the profit by selling compost, we have to establish the business flow by considering the balance of these 3 points, (a) Requirement of compost from makers and local governments, (b) Cost of operation and other materials to meet the requirement; and (c) Price of our compost.

3. Composition Survey and Macro Data

3.1 Composition Survey at Super Depo

A composition survey at "Super Depo" in December, 2013 shows that 51.4% of the MSW

(compostable food waste and woods) can be used for compost and 29.4% of the MSW (papers and plastics) can be used for valuables.

3.2 Waste and Waste Composition from Generation Source

The survey conducted by JICA (Japan International Cooperation Agency) shows the total amount of waste is 2,642 t/day in 2008. This survey also shows the waste composition from generation source. Kitchen waste, and grass and woods will be sources for composting, and potential of organic waste discharge for composting in Surabaya is found to be 1,855 t/day.

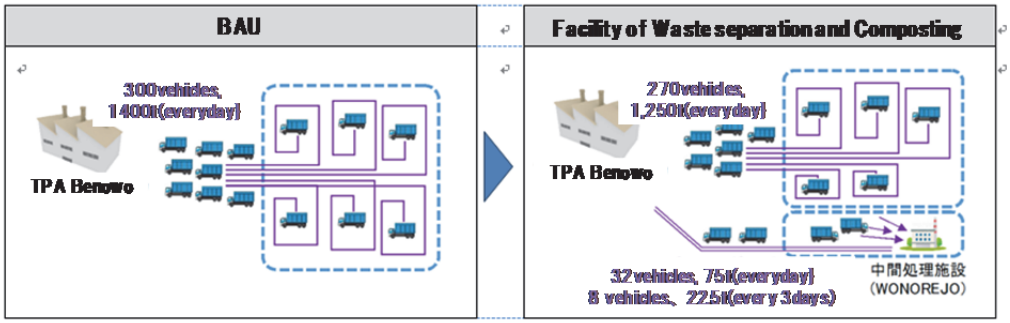
4. GHG Reduction

4.1 Calculation method of GHG Reduction

For "Reference GHG Emission (RE)" during the composting process, we will apply the methodology proposed in Laos for JCM scheme. In addition, we will consider the CO2 emission from the transportation vehicles of waste.

For "Project GHG emission (PE)", we need more information of composting process, e.g., amount of electricity and fossil fuel consumption in composting center. We use the emission factor calculated from the survey at Malang, East Java, or the amount of GHG generated by composting process is 0.14 t-CO2/ton (waste).

Furthermore, we considered the GHG reduction by the improvement of the transportation vehicles of waste.



4.2 GHG Reduction Potential

We calculated GHG reduction potential from 3 patterns as follows:

(a) Large facility with separation and composting x 1:
10,438 t-CO2/year (128 t-CO2/year is by transport);

(b) Large facility with separation and composting x 6:
62,570 t-CO2/year (710 t-CO2/year is by transport); and

(c) Whole potential for compost in Surabaya: 249,210 t-CO2/year (only composting)

In addition to composting, waste (MSW) management has potential for GHG reduction such as reduction of machinery use in TPA, waste to energy, etc.

Solid Waste Sector: Hitachi Zosen Corporation

Executive Summary

2. Outline of the Project

(1) Background

In Indonesia, although there should be accordance to the law against municipal waste open dumping and a similar law that orders the foreclosure of final dumping sites within 5 years of operation, regional governing bodies are still greatly restricted financially and are unable to come up with a tangible resolution. In addition, organic waste accounts for more than 70% of the total municipal solid waste, however effective utilization and reduction of the organic waste are challenges that need to be considered.

In 2012, Nishihara Corporation introduced an intermediate treatment facility, “Super Depot” into Surabaya City commissioned by the Ministry of Foreign Affairs Japan as a Feasibility Survey for waste disposal treatment. Based on the operations of the Super Depot including source separation of disposed waste and the acquisition of valuable wastes and organic wastes that can be turned into compost, from this year Nishihara Corporation is starting to plan for a composting facility.

In the next proposal, we propose a system which generates electricity from waste residue that is being produced by the Super Depot and the composting facility. Mainly, we should aim to target municipalities with a greater ratio of organic wastes as the combination of the Super Depot or composting facility with electricity generation by waste will minimize the amount of wastes going to final dumping sites and reduce greenhouse gas emissions.

(2) Applicable Technologies

For the purposes of municipal waste incineration, the selection of power reactors ranges from fluidized bed incinerators, kiln incinerators and stoker incinerators, however considering the initial investment and the ability to secure funds from the generated electricity for stable operations, the stoker incinerator is selected as the best large-scale performer.

3. Survey Methods

(1) Points of the Survey

The following 4 items are to be investigated:

① Analysis of the quality of the sample waste (Super Depot’s residue will be the focus of the study in terms of composition and calorific value)

② Examination of the waste incinerating electric generator plant (treatment flow, fundamental design, project estimate, electricity pricing)

③ Quantification of CO2 emissions reductions

④ Examination of the project's progressive measures

(2) Scope of the Survey

① Analysis of the quality of the sample waste

The treatment flow for Super Depot and the composting facility is shown in Figure 1. For this study, the 3 requirements for waste quality analysis of the wastes going into the electricity generating incinerator are shown below.

- Received waste ; 1
- Oversized waste ; 2
- Residue from the composting facility ; 3

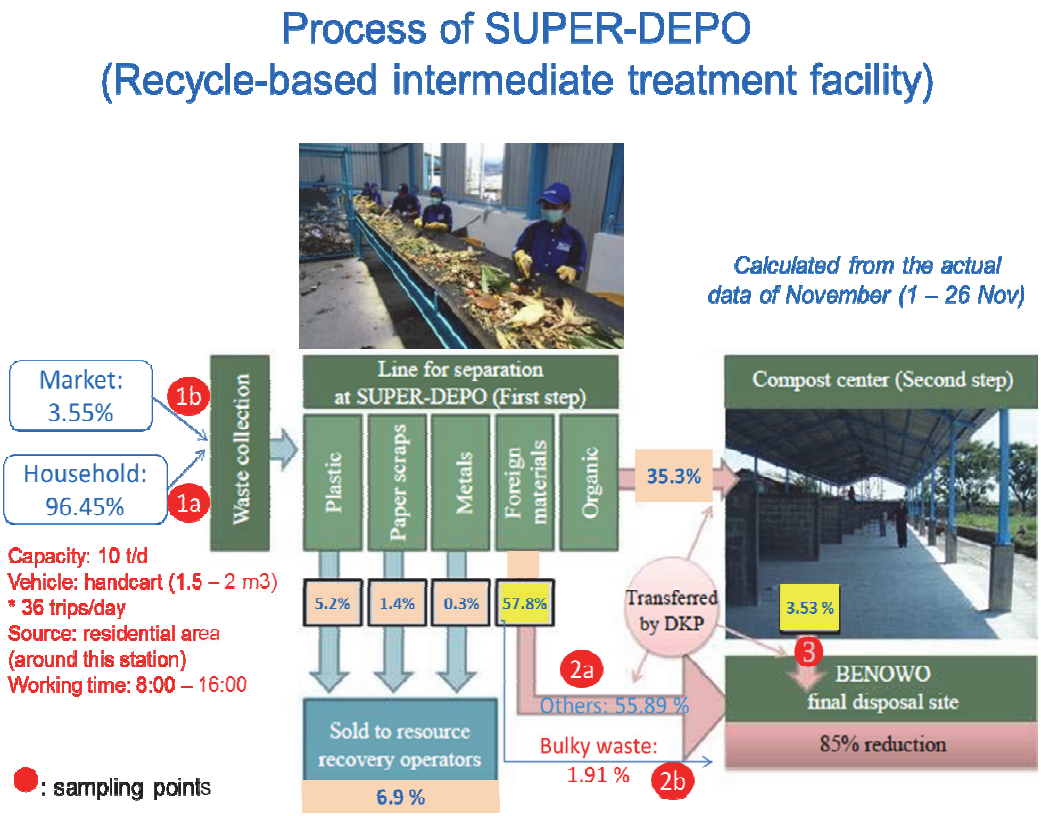


Figure 1 Waste treatment flow in SUPER DEPO and Composting site

② Examination of the waste incinerating electric generator plant

Based on the analytic results of the waste quality in ①, the basic specifications for the waste-to-electricity facility and the waste to be inputted and incinerated is decided. Using the same analytic results as a base to predict the elemental composition of the

wastes, we can determine the emitted gas temperature from the various stages of the treatment process from the combustion calculation. We can then find the recovered heat from the boiler, which in turn can calculate the electricity generated from the recovered heat.

③ Quantification of CO2 emissions reductions

Based on the generated electricity in ②, we can calculate the amount of saleable electricity once we discount the electricity being used within the facility, and Indonesia can use this co-operative alternative electricity to achieve yearly CO_2 reductions.

⑤ Examination of the project's progressive measures

It is necessary to examine the reality of the project's vision and the operations development forecasted in the next few years.

4. Survey Results

① Analysis of the quality of the sample waste

Based on the waste quality analysis results for generated electricity in ②+③, food wastes were 35% and diapers 30%, the moisture content was 67% and lower heating value was 1,115kcal/kg. The calorific value is influenced by ②'s amount of separated residue and calorific value (composition). In this analysis it showed that paper diapers resulted to 30%, however, in our preparation survey because paper diapers only amounted to a few percent, we deduce that there is an even lower caloric value than expected. For future reference, there will be further investigation of separation optimization for Super Depot as well as possible changes in the composition of the source residue from ②.

The above has been analyzed with respect to the waste-to-electricity plant and the expected calorific value of the wastes subjected to incineration based on the data from the preparation survey of 1,942 kcal/kg.

② Examination of the waste-to-electricity plant

The basic specifications for the waste-to-electricity facility are shown as below.

- Treatment capacity：500t/day for 1 line
- Calorific value：1942kcal/kg
- Steam condition：4MPa×400℃
- EPC cost：60 hundred million yen

③ Quantification of CO2 emissions reductions

By replacing fossil fuels with incinerator generated electricity, there will be CO2 reductions.

- Generated electricity：9,330kW

- Amount of electricity consumed by incineration facility：2,580kW
- Amount of electricity supplied to the grid: 6,750kW
- CO_2 emissions reductions：

  a Alternative energy to fossil fuels

  Electricity generated per year：54,000 MWh/year (=6,750 kW ×8,000h)

  GHG emissions reductions per year：0.560× 54,000 = 30,240 ton-CO2/year

  *CO2-Emmission Coefficient = 0.560t-CO2/MWh (JICA 2013)

  b Methane gas production avoidance at final dumping sites

  Waste treatment amount per year: 166,500 ton/year (500t/d×333days)

  GHG emissions reductions per year：15,000～70,000 ton-CO2/year

  * CO2-Emmission Coefficient = 90～420t-CO2/ 1000 ton （Calculations provided by Hitachi Zosen Corporation)

  c Total reduced amount (a+b)：45,000 ～100,000 ton-CO2/year

5. Analysis regarding operations development

In Subaraya city, a private business, Sunba Organic Corporation receives 1,200t/day of municipal waste to process for the landfill, and works to fulfill the condition of effective heat recovery within 3 years of starting operations. It was made clear that this company is interested in continual use of the treatment facilities with its efforts in effective usage of wastes by waste-to-energy methods and reduction of wastes entering the final dumping site. For time saving action purposes, it would be suggested to discuss the joint implementation of the feasibility survey and for the purposes of introducing waste-to-energy systems, to cooperate with waste service providers whom already possess the waste treatment operations permit.

Currently in Surabaya city, the waste treatment fee is set at a low of 1,200 yen/t, andby using the waste-to-energy system, another source of income that will greatly influence the successful progression of the operations is the selling of electricity. Further research needs to be done in this area.

In order to realize the waste-to-energy operations in Surabaya city, we intend on continuing our feasibility survey from the next year as well and have given the survey items as below.

- Understanding the waste treatment flow
- Data collection for continuous waste quality analysis
- Analysis of optimized composting recycling
- Survey of the most preferential system for purchasing waste-to-energy electricity

Solid Waste Sector: Amita Corporation

Project to Support the Large-Scale Formation of Joint Crediting Mechanism Programs to Realize Low Carbon Societies in Asia from Fiscal 2013

Project to Produce Waste-Based Alternative Fuel and Raw Materials for Cement Plants: Amita Corporation (Report Summary)

In Indonesia, industrial waste has been defined as "residue generated by business activities" by the hazardous waste management rules of the country. In the legislation, hazardous waste of an explosive, inflammable, reactive, toxic, infectious, or corrosive nature is categorized as B3 waste (Limbah Bahan Berbahaya dan Beracun), requiring processing by licensed contractors. As a result of the vitalization of the country's economic activities, the amount of such industrial waste is on the increase, with an estimated annual disposal amount of around 7 million tons.
Disposal permission for B3 waste is managed by the Ministry of the Environment (Kementrian Lingkungan Hidup), and permitted activities include volume reduction, storage, transportation, effective utilization, processing, and reclamation. Although there are approximately 60 companies granted permission, cases of recycling are few, and simple incineration and reclamation disposal are employed in most cases.

Meanwhile, in Japan, over 28 million tons of industrial waste out, of the total annual discharge of 400 million tons, is effectively utilized as the source material for cement. The ratio of industrial waste per 1 ton of cement accounts for 481kg, one of the highest in the world (fiscal 2012).

Amita Corporation undertakes resource recycling for a variety of industrial waste through the 'blending' process to produce resources including cement, alternative fuel, and raw metals. Producing slurry by mixing and homogenizing industrial waste including waste oil, oil-containing sludge, and waste liquid previously disposed of only through incineration, Amita developed an alternative fuel that is easy to handle (SlurMix ®). The product has been used mainly as an alternative fuel for replacing coal in pre-heating furnaces and rotary kilns, equipment used for the calcination process in cement plants. The product can be produced to meet user-required specifications, and due to its combustion residue utilized as raw material for cement, complete recycling without secondary waste is possible. Manufacturers of steel, lime, and paper have also been utilizing the product as an alternative fuel for crude petroleum.
Furthermore, Amita also produces CRM (Cement Recycle Material) as both fuel and raw material, utilizing a blend of sludge, combustion residue, and dust generated from the production processes of various industries. Raw CRM is mainly used in cement plants as a clay replacement, whereas the fuel CRM containing calories is used in pre-heating furnaces during the calcination process. As with SlurMix ®, these products can achieve complete recycling without generation of secondary waste. Established for 38 years, Amita recycles more than 140,000 tons of industrial waste per year, with over 4,000 kinds.

In this research project, Amita Corporation established a plant for recycling resources in Indonesia, in order to calculate the amount of carbon dioxide reduction achieved through the use of waste generated alternative fuel, and materials to replace fossil fuel and natural resources by Indonesia's cement manufacturers, verifying the feasibility of JCM/BOCM.

In this research, the following items are mainly investigated:

<Research Items>

(1) Baseline survey

- Amount of cement production
- Waste consumption rate at cement manufacturers
- Energy consumption, energy consumption rate, CO_2 emissions, and CO_2 emissions factor

(2) Market research

- Amount of industrial waste produced per type
- Current processing of industrial waste and associated costs
- Environmental legislation

(3) Feasibility research

- Construction of intermediate processing plant (raw cement material production)
- Supporting initiatives from the central government
- Formation of project financing (e.g., JBIC and JICA)

The research results can be summarized as follows:

(1) The majority of B3 waste is processed with simple incineration and reclamation disposal. Although some is recycled at cement manufacturers, the recovery percentage is low when compared to Japan. The potential resource recycling ability at cement manufacturers is high.

(2) B3 industrial waste producers in East Java must commission processing to licensed operators mostly located in West Java. Due to the distance and the high transportation costs involved, there is a market demand for affordable and stable resource recycling in East Java.

(3) The amendment of waste management legislation by the Indonesian government in 2008 prohibits any reclamation of B3 industrial waste previously undertaken by individual organizations. There is a Japanese corporation with several tens of thousands of previously disposed B3 industrial waste that needs external processing, but the availability of contractors with the capacity to appropriately process such amount of waste at a reasonable cost is extremely limited.

(4) Based on the testing of 16 B3 industrial waste samples obtained from 35 companies we have visited, the expected value of fuel CRM calculated with a weighted average method had fallen within the specification range accepted by cement manufacturers in Indonesia. In addition, the test proved SlurMix ® and the fuel CRM produced in Japan by Amita Corporation can be accepted by cement manufacturers in Indonesia.

Based on the research findings, the CO_2 emissions reduction (feasibility and mass deployment) has been calculated as follows:

(1) Estimated CO_2 reduction using alternative liquid fuel (SlurMix ®)

- Alternative liquid fuel (SlurMix ®) production capacity: 10,000t/year
- Alternative liquid fuel (SlurMix ®) calories: Average 3,350kcal/kg
→ 10,000t × 3,350kcal/kg = 33,500,000kcal/kg
- Calories of standard coal used by Semen Indonesia: Average 5,700kcal/kg
→ 5,877t/year of standard coal can be replaced
- Standard coal CO_2 emissions factor: 2.409t-CO_2/t
→ 5,877t/year × 2.409t-CO_2/t = <u>14,157t-CO_2/year</u>

As calculated above, the CO_2 reduction gained from the construction of an alternative liquid fuel (SlurMix ®) production plant to produce 10,000t of alternative fuel (3,350kcal/kg) per annum to replace the standard coal (approximately 5,700kcal/kg) is estimated to be approximately <u>14,157t-CO_2/year</u>.

(2) Estimated CO_2 reduction achieved by fuel CRM
- Fuel CRM production capacity: 24,000t/year
- Fuel CRM calories: Average 1,800kcal/kg
→ 24,000t × 1,800kcal/kg = 43,200,000kcal/kg
- Calories of standard coal used by Semen Indonesia: Average 5,700kcal/kg
→ 7,578t/year of standard coal can be replaced

- Standard coal CO_2 emissions factor: 2.409t-CO_2/t
→ 7,578t/year × 2.409t-CO_2/t = 18,255t-CO_2/year

As calculated above, the CO_2 reduction gained from the construction of an alternative liquid fuel (SlurMix ®) production plant to produce 24,000t of alternative fuel (1,800kcal/kg) to replace the standard coal (approximately 5,700kcal/kg) used in cement calcination processes is estimated to be approximately 18,255t-CO_2/year.

The cost effectiveness of the project deployment can be calculated as follows:

340 million JPY (total project cost) ÷ 32,412 t-CO_2 (reduction of energy field CO_2 emission) = approximately 10,500 JPY/1t-CO_2
In addition, other cost benefits beside CO_2 reduction include the lengthening of final disposal site usage and a reduction of vehicular exhaust gas emissions associated with transportation to West Java.

From this fiscal year's research, the recycling needs for both waste producers and cement manufacturers are recognized. However, realistic feasibility to confirm the commercialization would require market research involving a minimum of 100 companies along with a similar number of test samples; therefore, further research will be required for a final confirmation of commercial involvement.
A detailed feasibility study is scheduled to be completed by the following fiscal year, with an application to the Ministry of the Environment's Subsidy Scheme (Subsidy Scheme 1/2) upon full confirmation of commercialization.

Water Resource Sector: Matsuo Sekkei Corporation

A. Water Resource Areas (Part: Water Supply System)

1. Systems & project overview in target nation & target city

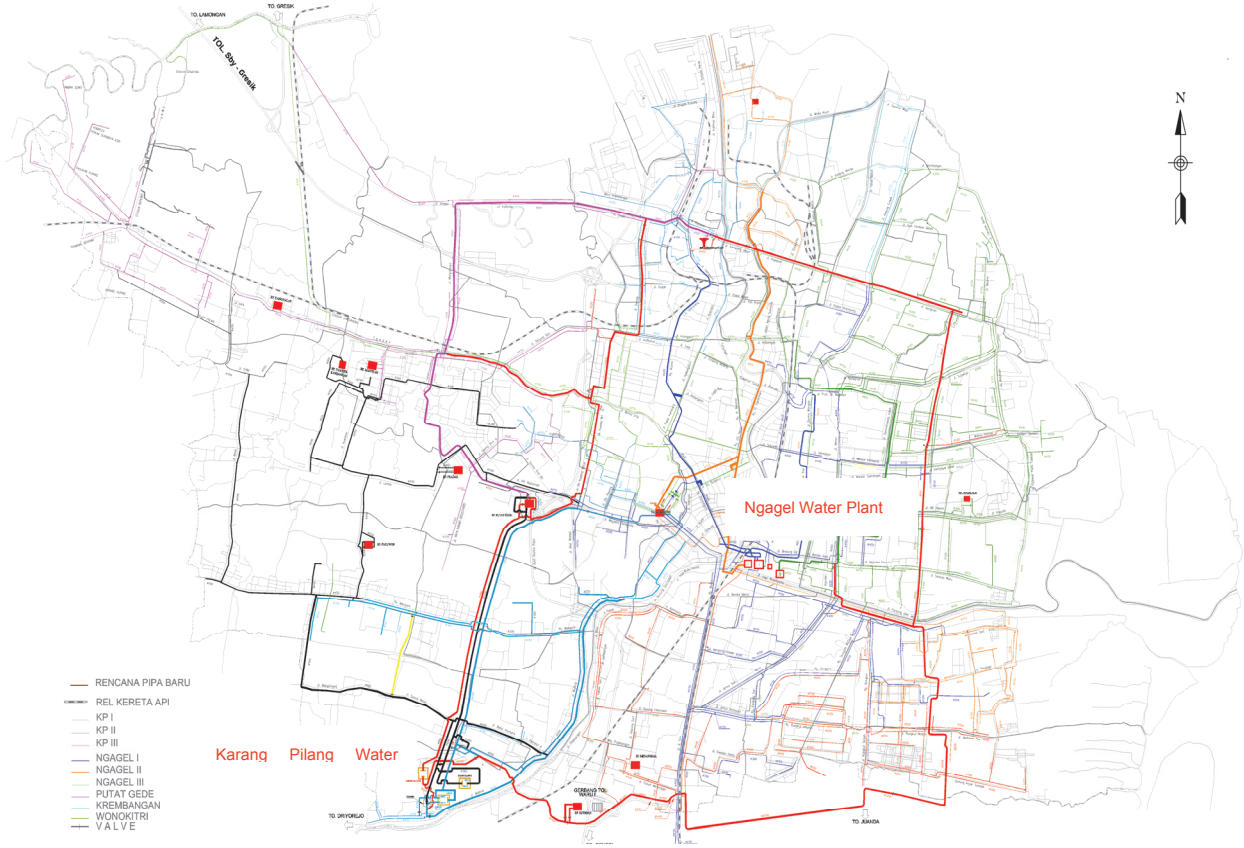
The administrative population in Surabaya City, Indonesia is 3,123,914 and 2,640,900 out of the above population:3,123,914 is the number of water-supplied population (population served by water supply as percent of total population 88.03%)

The rate for un-accounted water in Surabaya City (the proportion of un-accounted water amount to whole distributed amount from water treatment plant) is approximately 33% and specifically water-leakage ratio is 18%, operating loss such as measurement error is 10% and stolen water is 5%.

Water Supply Corporation Surabaya (PDAM) owns two (2) main-force plants (Ngagel Water Treatment Plant and Karang Pilang Water Treatment Plant) and water resource of both plants is from the river water.

Water supply throughout the city is mainly organized by pumping through distribution pumps. For distance water pumping, water supply from twelve (12) distribution stations (specifically inactive two (2) stations, nine (9) boosting pumps and one (1) distribution tank) are conducted.

Diagram－1　Layout Map



2. Investigation-Subjected Industry

2－1. Aim of Industry

We propose possibilities of CO2 reduction after studying on-site investigation and review in regard to countermeasures for energy-saving (in water treatment process and water transmission & distribution system) and water-leakage at Water Supply Corporation Surabaya (PDAM).

① Countermeasures for Energy-Saving

・ Overview of Countermeasures

In two (2) water treatment plants and twelve (12) booster pump stations, on-site investigation and its detailed check for inverter-control of pumps, pump renewal (to higher efficiency) and change of pumps to lower pump head are conducted

② Countermeasures for Water-leakage (Basic data planning)

・ Overview of Countermeasures

On-site investigation and its detailed check and review for reduction of ineffective water by promoting countermeasures against water-leakage (Ex. flow-control system installation etc.) are conducted.

3. Investigation Method

3－1. Arrangements for implementation

(1) Purpose of Investigation

Collecting existing data and confirm current conditions to study potential energy-saving facilities, equipment and water transmission & distribution system, water-leakage conditions in the process of water treatment.

(2) First investigation

【Investigation implementation period】 Jul. 4th-6th, 2013

【Investigation arrangement】Matsuo Consultants, Co., LTD

Associate director :Keishi Kabasawa, Engineer: Ichitaro Nomura

International Business Project Division,

Kitakyusyu City Water & Sewer Bureau

(Section Chef: Mr. Kubota & Mr. Kiyama Government official: Mr. Yayama)

【Place of conference and document collection】

Water Supply Corporation Surabaya

(3) Second investigation

【Investigation implementation period】 Nov. 4th-8th, 2013

【Investigation arrangement】Matsuo Consultants, CO., LTD

(Department director: Masao Nakano、Associate director: Keishi Kabasawa)

【Place of conference and document collection】

Water Supply Corporation Surabaya

4. Investigation Result

4.1 Countermeasures for energy-saving

4.1.1Water Treatment Process

From results of the first and second investigation, we found facilities are organized with regular maintenance under Water Supply Corporation Surabaya to maintain and operate properly.

Inside treatment facilities at Ngagel water system Ⅰ & Ⅱ, facility aging and processing performance decline are concerned. The 2012 electric consumption at Ngagel Ⅰ was higher

than other tank treatment systems and Karang Pilang water treatment plant. In addition, it was found that transmission & distribution pumps in Ngagel system Ⅰ & Ⅱ could not deliver rated flow rate due to aging. The plant system Ⅰ uses extremely large number of pumps.

Table 4.1(1) Treatment Capacity in Each Plant and Number & Capacity of Pumps

Plant Name		Treatment Capacity(ℓ/s)	Pump Capacity Total (ℓ/s)	Number of Pumps
Ngagel	Ⅰ	1,800	3,425	20
	Ⅱ	1,000	1,583	6
	Ⅲ	1,750	2,500	10
Karang Pilang	Ⅰ	1,450	3,640	6
	Ⅱ	2,500	3,750	9
	Ⅲ	2,000	2,800	4

Facilities require reviews on investigation in the process of water treatment are described below.

Aeration Facility	
Current Status	It is the facility to uptake DO, however, its necessity is unclear.
Counter-measure	The purpose of aeration installation is removal o iron, manganese & free carbon. Because water condition is unclear at this moment, we can not flatly deny its necessity. If aeration facility is not needed, energy-saving is possible by intake pump's lift-head change.

Pumping Facility	
Current Status	Intake pump & distribution pump are considered to directly supply steady amount of water for 24 hours. Therefore, the water flow is not controlled. The pump efficiency decline at aging Ngagel plant Ⅰ which was built in 1923 and Ⅱ built in 1956 is clear.
Counter-measure	・ Ngagel Water Treatment Plant System Ⅰ has a lot of pumps and energy-saving by optimizing its number is possible. ・The energy-saving is possible by promoting pump facilities' to higher efficiency. ・ The idea of inverter-control pump facility is refrained because the detailed pump operation hasn't studied and also from the viewpoint of fixed supply.

Power Receiving & Distribution Equipment Facility	
Current Status	The improvement of power factor is conducted by Automatic Power and Frequency Control (APFC)installation.
Counter-measure	Energy-saving is refrained because in the plants no boosting voltage inverter was found from one-line wiring diagram and power-factor was improved already.

Filter Washing	
Current Status	Regularly filter washing is conducted once in 24 hours except Ngagel plant Ⅲ which is once in 12 hours.
Counter-measure	Generally in Japan it is conducted once in 60 hours. It seems the number of filter washing is too often and it is improvable.

Sedimentation Tank Desludging	
Current Status	Regularly the drain valve installed at sedimentation tank in Karang Pilang Plant is slightly opened and drains, or discharges to the river every 15 minutes by opening the valve. Karang Pilang
Counter-measure	Although it is not limited to desludging only, we concerned that constant ineffective discharge may create useless power consumption by pump operation etc. However, on the second hearing investigation, we found it's returned to the receiving well. Therefore, we exclude this item from energy-saving countermeasure.

4.1.2 Water transmission & distribution system

There are three water distribution systems, case one is the distribution from water treatment plant by directly boosting pressure through pumps, case two is the distribution through nine (9) booster pump stations and case three is the distribution from distribution reservoirs. Each household installs a receiving tank and an elevated tank and the water is supplied a certain amount for 24 hours.

Pump pressuring is controlled by unit numbers, discharge volume opening & partial inerter-control depending on the water supply volume. It still has a room for further improvement of water-pressure control to accommodate change of water supply.

Therefore, saving the energy by installing water transmission system accommodates the change of water supply volume. (For example, inverter control of water distribution pumps)

Distribution Reservoir facility

Distribution Reservoir	Number of Places	Unit Number of Pumps	Power Consumption Estimate (kw / Year)
Direct Transmission	9	32	21,444,480
Elevated Tank	1	—	—

*Power Consumption Estimate is calculated from 50% efficiency of pump rated electric energy and worked out yearly power consumption.

4.2 Water-Leakage Countermeasure (basic data planning)

4.2.1 Water Transmission & Distribution System

Due to steady water transmission for 24 hours with the same water pressure, it is expected that the excess pressure is on at the time of midnight when the water consumption is low.

4.2.2 Water-Leakage Condition

Since the results from first and second investigation, Water Supply Corporation Surabaya is planning to promote or has promoted blocking of water distribution and organizes water-leakage control & study using flow meter and pressure gauge at distribution block. Fifty (50) personnel is in charge of the control, but it seems skilled personnel is not enough.

There is a possibility of early detection of water-leakage by conducting technical assistance for water-leakage investigation such as training for survey personnel etc.

There could be a high possibility of water-leakage in pipelines in Ngagel Water Treatment Plant I . We have the information that there is a segmentation plan of distribution blocking to check water-leak places and repair these parts. Also, the renewal plan of aging pipelines is developing.

The loss water ratio (water-leakage rate) is approximately 32% according to the first half of 2013. Water Supply Corporation Surabaya (PDAM) set the target water-leakage rate as 23% and is planning to promote energy-saving plan.

Also, locking plan of water distribution is already conducted or planning to install. Although no energy-saving item is seen on this plan, the distribution block focusing less water-leak are needed to verify in the future.

As for the flow meter-type for block distribution, Woltmann-type flow meters are used in many cases. There is a possibility of more precise measurement by changing them to electromagnetic flow meters. Furthermore, the improvement by changing electromagnetic meters with long-life battery (Japanese products usually last eight (8)-nine (9) years) could be considered because battery-life installed in electromagnetic meters are found to be short.

Current Status of Non Revenue-earning Water and Target Value

Kind of Water Loss		Current Status	Target
Water Leakage	Leakage Volume	52,757,556m3	38,102,679m3
	Leakage Rate	18%	13%
Operating Loss	Loss Volume	29,309,753m3	20,516,827m3
	Loss Rate	10%	7%
Stolen Water	Stolen Volume	14,715,088m3	8,792,927m3
	Stolen Rate	5%	3%
Total	Water Volume	96,782,397m3	67,412,433m3
	Non Revenue	33%	23%

*Target values are estimated from target ratio of current values.

As water-leakage countermeasures, hardware upgrading such as blocking of distribution network has already promoted by effective water-leakage investigation based on flow control. Technical advices to improve system control as countermeasures for water-leakage prevention such as data analysis are requested. However, this is excluded from survey subjects because it requires personnel training for data analysis of flow control or technology of water-leakage prevention so it is out of this scheme.

4.3 Effect of CO2 Reduction

4.3.1 Pump Facility Streamlining in Ngagel Water Treatment Plant System Ⅰ and Ⅱ

（1） Optimization of pump units in Ngagel Water Treatment Plant System I

Processing ability & the maximum water supply amount in Ngagel Water Treatment Plant Ⅰ system（September, 2013 data）

・Water treatment ability　1,800ℓ／sec

・Maximum water supply amount　1,420.8ℓ／sec（Month: March）

The rating capacity of operating pumps (excluded transmission pumps) is 3,425ℓ/s, which is approximately twice as much as water treatment plant capacity:1,800ℓ/s. Therefore, we need to study and sort out systems of supply destination. As described below we calculate the pump specifications if pumps are consolidated.

Suppose seven (7) pumps (one is back-up) for 1,800ℓ/s water treatment capacity and pumping head is 50m which is the largest lift head of existing pumps.

Pump Capacity　1,800ℓ/s divided by 6 units ＝ 300ℓ/s(18.0m3/min)

∴ 300ℓ/s×250kw×50m×7 units（One is back-up）

Calculation of CO2 Reduction

Power of currently operating pumps:1,925kw

Power by consolidating pumps:1,500kw

Possible power reduction:1,925kw － 1,500kw = 425kw

Yearly pump power reduction:425kw×24hr×365 日＝3,723,000kw/year

CO2 reduction amount:3,723,000kw×0.70/1,000＝**2,606ton/year**

(CO2 emission coefficient: 0.70kg-CO2/kw)

（2） Change of Pump Facilities to Higher Efficiency in Ngagel Water Treatment Plant System I and Ⅱ

According to the demonstration data of pump facilities from the manufacturer, the pumps with higher efficiency create 10-30% reduction of electricity. Therefore, we briefly estimate 20% reduction from current status because the precise value of electric reduction could be decided by selecting high-efficiency pumps after detailed investigation and study.

Pump Facilities		Current Status（A）		After Higher Efficiency（A）×20%
		Number of Unit	Power Consumption(kw)	Reduced Electricity(kw)
Ngagel	System Ⅰ	**7**	**1,500**	**300**
	System Ⅱ	6	595.5	**119.1**
Total		26	2,520.5	**419.1**

*Current status value of System Ⅰ indicates the value after optimization of pump number

Calculation of CO2 Reduction Amount

Possible reduction power: 41 9.1kw

Yearly pump power reduction:419.1kw×24hr×365day＝3,671,316kw/year

CO2 reduction amount:3,671,316kw×0.70/1,000＝**2,569ton/year**

4.3.2 Construction of Water Transmission & Distribution System（Control system for discharge pressure from water distribution pumps）

We conducted investigation of a field demonstration in regard to the reduction of electric consumption by installing new system construction that accommodates discharge pressure of nine (9) distribution pump stations among twelve (12) booster pump stations. Furthermore, it will save water-leakage if it resolves excess water pressure by controlling discharge water pressure of distribution pumps.

Although the reduction amount of power consumption will be calculated after the demonstrating investigation, the calculation examples are shown below in case of current 0.3Mpa discharge pressure from distribution pump with 0.05Mpa controlled discharge water pressure. Then, 0.10Mpa controlled discharge water pressure is reduced.

（1）Reduction of Estimated Electric Consumption

The 2% power reduction is estimated by 0.01 Mpa discharge pressure reduction.

（Reference: EBARA Times No.225(2009_10)Energy-saving technology of pump facilities for water supply system）

Estimated power consumption：21,444,480kw/Year（Calculated at 50% efficiency of rating power amount for water transmission pumps）

Pump discharge pressure：0.3Mpa

(A) Controlling value of pump discharge pressure ：in case of 0.05Mpa

Pump discharge pressure after control：0.3－0.05＝0.25Mpa

Possible power reduction：21,444,480×（0.05×2%）＝2,144,448kw/year

CO2 reduction amount：2,144,448×0.70/1,000=**1,501ton/year**

(B) Controlling value of pump discharge pressure：in case of 0.10Mpa

Pump discharge pressure after control：0.3－0.10＝0.20Mpa

Possible power reduction：21,444,480×（0.10×2%）＝4,288,896kw/year

CO2 reduction amount：4,288,896×0.70/1,000=**3,002ton/year**

（2）Reduction of Estimated Water-Leakage

We calculated the value of water-leakage reduction after control of discharge pressure through water distribution pumps from current water-leakage amount 52,757,556m3

(A)Controlling value of pump discharge pressure ：in case of 0.05Mpa

Pump discharge pressure after control：0.3－0.05＝0.25Mpa

【Used Formula】

$$\text{Water-Leakage Amount after Control} = \text{Water Leakage without Control} \times \left[\frac{\text{Controlled Water Pressure}}{\text{Water Pressure without Control}}\right]^{1.15}$$

Reference: Water-Leakage Prevention Guideline
(Japan Water Works Association)
Water Pressure Reduction Formula)

＝52,757,556×（0.25÷0.30）$^{1.15}$＝42,778,567m3

Water-leakage reduction＝52,757,556－42,778,567＝9,978,989m3

CO2 reduction amount：9,978,989×0.36/1,000=**3,592ton/year**

(B) Controlling value of pump discharge pressure : in case of 0.10Mpa
Pump discharge pressure after control : 0.3－0.10＝0.20Mpa
Water-leakage reduction after control＝52,757,556×（0.20÷0.30）$^{1.15}$＝33,096,321m3
Water-leakage reduction Amount＝52,757,556－33,096,321＝19,661,235m3
CO2 reduction amount : 19,661,235×0.36/1,000=**7,078ton/year**

4.4 Result of CO2 Reduction

Items for CO2 Reduction		CO2 Reduction Amount
Ngagel Water Treatment Plant System I & II Streamlining of Pump Facilities for higher efficiency		5,175 ton / year
Discharge Pressure Control System from Distribution Pumps	Electric Power Reduction (Reduction Amt.:0.10Mpa)	3,002 ton / year
	Water-Leakage Amount Reduction (Reduction Amt. :0.10Mpa)	7,078 ton / year
Total		**15,255 ton / year**

Above is brief estimate of CO2 reduction in case of 0.10Mpa pressure reduction by controlling discharge pressure of water transmission pumps. The value is subject to change after detailed investigation and study.

4.5 Project Costs

（1）Pump Facilities Streamlining of Ngagel Water Treatment Plant System I and II

Investigation & Design Costs	50 Million Yean
Construction Costs	1,500 Million Yean
Total	1,550 Million Yen

（2） Construction of Discharge Pressure Controlling System from Water Distribution Pumps

Investigation & Design Costs	50 Million Yen
Construction Costs	700 Million Yen
Total	750 Million Yen

∴ Whole Project Costs＝1,550 ＋ 750 = **2,300 Million Yen(Estimate)**

4.6 Cost-Benefit Performance（Estimate）

CO2 Reduction Project	(A)Project Costs (Million ¥)	(B)CO2 Reduction (ton/year)	Cost-benefit Performance (A)/(B) Million¥/ton
Ngagel Water Treatment Plant System Ⅰ & Ⅱ Streamlining for High Efficiency	1,550	5,175	0.30
Discharge Control System for Distribution Pumps	750	10,080	0.07
Project Total Costs	2,300	15,255	0.15

Legal pump working lifetime in Japan：15 years

5. Considerations towards Project

5－1. Pump Equipment Streamlining to Higher Efficiency in Ngagel Water Treatment Plant System Ⅰ & Ⅱ

（1） Pump number optimization in system Ⅰ

(A) Detailed investigations for optimization of the number of pumps

- Confirmation of current water transmission & distribution system

Conducting investigations for flow rate from each distribution system, pipeline, electric system and operational management system

(B) Basic plan for consolidation of water transmission & distribution system

Planning pump specifications, pump equipment layout, pipe-laying plan and electric equipment.

(C) Calculation of construction costs

Calculating construction costs for adjustment of pump facility such as machinery & electric equipment, pipeline arrangement and pump chamber.

(2) Pump Equipment Streamlining to higher efficiency in System Ⅰ & Ⅱ

(A) Detailed investigation of operating conditions

Conducting investigation regarding flow rate of water distribution system, pipeline, electric system and operational control condition. For system Ⅰ, detailed investigation results of optimization for pump units are applied.

(B) Basic Plan to higher efficiency

- Study of appropriate pump discharge amount and lift head
- Construction of economical pump control system
- Effective water supply control and management
- Introduction of energy-saving equipment
- Planning of pump equipment layout etc.
- Planning of pipe laying

For system Ⅰ, detailed investigation results of optimization for pump units are included in its study.

(C) Calculation of Construction Costs

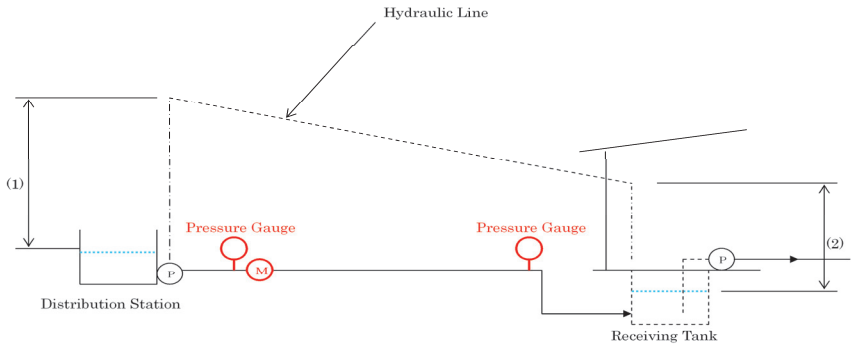
Calculating the construction cost in regard to pump equipment streaming for higher efficiency. Specifically, construction costs such as machinery and

electric equipment, pipeline arrangement and pump chamber are calculated. For system I , adjusted construction costs of optimization for pump units are included for its calculation.

5－2. Construction of Water Transmission & Distribution System (Discharge Pressure Control System from Water Distribution Pump

(1) Field demonstrating investigation

Conducting field demonstrating investigation of two (2) among nine (9) water distribution pump stations.



(1) : Pump Discharge Pressure (Discharge Head)
(2) : Remaining Water Pressure

Pressure gauges and electromagnetic flow meter (battery powered) are installed at the discharging side of distribution pump station and check the distributed amount and pressure per day.

The measurement is sorted and analyzed by decided period and confirm status of residual water pressure.

(2) Basic Design

- Study of appropriate pump discharge amount and lift head
- Construction of economical pump control system
- Introduction of energy-saving equipment
- Selection of pump specifications
- Adaptation to distribution pump stations except field investigations

(3) Calculation of Construction Costs

Construction costs such as machinery and electric equipment, pipeline arrangement and pump chamber are calculated

5－3.Schedule

CO2 Reduction Project	Financial Year 2014	Financial Year 2015	After Financial Year 2016
Ngagel Water Treatment Plant System Ⅰ & Ⅱ Pump Facilities Streamlining	Detailed Investigation of Pump Operating System	Basic Plan	Design & Construction
Distribution Pump Discharge Pressure Control System Construction	Investigation of Field Demonstration	Basic Plan	Design & Construction

5－4. Propositions and Requests toward Project Formation

（1） Propositions and Requests

Field Demonstrating investigations and detailed research for “Streamlining of Water Transmission & Distribution Pump Facilities in Ngagel Water Treatment Plant System Ⅰ、Ⅱ” and “Discharge Pressure Control System Construction of Water Distribution Pump Control“ are indispensable for the project formation.

At this moment, the project-effect (Ex. CO2 reduction) estimate is rough and it will be specific after detailed investigations. Therefore, further investigations are required. In addition, we felt enthusiasm and sincere attitudes towards better water utility such as facility control and water-leakage countermeasures in Water Supply Corporation Surabaya (PDAM). However, we could not exactly share same understandings on this project for CO2 reduction.

（2） Solution

More understandings of the project for future detailed investigations are important in Water Supply Corporation Surabaya (PDAM). Then, it is essential that both parties should have mutual recognition and cooperation towards project formation.

5－5.Imaginable Countermeasures considered to be effective after further investigations

（1） Countermeasures for Water-Leakage（Detailed Countermeasures）

Water Supply Corporation Surabaya (PDAM) has already promoted lesser unaccounted-for water countermeasures (such as blocking of water distribution network and water-leakage investigation) under investigation results of these water-leakage countermeasures (Basic data planning). If the construction of water transmission and distribution system is put in practice, less water-leakage rate could be proposed.

In addition, countermeasures focusing personnel training for the data analysis of flow control and the technology of water-leakage are desired.

（2） Countermeasures for Water-Saving System

Generally a receiving tank and an elevated tank are placed in each household and no direct supply from distribution stations is employed. Therefore, the energy-saving effect installing water-saving equipment such as water-saving packing etc. is expected to be low.

B. Surabaya Industrial Estate Rungkut (SIER)

1. Subjected nation, systems of subjected city and industrial background

Surabaya City is the second largest city next to Jakarta which is the capital of Indonesia and 8.5% of the city is an industrial area. At the south of the city there is the largest industrial estate. Surabaya becomes as the center of growth in eastern Indonesia supported by manufacturing, commerce and hotel and food-service industry. However, on the other hand, the city suffers environmental pollution associated with the rapid urbanization and industrialization and pollution prevention is one of key agenda for the city. Therefore, improvement of citizen's sanitary conditions, access to the safe water and upgrading of sewerage treatment system call for urgent attention. Also, people are interested in wastewater recycling technology in preparation for the increase of medium to long term water demand.

SIER Industrial Estate use tap water for industrial water and some food-producing factories which require quality-water conduct advanced treatment in each factory. For general use, tap water without treatment is used and factory employees drink packaged water.

The 20% of factories (sixty (60) factories) have their own advanced treatment system and they are mainly food-processing companies. High-level treatment is required in these factories and also facility aging & improvement of operating method are seen at the site.

Under these circumstances, we conducted investigations towards CO2 reduction possibility visited related organizations with the assistance of Surabaya city.

2. Subjected Investigation Industry

Surabaya Industrial Estate Rungkut (SIER) has established in 1974 as the governmental industrial estate. Currently 300 companies have rented and 50 of them are Japanese-affiliated companies. This time we studied to improve its operational method and major equipment by replacement at SIER Wastewater Treatment Facilities.

SIER Wastewater Treatment Facilities were constructed with the support of the German Government in 1980. The wastewater treatment facilities have already been operating for 33 years without serious problems. Most companies discharge industrial and domestic wastewater directly to the treatment plant without intermediate treatment. Some companies drain industrial wastewater after intermediate treatment, then discharge with domestic sewage.

Although the authorized capacity of Wastewater Treatment Facilities is 18,000m3/day, the actual processing ability is 15,000m3. The current inflow amount

is 4,000-6,000m3/day and it is less than the half of capable capacity. Therefore, it still has remaining capacity. However, currently SIER Industrial Estate is fully occupied and no inflow increase is expected.

3. Investigation Method

The investigation was conducted focusing on countermeasures of energy & CO2 saving at SIER Industrial Estate by selecting more effective contents. There are two effective items like below.

- ○ Sanitary sewage processing investigation
  Collecting existing information & future plan to study potential facilities for reproducing energy in the process of sanitary sewage treatment. Also, confirming on-site processing conditions.
- ○ Sanitary sewage system investigation
  Collecting existing information & future plan regarding sanitary sewage system. Also, confirming on-site conditions.

After above investigations, we found below matters.

- ○ Four (4) systems of circulating waterway are installed. Four (4) aeration devices with horizontal rotors which consume extremely high electricity are placed in each system.
- ○ One out of four (4) aeration devices is regularly stopped for energy-saving.
- ○ The sludge is transported by auto truck to Bogor which is 650km distance from the plant. The state-operating sludge treatment plant is the final disposal site.
- ○ The sludge drying beds are scaled down comparing with the first plan.

Four (4) systems of circulating waterway are installed. Then four (4) aeration devices with horizontal rotors which consume extremely high electricity are placed in each tank.

The sludge is transported by auto truck to Bogor which is 650km linear distance from the plant. The state-operating sludge treatment plant is the final disposal site.

4. Investigation Result

4.1 Electric Power Consumption

In SIER Industrial Estate the average electric power consumption per day during January to June, 2013 was 3,093kwh/day when it is calculated from monthly consumption.

Based on above calculation; 3,093kwh/day, mammoth rotors consume 89% of whole electricity from estimated rate of equipment in operation.

These mammoth rotors are horizontally-shafted and motor capacity is 18kw. These rotors are continuously operated in fixed rotation speed. One rotors out of four (4) is regularly stopped in operation for energy-saving.

According to received documents, the oxygen supply efficiency of existing horizontally-shafted mammoth rotors is 1.7(kgO2/shaft kw per hour). On the other hand, if high-efficient propeller type rotors are installed, the oxygen supply efficiency is 2.7(kgO2/shaft kw per hour).

Propeller: 2.7/Existing: 1.7=1.59

This shows the efficiency is approximately 50% increase.

Existing: 1.7/Propellr: 2.7=0.63

Compare with existing rotors, propeller type rotors supply same amount of oxygen with 63% operation of existing rotors. With this calculation, simply 37% of electricity could be reduced. However, 15% reduction would be appropriate considering flow speed maintenance in OD tanks and other uncertainties.

The annual electricity consumption of existing horizontal-shaft mammoth rotors is 504,576 x 2=1,009,152kwh/year. If these rotors are renewed to high-efficiency propeller-type, it would promote 1,009,152kwh/year x 0.15 = 151,373 =

approx.151, 000 power reduction.

CO2 emission reduction calculation

CO2 reduction amount

=electricity reduction amount x 1/1000 x CO2 emission coefficient

=151,000kwh/year x 1/1000 x 0.7

=approx. 106 Ton-Co2/year

4.2. Sludge Reduction

The average monthly sludge amount from sludge volume during July 2012 to March 2013 is 120-160 Ton/month at the wastewater treatment facilities in SIER Industrial Estate. This sludge is transported to Bogor which is 650km distance from the plant. The sludge reduction directly saves energy and CO2.

Based on the hearing investigation, the sludge moisture content is around 65%. If 5% moisture content is reduced and it becomes 60%, the sludge amount is 13% less.

The 65% rate of moisture content=solid material 1.0m3+water1.86m3=2.86m3

Sludge2.86m3 x moisture rate 0.65=water1.86m3

The 60% rate of moisture content=solid material 1.0m3+water1.50m3=2.50m3

Sludge2.50m3 x moisture rate 0.60=water1.50m3

2.50m3/2.86m3=87% (13% sludge reduction)

The 13% sludge reduction calculated 197 Ton/year sludge reduction.

1,518Ton/year x 0.13 = 197Ton/year

During the rainy season, the filter press machine is used for sludge drying and in dry season sludge is dehydrated by sun/air at SIER Industrial Estate wastewater treatment facilities. Sun/air dry process depends on number of drying days. If you want to reduce the moisture content to 60% from 65%, it can be achieved by extending drying period from 25 days to 32 days (1.3 times) supposing sludge loading 40kg/m2. Current drying period in the dry season at SIER facility is 20-25 days. If sun drying beds are expanded to 1.3 times, 60% moisture sludge can be obtained. It means 13 drying beds from current 10 beds will fulfill its requirements.

There is the waterway at the eastern part of SIER Industrial Estate and the eastern area from the waterway is the site that has been planned as sun dry beds from the beginning. We recommend the additional sun drying bed construction on this site as planned from the beginning. The total construction costs will be 19 million yen (US$183,000) includes civil engineering work, machine costs and electricity costs. This site is vacant at this moment.

CO2 emission reduction calculation

CO2 reduction amount

=transport weight x transport distance x fuel usage basic unit x 1/1000 x CO2 emission coefficient

=197 Ton/year x 800km x 0.0410 x 1/1000 x 2.62

=approx. 17 Ton-CO2/year

Transport weight=197Ton/year (Annual reduction amount of sludge)

Transport distance=800km (Actual travel distance from Surabaya to Bogor)

Above distance one way only

Fuel usage basic unit=0.0410L/Ton km

(Supposing that 10-12 Ton auto truck with 80% loading ratio and fueling light diesel oil)

CO2 emission coefficient=2.62Ton CO2 (light diesel oil)

5. Reviews toward Project Formation

The renewal of sixteen (16) mammoth rotors will create approximately 106 ton CO2/year reduction. The facility costs will be 0.5 billion yen (4.8 million US$).

In addition, the CO2 emission reduction by sludge weight reduction will be 17 ton-CO2/year. The facility costs will be 19 million yen (183 thousand US$).

The possibility of both project formations is low because of low CO2 reduction amount and the high facility costs. However, it is possible to promote the project at the time of renewal due to facility aging. Especially, the sludge weight reduction is feasible because its facility costs are relatively low and it creates approximately 17 Ton-CO2 reduction.

C. Keputih Septage Treatment Facilities

1. Subjected nation, systems of subjected city and industrial background

Surabaya City which has 326km2 area and approximately 3 million populations is the second largest city in Republic of Indonesia and also one of major cities leading domestic economy. However, environmental load has been increasing there. As citizens highly concern environmental issues, it led “Garbage War”, the war regarding waste processing. The conditions haven’t been resolved because the countermeasures by the government are not enough. Under these circumstances, Surabaya City is targeting the improvement of hygienic environment and develops the plan of “Green Space Park for Citizens” on the site of waste sanitary landfill to promote environmental education. In March 2004, the budget bill for this park was approved. On the other hand, Keputih Septage Treatment Facilities exist at this site, which are treating only one-fourth of planned amount and are not fully operating.

Furthermore, the turbidity of biochemical oxygen demand (BOD) from discharged water after treatment at Keputih is 200-250mg/L and exceeds 150mg/L standard which is the target value of operation management standard in this facilities. Therefore, it is concerned that this water might cause river pollution and health hazard to people in the surrounding area. In addition, there is a sign of facility aging and the necessity of operation improvement is apparent.

Under these circumstances, we conducted investigations towards CO2 reduction possibility visited related organizations with the assistance of Surabaya City.

2. Subjected Investigation Industry

The construction of Keputih Septage Treatment Facilities started in the late 1980s. However, the sludge regulating tank wasn’t included in the facilities because the design utilized the existing industrial wastewater treatment facilities at Surabaya Industrial Estate Rungkut (SIER) and built based on that design. Therefore, at the beginning, there was no sludge regulating tank, but later it was additionally installed. The first systems started an operation since 1991. Subsequently, the second system was built in 1993 and whole facilities were completed.

In 1997, the Surabaya Sewerge and Sanitation Development Programme 2020 (SSDP) master plan was prepared and implementation of sewerage system in urban areas and decentralized treatment system in the surrounding ara were planned. In accordance with these plans, the arrangement plan of septic treatment facilities, (existing) Keputih Septage Treatment Facilities (in charge of east area of Mas River) and Benowo Septage Treatment Facilities (in charge of west area of Mas River) for human excreta treatment (septic tank sludge), were proposed. So far only Keputih

Septage Treatment Facilities was built and Bento Facilities plan is up in the air.

Although the authorized capacity of Keptih Septage Treatment Tank is 400m3/day, the actual input is 80-100m3/day which is equal from one-fifth to one-fourth of its capacity.

3. Investigation Method

The investigation was conducted focusing on countermeasures of energy & CO2 saving at Keputih Septage Treatment Facilities by selecting more effective contents. The first construction of Keputih Septage Treatment Facilities was started in 1989 and currently its equipment explicitly suffers corrosion and aging. To improve its operational method and major equipment by replacement at the Keputih Facilities, there are two effective items like below.

- Equipment investigation
  Collecting existing information & future plan about septage treatment system. Also, confirming on-site conditions.
- System investigation
  Collecting existing information & future plan about septage treatment system. Also, confirming on-site conditions.

After above investigations, we found below matters.

- ○ Four (4) OD tank systems of circulating waterway are installed and two aeration devices per system are placed. These aeration devices are with horizontal rotors and power consumption is extremely large compare with others.
- ○ One or two out of four circulating waterway OD tanks are regularly stopped for energy saving.
- ○ The sludge is utilized for green spaces in Surabaya city.
- ○ During rainy season, the drying period on drying beds is extended 1.5 times longer than usual.
- ○ Treated water is back to OD tanks as dilution water, but its color is still brownish.
- ○ The odor across the septage treatment facilities is not so strong.

4. Investigation results

According to 2012 data of electric consumption at Keputih Septage Treatment Facilities, November consumption amount is extremely low. Therefore, we exclude

November data and the average electricity consumption per day is calculated as 931KWH/day.

Based on above calculation, mammoth rotors consume 75% of whole electricity from estimated rate of equipment in operation.

Therefore, the improvement of mammoth rotors is the most effective for energy saving. These rotors are horizontally-shafted and the motor capacity is 7.5HP & 10.5HP. These rotors continuously operate in fixed rotation speed. Two mammoth rotors are installed per tank and 1-2 tanks out of 4 are regularly stopped in operation for energy-saving. It seems that some parts of paddle corrosion were repaired.

According to SIER industrial estate documents, the oxygen supply efficiency of existing horizontal mammoth rotors is 1.7(kgO2/shaft kw per hour). On the other hand, if high-efficient propeller-type rotors are installed, the oxygen supply efficiency is 2.7(kgO2/shaft kw per hour).

Propeller rotor:2.7/ Existing:1.7=1.59

This shows the efficiency is approximately 50% increase.

Existing:1.7/Propeller2.7=0.63

Compare with existing rotors, propeller type rotors supply same amount of oxygen with 63% operation of existing horizontal-shaft type. From this calculation, simply 37% of electricity is reduced. However, 15% reduction would be appropriate considering flow speed maintenance in OD tanks and other uncertainties.

The annual electricity consumption of existing horizontal mammoth rotors is 107,826+150,957=approx.259,000kwh/year. If these rotors are renewed to high-efficiency propeller-type, it would promote 259,000kwh/year X 0.15= approx. 38.850kwh/year power reduction.

CO2 emission reduction calculation

CO2 reduction amount

= electricity reduction amount x 1/1000 x CO2 emission coefficient

= 38,850kwh/year x 1/1000 x 0.7

= approx. 27 Ton-CO2/year

5. Reviews toward Project Formation

The renewal of eight (8) mammoth rotors will create approximately 27 ton CO2/year reduction. The facilities cost will be 0.19 billion yen (approx. 1.8 million US$).

The possibility of project formation is low because of low CO2 reduction amount and

high facility costs. However, it is possible to promote the project at the time of renewal due to facilities aging.