MOEJ

Final Report

City to City Collaboration between Osaka and Quezon (Introduction of energy-saving technologies to factories and transport sector, and introduction of a solar power generation system to a closed landfill)

February 2019

Oriental Consultants Co., Ltd.
Osaka City

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Chapter 1 Study Outline

1.1 Background of the Study

The Philippines is one of the countries deemed most vulnerable to climate change and the impact of natural disasters such as typhoons, floods, and landslides. The Government of the Philippines has been formulating the National Climate Change Framework Strategy (NFSCC) since 2010, in order to build adaptation capacity for responding to climate change and optimize the activities of climate change mitigation for sustainable development by 2022. Renewable energy is positioned as a pillar of mitigation measures in the NFSCC and the cross-sectional strategies are as follows: 1) capacity development, 2) knowledge management and information, education and communication, 3) research and development (RD) and technology transfer, for determining the three strategies. In 2011, in order to materialize an action program based on the national strategy, the National Climate Change Action Plan (NCCAP) was formulated. The need for strengthening sustainable energy development is stated within this plan. In addition, a reduction of greater than 70% of the BAU scenario Green House Gas (GHG) emissions (CO2e) by 2030 (from 2000-2030) in the sectors of energy, transportation, waste, forestry, and industry, is stated as a mitigation objective in the Philippines' Intended Nationally Determined Contribution (INDC).

Under these circumstances, the Joint Crediting Mechanism (JCM) facilitates diffusion of leading low carbon technologies, products, systems, services, and infrastructure as well as implementation of mitigation actions, and contributes to sustainable development of developing countries on a global scale.

A bilateral document on the Joint Crediting Mechanism (JCM) was signed during the Japan-Philippines Summit meeting. In the overview of the bilateral documents, the following points are listed:

1) The establishment of JCM projects between the two countries to promote their collaborative efforts to promote low-carbon growth in the Philippines. For the operation of the JCM projects, a joint committee was established; 2) each country understands that each country can claim a portion of the greenhouse gas emissions

reduced through JCM projects for when they claim their contributions to climate change mitigation internationally.

The Joint Committee (JC) considered the draft Joint Crediting Mechanism Guidelines and adopted it on 9 February 2018, including the 3 JCM model projects currently adopted in Japan.

In the Philippines, Quezon City has the largest area in Metro Manila. As the population increases, issues arise in association with energy, transportation and urban greening are getting worse. The introduction and promotion of renewable energy and energy conservation technologies are positioned as major mitigation measures in the city. Quezon City developed a local climate-change-action-plan, including the introduction of solar panels for public schools and LED under the mayor's initiative. In addition, the Quezon City Government implemented its Green Building Ordinance, and its evaluation and certification shall be provided on the website. Besides, Quezon City joined C40 (C40 Cities Climate Leadership Group) for tackling-climate change. However, it is not enough for them to conduct effective initiatives because of lack of finance and knowledge of policy.

Osaka City had started a waste management project together with Quezon City since 2015. To strengthen the cooperative relationship between the two cities, Osaka City is supporting the formulation of Quezon City Climate Change Action Plan and the formulation of JCM projects supported by Oriental consultants Co., Ltd.

1.2 Purpose of the Survey

The following three activities institutionally and systematically support the large-scale expansion of JCM projects and support the development of Quezon into a low-carbon society:

1. Support for the climate change action plan
   · Confirmation of the status of climate change mitigation measures, implementation systems, and future policy

· Osaka City supports human capacity building through workshops on topics such as the Asian-Pacific Integrated Model, policy making, and the development of projects, based on the needs of Quezon City

2. Formulation of JCM Promotional Handbook for the practices of vehicle engine improvement and promoting energy efficiency in factories.
3. Formulation of JCM projects on landfill solar power generation and energy saving for vehicles and factories

1.3 Survey Implementation Structure

1.3.1 Outline of Implementation Structure

The survey is operated as follows: Oriental Consultants, as the representative implementer of the survey, works with Osaka City and Quezon City Government-Environmental Protection and Waste Management Department (EPWMD), who serve as co-implementers.

Feasibility studies on solar power and energy conservation are carried out with the private enterprises listed in the table below, which belong to Team Osaka Network. In cooperation with the Institute for Global Environmental Strategies (IGES) and E-konzal, capacity building on application of Asia-Pacific Integrated Model (AIM) was implemented. Application of AIM model to Quezon City was presented at the COP24 and a workshop in Quezon City.

Figure 1 shows the implementation structure of this project while the Table 1 shows the roles of the participants.

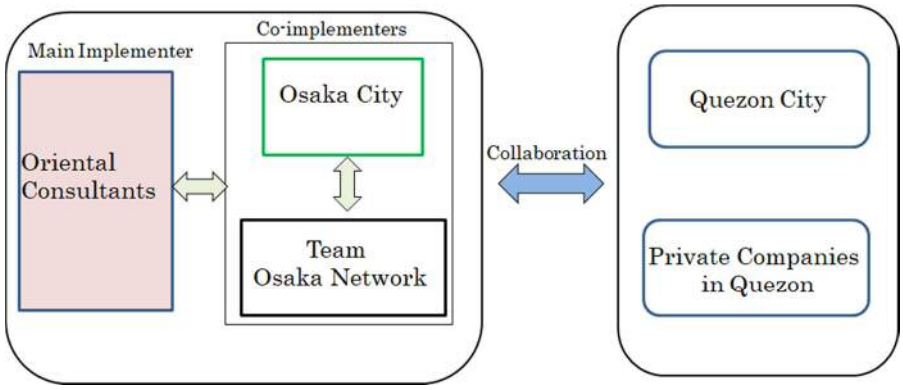

Figure 1: Survey Implementation Structure

Table 1: Roles of Participants

Role	Co-implementers	Tasks
Main implementer	Oriental Consultants Co., Ltd.	Coordinator and survey implementer Development of business models and MRV for potential JCM projects
Technical adviser	Japan Textile Consultants Center	Technical adviser pertaining to energy saving equipment in factories, etc. Implementation of energy auditing
Technical adviser	Nippon Thermoener Co., Ltd.	Technical adviser relating to boiler and furnace energy saving practices
Technical adviser	Asano Taiseikiso Engineering Co., Ltd	Technical adviser on confirmation of landfill ground stability including conducting penetration test on the ground
Technical adviser	SRG Takamiya Co., Ltd.	Technical adviser relating to solar PV system installation including racks and base treatment, etc.
Adviser on financing	Tokyo Century Corporation	Adviser on the financial aspects of JCM projects such as loans and other financial services for project owner to implement a JCM project

1.3.2 Team OSAKA Network

Team OSAKA network is a platform, which facilitates the collaboration of enterprises holding environmental technologies in the Kansai Region with the municipal government, Global Environment Centre Foundation (GEC) and universities for developing projects, which promote low-carbon societies in different Asian cities. Through collaboration activities, Team OSAKA Network aims to expand businesses overseas, revitalize the economy of the Kansai area, and signify the contribution and participation of Japan in the area of international environmental conservation. In this survey, Team OSAKA Network provides a platform for sharing information related to JCM projects in Quezon and up to date low carbon technologies.

Chapter 2 Support for Quezon City's Local Climate Change Action Plan

2.1 Overview of Quezon City

Metro Manila, as the fifth largest metropolitan in the world, consists of 16 cities and 1 municipality, and is the center of politics, economy, culture, transport, and information with a population of 22.9 million as of 2016. Quezon City is the most populous and largest city in Metro Manila. As the population increases, issues in association with urban waste, energy, transportation and urban greening are getting worse. The introduction and promotion of renewable energy and energy conservation technologies are positioned as major mitigation measures of the city. The city is actively working with businesses in the environmental conservation field. In 2008, Quezon City received the Galing Pook award (an award for excellent governance in the Philippines) for their efforts to rehabilitate the Payatas dumpsite. This was the first GHG reduction project at a waste disposal site in South Asia. In 2009, Quezon City was again awarded this honor for developing the nation's largest parks management and development program. In addition, the city joined C40 Cities Climate Leadership Group as the leading actor for tackling climate change.

Figure 2: Map of Quezon

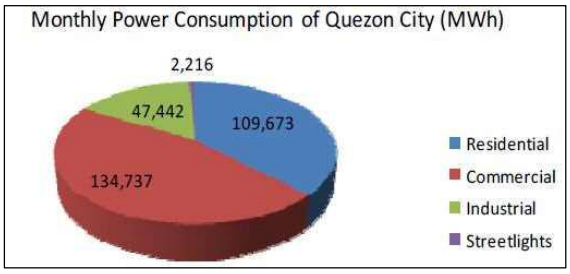

Figure 3: Power Consumption Structure

(Source: Study on Carbon Governance at Sub-national Level in the Philippines)

2.2 About EPWMD

Established in 2000, Quezon City EPWMD is obliged to improve the health and the living environment of citizens, prevent environmental pollutions, and promote efficient waste collection and treatment. The department is responsible for development and management of comprehensive environmental protection programs including waste collection services.

The planning department of the EPWMD is responsible for GHG inventory development for Quezon City, which received support for capacity building on inventory development from USAID under the 'Climate Change/Clean Energy Project. They also have conducted a rooftop solar power generation initiative under the collaboration with the German Corporation for International Cooperation GmbH (GIZ). EPWMD, as the counterpart of the survey, has supported to the study team through providing related data/information and coordinating field works.

2.3 Efforts toward Climate Change Issues in Quezon City

2.3.1 Quezon City Local Climate Change Action Plan (QC-LCCAP)

Quezon City has formulated the Quezon City Local Climate Change Action Plan 2017-2027 as a key measure against climate change, and seven priority areas were selected based on the National Climate Change Action Plan. The outline is as follows.

Table 2: Overview of Quezon City Local Climate Change Action Plan

Effects / events due to climate change	**Response to climate change**	**Purpose**
· Frequent occurrence and severity of abnormal weather (typhoons, storm surges, floods, heavy rain) · Change in precipitation	1.Food safety	· In order to adapt to climate change, improve knowledge on food preservation and food safety · Improve use, supply stability, and accessibility of safe and healthy food
	2. Stable supply of water	· Sustainable, safe, adequate supply of water · Evaluation of water management · Improvement of sanitation infrastructure
	3. Ecological and environmental	· Development of adaptive capacity of local governments and communities

pattern · Temperature rise	stability	· Improvement of the capacity of organizations and individuals to promote healthy/safe city life
	4. Human rights	· Protection from danger due to climate change (such as health damage and social security) · Promotion of construction of homes and services for climate change adaptation · Construction of adaptive capacity of local governments and communities
	5. Smart Industry service that contributes to climate issues	· Promotion of infrastructure development with strong climate change tolerance in Quezon City · Implementation of environmentally friendly solid waste management for mitigation and adaptation of climate change · Setting the scope of greenhouse gas emissions
	6. Sustainable energy	· Use of sustainable, renewable energy and energy-saving technologies (main components of sustainable development) · Promotion, repair, and improvement of use of energy systems and infrastructures affected by climate change
	7. Improvement of knowledge and ability	· Improvement of scientific knowledge on climate change · Adaptation/mitigation of climate change at local and community level · Improvement of skill relating to mitigation of disaster risk · Establishment of system related to gender and climate change, in order to educate Quezon City

		residents · Establishment of climate change countermeasure network sharing good practices and other resources

Quezon City is implementing with the plan through advancing various projects, including the follows.

1. Biogas power generation at landfill site
2. Introduction of solar power generation to public facilities
3. Introduction of LED to streetlights
4. Introduction of EV to Quezon City government
5. Promotion of energy saving in the industrial sector
6. Promotion of solid waste management

2.4 Assistance for Capacity Building

Along with increase in population, Quezon City is suffering from the common urban problems such as urban waste treatment, energy supply, transportation services, and urban greening. As countermeasures, the projects mentioned above are being deployed including those in the climate-change-action-plan. The Japanese Government is also assisting capacity development of national and local governments for solving the problems through organizing workshops and conducting technology transfers. These include the 'Regional Workshop for Development and Transfer of Low Carbon Technology' organized by the Ministry of the Environment of Japan (MOE), JCM City-to-City Collaboration workshops and seminars sponsored by ICLEI and MOE, and waste to energy projects conducted by Hitachi Zosen. Against this backdrop, Quezon City has shown interest in bilateral collaboration with Osaka City through JCM projects under the City-to-City Collaboration scheme. Through the survey, the two cities have signed a

Memorandum of Understanding (MOU) on 30 August 2018 for strengthening comprehensive cooperation regarding low-carbon technology promotion. During discussions, Quezon City expressed the following expectations from Japan and Osaka City:

1. A mayor-level policy dialogue based on the MOU
2. Designing LCS scenarios of Quezon City through AIM
3. Sharing the energy conservation and renewable energy plans and case studies of Osaka City
4. Sharing knowledge on JCM

The details are as follows.

2.4.1 A mayor-level policy dialogue based on the MOU

As mentioned above, Mayor Herbert M. Bautista of Quezon City was invited to Osaka to deepen cooperation between the two cities for the realization of a low carbon society, and two mayors signed an MOU. The MOU includes implementation of mayor-level policy dialogue regularly as per progress of the policy implementation

MOU signing ceremony

Under the MOU, the two cities agreed to work together towards the development of a low-carbon society and to promote cooperation through the following:

1. Establish standards and systems supporting the low-carbon policies in Quezon City;

2. Share professional skills, knowledge, measures, researches, and assessment of greenhouse gas emissions toward the development of a low-carbon city;

3. Promote public-private-partnership projects in the field of climate mitigation change and environmental conservation;

4. Strengthen capacity building on implementation of the low-carbon policies in Quezon City.

The first mayor-level policy dialogue took place after the MOU ceremony, and the latest efforts on climate change mitigation were introduced by both cities. The next day, representatives from Quezon City visited project sites such as Osaka Hikarinomori project site, a site for a solar PV project, and a waste incineration plant. Osaka City also introduced mega solar and waste treatment projects. Osaka Hikarinomori was a final landfill site for industrial waste. Since its closure, Osaka city has installed a large-scale PV system to the site through the feed-in tariff scheme.

As a model case in effective use of landfill sites, the project contributes to the realization of a sustainable society through renewable energy diffusion. Quezon City also showed interest in effective utilization of the Payatas landfill site and exchanged ideas on the matter.

Site visit to Osaka Hikarinomori

The Higashiyodo Plant is a waste incineration site constructed by Hitachi Zosen, Ltd., with a stoker-type waste incinerator (200 t/day × 2 furnaces = 400 t/day) and wet exhaust gas treatment facilities. This technology has achieved over 20% efficiency by use of a low-temperature economizer, two-step bleeding turbine, etc. These facilities were introduced as examples of advanced Japanese technologies to promote future renewable energy and energy saving projects in Quezon City.

Site visit to Osaka Higashiyodo Plant

Low Carbon Society (LCS) scenarios for Quezon City through AIM

Since the QC LCCAP mainly focuses on climate change adaptation, Quezon City is now developing its roadmap for climate change mitigation and is integrating it in the QC LCCAP, which deals with the City's protocol in GHG emission inventory and other related low carbon initiatives as well as setting the City's emissions reduction target. Through the years, Quezon City's environmental programs have evolved from adopting mere "clean and green" strategies to a more holistic and comprehensive strategy taking into consideration the global challenge of addressing the impacts of climate change. This project on establishment of low carbon society (LCS) scenarios is also expected to contribute to GHG emission target setting and updating the QC LCCAP for mainstreaming both adaptation and mitigation. The AIM application mainly targeted Carbon Dioxide (CO_2) from energy related

activities such as industry, commercial, residential and transport sectors through using data and information on socioeconomic activities and energy demand, which are collected from a variety of sources including both regional and national statistics, and international reports. The data and information were input to Extended Snapshot Tool (ExSS) to get socioeconomic indicators and CO_2 emissions for both of the base year and the target year. ExSS was developed by the AIM model team and applied to many cities in their establishment of LCS scenarios.

For this project, the LCS scenario using AIM was discussed at a workshop organized in Quezon City.

Workshop on the LCS scenario using AIM

With cooperation of Quezon City, data collection was completed in a short period; pamphlets were delivered at the Japan Pavilion during COP 24. In addition, the result of the model application was reported in the second workshop held in Quezon City.

COP24 Japan Pavilion

LCS scenarios include projects and respective GHG emissions from them explained as follows.

(1) Solar Energy Project

Quezon City has already started investing in solar energy technology. Currently, the city government has a pilot project in a Commonwealth High School that can generate electricity totaling 146,000 kWh/year. It is assumed that 100MW PV systems are to be installed by 2030 for the LCS scenario, which reduces CO_2 emission by 76.3 $ktCO_2$/year.

(2) Waste to Energy Project

In 2016, a consortium led by Metro Pacific Investments Corporation submitted a proposal to the city government about a Waste-to-Energy facility that can process and convert the city's municipal solid waste (MSW) into clean energy. The facility is capable of processing 3,000 ton/day of MSW and converting it into 42MW of electricity. The project will be undertaken through a joint venture between QC local government unit (LGU) and the consortium in accordance with QC LGU Ordinance: No. SP-2336, S-2014. It is assumed that the CO_2 emission reduction is 155.2 $ktCO_2$/year.

(3) Electric Vehicle Project

Quezon City has had partnerships with Meralco Energy Inc. and MC Metro Transport Operation, Inc. to promote electric vehicles (EV). Two EVs (Meralco Energy Inc.) are being utilized by EPWMD in its operations, while EVs contributed by MC Metro Transport Operation, Inc. are operated on selected routes from City Hall to Maginhawa Food and Art Hub Area. It is assumed that EVs will account for 20% of passenger cars by 2030, which will help reduce CO_2 emission by 323.7 $ktCO_2$/year.

2.4.2 Project Case Studies

Quezon City has showed a high interest in sharing Osaka City's climate-change-action-plan and its projects, which has helped solve many environmental problems in the past. In order to achieve the aforementioned LCS scenario, it is meaningful to share Osaka City's experience, particularly in the electric vehicle introduction

policy and business. At the workshop in Quezon City, Osaka city officials presented information about EV promotion such as the advantages of Japanese technology, diffusion methods through policy, and goals in the future.

Figure 4: Introduction of EV diffusion by Osaka City

2.4.3 Sharing JCM Knowledge

In 2017, the Philippines became the 17th country to sign a JCM agreement with Japan. The first JCM Joint Committee meeting took place in 2018. It is still necessary to increase the awareness of JCM in the Philippines. In order to do so, preparation of a JCM Manual for Quezon City and related organizations is deemed necessary. Detailed information about the JCM promotion in Quezon will be described in Chapter 4.

Chapter 3 JCM Project Feasibility Study

3.1 Solar Power Generation JCM Project

3.1.1 Overview

In this project, technical support for Quezon City's low-carbon city development was implemented under the City-to-City Cooperation scheme. In Quezon City, a renewable energy program has been promoted based on QC-LCCAP. In particular, the 'Solar Power Facility Project', is a flagship project bringing solar power systems to public schools and government buildings. In collaboration with the initiative, this study investigated the possibility of promoting the solar PV systems through JCM scheme.

The study targeted the Payatas landfill area, which was entirely closed in 2017, to introduce a solar PV system to the area. To do so the study observed the current situation of the target land including topping condition, topography, waste types, vegetation coverage, water seeping, methane gas emission, the level of land sinking and the condition of land slide, etc. The land area of Payatas is 30 ha. The landfill area closed in 2010 was greened and renovated as a park (the area circled in green in Figure 6). The remained area was also closed in 2017. Since the recently closed area is still flat, it is assumed stable enough to install a solar PV system on it.

Since 2007, Pungea Green Energy Phils has conducted methane power generation through recovering methane gas from the area closed in 2010. They already started piping for methane recovery on the land closed in 2017. Quezon City has developed a preliminary plan to maintain, operate, and reuse the land after the closure. During the study, the study team discussed solar power generation with the consulting company who made the preliminary plan

Figure 5: Location of Payatas Landfill in Quezon City

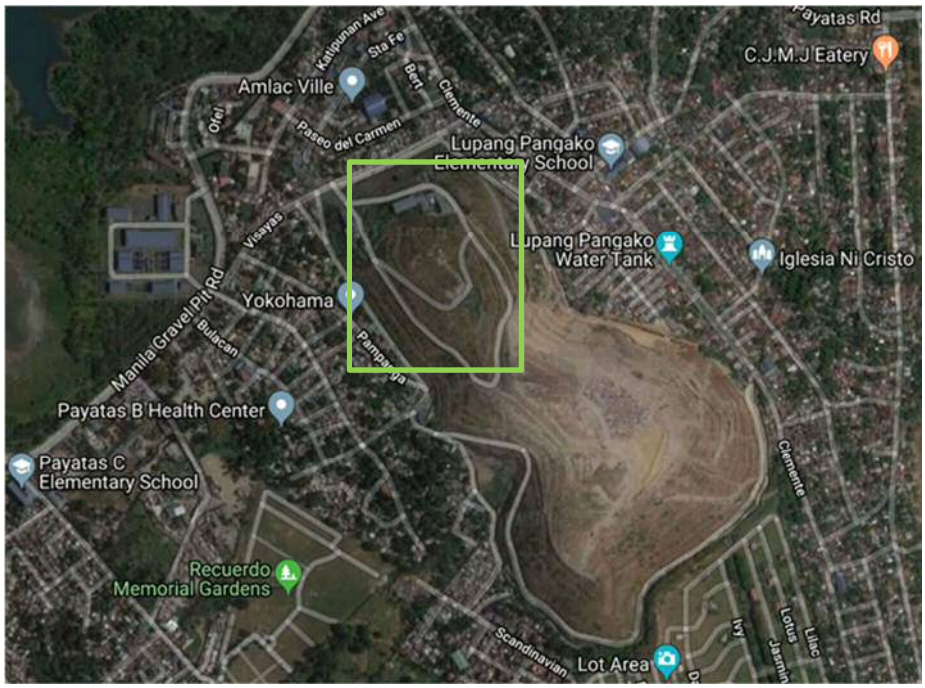

Figure 6: Outline of the Landfill Area

Figure 7: Points of Penetration Test

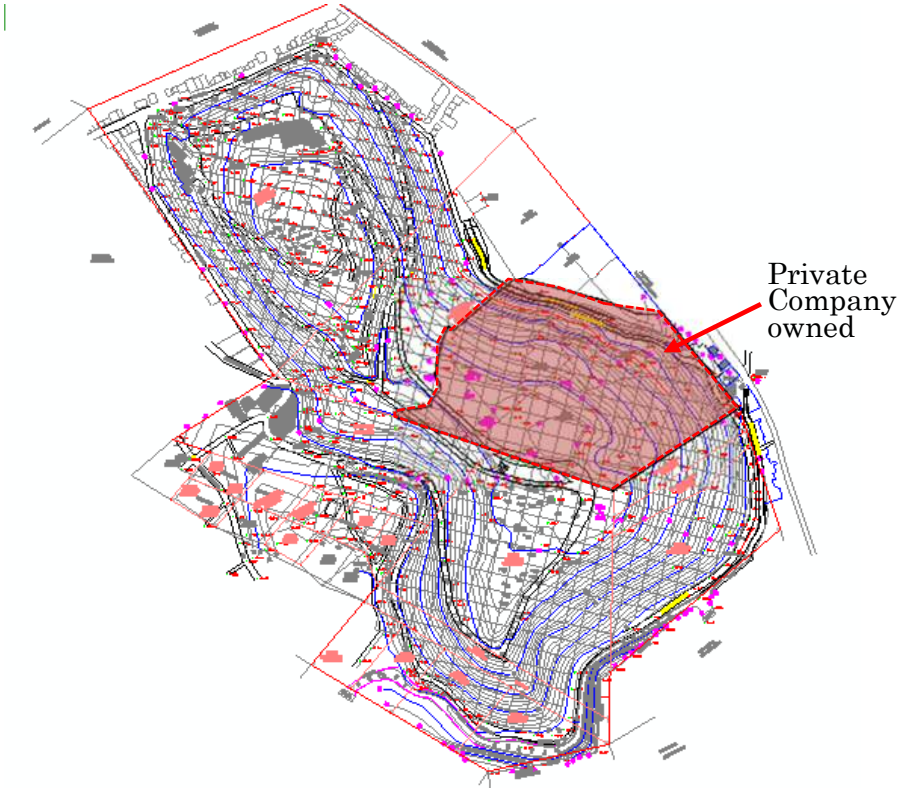

Figure 8: Topographical Map of the Landfill

3.1.2 Installation of Solar PV System in the Landfill and Related Regulations

The Republic Act (RA) 9003-Ecological Solid Waste Management (ESWM) Act (2000) rules the management, operation, and closure of the landfill sites. As for the treatment and utilization of the closed landfill, "Guidebook for Safe Closure of Disposal Sites was established with the technical support by JICA. It describes procedures of land use, requirements of technical and environmental aspects, etc. For example, possible options are park, parking, road, low-slung building, commercial/industrial facilities, etc. and precautions for each type of usage are included in the guidebook. However, there are no ordinances, regulations, or guidelines for the installation of solar PV system on closed landfills. Quezon City is planning to install the small-scale solar PV system in the publicly owned area of the landfill site, particularly on the rooftop of the buildings. The results of the study is expected to be reflected in the future plan.

Considering the post-closure management and maintenance of the landfill, the study observed and investigated stable and suitable areas for installation of solar panels. Based on the area suitable for installation of solar panels, the size (number of solar panels) of solar power generation system was estimated, the base and frame of the system were discussed, and the feasibility of the system was analyzed. Details are as follows.

From comparison of topographies from 2012 to 2017, there was no any significant change in height and shape of the landfill. However, after 2015, the flat area in the southern part of the landfill seemed to have expanded along with expansion of the landfill area.

The section view of the southern part of the landfill is given in Figure 9 below. There are some minor changes in the height and shape over time, but the trend of any regular change is not shown.

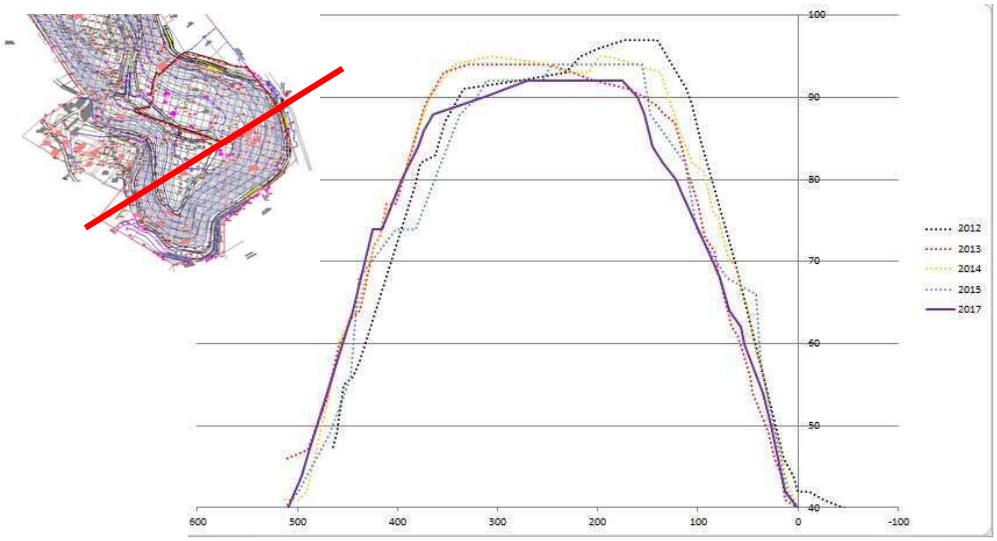

Figure 9: Section View of the Southern Flat Part

Observations showed that there were no significant subsidence and slide of slopes so far. Therefore, it is recommended to install a solar power generation system on the southern flat part of the landfill.

However, since vegetation on the slopes is not sufficient and shallow slides may occur following heavy rains, slopes and areas near the slopes are not suitable for installation of solar panels.

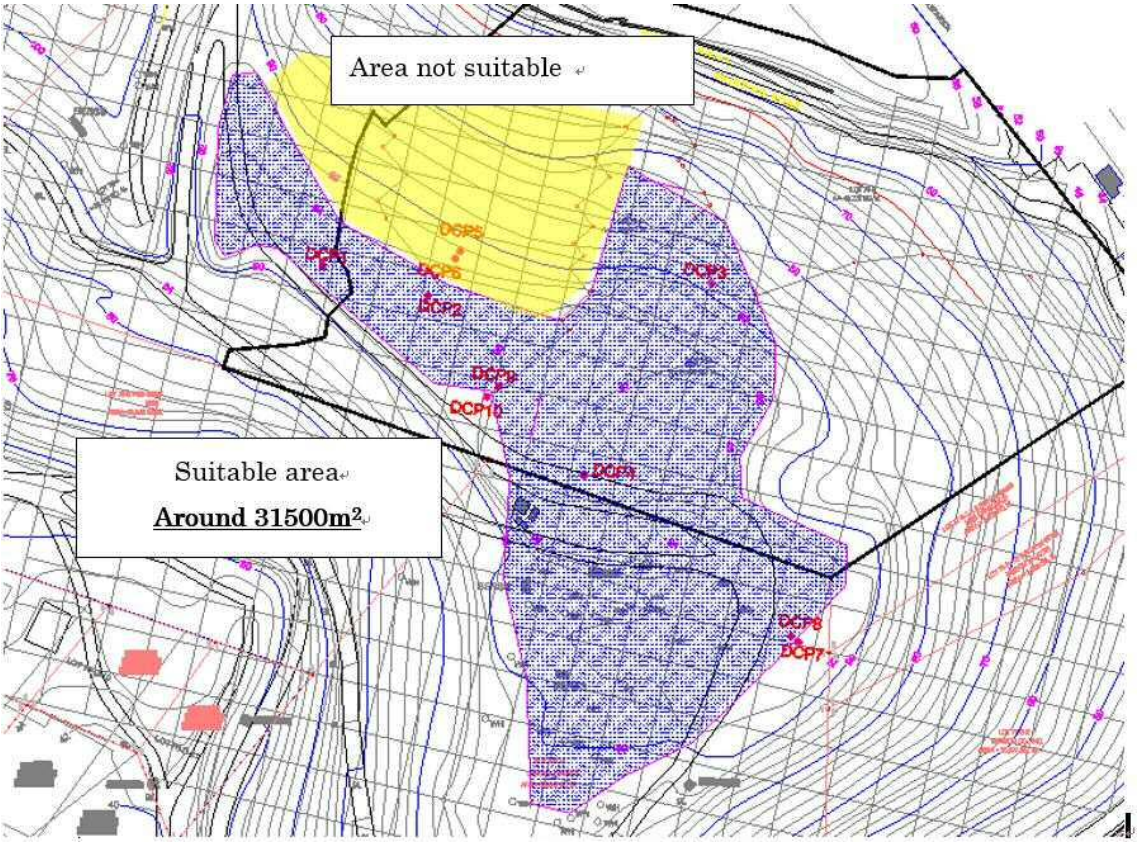

Figure 10: Suitable Area for Installation of Solar Power Generation System

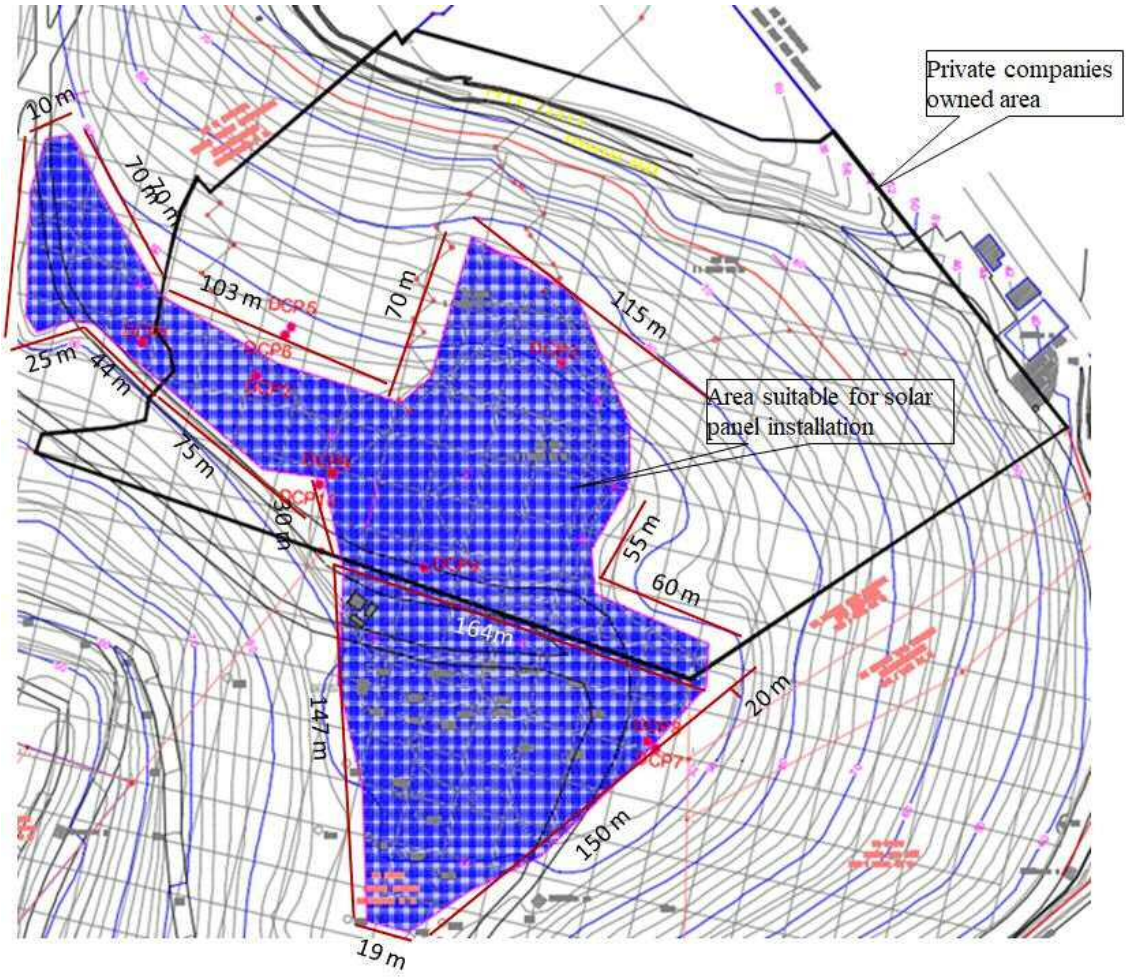

Figure 11: Solar Power Generation Installation Area

As shown in the figures above, the land area suitable for installation of a solar power generation system is around 31,500m^2, which covers lands owned by both of Quezon City and private companies. The area of the land owned by private companies is around 16,249m^2 nearly half of the total land suitable for the project.

3.1.3 Solar Power Generation System

A solar power generation system is mainly composed of solar panels, a connection box (equipment for collecting DC wiring from solar cell into one and sending it to power conditioner), and a power conditioner (equipment for converting DC power generated by a solar cell to AC power). In the study, as mentioned previously, the penetration test on the target landfill was conducted to identify surfaces suitable for

installation of a solar power generation system. Based on the area of the land suitable for installation of solar panels, the size and structure (stand and frame) of the system was discussed. Directions and tilt angles of panels were also considered.

Figure 12: Image of Frame and Stand

As the target city Quezon is situated between 14-15° N latitude, the optimal tilt of solar panels is postulated as 12° based on the calculation of angle from horizontal facing south $0.812 \times Latitude$[1]12°. Furthermore, a distance between arrays set at 0.6 m considering the relationship shown in Figure 13 below.

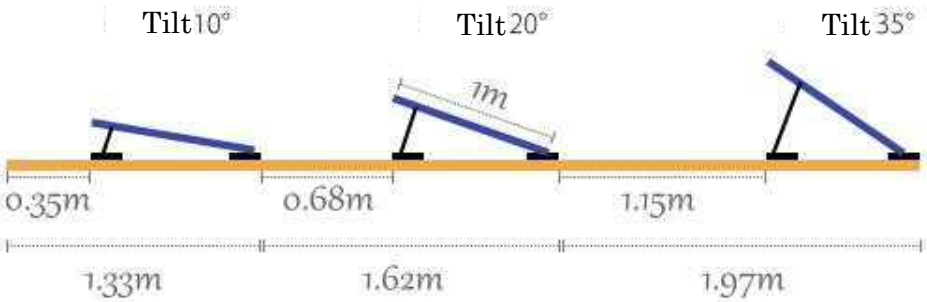

Figure 13: Tilt and Distance of a Solar Panel at 1 m height

Source: http://standard-project.net/solar/angle.html

[1] https://www.researchgate.net/publication/320685573_Optimal_Tilt_of_Solar_Panels_in_the_Philippines

Continuous stand structure (reinforced concrete spread stand) is recommended considering the possibility of the occurrence of uneven settlement in the target area. It is estimated that a 2.9 MW system can be installed in the whole area. The company, which is currently running methane power generation, is expected to operate the solar power generation project and sell the power generated to the Manila Electric Co. (Meralco).

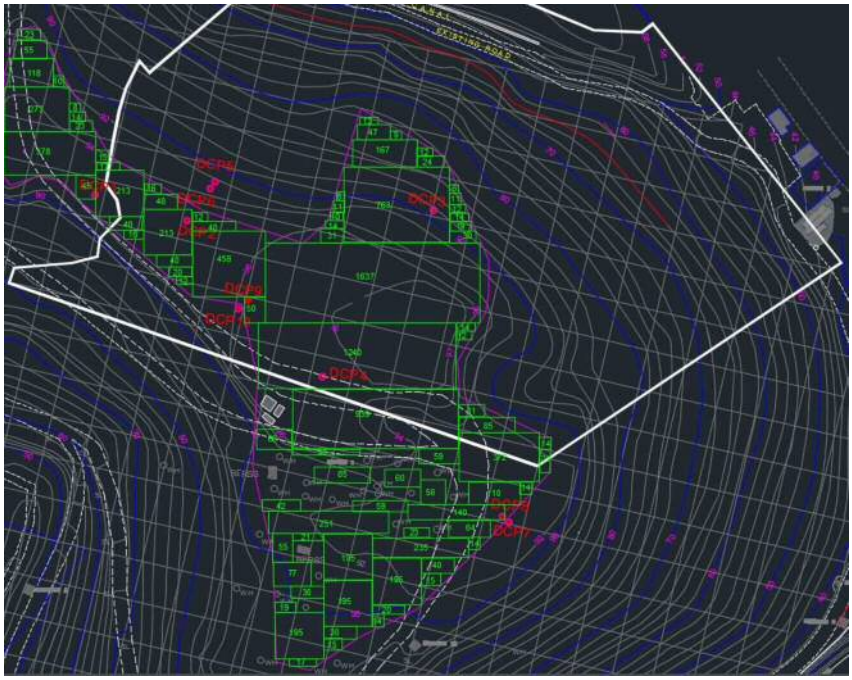

Figure 14: Estimated Number of Solar Panels

The core technologies of the proposed system consists of 9,909 solar panels (300 W modules) and 6 power conditioners with 500W (P500JFL1-A02) capacity each. The specifications of the technologies are as follows.

Table 3: Technology Specifications

Cell types	Mono	Max system voltage	1,000V
Nominal max output	300W	Static load	2,400Pa
Conversion factor (module)	18.2%	Snow depth	Depends on tilt angle. Max 90 cm
Max voltage	32.68V	Fixation	Four points with bolts or clips
Nominal max ampere	9.18A	Dimension	994x1,652x46mm
Nominal Max open voltage	40.03V	Weight	18.5kg
Nominal short-circuit current	9.71A		

Type	P500JFL1-A02
Standard output	500kW
Environment	Indoor
Dimension (W ×D ×H)	2220×1390×2090mm
Weight	2000kg
Insulation type	Transformerless
Voltage range	310~700Vdc
Standard output voltage	210Vac
Frequency	50/60Hz
Efficiency	98.40%
Fault Ride Through	○
Recording	○

In the case of installing a solar power generation system on the land owned by a private company alone, the size of the system is estimated to be 1.7 MW with 1,613 solar panels (refer to Figure 15 below).

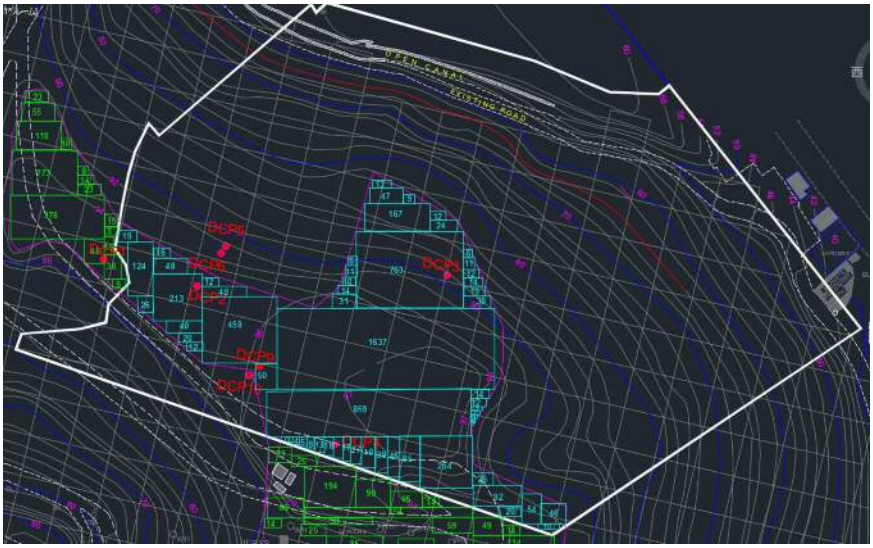

Figure 15: Size of a Solar Power Generation System for Private Land

3.1.4 Host Country's Support Law System Concerning the Introduction of Solar PV System.

Philippines introduced a feed-in tariff (FIT) scheme for renewable energy power projects from July 2012. In the Energy Regulatory Committee's (ERC) sixth resolution in April 2015, the second phase price was set as shown in the table below. The FIT rate for photovoltaic generation of 9.68 pesos/kWh in the first phase was reduced to 8.69 pesos/kWh in the second and is applied to solar energy projects with applications received before March 15, 2016, and the Department of Energy (DOE) is not planning to apply the FIT system to solar power generation projects beyond that. Therefore, the FIT scheme is not available for solar power generation projects now.

Table 4: FIT Rate for Renewable Energies

RE Technology	Approved Rates (PHP/kWh)	Installation Target (MW)
Wind	7.40*	400**
Solar	8.69*	500**

Source: Department of Energy of the Philippines.

In addition, in May 2013, ERC approved the Net Metering system and it was implemented on July 24, 2013. The net metering system is a mechanism that enables operators to introduce a solar-grid linked power generation system for their own consumption and balance the excess power with the power consumption from the grid. Currently, in the Philippines, it is targeted for systems of 100 kW or less.

As of October 2017, 1,029 customers are using the net metering system of Manila Electric Co. (Meralco) with significant recent increases. The application procedure for this system is as follows.

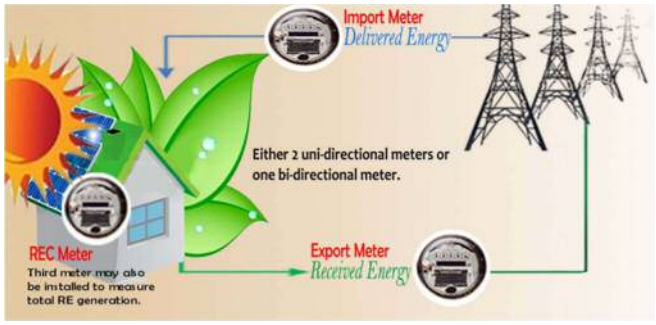

Figure 16: Image of the Net Metering for Solar PV System

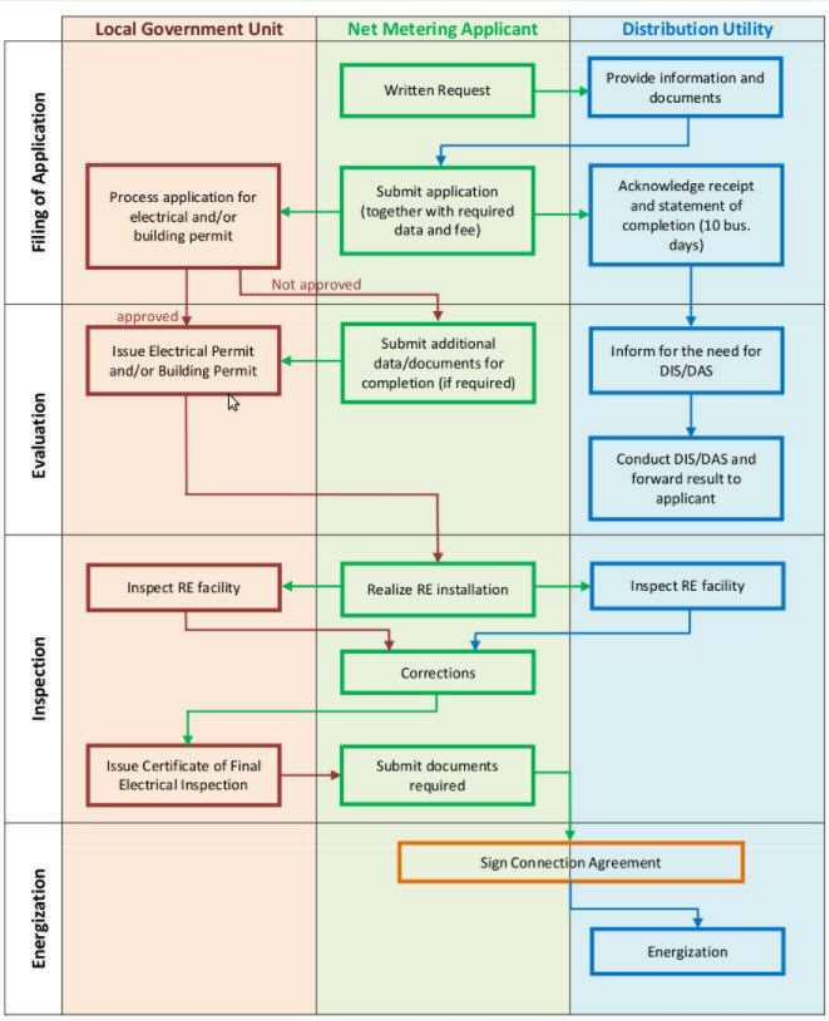

Figure 17: Net Metering Procedure Flow

Source: Philippine Department of Energy website, https://www.doe.gov.ph/2-how-apply-net-metering-services-your-distribution-utility[2]

Since the size of proposed project is far beyond the cap size for net metering and the FIT scheme is not available, the project is expected to sell the electricity generated to Meralco based on negotiations and agreements with Meralco.

[2] https://www.doe.gov.ph/2-how-apply-net-metering-services-your-distribution-utility

3.1.5 Development of MRV Methodology for Green House Gas (GHG) Reduction and Monitoring

3.1.5.1 Summary of the Methodology

For developing a MRV methodology for the solar power generation project, the following approved JCM methodology was referenced.

Table 5: Methodology References

Methodology	Notice
VN_AM007 "Installation of Solar PV System"	Approved on October 10, 2017

This methodology is applied for displacement of grid electricity and/or captive electricity by installation and operation of solar PV system(s).

Table 6: Terms and Definitions

Terms	Definitions
Solar photovoltaic (PV) system	An electricity generation system, which converts sunlight into electricity by the use of photovoltaic (PV) modules The system also includes ancillary equipment such as power conditioner required to change the electrical current from direct current (DC) to alternating current (AC).
Grid	The spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved)

Table 7: Summary of the Methodology

Items	Summary
GHG emission reduction measures	Displacement of grid electricity and/or captive electricity by installation and operation of the solar PV system(s)
Calculation of reference emissions	Reference emissions are calculated based on the AC output of the solar PV system(s) multiplied by either 1) the conservative emission factor of the grid, or 2) conservative emission factor of diesel power generator.
Calculation of project emissions	Project emissions are calculated based on electricity consumption of the solar PV system(s) multiplied by either 1) the conservative emission factor of the grid, or 2) conservative emission factor of diesel power generator.
Monitoring parameters	1) The quantity of electricity generated by the project solar PV system(s) 2) The quantity of electricity consumed by the project solar PV system(s)

3.1.5.2 Eligibility Criteria

The following eligibility criteria are identified for application of the methodology based on the field survey and literature reviews. Criterion 1 and 2 are the requirements concerning a definition of the project, and Criteria 3, 4, and 5 are the requirements relating to the technology to be introduced. This methodology can apply to projects, which satisfy all of the criteria.

Table 8: Eligibility Criteria

Criterion 1	This project either introduces new solar power systems or replaces existing systems with new units.
Criterion 2	The project is to supply electricity to the grid.
Criterion 3	The photovoltaic power generation system introduced in the project can measure the net electric energy supplied to the grid.
Criterion 4	Photovoltaic solar cells introduced in the project are certified by the International Electro technical Commission (IEC) for performance certification standards and safety certification standards, or are certified with national standards that are fully consistent with these standards.
Criterion 5	The power conditioner of solar power generation system introduced in the project is a device with power conversion efficiency of 95% or more.

Criteria 1 and 2 ensure the flexibility of the methodology. The methodology can be applied to projects that utilize FIT and net metering, etc. in the host country, as well as self-consuming projects. In addition, this methodology can apply to either existing or new facility. Criteria 3-5 ensure the quality of the technology.

3.1.5.3 Calculation of Greenhouse Gas Emission Reduction

3.1.5.3.1 Reference and Project Emissions

Reference emission includes CO_2 emissions from electricity generated in power plants that is displaced due to the project activity. The methodology assumes that all project electricity above baseline levels would have been generated by existing grid-connected power plants or captive power generators.

Reference emissions are calculated as follows:

$$RE_y = \sum_i \left(EC_{y,i} \times EF_{co2} \right) \quad (1)$$

RE_y	Reference emissions during the period y (tCO_2/y)
$EC_{y,i}$	Quantity of electricity consumed or sold to the power company from the project solar PV system i during the period y (MWh/y)
EF_{co2}	Electricity CO_2 emission factor (tCO_2/MWh)

On the other hand, the project emission is the CO_2 emission from the electricity consumption of the solar PV system and calculated as follows.

$$PE_y = EC_{PJ,y} \times EF_{co2} \quad (2)$$

PE_y	Project emissions during period y (t CO_2/y)
$EC_{PJ,y}$	Electricity consumption by the project solar PV system (MWh/y)
EF_{co2}	Electricity CO_2 emission factor (tCO_2/MWh)

In addition, emission reduction is calculated as follows.

$$ER_y = RE_y - PE_y \quad (3)$$

ER_y	Emission reduction during period y (t CO_2/y)
RE_y	Reference emission during period y (MWh/y)
PE_y	Project emission during period y (tCO_2/MWh)

The source of each data and parameter fixed ex-ante is as listed below.

Table 9: Parameters Decided Ex-Ante

Parameters	Description of Data	Sources
$EF_{RE,i}$	CO2 emission factor of electricity In the case of the PV	Grid emission factor published by the host country (if there is no any requirement from Joint Committee)

	system connecting to the national grid, a conservative grid emission factor is applied. In the case of the project replacing a captive power generator, the lower emission factor between the grid emission factor and a captive power generator is applied. $EF_{RE,i}$ = min (EF grid, EF captive)	(IGES's List of Grid Emission Factors updated in August 2017) 0.670 tCO_2/MWh (Philippine Combined margin) Captive power generator (diesel power generator): (Table2 I.F.1, Small Scale CDM Methodology: AMS I.F. ver.2) 0.8 kgCO2/kWh

The estimated reduction of CO_2 emission from the project activity is calculated based on the following conditions.

Table 10: Data and Conditions for Calculating Emission Reductions

Items	Values
PV system capacity (kW)	2,900/1,700
Solar irradiance in the host country (kWh/m²/day	5.28
Loss factor	0.75
Grid emission factor (tCO₂/MWh)	0.670

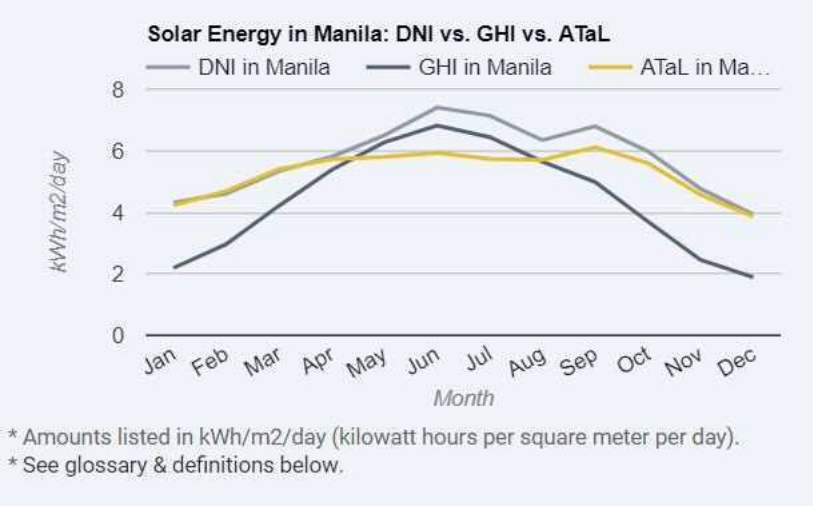

Figure 18: Solar Irradiance in Manila

Source: https://solarenergylocal.com/states/utah/manila/

The estimated power generation from the solar PV system in the project is calculated based on the following equation in the Guidebook of NEDO for solar power generation. The average solar irradiance in Manila 5.28 kWh/m²/day is applied for the calculation.

$EGy = H \times K \times P \times 365 \div 1$

EGy: Estimated power generation of the solar PV system (kWh/year)

H: Solar irradiance in Manila (kWh/m²/day)＝5.28

K: Loss factor 75% (varies by technology and operating conditions)

- Loss due to cell temperature 15% (average rate of the proposed technology)
- Power condition loss rate 5% (average rate of the proposed technology)
- Loss from cables and soiling on panels (around 5%)

P: System capacity (kW)＝2,900kW

365: Days in a year (day)

1: Standard solar irradiance (kW/m²)

The estimated emissions from reference and project scenarios and emission reduction are shown in the table below.

Table 11: Estimated Emission Reduction

Emissions	Values	
	Whole land	Private land
Reference Emission tCO_2/y	2,808	1,631
Project Emission CO_2/y	56	33
Emission Reduction tCO_2/y	2,752	1,598

3.1.5.4 MRV System

The following two parameters should be monitored.

1) The amount of electricity generated by the project solar PV system in the period y (MWh/y).

2) Electricity consumption of the solar PV system in the period y (MWh/y).

The table below shows information about the monitoring. The parameters need to be measured and recorded automatically by the system. In addition, it is required for a designated person assigned by the operator to record the data into prepared data sheets.

Table 12: Monitoring Parameters and Frequencies

No	Parameter		Monitoring Method	Frequency of the Monitoring
1	$\mathbf{EG_{i,p}}$	The amount of electricity generated by the project solar PV system in the period y	Continuous measurement by electricity meters Collected and recorded into prepared data sheets by a designated person once a	Continuous measurement/collect once a week

		(MWh/y)	week.	
2	$EC_{PJ,p}$	Electricity consumption of the solar PV system in the period y (MWh/y)	Continuous measurement by electricity meters Collected and recorded into prepared data sheets by a designated person once a week	Continuous measurement/collect once a week

The MRV methodology in detail will be developed by OC together with JCM representative participant and project owners. Monitoring is implemented by a project operator based on the MRV methodology. Parameters will be measured consistently and automatically through power meters. However, it is necessary to assign a person to collect the data periodically and record it into a prepared data sheet. The collected and recorded data should be reported to the section/office that is responsible for the JCM project. The section should check the data and prepare a data sheet calculating emission reductions on a monthly basis. The monthly-prepared data should be checked and compiled by a person responsible for the JCM project and then reported to the representative participant for submission to the Joint Committee.

The representative participant is responsible for training the staff of the project owner on implementation of monitoring. OC will support the representative participant as necessary.

3.1.6 Project Implementation Structure and Business Model

During the study, business models and their feasibility are discussed regarding the project, which installs a power generation system on the closed landfill. Two business cases are discussed. One is to install 2.9 MW system on the entire area owned by Quezon City and private companies. The other is to install 1.7 MW system on the land owned by private companies. In either case, the company currently operating the landfill-gas-power generation plant is assumed to invest and operate the project.

Table 13: Proposed Solar Power Generation Systems

Target Lands	Panels	Power Conditioners
Total	300W×9,909 (mono crystalline)	500kW×6
Private land	300W×5,613 (mono crystalline)	500kW×4

The initial investment cost of a system includes costs in association with engineering, procurement, and construction, such as equipment costs, design, construction expenses, shipping, packaging, and tariffs. Costs for equipment, designing, and construction can be finalized as per final quotations from technology and service providers based on a detailed design of systems in due course.

The following tariffs and taxes are applicable between Japan and the Philippines: the most favorable nation tax rate, the Japan-Philippine Economic Partnership Agreement applicable tax rate, ASEAN-Japan Comprehensive Economic Partnership applicable tax rate, and 12% VAT on imported goods.

These rates can be checked online at (http://tariffcommission.gov.ph/finder/index.php?page=tariff-finder) and for solar panels and power conditioners, there is supposed to be no tariff. However, it is necessary to consult with experts and related organizations before applying for the JCM model project.

The final revenue structure of the project needs to be finalized before implementation of the project. It is recommended that the existing independent power producer (landfill-gas-power-generation-operator) invest and operate the project and share benefits between shareholders. The estimated revenues from the project are as follows.

Table 14 Estimated Power Generation and Benefits

Target lands	New electricity generate (kWh/year)	Tariff (Yen/kWh) and Benefits (Thousand yen/year)

Whole land	4,107,827	15	63,162
Private land	2,385,231	15	35,778

Note: Tariff is 6.99 peso/kWh. 1 Peso=2.15 Yen

In the case of targeting the entire suitable land and with 30% JCM subsidy, the cash flow of the project is as shown in the following table (it is assumed that 10% of power sales are given back to Quezon City as a dividend for its land equity).

Table 15: Project Cash Flow

Unit:Thousand Yen

	Items	Total	Construction Period	Operation Period									
			0	1	2	3	4	5	6	7	8	9	10
1	**Cash in**	616,170	0	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617
1.1	Power sales	616170	0	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617
1.2													
2	**Cash out**	456,767	344,407	11,236	11,236	11,236	11,236	11,236	11,236	11,236	11,236	11,236	11,236
2.1	Initial cost	344,407	344,407	0	0	0	0	0	0	0	0	0	0
2.2	M&O	49,200	0	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920
2.3	Dividend	63,160	0	6,316	6,316	6,316	6,316	6,316	6,316	6,316	6,316	6,316	6,316
3	**Net income**	159,403	-344,407	50,381	50,381	50,381	50,381	50,381	50,381	50,381	50,381	50,381	50,381

IRR	**8%**
Payback period	**7**
Net Income	**159,403**

In the case where the company loans its investment from financial institutions, the economic feasibility is explained as follows.

The bank interest rate is assumed 3.5% (based on January 2018 long-term loan interest rate information (http://www.bsp.gov.ph/statistics/keystat/intrates.htm) from various banks in the Philippines) and the repayment period is assumed 7 years.

Table 16: Project Cash Flow (In the case of loan)

Unit:Thousand Yen

	Items	Total	Construction Period	Operation Period									
			0	1	2	3	4	5	6	7	8	9	10
1	**Cash in**	616,170	0	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617
1.1	Power sales	616,170	0	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617	61,617
1.2													
2	**Cash out**	468,821	344,407	12,958	12,958	12,958	12,958	12,958	12,958	12,958	11,236	11,236	11,236
2.1	Initial cost	0	0	0	0	0	0	0	0	0	0	0	0
2.2	M&O	49,200	0	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920	4,920
2.3	Dividend	63,160	0	6,316	6,316	6,316	6,316	6,316	6,316	6,316	6,316	6,316	6,316
2.4	Rate+premium	356,461	344,407	1,722	1,722	1,722	1,722	1,722	1,722	1,722	0	0	0
3	**Net income**	147,349	-344,407	48,659	48,659	48,659	48,659	48,659	48,659	48,659	50,381	50,381	50,381

IRR	**7%**
Payback period	**7**
Net Income	**147,349**

In the case of a project on the private owed land, the cash flow with 30% JCM subsidy is shown as follows.

Table 17: Project Cash Flow (Private land)

Unit:Thousand Yen

	Items	Total	Construction Period	Operation Period									
			0	1	2	3	4	5	6	7	8	9	10
1	**Cash in**	357,780	0	35,778	35,778	35,778	35,778	35,778	35,778	35,778	35,778	35,778	35,778
1.1	Power sales	357780	0	35,778	35,778	35,778	35,778	35,778	35,778	35,778	35,778	35,778	35,778
1.2													
2	**Cash out**	235,850	181,880	5,397	5,397	5,397	5,397	5,397	5,397	5,397	5,397	5,397	5,397
2.1	Initial cost	181,880	181,880	0	0	0	0	0	0	0	0	0	0
2.2	M&O	18,190	0	1,819	1,819	1,819	1,819	1,819	1,819	1,819	1,819	1,819	1,819
2.3	Dividend	35,780	0	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578	3,578
3	**Net income**	121,930	-181,880	30,381	30,381	30,381	30,381	30,381	30,381	30,381	30,381	30,381	30,381

IRR	**11%**
Payback period	**6**
Net Income	**121,930**

As the life expectancy of solar power generation systems is 15-20 years, the ultimate accumulated benefits of the projects are supposed to be much more than the above.

Regarding a project implementation system, a representative participant has not currently decided yet. Once the representative participant has been decided, an international consortium will be formed. An application for JCM model project will proceeded together with development of MRV systems.

In the consortium, the representative participant is responsible for project management, application, and allocation of subsidy. OC is responsible for developing MRV methodology as necessary.

In order to start the project, it is necessary to confirm the investment decision of the landowners and develop a detailed design of the system and project implementation schedule.

The projects will be implemented on the grounds of the Payatas landfill as per procedures and regulations required by the host country. It is believed that there are no any significant negative environmental impacts incurred by the projects.

3.1.7 Risks and Countermeasures regarding Project Implementation

The tentative schedule of the JCM project is as follows.

February 2019:	Completion of JCM feasibility study
March 2019:	Final confirmation of the investment decision of landowners
March 2019:	Formulation and finalization of JCM implementation system
	Establishment of international consortium
	Development of project documents and MRV methodology
	Finalization of monitoring plan
	Engineering, procurement, and construction plan
April 2019:	Application for JCM model project
July 2019:	Commencement of JCM model project. Starting installation of system
August 2019:	Verification of MRV methodologies
October 2019:	Application of project registration for Joint Committee
February 2020:	Trial operation
	Technology and knowledge transferring on operation and maintenance
	Capacity building on MRV implementation
February 2020:	Operation start
	Monitoring start
March 2020:	Development of JCM model project report

In order to implement the project based on the schedule described above, the following risks should be carefully considered.

The first is the determination of the size and corresponding technology of the project. It is expected that the project will be implemented using the entire area of land suitable for solar panel installation. As nearly half of the land is owned by Quezon City and government projects must go for open bidding processes, which may increase the risk of JCM project, it is recommended that Quezon City allow the private company to use its land (renting from Quezon city) to invest a solar power

generation project on the whole area. If this business model proves difficult, the private company will implement the project on its own land.

The second is the completion of the project in time with a satisfactory level of quality. At the time of the completion of the feasibility study, the roughly estimated costs of the projects are being discussed. In order to apply for a JCM model project, further effort is needed for developing the detailed design of the system and the schedule of the project. Moreover, it is necessary to establish a project management and quality assurance system together with different stakeholders.

The third is the uncertainty of procurement lead-time. Power conditioners are imported from Japan and low transparency in custom clearance in the host country may cause long procurement lead-time. Consultation with related government agencies will be conducted and practices of prior projects will be observed to scrutinize the time consumption for procurement of the technology.

3.2 Factory Energy Saving JCM Projects

In order to facilitate Quezon City's QC-LCCP, the study introduced energy saving technologies and practices such as condensate recovery, improvement of preheat furnaces and cooling towers in food processing and steel mill factories in Quezon City. In order to observe the energy saving potentialities of practices such as recovery of waste heat and improvement of boilers and furnaces in the factories, the study conducted energy auditing in the factories to identify appropriate technologies for the corresponding practices and examine their energy savings.

3.2.1 Energy Saving Promotion in a Steel Mill

The study also visited a steel mill in Quezon and investigated the possibility of improvement of a reheating furnace in the factory.

The target factory, one of the leading steel mills in the Philippines, was established in 1973. The factory has a pusher reheat furnace with 50 ton/h (made in China) and produces around 300,000 ton steel bars a year. The furnace using fuel oil (bunker oil) has top and bottom firing and is equipped with preheating (with 2 burners), heating (with 4 burners) and soaking zones (10 burners) and the temperature of inside chamber is estimated to be 1,200 °C.

The study discussed the energy saving potentiality of introducing regenerative burners to the furnace such as replacing existing six burners in preheating and

heating zone with two pair regenerative burners.

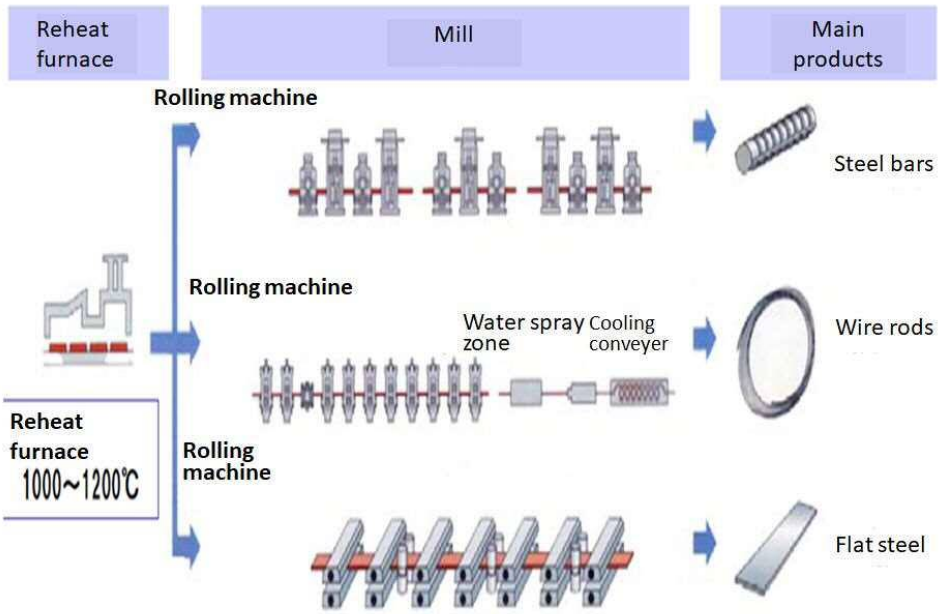

Figure 19: Flow of Steel Bar Manufacturing

3.2.1.1 Technology and Energy Saving

Burners are indispensable for factories using industrial furnaces, as mentioned in the above, the study discussed about introduction of regenerative burners to the reheating furnace with conventional burners.

Regenerative burner system generally ignites a pair of burners (A and B) integrated with the heat reservoirs alternately at intervals of several tens of seconds. While one (A) burner is burning, the exhaust gas passes through and heats the other burner's (B) heat reservoir to recover the energy of the exhaust gas. Then, when the other burner (B) burns, the air for combustion in turn passes through the preheated heat reservoir to recover the exhaust gas energy, which had conventionally been wasted so that the system is able to provide high efficient combustion and secure at least 1,000 °C preheated air.

In general, 35-50% of energy can be saved by adopting the regenerative burner system, though this depends on the furnace temperature, air ratio, and operating patterns of the installed unit. Moreover, regardless of high temperature preheated air, the system is able reduce NOx emission under 150 ppm. The main features of the system are as follows.

- Automatic control of air ratios according to fuel condition and the temperature of air
- Applicability for various type of fuels such as diesel and fuel oil (bunker oils)
- Low NOx emission

In this study, it is proposed to replace six existing burners with two regenerative burner systems. The average yearly production capacity of the factory is 218,400 tons and the yearly fuel consumption of the furnace is 8,076 tons. Based on observations in the factory and related studies, it is expected to save energy by 10% through the project. However, it needs further investigation to finalize the level of energy saving possible through the technology.

3.2.1.2 Development of MRV Methodology for Green House Gas (GHG)

3.2.1.2.1 Summary of the Methodology

In order to develop a MRV methodology for the project, the following existing JCM methodology is referenced.

Table 18: Methodology References

Methodologies	Notices
ID_AM009 "Replacement of conventional burners with regenerative burners for aluminum holding furnaces, ver. 2.0"	The methodology was approved by JCM joint committee on October 10, 2017 and applied for a project seeking fuel (Natural gas) consumption reduction at aluminum holding furnaces in an aluminum-producing factory in Indonesia

The methodology proposed here applies to projects, which introduce regenerative burners to furnaces in steel mills in Philippines.

Table 19: Terms and Definitions

Terms	Definitions
Regenerative burner	Burner systems, which absorb exhaust gas heat to a reservoir and preheat combustion air using the absorbed heat in the reservoir to improve energy efficiency
Conventional burner	Burner systems, which do not have combustion, air preheating facility

Table 20: Summary of the Methodology

Items	Summary
GHG emission reduction measures	By replacing conventional burners with regenerative burners for reheating furnaces, consumption of fossil fuel can be reduced, which leads to reduction of GHG emissions.
Calculation of reference emissions	Reference emissions are CO_2 emissions from the use of the reference-reheating furnace, which are calculated based on the steel production in the project and the energy intensity of the reference furnace.
Calculation of project emissions	The project emissions are calculated based on fuel and electricity consumption of the furnace in the project and the CO_2 emission factors of the electricity and fuel.
Monitoring parameters	The following parameters need to be monitored 1) The quantity of fuel consumed by the reheat furnace in the project 2) The quantity of steel bar produced in the project 3) The quantity of electricity consumed by the project furnace

3.2.1.2.2 Eligibility Criteria

This methodology is applicable to projects that satisfy all of the following criteria shown in Table 21 below.

Table 21: Eligibility Criteria

Criterion 1	Projects replace conventional burners with regenerative burners in steel mills
Criterion 2	Projects target new, existing, or additional facilities.

3.2.1.2.3 Emission Reduction Calculation

Establishment and calculation of reference emissions:

The reference emission is the emission from consuming fossil fuels to produce the same amount of steel bar in the project under the condition of reference burners. In this methodology, the energy intensity of reference furnaces is determined ex-ante as a default value based on the operation data of the factory.

Although reference furnaces also consume electricity, CO_2 emissions from the electricity consumption are not included in the reference emission for ensuring simplicity and conservativeness.

$$RE_y = FC \times P_y \times NCV \times EF_{co2} \quad (1)$$

RE_y	Reference emissions (tCO_2/y)
FC	Energy intensity of a reference furnace (liter/ton)
P_y	The quantity of steel bar produced in the project (ton/y)
NCV	Net caloric value of furnace fuel (TJ/Gg)
EF_{co2}	CO_2 emission factor of furnace fuel (tCO_2/TJ)

Establishment and calculation of project emissions:

The project calculations are calculated as follows.

$$PE_y = EC_{PJ,y} \times EF_{e,co2} + FC_y \times NCV \times EF_{co2} \quad (2)$$

PE_y	Reference emissions (tCO_2/y)

$EC_{PJ,y}$	Electricity consumption by project furnace (MWh/y)
$EF_{e,co2}$	CO_2 emission factor of electricity (tCO_2/MWh)
FC_y	Fuel consumption by project furnace (ton/y)
NCV	Net caloric value of furnace fuel (TJ/Gg)
EF_{co2}	CO_2 emission factor of furnace fuel (tCO_2/TJ)

Emission reduction can be calculated as follows.

$$ER_y = RE_y - PE_y \quad (3)$$

ER_y	Emission reduction (tCO_2/y)
RE_y	Reference emissions (tCO_2/y)
PE_y	Project emissions (tCO_2/y)

Regarding data and parameters need to be determined ex-ante are given in Table 22 below.

Table 22: Data and Parameter Fixed Ex-Ante

Parameters	Description of data	Source
FC	Energy consumption intensity of reference furnace (liter/ton)	The most steel mills in Philippine have fuel intensity over 450Mcal/t. For this project, 43 l/ton (411 Mcal/ton) is applied.
$EF_{RE,i}$	CO_2 emission factor of electricity In the case of grid: 0.670 tCO_2/MWh In the case of captive power plant (diesel):	In the case of grid (Official data from Philippine Government) ((IGES's List of Grid Emission Factors updated in August 2017)) In the case of diesel captive power plant (Table I.F.1, Small Scale CDM

	0.8 tCO_2/MWh	Methodology: AMS I.F. ver.2).

Estimations of emission reductions are calculated through spreadsheets based on the methodology.

Table 23: Data and Conditions for Calculating Emission Reduction

Items	Values
Project production (t/y)	218,400
Energy intensity of reference furnace (l/t)	43
Density of furnace fuel(fuel oil) (kg/l) [3]	0.9855
CO2 emission factor of electricity (tCO_2/MWh)	0.670
Heat capacity of furnace fuel (TJ/Gg)	39.8
CO2 emission factor of furnace fuel (t/TJ)	75.5

As a result, the CO_2 emission reduction from the proposed project is estimated as follows.

Table 24: CO_2 Emission Reduction Estimation from the Project

Scenarios	Emission Reduction
Reference emission (tCO_2/y)	27,810
Project emission (tCO_2/y)	25,029
Emission reduction (tCO_2/y)	2,781

[3] file:///C:/Users/oc2964/Downloads/OrderERCCaseNo2015-225RC.pdf, Republic of the Philippines ENERGY REGULATORY COMMISSION

3.2.1.2.4 MRV System

The following three parameters need to be monitored over the project period.

1) Furnace fuel consumption in the project (l/y)

2) Amount of production in the project (t/y)

3) Furnace electricity consumption in the project (MWh/y)

Table 25 shows the parameters that need monitoring, monitoring methods, and monitoring frequencies. The parameters are measured or recorded automatically or manually and compiled once a week by a designated staff member.

Table 25: Monitoring Parameters and Methods

No	Parameters		Methods and procedures	Frequency
1	$\boldsymbol{P_y}$	Amount of production (t/y)	Responsible staff member collects data from a production logbook once a week and records them into a spread sheet	Daily record/weekly compile
2	$\boldsymbol{FC_y}$	Furnace fuel consumption (l/y)	Responsible staff member collects data from a furnace operation logbook once a week and records them into a spread sheet	Daily record/ /weekly compile
3	$\mathbf{EC_{PJ,y}}$	Furnace electricity consumption (MWh/y)	Responsible staff member collects data from a power meter once a week and records them into a spread sheet	Continuous record/weekly compile

The MRV methodology will be developed in detail by OC together in collaboration with JCM representative participants and project owners. Monitoring is implemented by the factory based on the MRV methodology. Parameters will be measured or recorded automatically or manually. It is necessary to designate a

person to collect the data periodically (once a week) and record it into a prepared spreadsheet. The collected and recorded data should be reported to the section/office responsible for the JCM project. The section should check the data and prepare a data sheet with the calculations of emission reductions on a monthly basis. The monthly-prepared data should be checked by a person who is responsible for the JCM project and then it should be reported to the representative participant for submission to the Joint Committee.

The representative participant is responsible for training the staff of the factory on the implementation of the monitoring. OC will support the representative participant as necessary.

3.2.1.3 Project Implementation Structure and Business Model

The feasibility of introduction of regenerative burner system (RCB low NOx emission burner) was discussed based on field surveys and existing related studies. Technology specifications have been tailored and initial costs are estimated based on the application and study cases of similar technology[4,5].

The following tariffs and taxes are applicable between Japan and the Philippines: the most favorable nation tax rate, the Japan-Philippine Economic Partnership Agreement applicable tax rate, ASEAN-Japan Comprehensive Economic Partnership applicable tax rate, and 12% VAT on imported goods.

These rates can be checked online (http://tariffcommission.gov.ph/finder/index.php?page=tariff-finder) and it is interpreted that there is no tariff for the proposed technology; however, it is necessary to consult with experts and related organizations before applying for the JCM model project.

The final quotation for the construction is necessary in due course toward application for the JCM model project. The cost of furnace fuel (Bunker C with

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[4] Energy saving guideline-study on the promotion of energy saving in Indonesia

[5] JCM project feasibility study on the promotion of energy saving technologies in steel industry in Vietnam (March 2015)

density 0.9855 kg/liter) is 33.5 peso/liter[6].

Table 26 below shows the feasibility of the case in which the factory finances the project with 50% of JCM subsidy.

Table 26: Project Feasibility

Technology	2 regenerative burner systems
Initial cost (peso)	120,000,000
JCM Subsidy (%)	50
Energy saving (peso/year)	31,460,520
Payback period (year)	2
IRR (%)	51

As depicted in the table above, application of 50% JCM subsidy makes the project economically feasible with a 2-year payback period.

Table 27 below shows the feasibility of the case, in which the factory goes for a loan to finance the project. Based on the recent information from Bank of Philippine Islands (http://www.bsp.gov.ph/statistics/keystat/intrates.htm), the rate of 7.5% for mid-term loan is applied under a 5-year payment period term.

Table 27: Project Feasibility (in the case of loan)

Technology	2 regenerative burner systems
Initial cost (peso)	120,000,000
JCM Subsidy (%)	50
Loan	82,500,000
Energy saving (peso/year)	31,460,520
Payback period (year)	3
IRR (%)	36

Regarding the project implementation system, the representative participant has not yet been decided. Once the representative participant has been decided, an international consortium will be formed and application for JCM model project will proceed.

6 https://business.mb.com.ph/2018/06/30/coal-is-33-cheaper-than-bunker-fuel-sardine-makers/

In the consortium, the representative participant is responsible for fund procurement and management of the project. OC is responsible for developing MRV methodology as necessary.

In order to start the project, it is necessary to confirm the investment decision of the factory and develop a detailed design of the system and project implementation schedule.

The project will be implemented in the factory as per procedures and environmental regulations required by the host country. It is believed that there are no any significant negative environmental impacts from the project.

3.2.2 Food Processing Factory Energy Saving

3.2.2.1 Energy Auditing

In the end of September 2018, the study team conducted a 3-day energy audit in a food-processing factory in Quezon City. The factory, which was established in 1987, is one of the leading companies in the field of edible oil production and distribution. Its products include refined, bleached, and deodorized palm oil, palm olein, palm stearin, palm kernel oil, coconut oil, margarines, confectionary fats, cocoa butter substitutes, milk fat substitutes, creaming fats, ice cream fats, culinary fats, frying fats, shortenings and customized fats.

The energy audit examined energy saving potentiality on the factory's utilities such as boilers and cooling towers.

Information about the main utilities of the factory is as follows.

Utilities:

Coal boilers: 10 ton/h×2, 4 ton/h×1

Diesel boilers: 6 ton/h×1

High-pressure boilers: 400 Kcal/h×2

Energy and water consumption:

Coal: 11,658 MT/year, 971 MT/month

Diesel: 574,000 li/year, 47,830 li/month

Electricity: 9,079,354 kWh/year, 756,612 kWh/month

Water: 94,175 m3/year, 7,848 m3/month

The contents of the energy auditing are as follows.

1) Boiler operation condition

During the survey in the factory, two coal boilers (No. 1 10 t/h and No. 2 4t/h) were being operated in the factory for production.

Figure 20: Appearance of 10t boiler

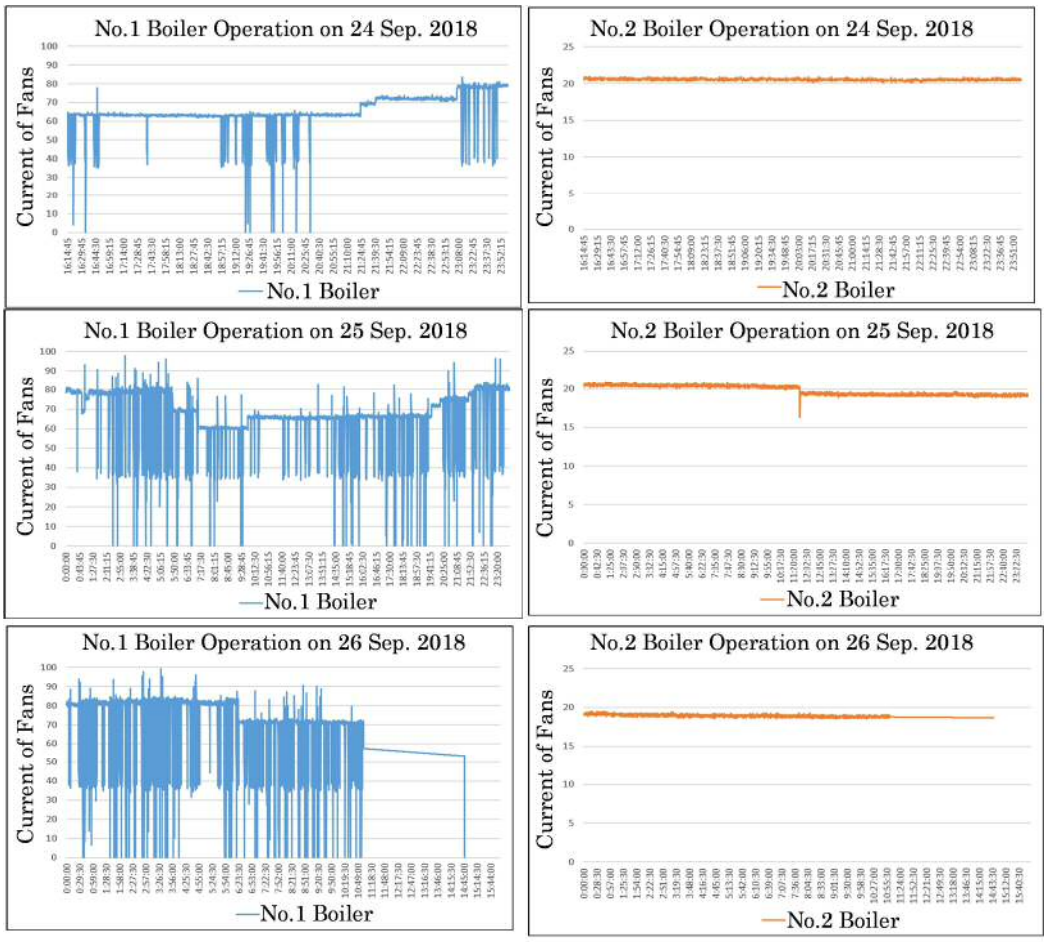

Figure 21: Boiler Operation

The figures above show that the No. 2 boiler was operated continuously without interruption while No.1 boiler was operated corresponding to demand fluctuation during the survey Energy efficiencies of the boilers are calculated as follows.

Table 28: Boiler Efficiency Calculation (No. 1 boiler)

No1 (10t/h) Coal heat capacity= 5,000 kcal/kg-coal

Days	Start	Over	Steam	Coal	Pressure	Temp	Enthalpy	In	Out	Effi	Load
			kg	kg	MPa	℃	kcal/kg	kcal	kcal	%	%
9/23	7:00	19:00	17,168	5,500	1.06	66.3	664.5	27,500,000	10,269,898	37.3%	34.8%
	19:00	7:00	16,257	4500	1.04	62.0	664.3	22,500,000	9,791,591	43.5%	
	Total/Ave		33,425	10,000	1.05	64.2	664.4	50,000,000	20,061,489	40.1%	
9/24	7:00	19:00	15,024	3,500	1.04	44.4	664.3	17,500,000	9,313,378	53.2%	29.8%
	19:00	7:00	13,575	4,250	1.01	67.8	664.5	21,250,000	8,100,203	38.1%	
	Total/Ave		28,599	7,750	1.025	56.1	664.4	38,750,000	17,413,580	44.9%	
9/25	7:00	19:00	13,481	3,750	1.05	59.1	664.4	18,750,000	8,160,049	43.5%	26.5%
	19:00	7:00	11,917	4,500	1.04	53.7	664.4	22,500,000	7,277,712	32.3%	
	Total/Ave		25,398	8,250	1.045	56.4	664.4	41,250,000	15,437,761	37.4%	
		Ave	29,141	8,667	1.04	58.9	664.4	43,333,333	17,637,610	40.8%	30.4%
			1,214kg/h	361kg/h							

Table 29: Boiler Efficiency Calculation (No. 2 boiler)

No2 (4t/h) Coal heat capacity= 5,000 kcal/kg-coal

Days	Start	Over	Steam	Coal	Pressure	Temp	Enthalpy	In	Out	Effi	Load
			kg	kg	MPa	℃	kcal/kg	kcal	kcal	%	%
9/23	7:00	19:00	17,168	5,500	1.06	66.3	664.5	27,500,000	10,269,898	37.3%	34.8%
	19:00	7:00	16,257	4500	1.04	62.0	664.3	22,500,000	9,791,591	43.5%	
	Total/Ave		33,425	10,000	1.05	64.2	664.4	50,000,000	20,061,489	40.1%	
9/24	7:00	19:00	15,024	3,500	1.04	44.4	664.3	17,500,000	9,313,378	53.2%	29.8%
	19:00	7:00	13,575	4,250	1.01	67.8	664.5	21,250,000	8,100,203	38.1%	
	Total/Ave		28,599	7,750	1.025	56.1	664.4	38,750,000	17,413,580	44.9%	
9/25	7:00	19:00	13,481	3,750	1.05	59.1	664.4	18,750,000	8,160,049	43.5%	26.5%
	19:00	7:00	11,917	4,500	1.04	53.7	664.4	22,500,000	7,277,712	32.3%	
	Total/Ave		25,398	8,250	1.045	56.4	664.4	41,250,000	15,437,761	37.4%	
		Ave	29,141	8,667	1.04	58.9	664.4	43,333,333	17,637,610	40.8%	30.4%
			1,214kg/h	361kg/h							

Table 30: Comparison of the Efficiencies of the Boilers

Boilers	Efficiency	Load
No. 1 10t/h	55.3%	40.9%
No. 2 4t/h	40.8%	30.4%

The efficiencies of the boilers are very low as shown in the table above. The reasons are that the main one is low-load operation, and excess air ratio may be another reason for the low efficiency of No.2 boiler regardless of its continuous operation.

As countermeasures, it is recommended to adjust boiler operation assignment and schedule as per the production plan so ensure boilers are operating at as high of a load as possible. In addition, improving coal-feeding system to ensure complete combustion of coal inside the furnace is a way to improve the efficiencies of the boilers.

2) Condensate recovery condition

Since the most production lines in the factory are located close to the boiler room, it is assumed very convenient for recovering and returning condensate to the boilers as a component of boiler feed water. However, at present only a small portion of condensate generated from the factory is recovered. A deaerator system has been applied to remove oxygen and other dissolved gases from boiler feed-water to avoid

corrosion damage to the boilers. As an energy saving practice, it is recommended to increase the rate of condensate recovery.

The result of the observations regarding feed-water condition and condensate recovery practices is as follows.

Table 31: Current Condensate Recovery

Days	Boiler	Steam	Blowdown	Soft water	Condensate	Recovery	Coal
		Kg/day	Kg/day	Kg/day	Kg/day	%	Kg/day
9/23	No1	77,114	3,856	80,970	13,087	11.3%	29,650
	No2	33,425	1,671	35,096			
	Total	110,539	5,527	116,066			
9/24	No1	105,822	5,291	111,113	15,915	11.3%	30,282
	No2	28,599	1,430	30,029			
	Total	134,421	6,721	141,142			
9/25	No1	111,716	5,586	117,302	16,233	11.3%	30,236
	No2	25,398	1,270	26,668			
	Total	137,114	6,856	143,970			
	Average	127,358	6,368	133,726	15,078	11.3%	30,056

So far only 11% of condensate has been recovered in the factory, so it is possible to increase the rate of condensate recovery to 30~50% through installing a condensate recovery system.

3) Working Condition of Economizers

Generally, coal boilers come with economizers, which help increase boiler efficiency through preheating boiler water using boiler exhaust gases. The efficiency of an economizer drops due to adhesion of the dust particles from exhaust gas to the surface of the economizer. The heat recovery capacity of the economizer of No. 1 boiler was calculated based on the measured data such as the temperature of water in and out.

Table 32: Working Conditions of Economizer

	In	Out	Difference
	℃	℃	℃
9/24	65	78	13
9/25	62	75	13
9/26	62	75	13
Average	63	76	13

The examination of the economizer shows that the economizer's contribution to the efficiency of the boiler is only 1.3% while the standard figures for coal boilers are 4%-6%. Therefore, regularly cleaning the economizer will help increase its efficiency.

4) Scrubber System Heat Recovery

At present, particulars and other gases in boiler exhaust gases are removed using wet scrubber systems. Measurements of the temperatures of the water used for the system are as follows.

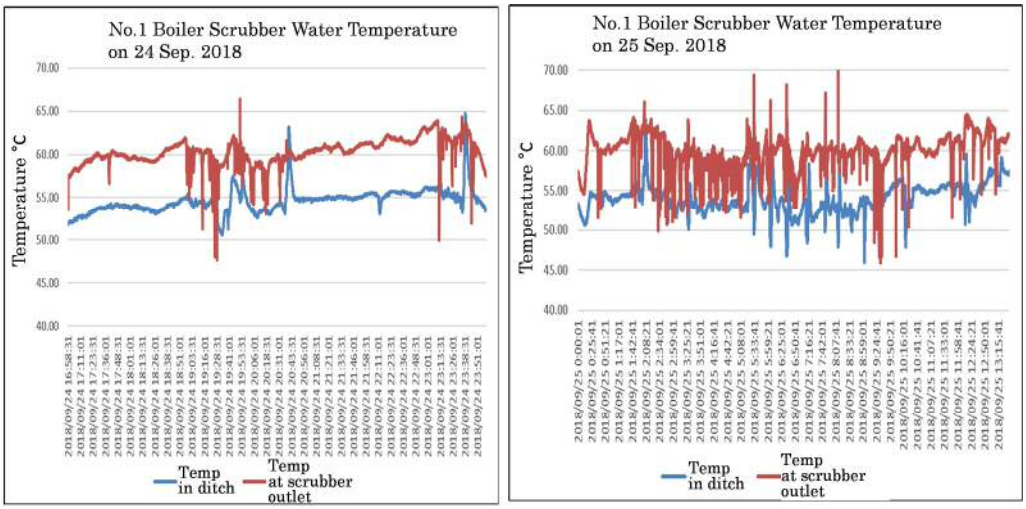

Figure 22: Scrubber Water Temperatures

It is possible to recover the heat conveyed by the exhaust gas by installing a heat exchanger at the appropriate point of the scrubber system.

It is recommended to install the heat exchanger below the water spray to avoid adhesion of dust particles to the pipes of the heat exchanger.

5) Cooling Tower Operation Condition

In the factory, there are 3×1000RT cooling towers and two of them run continuously.

Figure 23: View of Cooling Tower System

Table 33: Water Temperatures in the Cooling Tower System

	Inlet Temp °C	Outlet Temp °C	Differences °C
25 Sept	32.9	29.4	3.5
26 Sept	32.1	28.8	3.3
Average	32.5	29.1	3.4

The cooling tower system works at 66.9% cooling efficiency, which is seen as a condition of low efficiency. Visual observation also showed that homogeneous spray was not occurring within the cooling tower.

Figure 24: Spraying Condition of the Cooling Tower

The result of cooling water quality analysis is as follows.

Table 34: Water Quality Indicators

Items	Unit	Spot Value	Japanese Standard Values
Electrical conductance	uS/cm	1,630	800≧
pH	-	8.5	6.5-8.2
Total hardness	mg$CaCO_3$/ℓ	200	200≧

Regarding the quality of cooling water, the electrical conductivity was two times higher than that of required by Japanese standards. This implies that the cooling water is contaminated to a significant level. Since the cooling tower system has no blowdown system, high concentration of minerals in the cooling water occurs habitually, which accelerates formation of scale in the cooling tower.

Therefore, it is recommended to install a simple blowdown system to the cooling system and clean the system regularly using a peroxide solution.

3.2.2.2 Technologies and Energy Savings

Recommended energy saving technologies, knowledge, and their corresponding effects are concluded as follows.

Table 35: Technologies and Energy Savings

NO	Facilities/Items	Current Situation	Recommendation	Coal saved ton/year		Money saved US$/year	
				min	max	min	max
1	Economizer (10 ton boiler)	Contribution to boiler efficiency is 1.3% Heat recovery=55,861kcal/h	Increase heat transfer area of the the economizer. Increase the contribution rate to 4%~6%	357	595	35,700	59,500
2	Condensate recovery	Recovery rate is 11.3%	Increase recovery rate to 30%~50%. and Temperature rise in boiler water is around 27 °C. Stop using the existing deaeretor.	428	828	42,800	82,800
3	Heat recovery from srubber system	Flue temprerature is 200 °C.	Install a heat exchanger at the bottom of the scrubber to recover waste heat from exhaust gas	191		19,100	
4	Cooling towers	Capacity is around 70% of the rated capacity		-			
		Electrical conductivity of circulated water is 2 times higher than a Japanese standard value	Install an automated blowdown system to avoid over concentration of minerals in cooling water	-			
		High mineral concentration	20~30% improvement in cooling capacity can be expected through cleaning the towers using	-			
		Cooling towers need cleaning		-			
			Total	976	1614	97,600	161,400

＊100USD/t coal

Economic analysis and estimation of CO_2 emission reduction for the case of recovering 30% of condensate in the factory are as follows.

3.2.2.3 Development of MRV Methodology for Green House Gas (GHG) Emission Reduction

Since there has been no any JCM MRV methodology related to condensate recovery in industry sector, a CDM methodology (shown in the Table 36) was studied to develop MRV methodology for the project.

Table 36: Related CDM Methodology

Methodology	Notice
≪CDM Methodology≫ AM0044：AM0017: Steam system efficiency improvements by replacing steam traps and returning condensate --- Version 2.0	Methodology for projects, which recover condensate from production processes in factories The methodology is referenced for developing the JCM MRV methodology.

3.2.2.3.1 Summary of the MRV Methodology (condensate recovery)

This methodology applies to condensate recovery and utilization in food processing factories in the Philippines.

Table 37: Terms and Definitions

Terms	Definitions
Condensate	Condensate is the liquid formed when steam passes from the vapor to the liquid state. In a heating process, condensate is the result of steam transferring a portion of its heat energy, known as latent heat, to the product, line, or equipment being heated.
Condensate recovery and utilization	Practices of recovering high temperature condensate from steam traps and returning the condensate directly to boilers or through boiler feed water tank in the purpose of reducing boiler fuel and water consumption

Table 38: Summary of the Methodology

Items	Descriptions
GHG emission reduction measures	The quantity of heat energy used for producing steam in a boiler can be reduced by returning the condensate to a boiler feed water tank. This practice helps reduce the boiler fuel (coal) consumption that in turn leads to reduction of GHG emissions from food processing
Calculation of reference emissions	GHG emissions from consumption of fossil fuels to produce the amount of energy equivalent to the energy recovered. It is calculated as follows. [(temperature of boiler feed water outlet)-(temperature of boiler feed water inlet] × (amount of boiler feed water) × (water heat capacity)/(boiler efficiency) × (CO_2 emission factor of boiler fuel) 100% is used for boiler efficiency from the perspective of

	conservativeness
Calculation of project emissions	The project emissions are calculated based on electricity consumption of a condensate recovery system and the CO_2 emission factor of the electricity.
Monitoring parameters	The following parameters need monitoring 1) The temperature of feed water through a feed tank to the boiler in the project 2) The quantity of feed water through a feed tank to the boiler in the project 3) The quantity of electricity consumed by a condensate recovery system

3.2.2.3.2 Eligibility Criteria

Eligibility criteria of the methodology are developed based on field surveys and literature reviews. The criteria are listed in Table 39 below. Criteria No. 1 refers to the concept of a project and No. 2 stipulates the technological aspects of a project.

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

Table 39: Eligibility Criteria

Criterion 1	Condensate recovery from production processes in existing or new food processing factories.
Criterion 2	Specialized centrifugal pumps with ejectors are used

3.2.2.3.3 Establishment and Calculation of Reference Emissions

The reference emission is the GHG emissions from consuming fossil fuels to retain the amount of energy equivalent to energy recovered from the project. The reference emissions are calculated as follows. CO_2 emission factors of boiler fuels deploy default values from the IPCC Guideline and lower values are used. Temperatures and the amount of boiler feed water need monitoring.

$$RE_y = (T_{ws} - T_{rw}) \times BW_y \times W_{th}/ef \times EF_{co2} \times 10^{-6} \quad (1)$$

RE_y	Reference emissions (tCO_2/y)
T_{ws}	Project boiler feed water temperature (°C)
T_{rw}	Existing feed water temperature (°C)
BW_y	Quantity of boiler feed water (ton/y)
W_{th}	Heat capacity of water (kJ/kg °C)
ef	Boiler heat efficiency (%)
EF_{co2}	CO_2 emission factor of boiler fuel (tCO_2/TJ)

Project emissions are calculated based on the quantity of electricity consumed by the condensate-heat-recovery system and the CO_2 emission factor of electricity the system using. For CO_2 emission factor of electricity, grid emission factor is applied.

$$\mathrm{PE_y} = \mathrm{EC_{PJ,y}} \times \mathrm{EF_{elec}} \quad (2)$$

$\mathrm{PE_y}$	Project emissions (tCO_2/y)
$\mathrm{EC_{PJ,y}}$	Electricity consumption by the waste heat and condensate recovery system (MWh/y)
$\mathrm{EF_{elec}}$	CO_2 emission factor of the electricity the system using (tCO_2/MWh)

Emission reduction is calculates as follows.

$$\mathrm{ER_y} = \mathrm{RE}_y - \mathrm{PE_y} \quad (3)$$

$\mathrm{PE_y}$	Emission reduction (tCO_2/y)
RE_y	Reference emissions (tCO_2/y)
$\mathrm{PE_y}$	Project emissions (tCO_2/y)

Parameters requiring determination ex-ante are as follows.

Table 40: Parameter Fixed Ex-Ante and Sources

Parameter	Description of data	Source
Ef	Boiler efficiency	Factories (100% is used for conservativeness)
$EF_{CO2,fuel}$	CO_2 emission factor of the fuel used for steam generation Coal: 87.3 tCO_2/TJ (lower case of default value)	2006 IPCC Guidelines for National Greenhouse Gas Inventories: Table 1.4, Chapter 1, Volume 2.
T_{rw}	Existing feed water temperature (°C)	Project implementers based on a 3 month--measurement campaign
EF_{elec}	CO_2 emission factor of electricity In the case of grid: 0.670 tCO_2/MWh In the case of captive power plant (diesel): 0.8 tCO_2/MWh	In the case of grid (Official data from Philippine Government) ((IGES's List of Grid Emission Factors updated in August 2017)) In the case of diesel captive power plant (Table I.F.1, Small Scale CDM Methodology: AMS I.F. ver.2).

Estimated emission reduction:

The emission reduction for the case of recovering 30% of condensate in the factory was estimated based on the data and information from the factory and methodology. Table 41 below provides the conditions for the estimation.

Table 41: Conditions for Estimation of Emission Reduction

Items	Values
Yearly operation days d/y	350
Current temperature of boiler feed water °C	34
Project temperature of boiler feed water °C	48 (30% collection) 61 (50% collection)
Water heat capacity kJ/kg °C	4.184
Amount of boiler feed water t/y	46,804
CO_2 emission factor of boiler fuel tCO_2/TJ (coal)	87.3
Electricity consumption of condensate recovery system kW	3

Based on the conditions depicted above, the amount of emission reduction from the proposed project was estimated as follows.

Table 42: Estimation of Emission Reduction

Scenarios	Emissions	
	30% condensate collection	50% condensate collection
Reference emission tCO_2/y	239	462

Project emission tCO_2/y	17	17
Emission reduction tCO_2/y	222	445

3.2.2.3.4 MRV System

Monitoring parameters and methods are discussed from the perspectives of lessening the burden of target factory, conservativeness, and transparency. As a result, the following parameters require monitoring over the project.

1) Temperature of boiler feed water to the boiler (°C)

2) The amount of boiler feed water (t/y)

3) The electricity consumption of condensate recovery system (MWh/y)

Table 43 shows the ways and frequency of the monitoring and Figure 24 shows the points where related measuring meters need to be installed.

For measuring the temperature, thermometers, which have functions of data transmission through frequency conversions, will be used to ensure continuous data collection and recording. For parameter 2, flow meters with data transmission functions will be installed to promise continuous data collection and recording. A designated and assigned person in the factory will collect the data recorded automatically once a week and record them into data sheets prepared beforehand. For electricity, power meters will be installed to control panels of the system introduced to measure accumulated power consumption of the system. A designated factory employee will read power meters and record the figures after each shift. Factory managers will collect all data once a week and record them into data sheets prepared beforehand. All meters with sensors will be inspected, maintained, and calibrated regularly as per specifications and guidelines from manufacturers.

Table 43: Monitoring Methods and Frequencies

No	Parameters		Monitoring methods	Frequencies
1	T_{ws}	Temperature of the feed water (°C)	Continuous measurement through thermometers meters Collected and recorded into prepared data sheets by a designated person once a week	Continuous measurement, compile once a week
2	BW_y	Amount of feed water (t/y)	Continuous measurement through flow meters Collected and recorded into prepared data sheets by a designated person once a week	Continuous measurement, compile once a week
3	$EC_{PJ,y}$	Electricity consumption of condensate recovery system (MWh/y)	Continuous measurement through power meters Collected and recorded into prepared data sheets by a designated person once a week	Continuous measurement, compile once a week

Regarding the temperature of the current (reference) boiler feed water, an average value of 3 months data collected before project implementation is applied.

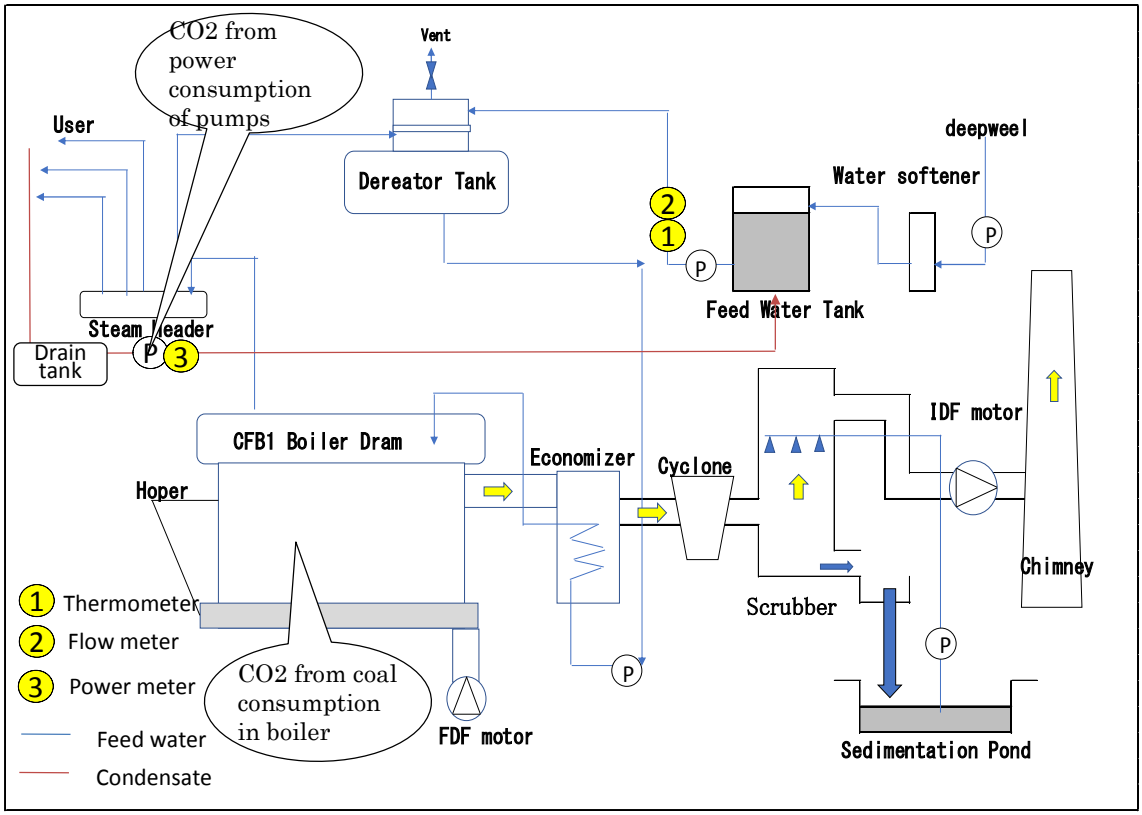

Figure 25: Monitoring Points

QA/QC system is very important to ensure reliability of a monitoring. As situations are different by factories, it is hard and inappropriate to develop a uniform QA/QC system for all factories. Concrete monitoring plans for the factories will be developed in due course of implementation process.

MRV methodology will be developed in detail by OC together with the JCM representative participant and project owners. Monitoring will be implemented by the factory based on the MRV methodology. Parameters will be measured consistently and automatically by meters. However, it is necessary to collect the data periodically and record into a prepared data sheet by a designated person from the factory. The collected and recorded data should be reported to the section responsible for the JCM project. The section should check the data and prepare a data sheet, which calculates emission reduction in monthly basis. The monthly-prepared data should be checked and accumulated by a person for the JCM project and reported to the representative participant for submission to the Joint Committee.

The representative participant is responsible for training the staff of the factory (project owner) on the implementation of monitoring and OC will support the representative participant if necessary.

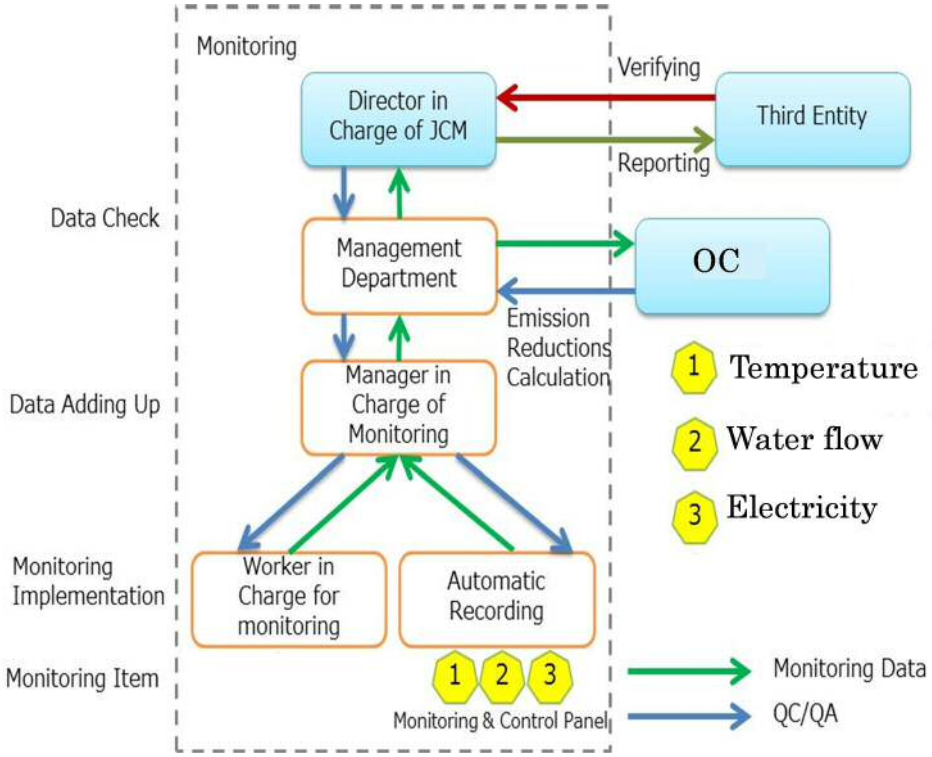

Figure 26: Monitoring Scheme and Process

3.2.2.4 Project Implementation Scheme and Business Model

3.2.2.4.1 Economic Analysis

Initial costs for the condensate recovery project include the costs of pipes, pumps, system design, and construction. The feasibility of the project, which recovers 30% of condensate in the factory, was discussed by the study team as follows. Specialized centrifugal pumps (2×2.2 kW) with ejectors installed at the inlet side of the pumps and 50A~65A stainless pipes are proposed for the project. The image of condensate recovery in the project is shown in Figure 27 below.

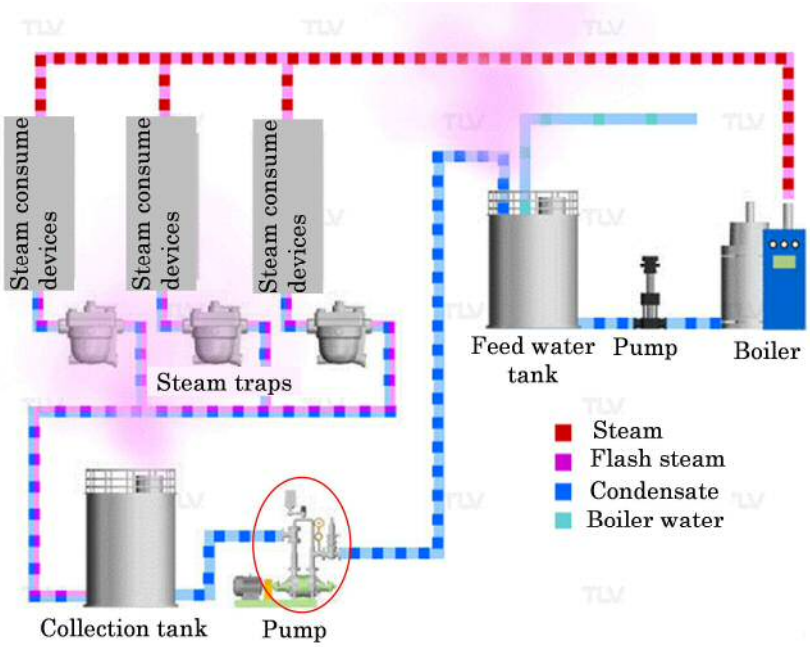

Figure 27: Image of Condensate Recovery

Source: https://www.tlv.com/ja/steam-info/steam-theory/drain-recovery/1212condensate-recovery

The project is expected to result in energy savings totaling approximately 4,700 thousand yen/year. With 50% JCM subsidy, the initial cost of the project can be paid back within 3 years.

Finalization of the initial costs needs further survey including the detail design of the recovery system.

As addressed previously, there are other low-cost measures such as improvement of the way of coal feeding to boilers, regular cleaning of economizers, are available in the factory, together with these measures, the project is expected to give more benefits.

3.2.3 Risks and Countermeasures regarding Project Implementation

The tentative schedule of the project is as follows.

February 2019:	Completion of JCM feasibility study
March 2019:	Final confirmation of the investment decision of the factory
March 2019:	Formulation and finalization of JCM implementation system
	Establishment of international consortium

	Development of project documents and MRV methodology
	Finalization of monitoring plan
	Engineering, procurement, and construction plan
April 2019:	Application for JCM model project
July 2019:	Commencement of JCM model project
	Starting installation of system
August 2019:	Verification of MRV methodologies
October 2019:	Application of project registration for Joint Committee
February 2020:	Trial operation
	Technology and knowledge transferring on operation and maintenance
	Capacity building on MRV implementation
March 2020:	Operation start
	Monitoring start
March 2020:	Development of JCM model project report

In order to implement the project based on the schedule described above, the following risks should be considered carefully.

The first is completion of the project in time with a satisfactory level of quality. At the time of the feasibility study completion, discussions are conducted based on a rough estimate of the project cost. In order to apply for JCM model project, a final quotation needs to be developed based on the detailed design of the system and the schedule of the project. Moreover, it is necessary to establish a project management and quality assurance system together with different stakeholders.

The second is uncertainty of procurement lead-time. The core technology of the system like condensate-recovery-use pumps are planned to adjust from Japan and low transparency in custom clearance in host country may cause long procurement lead-time. Consultation with related government agencies will be conducted and practices of prior projects will be observed to scrutinize the time consumption for procurement of the technology.

3.3 Improvement of Solid Waste Collection Trucks

3.3.1 Study Overview

The study targeted the trucks owned by companies who are responsible for collecting and transporting solid waste in Quezon City, and discussed energy saving potentiality of the trucks through improving engines, and methods of maintenance and operation.

The amount of municipal solid waste generated in Quezon City is 2,700 ton/day and the city government outsources the collection and transportation of the municipal solid waste in its six districts to private companies. Each day, nearly 500 trucks are dispatched to collect solid waste in the city.

Since there has been no intermediate treatment facility in Quezon City, the collected solid wastes are finally transported to the Rodriguez landfill site (around 20 km from Quezon City) in Rizal (the Payatas landfill in Quezon City was closed in 2017). The process of solid waste collection in Quezon City is depicted in the following figure.

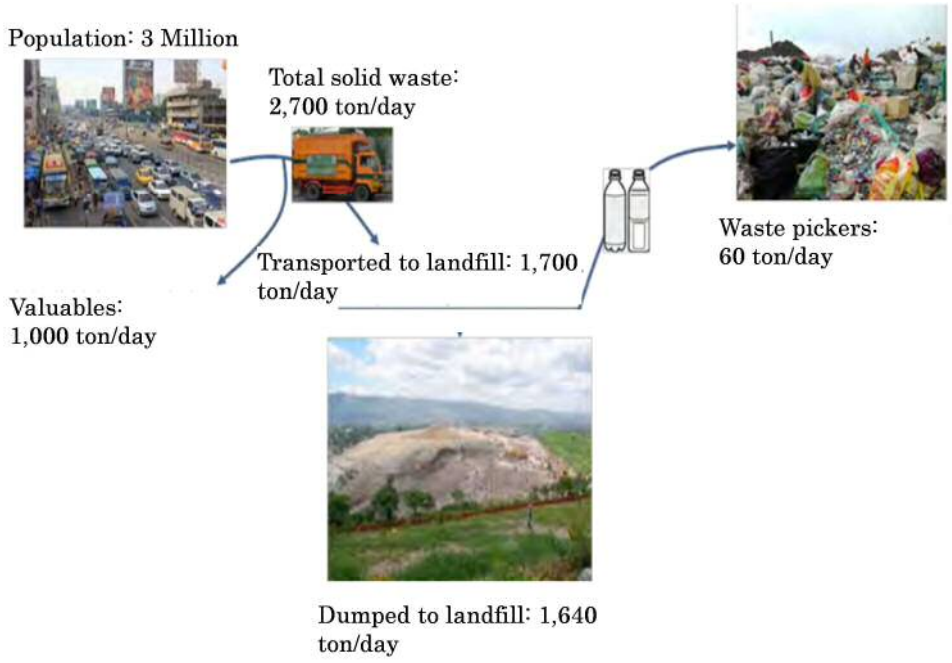

Figure 28: the Process of Waste Collection in Quezon City

Source: Introduction of Paper and Plastic Fuel in Philippines (May 2017, JICA) 2017

Six private companies are responsible for collecting solid waste on a daily basis in Quezon City. Each of them dispatches trucks to its assigned district generating around 70 trips a day. Most trucks are older than 15 years and used trucks are the primary source of procurement of trucks.

Mainly 10 and 6 wheel trucks are used and 10-wheel trucks are used for collecting solid waste from the city and transporting them directly to the landfill while 6-wheel trucks for collecting wastes in the city and bringing them to each company's own yard for reloading to 10-wheels.

For the study, total 6 trucks (3 are 10-wheel and 3 are 6-wheel) from three contractors, are investigated for observing the operation and maintenance conditions of the trucks.

In detail, the fuel efficiency of the trucks is calculated based on the data of vehicle kilometer travelled (VKT) and fuel consumption that are observed through field surveys conducted on the days of 1 October to 5 October 2018.

1) Company A

The travel condition of Isuzu trucks (6-wheel is 1985 and 10-wheel is 2006 model) are as follows.

The 6-wheel truck's distance travelled is 57 km and the 10-wheel's is 56 km. Fuel (diesel) consumptions are 14 liter and 34 liter correspondingly.

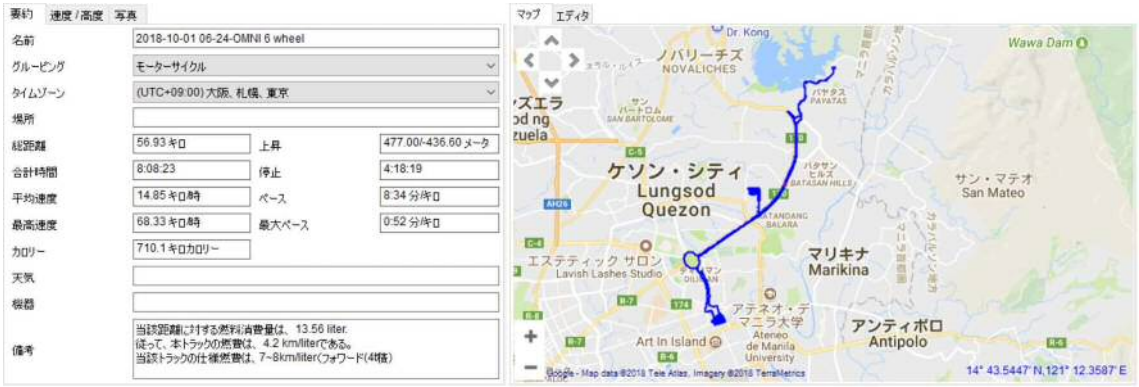

Figure 29: Travel Distance of the 6-Wheel Truck of Company A

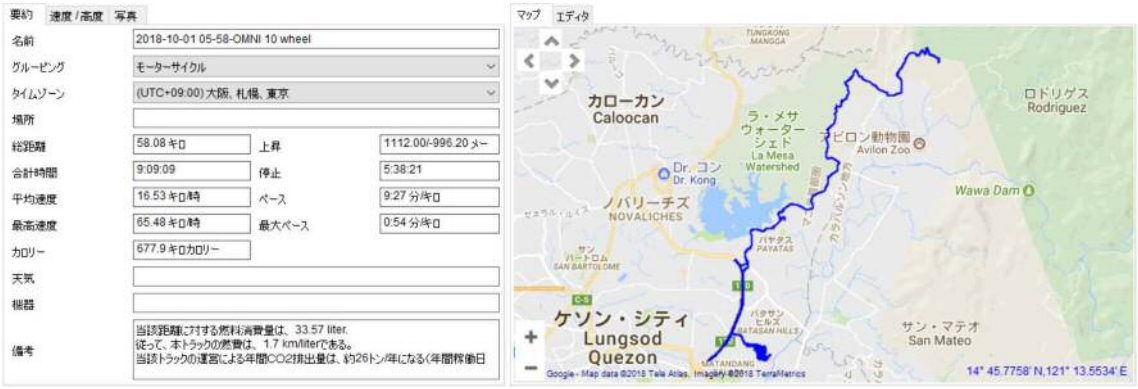

Figure 30: Travel Distance of the 10-Wheel Truck of Company A

2) Company B

The 6-wheel and 10-wheel trucks of Company B consumed 12 liters and 36 liters of diesel respectively for distances shown in the figure below.

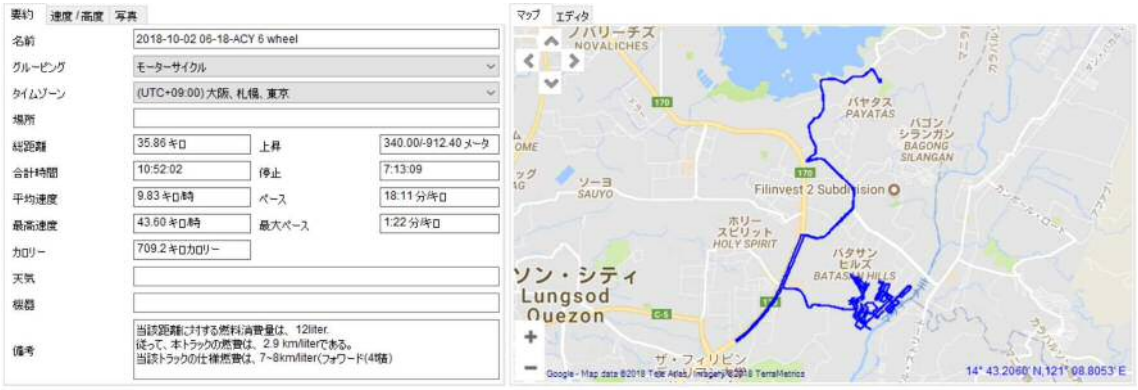

Figure 31: Travel Distance of the 6-Wheel Truck of Company B

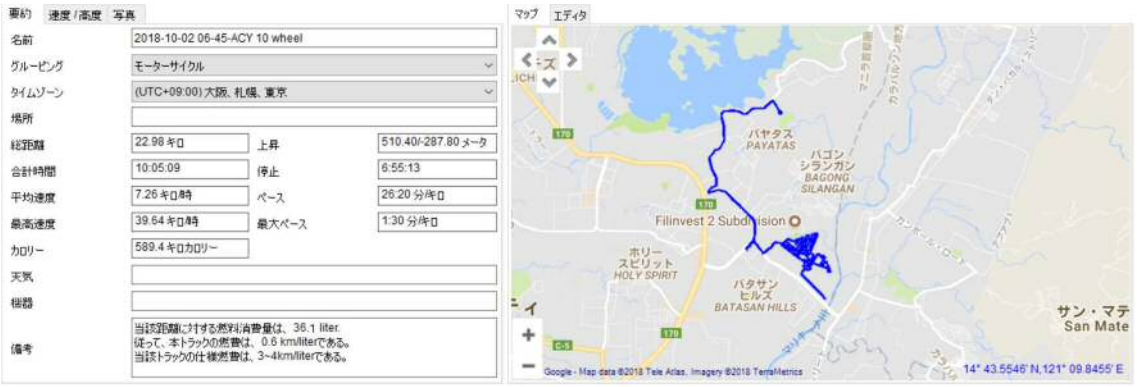

Figure 32: Travel Distance of the 10-Wheel Truck of Company B

3) Company C

The 6-wheel and 10-wheel trucks of Company B consumed 18 liters and 25 liters of diesel respectively for distances shown in the figure below.

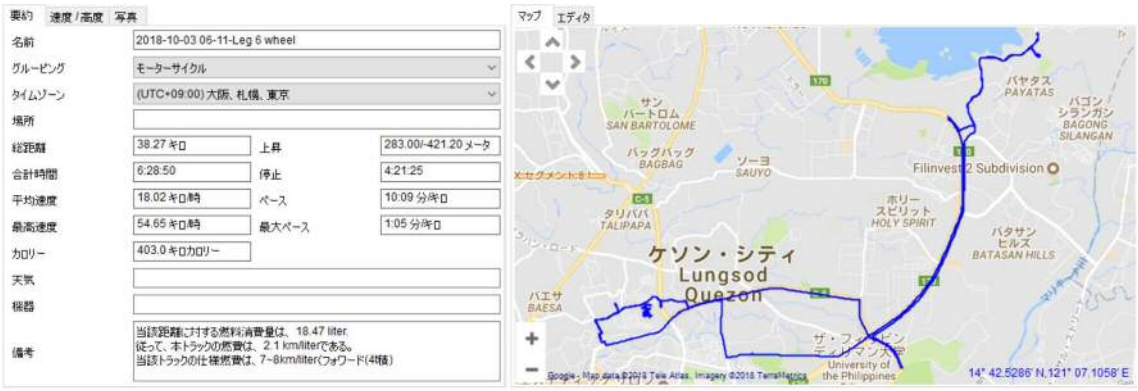

Figure 33: Travel Distance of the 6-Wheel Truck of Company C

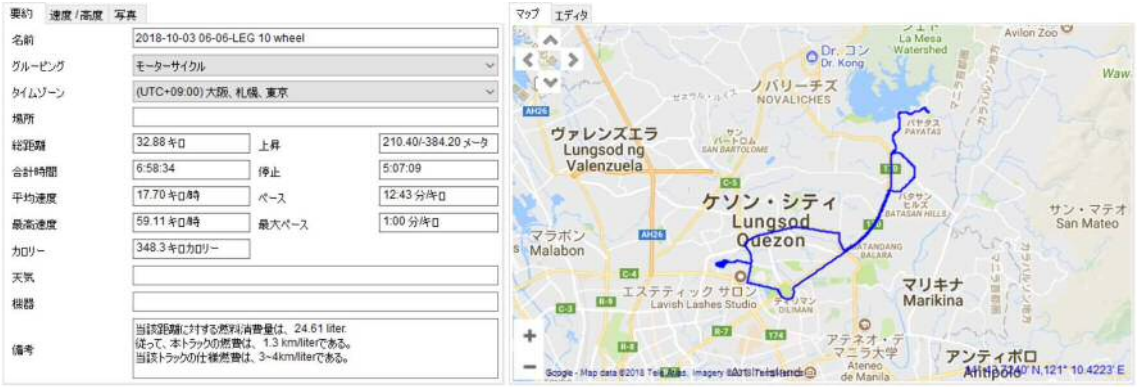

Figure 34: Travel Distance of the 10-Wheel Truck of Company C

The all trucks under the study are Isuzu trucks and their fuel efficiencies are as follows.

Table 44: Targets Trucks

Companies	Vehicle Type	Model	Travel Distance (Km)	Fuel Consumption (Liter)	Fuel Efficiency (Km/Liter)
A	6-wheel	1985	57	14	4.2
	10-wheel	2006	58	34	1.7
B	6-wheel	2009	36	12	3.0
	10-wheel	1991	23	36	0.6
C	6-wheel	1997	38	18	2.1
	10-wheel	1978	33	25	1.3

The most trucks operated in Metro manila including Quezon City are old trucks, which are not maintained and tuned well due to lack of technicians, education and manuals regarding vehicle maintenance and operation, and trucks, along with buses and jeepneys, have become the main source of air pollutants such NOx and PM10.

Therefore, it is expected that introducing engine overhauling and Diesel Dual Fuel (DDF) technologies will improve fuel efficiency of the trucks in Quezon City.

3.3.2 Law and Regulations Related to Vehicle Emission and Inspection

In 1999, Department of Environment and Natural Resources (NEDR) enacted the Clean Air Act, which stipulated the ways of measuring air pollutants, vehicle emission standards, types of fuels that can be used, and the functions of government agencies. Based on this act, the Certificates of Conformance (COC) are issued to manufacturer, import business operators for their vehicles or vehicle type's clearance of standards required by Clean Air Act. Once issued COC is valid for 6 years. Land Transport Office (LTO) also issues the Certificate of Compliance to Emission Standards (CCES) to all vehicles before registration.

There are also stipulations regarding penalties such as fines or confiscation of number plates for the vehicles, which violated emission standards found in inspection centers or through roadside inspections.

In order to strengthen pollution abatement policies, DENR revised the standards of vehicle emissions and issued DENR Administrative Order No. 2015-04 on 24 March 2015. The revision requires EURO IV standard for new vehicles and EURO III or equivalent (CO: 0.5%, HC: 250 ppm with light absorption coefficient 2.0/m) for vehicles registered after 2008.

Department Order No. 96-963 issued by Department of Transportation and Communication (DOTC) in 1996 restricts operation of buses older than 15 years.

The revised Department Order No. 2002-30 in 2002 further tightens the regulation and limits operation of buses and commercial trucks older than 15 years.

Vehicles, which are not able to clear the requirement in annual inspection cannot be registered at LTO and cannot be issued business licenses by Land Transportation Franchising and Regulatory Board (LTFRB).

However, looking at the trucks operated in the city, for example, five trucks of out of six trucks are older than 15 years old and yet are still operated. It was confirmed that the backlash from the public bus association and truck association against the revision made the government suspend and reconsider the regulation.

3.3.3 Proposed Technology and Energy Saving

The study proposes the technologies of engine overhauling and DDF to solid waste collecting trucks in Quezon City.

DDF refers to diesel ignition gas engines. It is a system, which injects diesel and Liquefied Petroleum Gas (LPG) at the same time by controlling the portion of each through an electronic control to reduce diesel fuel consumption, CO_2 emission and other roadside air pollutant emissions as well.

DDF can be developed through introducing additional kits to a regular diesel engine. The main parts include a LPG tank, Engine Control Unit (ECU), and regulator.

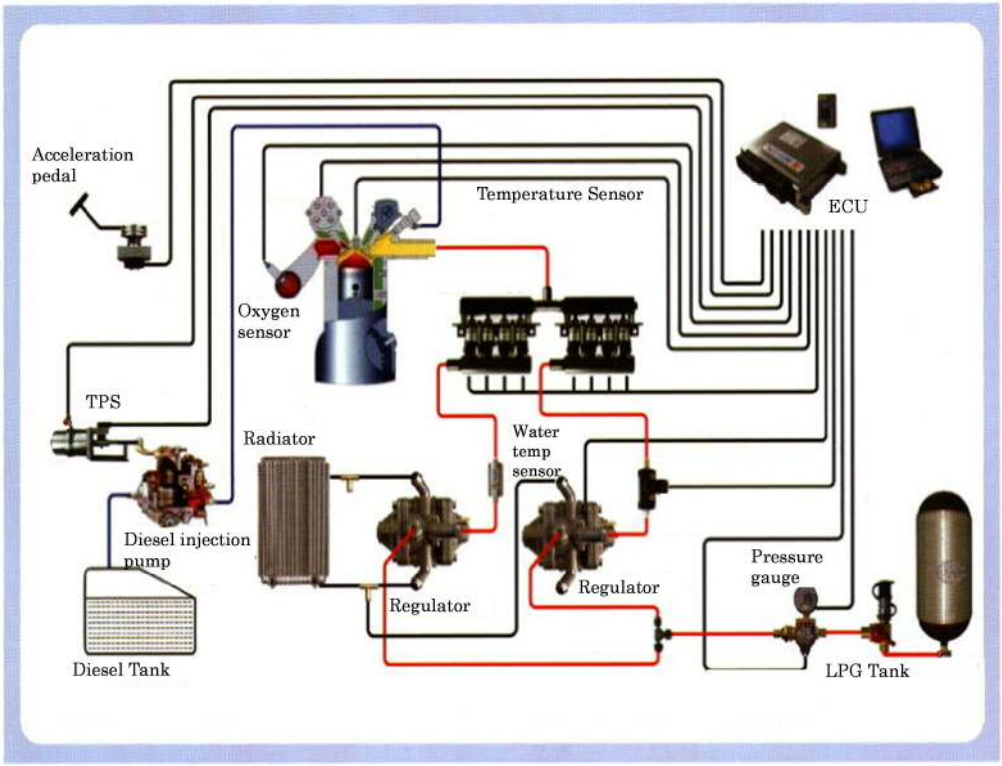

Figure 35: Image of DDF

Source: http://www.hanaeng-japan.com/page4ddf.html

The DDF technology is not so popular in Japan. One of the reasons is that the emission standard launched in 2008 restricted the use of old diesel engine vehicles, and responding to the regulation, manufacturers introduced direct-injection-engines, which go beyond DDF, to the market.

DDF requires LPG tanks with the size of 50-100 L and their installation places vary from truck to truck. LPG is available in Metro since there have been LPG taxis operating around. According to official data published in 2013, there were 137 LPG stations in Metro Manila out of 218 stations set up nationwide.

So far, the technology provider has had 10 practical applications of DDF. In the Philippines, they have demonstrated the technology on a forklift, a bus, and a jeepney. The demonstration of the technology on EURO I standard diesel engines showed that the DDF can help reduce NOx emission by 40%, CO by 90%, THC by 35% and PM by 70%, and improve fuel efficiency by 15-33%. That is the level of improvement cleared the standards of EURO III engine.

In order to implement DDF, it is imperative to conduct engine overhauling and then install additional parts for LPG application. The overhauling is mostly effective for improving fuel efficiency. In addition, less expensive and less CO_2 intensive LPG account for about one fourth of the fuel a vehicle need. Therefore, the project is expected to save energy and contribute to mitigation of climate change and roadside air pollution. During the study, through awareness building activities among the waste collection companies/contractors, one of the contractors already sent one of their trucks' engines for overhauling.

3.3.4 Development of MRV Methodology for Green House Gas (GHG) Emission Reduction

In order to develop a MRV methodology for the project, which introduces engine improvement technologies to trucks, the following registered JCM project is referenced.

Table 45: MRV Methodology Reference

Methodologies	Notices
≪JCM Methodologies≫ VN-AM001: Transportation energy efficiency activities by installing digital tachograph systems---Version 2.0	Apply to projects, which introduce a system consists of digital tachograph device and tachograph data analysis systems to commercial trucks to promote efficient driving patterns to reduce trucks' fuel consumption.

This methodology applies to projects, which introduce engine improvement technologies such as DDF, engine overhauling for trucks, buses, and jeepneys in the Philippines.

Table 46: Terms and Definitions

Terms	Definitions

DDF	An engine using both conventional diesel fuel and LPG through controlling the injection portion of each fuel DDF engines are modified diesel engines, which use primary fuel as diesel and secondary fuel as LPG.
Overhauling	An overhauled engine is an engine that has been removed, disassembled (torn down), cleaned, inspected, and repaired as necessary and tested using factory service manual approved procedures.

3.3.4.1 Summary of the Methodology

Table 47: Summary of the Methodology

Items	Summary
GHG emission reduction measures	Introduction of DDF helps improve fuel efficiency, reduce the quantity of fossil fuel (diesel), and replace the fuel (diesel) with the fuel (LPG) which has a lower CO_2 emission factor.
Calculation of reference emissions	Reference emission is calculated based on the distance of a target vehicle travelling, the fuel efficiency of trucks before retrofitting and the CO_2 emission factor of the fuel (diesel) used by the trucks.
Calculation of project emissions	The project emissions are calculated based on the respective quantity of fuel consumed by target trucks and the CO_2 emission factors of the fuels.
Monitoring parameters	The following parameters need to be monitored 1) Quantity of fuel consumed by target trucks in the project 2) Distance traveled by target trucks in the project

3.3.4.2 Eligibility Criteria

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

Table 48: Eligibility Criteria

Criterion 1	DDF introduction to diesel engine vehicles such as trucks, buses, jeepneys
Criterion 2	The distance travelled and quantity of fuel consumed by target vehicles are available
Criterion 3	In the case of routes of where the target vehicles changes after the project implementation, the reference scenario should be adjusted accordingly.

3.3.4.3 Establishment and Calculation of Reference and Project Emissions

The reference emission is the emissions from consumption of fossil fuel (diesel) by target trucks for travelling the same distance as happened in the project. The reference emission is calculated using the travelled distance of trucks in the project, the fuel efficiency of reference trucks and the CO_2 emission factor of the fuel trucks used in the project.

The reference fuel efficiency of trucks is determined though surveys before project implementation. The reference emission is calculated based on the equation as follows.

$$RE_y = \sum_i RE_{i,y} \quad (1)$$

$$RE_{i,y} = PD_{i,y}/FE_{RE,i,diesel} \times De_{diesel} \times NCV_{diesel} \times EF_{co2,diesel} \times 10^{-6} \quad (2)$$

RE_y	Reference emissions (tCO_2/y)
i	Target vehicle
$RE_{i,y}$	Reference emission of a target vehicle i (tCO_2/y)
$FE_{RE,i,diesel}$	Fuel efficiency of a target vehicle i (km/l)
$PD_{i,y}$	Distance of travelled by a target vehicle i (km)
De_{diesel}	Density of diesel (kg/l)
NCV_{diesel}	Net caloric value of diesel (TJ/Gg)
$EF_{co2,diesel}$	CO2 emission factor of diesel (tCO_2/TJ)

The project emission is the emission from trucks operated in the project. It is calculated as follows.

$$PE_y = \sum_i PE_{i,y} \quad (3)$$

$$PE_{i,y} = (FC_i \times Ra_{diesel,i} \times NCV_{diesel} \times EF_{co2,diesel} \times 10^{-3}) + ((FC_i \times Ra_{LPG,i} \times NCV_{LPG} \times EF_{co2,LPG} \times 10^{-3}) \quad (4)$$

PE_y	Project emissions (tCO_2/y)
i	Target vehicle
FC_i	The quantity of fuel consumption by a target vehicle i (t/y)
$Ra_{diesel,i}$	Ratio of diesel in the fuel of vehicle i in the project
NCV_{diesel}	Net caloric value of diesel (TJ/Gg)
$EF_{co2,diesel}$	CO_2 emission factor of diesel (tCO_2/TJ)
$Ra_{LPG,i}$	Ratio of LPG in the fuel of vehicle i in the project
NCV_{LPG}	Net caloric value of LPG (TJ/Gg)
$EF_{co2,LPG}$	CO_2 emission factor of diesel (tCO2/TJ)

Emission reduction is calculated as follows.

$$ER_y = RE_y - PE_y \quad (5)$$

ER_y	Emission reduction (tCO_2/y)
RE_y	Reference emissions (tCO_2/y)
PE_y	Project emissions (tCO_2/y)

3.3.4.4 Data and Parameters Determined Ex-ante

The source of each data and parameter fixed ex-ante is listed as below.

Table 49: Data and Parameters Determined Ex-Ante

Parameter	Description of data	Sources
$FE_{RE,i,diesel}$	Fuel efficiency of a target vehicle	Field survey data (calculated based on measured travel distance and fuel consumption)
$EF_{co2,diesel}$ $EF_{co2,LPG}$	CO_2 emission factor of the fuels consumed by vehicles: Diesel: 72.6 tCO_2/TJ LPG:61.6 tCO_2/TJ	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 1.4, Chapter 1, Volume 2. (Table 1.4) Lower values are applied.
NCV_{diesel} NCV_{LPG}	Net caloric values of the fuels consumed by vehicles Diesel: 41.4 TJ/Gg LPG: 44.8 TJ/Gg	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 1.4, Chapter 1, Volume 2. (Table 1.2)

3.3.4.5 Estimation of Emission Reduction

The estimation of emission reduction from introduction of DDF to six target trucks is given as follows.

Table 50: Conditions for Estimation of Emission Reduction

Companies	Truck Type	Model	VKT (Km)	Fuel Consumption (Liter)	Fuel Efficiecy (Km/liter) (Reference)	Fuel Efficiency (Km/liter) (Project)*	CO2 Emission Reduction (Ton/year)
A	6-wheel	1985	57	14	4.2	5.4	4
	10-wheel	2006	58	34	1.7	2.2	9
B	6-wheel	2009	36	12	3.0	3.9	3
	10-wheel	1991	23	36	0.6	0.8	10
C	6-wheel	1997	38	18	2.1	2.7	5
	10-wheel	1978	33	25	1.3	1.7	7

VKT: vehicle kilometer travelled. *30% improvement is assumed.

3.3.5 MRV System

The following parameters need monitoring over the project period.

Table 51: Monitoring Methods and Frequencies

Parameters		Methods	Frequencies
FC_i	Fuel efficiency of target truck i in the project	Recording from flow meter for every filling	For each fill/ compile weekly
$PD_{i,y}$	Travel distance of target truck i in the project	Recording from GPS	Daily record/ compile weekly

QA/QC system is very important to ensure reliability of a monitoring. As situations are different by companies, it is hard and inappropriate to develop a uniform QA/QC system for all truck operators. Concrete monitoring plans for a company will be developed during the implementation process.

Monitoring will be implemented by each truck company based on the MRV methodology developed. Parameters will be measured consistently and automatically as necessary. However, it is necessary for a designated person from each company to collect the data periodically and record it into a prepared data sheet. The collected and recorded data should be reported to the section responsible for the JCM project. The section should check the data and prepare a data sheet with calculations of emission reduction on a monthly basis. The monthly data should be checked and accumulated by a person, who is responsible for the JCM project and reported to the representative participant for submission to the Joint Committee.

The representative participant is responsible for developing monitoring methodology and training the staff of companies on the implementation of monitoring and OC will support the representative participant as necessary.

3.3.6 Project Implementation Scheme and Business Model

3.3.6.1 Economic Analysis

The conditions for the economic analysis of the project, which targets total 6 trucks from three companies, are given as follows.

Initial costs: 1.20 Million Yen (0.58 Million Peso as Yen/Peso=0.48) (DDF with overhauling)

Diesel cost: 47 peso/liter[7] (October 2018)

LPG cost: 33 peso/liter[8] (October 2018, the lowest rate in Metro manila)

The rate of fuel efficiency improvement: 30%

Truck maintenance cost: 9,000 peso/month

Additional costs from introducing DDF including the costs for replacement of LPG filters, regulators and plugs, are estimated to be 50,000 yen/year. However, engine overhauling along with DDF is estimated to bring down overall maintenance cost by about 50%.

The result of estimation of the benefits of DDF introduction is as follows.

Table 52: Economical Benefits of DDF

Companies	Truck Type	Distance (Km)	Fuel Consumption (Liter)	Fuel Efficiency Km/l) (Reference)	Fuel Efficiency (Km/l) (Project)*	Fuel Cost Saving (Peso/year)	Maintenance Cost Saving** (Peso/year)	Total Saving (Peso/year)	Payback Period (Year)
A	6-wheel	57	14	4.2	5.4	71,955	54,000	125,955	4.6
	10-wheel	58	34	1.7	2.2	183,360	54,000	237,360	2.4
B	6-wheel	36	12	3.0	3.9	65,094	54,000	119,094	4.9
	10-wheel	23	36	0.6	0.8	207,938	54,000	261,938	2.2
C	6-wheel	38	18	2.1	2.7	95,940	54,000	149,940	3.9
	10-wheel	33	25	1.3	1.7	139,344	54,000	193,344	3.0

*Assumed improvement rate **50% reduction is assumed

The results show that the investment effect of DDF to 10-wheel trucks seems more attractive than that of 6-wheel trucks due to their cost differences (around 80,000 peso for a 6-wheel used truck and 1.5 million peso for a 10-wheel truck).

With 50% JCM subsidy, the feasibility of the project is depicted as follows.

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[7] https://www.globalpetrolprices.com/Philippines/diesel_prices/

[8] https://www.doe.gov.ph/sites/default/files/pdf/price_watch/lpg_mm_2018_october_01.pdf

Table 53: JCM Project Feasibility

Companies	Truck Type	Distance (Km)	Fuel Consumption (Liter)	Fuel Efficiency Km/l) (Reference)	Fuel Efficiency (Km/l) (Project)*	Fuel Cost Saving (Peso/year)	Maintenance Cost Saving** (Peso/year)	Total Saving (Peso/year)	Payback Period (Year)
A	6-wheel	57	14	4.2	5.4	71,955	54,000	125,955	2.3
	10-wheel	58	34	1.7	2.2	183,360	54,000	237,360	1.2
B	6-wheel	36	12	3.0	3.9	65,094	54,000	119,094	2.4
	10-wheel	23	36	0.6	0.8	207,938	54,000	261,938	1.1
C	6-wheel	38	18	2.1	2.7	95,940	54,000	149,940	1.9
	10-wheel	33	25	1.3	1.7	139,344	54,000	193,344	1.5

However, from the perspective of cost-benefits criteria of JCM projects, it seems to be difficult to apply the JCM scheme to the project.

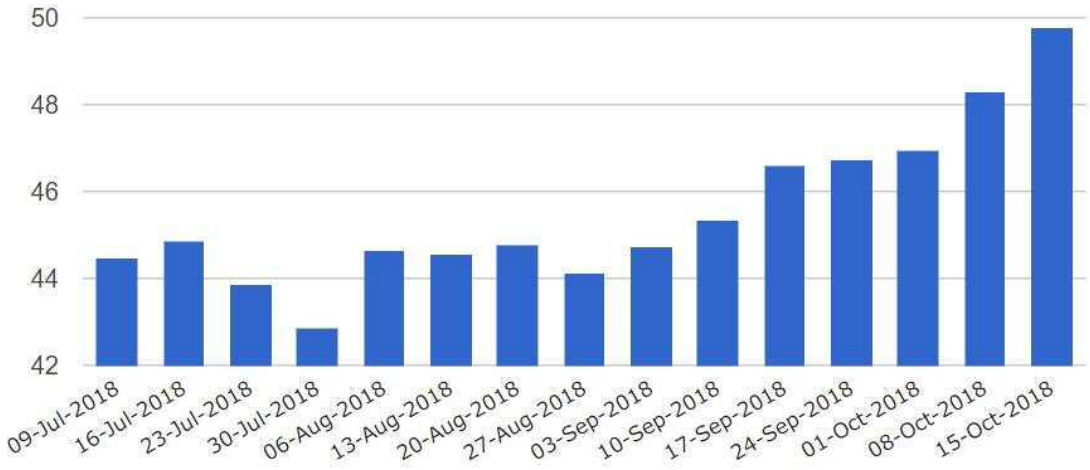


Figure 36: Diesel Price Change Trend in Philippine (peso/liter)

Source: https://www.globalpetrolprices.com/Philippines/diesel_prices/

Year/Month	Domestic Price	Adjustment/Kg. Increase(-Decrease)
2018		
January	550.00-777.00	-0.37
February	535.00-760.00	-3.15
March	517.00-742.00	-1.65
April	523.00-723.00	0.25
May	541.00-751.00	1.9
June	582.00-787.00	3.4
July	580.00-800.00	0.9
August	599.00-819.00	1.75
September	620.00-840.00	1.95
October	645.85-865.85	2.35

Figure 37: LPG Price Change Trend in Philippine (peso/11 kg)

The average fuel cost of the truck companies is around 1.3 million peso/month and the companies are really feeling the impact of fuel price fluctuation in their business. In the case of 10-wheel truck, DDF is expected to give an attractive energy saving with 3-year payback period. Therefore, it is recommend introducing DDF to 10-wheel trucks in business basis. For 6-wheel trucks, engine overhauling is recommended as it costs around 130,000-180,000 pesos.

Table 54: Economical Feasibility of Engine Overhauling on 6-wheel Trucks

Companies	Truck Type	Distance (Km)	Fuel Consumption (Liter)	Fuel Efficiency Km/l) (Reference)	Fuel Efficiency (Km/l) (Project)*	Fuel Cost Saving (Peso/year)	Maintenance Cost Saving** (Peso/year)	Total Saving (Peso/year)	Payback Period (Year)
A	6-wheel	57	14	4.2	5.4	49,611	54,000	103,611	1.4
B	6-wheel	36	12	3.0	3.9	45,554	54,000	99,554	1.5
C	6-wheel	38	18	2.1	2.7	66,148	54,000	120,148	1.2

Since the technology provider has a joint-venture company in Quezon City that conducts vehicle repair and maintenance service business. It is possible to provide aftersales service though the company. Therefore, it may possible to provide DDF and engine overhauling services through the local company by sending Japanese technicians as necessary.

3.3.7 Risks and Countermeasures regarding Project Implementation

In order to implement the project successfully, the following issues should be carefully considered.

As mentioned before, the first is the difficulty of applying the JCM scheme due to low emission reduction from the project. In addition, a JCM subsidy can hardly cover incremental works and costs from JCM project. Therefore, it is recommended to promote the technology on a business basis, as the energy saving effect of the technology is still believed attractive.

The second is the necessity of demonstrating the benefits of the technology. During the study, the truck companies also asked for demonstration of the technology on their trucks. For this, it is planned to conduct a demonstration of DDF technology on a truck and a bus as part of next year's study project under the City-to-City Cooperation scheme.

Chapter 4 Development of JCM Manual

4.1 Overview

Quezon City has developed QC-LCCAP but there are parts where it is completed only by showing the direction of energy conservation and renewable energy without mentioning specific actions. In addition, since the Philippines just signed a bilateral agreement with Japan in FY 2017 to become a JCM member country, government officials from federal and local governments still do not have a clear understanding about the JCM system. For this reason, it is necessary to prepare a JCM manual to facilitate projects in the QC-LCCAP utilizing the JCM subsidy scheme.

In this survey, the study team closely worked with Quezon City to develop JCM potential projects such as solar power generation on Payatas landfill, condensate recovery in an edible oil refinery factory, furnace improvement in a steel mill, and truck engine improvement for waste collection truck. The study also developed a JCM manual for the projects, which outlines specific processes of formulating such projects and other necessary information. This manual is deemed helpful to related parties to deepen their understanding about the JCM.

4.2 Structure of the JCM Manual

JCM Manual includes the concepts of JCM and features, implementation process and structure of JCM projects together with the proposed JCM model projects. The manual was designed to be easy to understand by readers with little experiences of JCM.

4.3 JCM Manual

For details about the JCM manual, see Appendix 3.

Chapter 5 Workshops, Trainings and Meetings

5.1 Overview

Through City-to-City Collaboration between Osaka City and Quezon City, the survey assisted Quezon City on their update to climate change policy, and investigated the feasibility of low-carbon projects (in the fields of solar power generation and energy conservation). The activities in this study are shown in the following table.

Table 55: Project Activities

Activities	Date	Description
Kick off meeting in Osaka	18 May	・Kick off meeting with co-implementers and Osaka city to implement the study
The 1st field survey in Quezon	18-28 June	・Meeting with EPWMD, Department of Environment and Natural Resources, and business entities related to FS
The 2nd field survey in Quezon	5-11 August	・Meeting with EPWMD, MMDA, business entities related to FS ・Workshop on the LCS scenario and FS
MOU signing ceremony and policy dialogue in Japan	30-31 August	・MOU signing ceremony ・Mayor-level policy dialogue ・Site visit to solar power generation and waste incineration facility
The 3rd field survey in Quezon	23 September -6 October	・Soil boring test at Payatas landfill site ・Energy auditing of food factories ・Survey of fuel consumption of waste collection vehicle
The	25-26	・Site visit to wind to hydrogen project facilities

City-to-Ccity Collaboration workshop in Yokohama	October	and city hall installed BEMS ・Role of City-to-City Collaboration and progress of this study
The 4th field survey in Quezon	15-25 January	・Second workshop with EPWMD ・Report the progress of three feasibility studies ・Capacity building of Quezon City officials

5.2 The 1st and 2nd Field Surveys

The 1st and 2nd field surveys include activities such meetings to explain the outline of the feasibility study, interviews on the landfill site, consent seeking for energy auditing from factories, and workshops. The workshops covered several topics such as LCS scenario establishment, sharing climate change policies, and sharing the progress of the study. See Annex 4 for the agenda / presentation materials of the workshops.

Discussion at the Payatas Landfill Office

Workshop Participants

Workshop Discussion

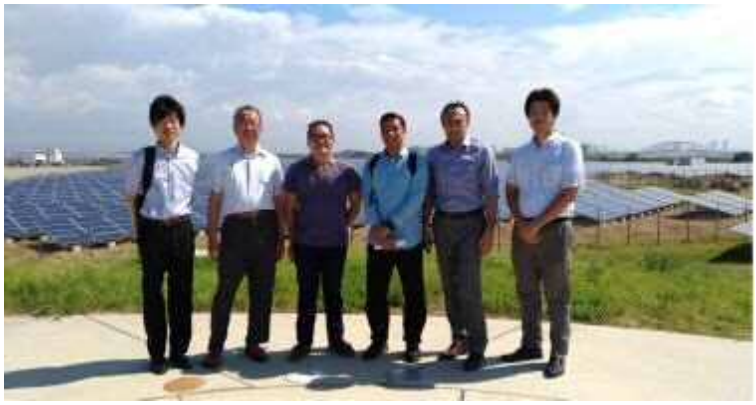
5.4 MOU Signing Ceremony and Mayor Level Policy Dialogue

The two cities signed an MOU for Low Carbon Development on 30 August 2018. A Mayor-level policy dialogue took place after the MOU ceremony, and the latest efforts of both cities on climate change mitigation were introduced. The next day, representatives from Quezon City visited project sites such as Osaka Hikarinomori mega solar site and Higashiyodo waste incineration plant.

MOU signing ceremony[9]

Mayor Level Policy Dialogue

[9] Quezon City Local Government https://www.facebook.com/qclocalgovernment/photos/pcb.1656306591146795/1656456871131767/?type=3&theater



Visit to Osaka Hikarinomori

5.5 The 3rd Field Survey in Quezon

In the 3rd field survey, the study team conducted energy auditing in an edible oil refinery factory. In order to confirm the potentiality of solar power generation on the landfill, a penetration test at the Payatas landfill site was implemented for clarifying the stable areas of the landfill. In addition, investigations on 6 dump trucks from solid waste collection companies were conducted to define the fuel efficiencies and travel distances of the trucks.

5.6 The City-to-City Collaboration Workshop in Yokohama

The City-to-City Collaboration workshop was held in Yokohama. The workshop shared information on the progress of feasibility studies from partner cities, and discussions on JCM model projects.

5.7 The 4th Field Survey in Quezon

In the 4th field survey, the survey team reported the results of three feasibility studies to related project participants and the result of development of LCS scenario in Quezon City, was shared at the workshop.

Chapter 6 Future Tasks and Proposals

This survey conducted feasibility studies regarding renewable energy promotion and industry energy-saving potential projects, such as the introduction of a solar PV system on the closed Payatas landfill site, heat recovery systems in a food-processing factory, and DDF technology to the engines of waste collection trucks. The survey also examined the economic feasibility and business models of the projects, which introduce the respective technologies.

Quezon City has already implemented a project, which generates electricity recovering landfill gas from the closed Payatas landfill site. The City is considering the possibility of solar power generation on the landfill as a part of the post closure plan of the landfill. In this feasibility study, a penetration test was conducted to define the land area suitable for installation of solar PV panels, the size of the system and costs were estimated, and business models were discussed. The study team reported and discussed the results to/with landowners. The private company, who is operating landfill-gas power generation plant on the site, has showed its interest to the project. Further discussions and studies are required to finalize the implementation structure, and technology specifications of the project towards the JCM model project. It is expected that the project help disseminate solar power generation projects on closed landfills across the country.

The survey conducted an energy auditing in the edible oil refinery factory and provided the factory with information about energy saving practices such as condensate recovery, boiler economizer improvement, waste heat recovery from exhaust gas and cooling tower improvement. The energy saving potentiality of each practice was also estimated. Through discussions with people from the factory using the concrete figures of energy saving, favorable feedbacks from the owners of the factory are received. In preparation for a JCM model project, additional works and discussions need to be conducted in due course of time closely working with the factory and other stakeholders.

Regarding the truck engine improvement project, it was confirmed that CO2 emission reduction from waste collection trucks are very low, which hardly guarantee attractive amount of subsidy from JCM scheme. For this reason,

promoting the technology through a business model without JCM subsidy is considered a more realistic option. It is noted that the potentiality of CO2 reduction from long distance buses is comparatively high and there are business opportunities of JCM model projects due to many bus companies operating in Quezon City.

In addition to the feasibility studies described above, the LCS scenario of Quezon City through AIM was completed and published at COP24. Furthermore, the mayors of Quezon City and Osaka City signed a MoU on Low Carbon Development. This is expected to deepen the cooperation between the cities towards realization of a low-carbon society.

As a next step, it is necessary to mainstream climate change mitigation into the QC-LCCAP through creating a roadmap to realize the LCS scenario and furtherly promoting low carbon projects. The continuation of intercity cooperation between Osaka City and Quezon City is an effective way to realize low-carbon society in Quezon City through sharing knowledge and information on the climate change policies and implementing energy saving, and renewable energy projects through the JCM scheme.