FY 2018 Project for Ministry of the Environment, Japan

FY2018
Study of City-to-City Collaboration Project for Low Carbon Society

Study on feasibility of the building of low-carbon industrial area and promotion of activities in Ayeyarwady region

Project Report

February 2019

Mitsubishi Research Institute, Inc.
Fujita Corporation

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List of Abbreviations

This report uses the following standardized units and abbreviations.

Units

T	ton
Kg	kilogram
MJ	Megajoule
MW	Megawatt
kW	Kilowatt
kWh	Kilowatt hour
GWh	Gigawatt hour
TWh	Terawatt hour
MPa	Megapascal
Ha	Hectare
Km	kilometers
m2	Square meter
m3	Cubic meter
t-CO2	Carbon dioxide emissions (t)
kg-CO2	Carbon dioxide emissions (kg)
MMK	Myanmar kyat
USD	U.S. dollar
JPY	Japanese Yen

Abbreviations

BTG	Boiler, Turbine, Generator
CDM	Clean Development Mechanism
COP	International Conference of the Parties
EIA	Environmental Impact Assessment
EIAP	Environmental Impact Assessment Procedure
EMP	Environmental Management Plan
EPC	engineering, procurement, construction
FY	Fiscal Year
GHG	greenhouse gas
IEE	Initial Environment Examination
IFC	International Finance Corporation
INDC	Intended Nationally Determined Contributions
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
LDC	Least Developed Country
MAPCO	Myanmar Agribusiness Public Corporation
MESC	Mandalay Electricity Supply Corporation
MIC	Myanmar Investment Commission
MIMU	Myanmar Information Management Unit
MRV	Measurement, Reporting and Verification
PV	Photovoltaics
SPC	Special Purpose Company

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Study on feasibility of the building of low-carbon industrial area and promotion of activities in Ayeyarwady region

Executive Summary

Through city-to-city collaboration with Ayeyarwady Region and Sagaing region, under "Partnership for Low-Carbon Initiative," feasibility of business using energy saving and renewable energy technologies, such as power plant and heat utilization using biomass resources (e.g. rice husks) was examined, for realizing a low-carbon, resilient and sustainable rural city. Additionally, activities for low-carbonization of industrial zones and was supported.

1. Background of the project

Through city to city collaboration between Ayeyarwady Region, Sagaing Region and Fukushima City, "Partnership for Low-Carbon Initiative (with Ayeyarwady region: starting from in 2015, and with Sagaing Region: starting from Aug. 2017)" was established. Under the initiative, workshops were held in Monywa, Sagaing Region and Yangon, in which through discussions on policy trends, current situation and local needs of the region, activities in Fukushima City, and relevant technologies (e.g. waste treatment) were introduced. Possibility for JCM project formulation and collaboration for low-carbon development in waste treatment and renewable energy area was discussed.

<Overview of Ayeyarwady Region, Myanmar>

Ayeyarwady Region is the largest agricultural area in Myanmar, and the region has been promoting new initiatives in recent years, including the development of new industrial parks (new industrial park in Pathein city, industrial park in Myaunmyau, Maubin industrial park etc.), in order to promote the industrialization of the region. The area is one of the most promising rural regions for future economic development.

<Overview of Sagaing Region, Myanmar>

Sagaing Region is located in the north western part of Myanmar, with large amount of rice production. Large number of rice mills exist in Shwebo District, located in the eastern part of the region and in the north western part of Mandalay (the second largest city after Yangon), making the district one of the most populated area of rice mills in the region. The quality of rice is higher than that of Ayeyarwady Region; rice mill business management is well done in the area, with construction of new rice mills, expansion and renewable of rice mills expected in the future. The area is one of the rural regions for future economic development.

<Overview of Fukushima City>

Fukushima City, while putting the utmost importance on the introduction of renewable energy sources through cooperation among the municipal governments, citizens and

business operators, has also been engaged in various initiatives and activities such as “creation of a low-carbon, circular-type society with effective global-warming preventive measures and low burden on the environment”, “restoration from nuclear disaster”, “revitalization of local areas” and “promotion of the building of townships resistant to disasters and emergencies”, aiming at making “Fukushima” a vigorous and environmentally most advanced city, based upon well advanced local production and consumption features, as well as safe and secure energy sources, in the future.

2. Project Feasibility and Low-carbon society development support -for building low-carbon industrial cities in Ayeyarwady and sagain regions

Key Points of Project Formulation for Rice husk-based Power Generation.

<Results of the construction of power supply system to industrial park, etc.>

- The Myanmar side showed a strong interest in the idea and Japanese examples of power consignment systems to connect power sources of rural areas to the national grid.
- Unlike Japanese power distribution systems, the national grid in Myanmar has frequent power outages. It is necessary to carefully consider if introduction of a system similar to the Japanese power consignment system is possible or not. However, we felt a presentiment that the Japanese system, if introduced in Myanmar, might be an effective approach to utilize rice husk power as a model for geographically distributed power sources.
- Whereas the national grid of Myanmar is under the jurisdiction of the Ministry of Power, a regional government is allowed to consider operation in specific local areas. It is suggested to discuss the matter with the Minister of Power of the Region’s government.

<Results of Considering Project Implementation in the Ayeyawady Area>

- With regard to the rice husk-based power generation project at the Maubin Industrial Park, a proposal of multiple facilities (by 1.8 MW as a model unit) according to the scale is promising. From the results of exchange of opinions with stakeholders in the field survey, the rice husk power generation project in Maubin Industrial Park is still in a difficult situation regarding implementation because of delays in the progress of the industrial estate project itself. (We will give further consideration depending on the progress of the industrial project.)
- The Region’s government proposed plural candidate sites in the local workshop in January 2019. (We will continue consultations and consideration. It seems to be necessary to prioritize candidate sites, and prepare a short and medium-term roadmap of the project.)

- Regarding heat supplies, we have been preparing business models. (We have been considering the possibility of introducing a heat supply project in Myaunmyau.) Development of business models of collaboration with rice-polishing plants: Development of rice-polishing plants has been in progress in other regions. We have been considering a model that can be extended to other regions, and also can be proposed to the association of rice-polishing businesses.

<Project Feasibility of Horizontal Development to Sagaing Region (Preliminary study stage)>

- Industrial Estates in Sagaing: Shwebo Industrial Estate, Sagaing Industrial Estate, and Monywa Industrial Estate, may be candidates.
- Because the sales price of power is more than 140 MMK/kwh, they can sell power even off-grid with a capacity of several megawatts. Due to steadily progressing industrialization in Sagaing, demand for power has been rapidly increasing.
- Demand from new customers is significantly high compared to traditional industries such as the garments and agro-businesses. (Local needs are high.) It is necessary to promote project implementation through close dialogues with the Region government and local rice-polishing businesses.

(Future developments)

- We also exchanged views on the horizontal development of rice husk power generation in an industrial estate in Myaunmyau making use of the JCM framework. (The Region government has proposed plural candidate sites.)

Key Points of Inter-City Collaboration (Policy Dialogue) (Idea consolidation based on results of the meeting in Fukushima and the local workshop in Myanmar)

- Because both Ayeyawady and Sagaing Regions have difficulties with urban waste disposal, they showed great interest in the systems of segregated garbage collection and waste treatment (for example, power generation from waste, power consignment, and use of power in schools in the city) of Fukushima City.
- It is by no means easy to transition from land-fill to incineration of waste for various reasons, including financial constraints. We shared the importance of practical solutions that are within the reach of local governments in Myanmar.
- In the course of discussions between the Myanmar and Japan sides, specific opinions that support the segregation of household garbage as a key to something more important, and also environmental education in schools to teach methods of waste segregation to children were expressed. We also discussed the present situation of urban waste disposal, local needs, and specific solutions. (For example, the promotion of waste segregation, compost treatment, and environmental education)
- The Region government has been considering a large-scale, extensive regional plan

(a master plan covering the area of the western coastal areas and Pathein, the District capital). The Myanmar side has been expecting cooperation from Japan. It is important to propose a conceptual plan with emphasis on a low carbon society in regional development.

- We also exchanged views on the horizontal development of rice husk power generation in an industrial estate in Myaunmyau making use of the JCM framework. We both understood the future delection of enhancing horizontal development of rice husk power generation through inter-city cooperation (policy dialogue).

1. Purpose and Implementation Arrangement

1.1 Project Objective

All countries attended the 21st International Conference of the Parties (COP21) on the United Nations Framework Convention on Climate Change held in December 2015 in Paris, France. They adopted the Paris Agreement, a legal framework of equitable and effective measures against climate change from 2020 onward. The Paris Agreement demands the promotion of activities toward decarbonization, stating that the temperature rise of the earth should be less than 2 degrees C adequately compared to the preindustrial era and efforts should be made to decrease it down to less than 1.5 degrees C. COP21 also decided that the activities of non-state entities including cities must be grasped, and that the efforts of all nongovernmental entities (cities and other local public bodies) are appreciated and their scale-up must be promoted.

A city is the place of activities that support the development of society and economy. Many people live there. About 50% of the world population live in cities, the area of which is less than 2% of that of all lands in the world. The ratio is anticipated to increase up to 70% by 2050. As it is estimated that more than 70% of CO2 emissions in the world were from cities in 2006, the role that cities play in mitigating climate change is great. For achieving the goal of Paris Agreement, it is important to implement measures against climate change steadily in urban areas to reduce emissions of greenhouse gas.

In this project, Japanese research institutes, private companies and universities as well as Japanese municipalities having experience regarding the formation of a low-carbon society supported such formation by the cities of developing countries based on intercity cooperation.

1.2 Survey Items

Based on the background and objective, this research surveyed the following items for introduction of low-carbon waste treatment system in a new industrial zone in progress in Ayeyarwady Region, Myanmar. The activities for low-carbonization of industrial zones also supposed.

(1) Overview of the area and finding the conditions of local related regulations
(2) Project Feasibility
(3) Low-carbon society development support
(4) Local surveys, workshops and other meetings

1.3 Survey Arrangement

The research was conducted by Mitsubishi Research Institute (MRI) as the representative, cooperating with Fujita, its research partner, Fukushima City, and

Fukushima Chamber of Commerce and Industry Companies. The research was conducted in coordination with local companies and with cooperation from Sagaing Region and Ayeyarwady Region.

<Roles of entities from Japan>

Mitsubishi Research Institute, with its rich experiences in policy implementation, planning, and JCM research for the Japanese national and municipal government, collected relevant information, managed workshops, considered measures for forming JCM projects, and supported policy dialogue between Fukushima City and the local government (Ayeyawady and Sagaing Regions), in addition to its role of the overall project management.

Fujita Corporation, with its knowledge and experiences in industrial, urban, and regional development, considered possibilities for specific project formulation (rice husk power plant). Fujita Corporation is implementing rice husk power generation in the Ayeyarwady region (JCM project) with MAPCO (Myanmar Agribusiness Public Corporation). The examined the experience of this project.

Fukushima City had policy dialogue with the officials of the local government to discuss policy-side approach for low-carbon, environmentally friendly regional development, introducing its experiences in establishing waste treatment plans, renewable promotion plans, and raising environmental consciousness (e.g. educational programs at school). Department of environment served as the main counterpart from Fukushima City.

Fukushima Chamber of Commerce and Industry Companies cooperated with its member companies to introduce their technologies and know-how in businesses, and to investigate possibilities in transferring technologies of companies from Fukushima City.

<Roles of entities from Myanmar >

Under the leadership of the Chief Minister of the Regional governments, Ministers and officials in related departments participated in the study.

MAPCO (Myanmar Agribusiness Public Corporation) served as the local partner company.

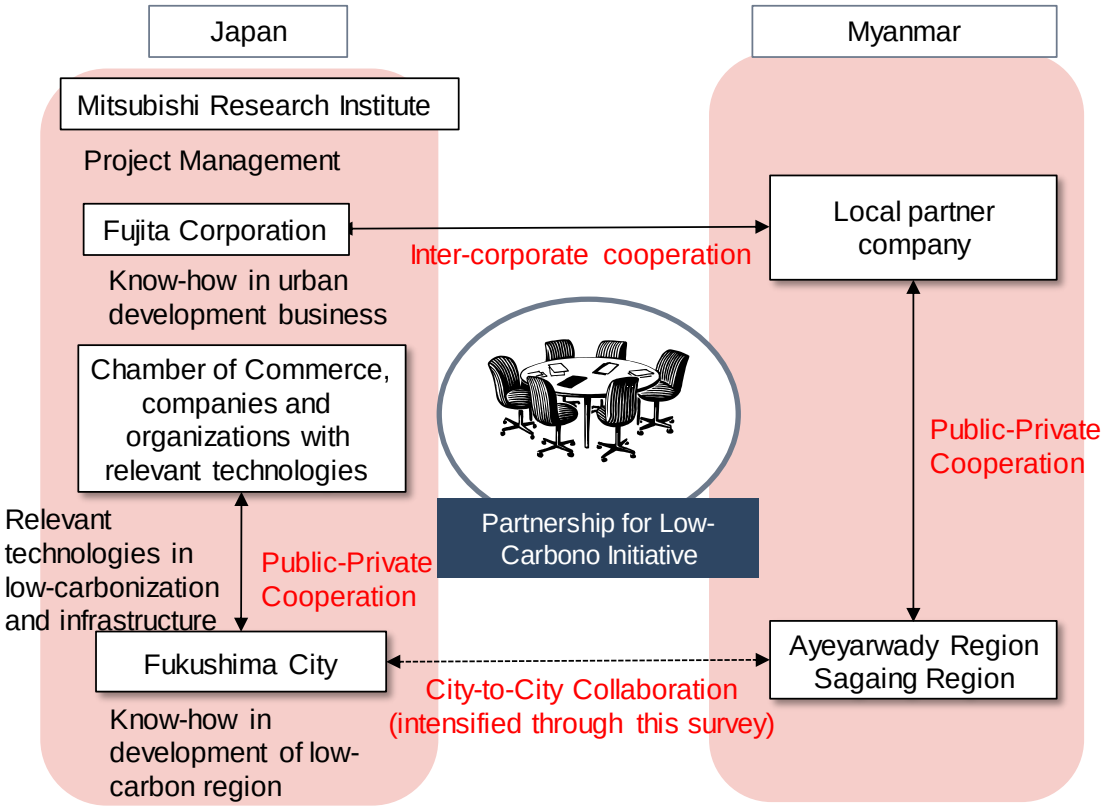


Figure 1-1 Organizational Structure

1.4 Overview of City-to-City Cooperation

As economy grows, addressing power shortages and emerging environment problems (waste, water preservation, etc.) became the most important issue in local cities in Myanmar.

Establishment of low-carbon, environmentally-friendly industrial zone is expected by applying the experiences of Japanese municipalities and companies. Additionally, such unique regional development is important for attracting businesses and promoting the industrial sector.

Myanmar has high expectations for Japanese experiences and technologies which have undergone rapid economic growth in the past. When the Chief Minister of Ayeyarwady Region visited Japan towards the end of April 2015, he learned about the activities related to energy efficiency and renewable energy in Fukushima City. Then, in June of the same year, the Chief Minister sent an official letter of intent to the Mayor of Fukushima City asking for support and cooperation in the development of Pathein Industrial City (letter asking for support and cooperation for the creation of a sustainable low-carbon city under an inter-city cooperation scheme).

In response to such a request for support and cooperation, Fukushima City, the Fukushima Chamber of Commerce and Industry, Mitsubishi Research Institute, and Fujita Corporation jointly established a partnership called the “Partnership for a Low-Carbon Initiative in Ayeyarwady” as a platform for city-to-city collaboration and decided to perform activities for such purpose. In FY 2015, the Partnership held workshops in Pathein City in Ayeyarwady Region as well as in Fukushima City, conducted field surveys and made policy dialogues, and examined the possibilities of developing a project applicable to the subsidies under JCM Scheme. And furthermore in February 2016, when government officials of Fukushima City visited the site in Ayeyarwady Region, they handed the Chief Minister of the Region a letter from the Mayor of Fukushima City responding to the request for support and cooperation, and expressed Fukushima City’s willingness to cooperate with Ayeyarwady Region not only in the sectors of renewable energy and waste treatment but also in various important matters such as the formulation of a master plan, based on Fukushima City’s experience hitherto so as to achieve a sustainable, resilient, and low-carbon society in Pathein City.

In July 2017, it has expanded to cooperate with other region that are the main production regions of rice (specifically, Sagaine Region). We expanded the low carbon partnership with Ayeyarwady and Sagain Regions.

Table 1-1 Overview of Ayeyarwady Region and Sagaing Region

	Myanmar	Ayeyarwady Region	Sagaing Region
Area	680,000 km2 (1.8 times the area of Japan)	35,000 km2	94,000 km2
Population	50 million	6 million	5 million
Overview	Consists of 7 Divisions and 7 States	Located adjacent to Yangon; located in the delta of Ayeyarwady River	Located in the northwestern part of Myanmar. One of the key are of rice production, and quality of rice is goof.

<Past Activities>

June 2015	Chief Executive of Ayeyarwady Region made a request to Mayor of Fukushima City for cooperation.
October 2015	Relevant parties of Ayeyarwady Region visited Fukushima City.
February 2016	Relevant parties of Fukushima City (Deputy Director of Environment Division, etc.) visited Ayeyarwady and hand over a reply letter of Mayor of Fukushima City regarding the request to the responsible Minister of Ayeyarwady Region.
September 2016	Workshop in Ayeyarwady (attendance of Chief Executive of the region)
October 2016	Director of Urban Development Bureau of Ayeyarwady Region, etc., visited Fukushima City.
January 2017	Discussion on the direction of project expansion at WS in Ayeyarwady (attendee: responsible Minister of Ayeyarwady Region, Chief of Environment Section of Fukushima City, etc.)

With such background, central government officials, in discussions for policy development regarding local distributed power supply system, asked MAPCO to consider expanding the first JCM project in Myanmar for rice husk power plant (Myaung Mya project, by Fujita and MAPCO) in other areas from Ayeyarwady Region; Sagaing Region (Shwebo District in particular) was proposed as a specific candidate project site.

MAPCO conducted its own local survey, and Fujita Corporation conducted preparatory survey in June. Afterwards, request for constructive development support under collaboration between Sagaing Region and Ayeyarwady Region was proposed (as an official letter from the regional minister to mayor of Fukushima City). The letter consisted of following requests:

- Promoting measures for waste treatment system (including local rice husk power

plant project)

- Promoting micro-grid systems utilizing local renewable energy sources

As a result of discussion between Fukushima City and Fukushima Chamber of Commerce, it was decided that activities under Partnership for Low-Carbon Initiative in Ayeyarwady would be expanded to inter-regional collaboration between Sagaing Region as well.

July 2017	Responsible Minister of Ayeyarwady Region made a request to Mayor of Fukushima City for cooperation for development under collaboration of Sagaing and Ayeyarwady Regions.
September 2017	Workshop in Sagaing Region (in Monywa City, Sagaing Region with attendance of the Chief Minister of the region)
February 2018	Workshop in Ayeyarwady
February 2018	Discussions in Fukushima City
March 2018	Reporting of city-to-city collaboration activities (Naypyidaw)

Part of the activities under city-to-city cooperation through the partnership for low-carbon initiative are conducted in cooperation with FY 2017 Feasibility Study of Joint Crediting Mechanism Project by City to City Collaboration (“Study on feasibility of solar power generation system and solar powered low-carbon water treatment system, and promotion of activities in Ayeyarwady Region” and FY 2017 Feasibility Study of Joint Crediting Mechanism Project by City to City Collaboration (“Study on feasibility of a low-carbon waste treatment system and micro-grid system and promotion of activities under inter-regional collaboration in Ayeyarwady region and Sagaing region”).

<Activities conducted this year>

In July 2018, we held the first meeting to share the year’s activities among concerned parties and to start this project in Fukushima.

In October2018, we held Fukushima Program with officials in Ayeyarwady region and Sagaing region. We also participated the City-to-City seminar in Tokyo.

In January 2019, we had local workshops and field surveys in Yangon, Myanmar.

In February 2019, we held the second meeting to share the year’s activities among concerned parties and discussed further activity of City to City Collaboration.

2. Overview of the area and Finding the conditions of local related regulations

2.1 Overview of the area

Overview of Ayeyawady region

According to the Myanmar Information Management Unit (MIMU), Ayeyarwady Region is the most populated region in Myanmar, next to the Mandalay District, Yangon, with population of approximately six million and area of about 35 thousand square kilometers. There are six districts and 33 townships in the region. The Maubin District, Myaungmya District, which was the target of the study, are adjacent to the Pathein District where is the region's capital city.

Rice production and rice milling industry is an important industry in Ayeyarwady Region. New work is underway for industrialization in Ayeyarwady Region as well. There are numerous plans for industrial zone construction by foreign investors and local companies. In this way, infrastructure for industrialization is being developed in Ayeyarwady Region, and it may become one of the economic centers of Myanmar in the future.

Overview of Maubin District

Maubin District, one of rice farming centers in Ayeyawady area, is about 60 km west of Yangon. Maubin Township is at the center of the District. Myanmar's administrative structure is composed of regions, districts, and townships. The area of Maubin District is almost two times that of Biwako Lake in Japan. Its height above sea level is almost the same as that of Kanda Station, Tokyo. Composed of four townships, the population density of Maubin District is 260 persons/km2, which is almost equivalent to those of Ishinomaki City and Tottori City in Japan.

Somewhat far from the center of Maubin Township, there is an area planned for the Maubin Industrial Estate. Some 200 meters from the rightmost edge of the planned area, and facing a tributary of the Ayeyawady river, there is a land owned by MAPCO (the yellow-colored area on the attached map). This is land where the military regime had cultivated jute for producing rice sacks in the past, and was later passed by the government to MAPCO.

Rice Farming in Maubin

The crop yield per unit area is 390 tons/km2, which is fairly low. The situation is similar in Maubin District as a whole. It is said that the reason is lost opportunities by rice-polishers from self-efforts due to the government monopoly of rice transactions under the military regime, and the resultant continuation of inadequate business management from those days.

Possibilities of New Rice-polishing Businesses in Maubin

Connected to Yangon through the Twante Canal, and taking advantage of its geographical superiority, Maubin had been the hub and port of shipment for rice transportation in one of the largest rice farming areas in Myanmar. According to our interview survey in Maubin, however, local rice-polishing businesses in Maubin lag behind competitors in other areas, which increased their handling volume after the liberalization of rice transactions.

MAPCO, on the other hand, is an enterprise established as a part of government policy, receiving equity financing from many investors, and their interests do not seem to be simple. The management of MAPCO insists there have been no changes to the plan.

According to our direct interviews with Maubin rice-polishing businesses, however, they cannot see any possibility of expanding rice collection in Maubin, and the current level of business will continue. This is closely linked to the rice distribution situation in Myanmar. In Myanmar, it is not rice polishers but middlemen who purchase unhulled rice directly from farmers. Middlemen naturally consider favorable target buyers, taking into account handling volume and price. Therefore, their sales destinations tend to be areas with influential rice polishers.

If this assumption is correct, MAPCO's new rice-polishing facilities might apply pressure on existing local rice-polishing businesses, and it may not be clear if MAPCO's plan will progress smoothly. We are a little doubtful about its feasibility. In addition, the plan for the Maubin Industrial Zone has not been making good progress. We presume MAPCO's plan in the area has been shelved.

Plan of Maubin Industrial Estate

The area for the planned Maubin Industrial Estate is currently agricultural land totaling 283 acres (about 115 hectares). Major investors of the planned Estate are Maubin Development Public Corporation, which is composed of 108 landowners (farmers) (30%), Shanghai Yuandong (Chinese enterprise) (50%), and Southern Metal Industry (Myanmar enterprise) (15%).

Electric power is to be introduced from a nearby national grid substation. The number of prospective tenant businesses is nearly 50, of which 43 are garment factories and three are in the food processing industry. Although the government has already approved the investment, and the project contract was concluded in July 2016, there has been no progress so far. This is something that happens often in Myanmar. There are many examples of projects having taken several years from investment approval to actual implementation.

MAPCO Business Plan

There are plans to establish new rice-polishing facilities on the premises, and to use the rice husk produced by the project for biomass power generation. The generated power is to be used by rice-polishing and other facilities. Surplus power, if any, will be sold to the nearby Maubin Industrial Zone.

MAPCO plans to establish two rice-polishing facilities with a capacity of 10 tons per hour each. If fully operated, the two facilities will provide enough rice husk for operating two biomass power plants with outputs of 1.8 MW each.

Situation of Maubin Industrial Park (Key finding)

Plan of Maubin Industrial Park

- MIC has already granted approval for the Maubin Industrial Estate project.
- The planned area for the development is 283 acres (114 ha).
- Major investors for the project are Chinese-origin companies.
- A total of 108 local farmers who own land are assumed to be participating in the project in the form of leasing their land.
- Among these landowners, those who are influential also engage in the rice polishing business.
- Around 50 companies are expected to participate in the business in the Estate. Many of them are from the garment industry.
- Further participation from the garment industry cannot be expected. Power shortages seem to be a bottleneck for attracting companies from other industries.

Situation of Electricity

- The total demand for electricity power in Maubin Industrial Estate is estimated at 25 MW.
- Although power is to be delivered from a 230 KV substation in Kyeit Lat, it is considered not to be sufficient to meet total demand in the Estate.

Situation of Rice husk and possibility of collection

- The results of our interview survey with the local rice-polishing businesses indicate that further increases in collections of unhulled cannot be expected, and it seems to be difficult to establish new rice-polishing facilities.
- The operating rate of rice-polishing facilities in surrounding areas is also showing no change or is declining, and securing the necessary volume of unhulled rice has become increasingly difficult. Collection points for unhulled rice have been integrated in other parts from Maubin.

2.2 Finding the condition of local related regulations

In implementing the rice husk power generation project, the following procedures of investment permission and environmental measures will be needed.

Investment must undergo investment approval procedures at MIC (Myanmar Investment Committee) under Foreign Investment Law and Foreign Investment Rules.

Possibility of environmental impact (e.g. air and water contamination) from the rice husk power plant project and necessary measures, procedures for environmental impact assessment, possibility of social impact and measures are discussed.

In order to acquire approvals for foreign investment, project categories identified under the EIAP (Environmental Impact Assessment Procedures) must conduct EIA (Environmental Impact Assessment) or IEE (Initial Environmental Examination), or prepare an EMP (Environmental Management Plan).

EIAP identifies the following project categories to conduct IEE or EIA:

1) Project in which investment is decided by the Parliament or the government cabinet or the President,
2) Energy sector development,
3) Agriculture, livestock and forestry development,
4) Manufacturing (food and beverage manufacturing, garments, textiles and leather products, wood manufacturing, chemicals manufacturing, manufacture of glass and ceramics, manufacture of construction materials, metal, machinery and electronics),
5) Waste management,
6) Water supply,
7) Infrastructure and service development,
8) Transportation,
9) Mining.

There is no compulsory environmental standard referenced in EIA. National Environmental Quality (Emission) Guideline was established in 2015 with reference to Environmental Health and Safety Guideline established by IFC (International Finance Corporation), but this standard is only a reference standard. Therefore, currently, EIA must be conducted with regards to international standards (e.g. JICA, IFC, ADB, etc.).

The 3 MW scale rice husk power plant project would fall under the project category “Power Plants from Waste Products” in EIAP. Under this category, projects over 50 MW need to undergo IEE, and projects designated by the government need to undergo EIA. Therefore, it is expected that the proposed project does not need to undertake IEE nor

EIA.

In terms of individual environmental standards, such as ambient air quality, industrial effluent, water contamination and noise, compliance with the guideline of exhaust gas emission from small scale combustion facilities, in the general and thermal power IFC EHS Guideline (International Finance Corporation Environmental Health and Safety).

Small scale combustion process points to the system designed to supply electricity, machinery power, steam, heat and/or the combination of these equivalent to 3-50MW in thermal output derived from the total of rated value heat capacity, irrespective of types of fuel.

Environmental protection of power plant

<Exhaust emission>

- IFC EHS Guidelines (general)
- Assuming compliance with “Exhaust gas guidelines of small-scale combustion facility （Heat output3-50MW, Solid fuel ）”
- Particulate matter: Cyclone dust collector
- NOx and Sox: Since nitrogen and sulfur component of rice husk is small, special processing is unnecessary
- Dioxin: Although rice husk hardly contain chlorine, it is assumed that it is shifted to rice hulls by absorbing dioxin of soil (no guideline value)

<Ash>

- Fry ash: Considering the introduction of bag filter or electrostatic precipitator (include assume dioxin measures also)
- Main ash: Study multiple reuse (Cement, fertilizer, Building material, other)

Currently, there are no regulations for landfill of burnt ash generated from rice husk power plant, but necessary measures for reducing environmental impact will be taken under discussions with the regional stakeholders.

3. Project Feasibility Study

3.1 Project Formulation of Rice Husk Power Plant

Promising technology for low-carbon waste treatment system would be rice husk power generation technology.

Feasible JCM project for low-carbon waste treatment system (rice husk power plant) in Maubin Industrial Park, Ayeyarwady Region, along with its candidate site and applied technology, is considered.

3.1.1 Project Overview

As a power plant to be installed in the industrial zone and rice mills in Maubin Industrial Park, Ayeyarwady Region, achievement of an operation of a about 3 MW scale biomass power plant using rice husks under the SPC established between Japanese and Myanmar local companies is aimed.

3.1.2 Project Site

We compared the appropriate sites of project sites in the Maubin Industrial Park area and adjoining area of large-scale rice mills.

3.1.3 Applied Technology

Technology to be applied in the proposed project is considered from the following perspectives to sustainably operate the project: (1) collectable amount of rice husks, (2) generation system, and (3) rice husk supply.

(1) Collectable Amount of Rice Husks

Through the field survey, we investigated procurement method of rice husk in the surrounding area of Maubin Industrial Park. There are about 15 large-scale rice miller, and it seems that the rice husk of about 100 tons per day is produced in this area. Ten of these are relatively close at a distance. However, it is difficult to judge whether the Paddy will increase in the future like the Myumiya district which advances the effort ahead of rice husk power generation project.

Since the local rice milling business sector does not have the viewpoint of the amount of rice husk generation. It is thought that it is necessary to deep study of each rice millers to understand the actual situation in each mills.

(2) Electricity Demand and Current Power Supply

The total demand for electricity power in Maubin Industrial Estate is estimated at 25 MW. Although power is to be delivered from a 230 KV substation in Kyeit Lat, it is considered not to be sufficient to meet total demand in the Estate. Therefore, the power supply from the rice husk power generation project is a high-need solution for the promotion of Maubin Industrial park.

(3) Power Generation System

In terms of initial cost of the equipment, it is possible to reduce costs by constructing one facility (3MW scale). On the other hand, view of the stable procurement of rice husk and various administrative procedures are also important. It is pointed out that it is generally advantageous to build two 1.8 MW models of the current implementation (the first project of Myaung Mya) from local government officials. The reason for this is that 2MW is completed only by the local government without the central government's examination and other procedures. 1.8 MW is a basic type of model unit. The increase of cost will be reduced by devises such as same site location, and the commonization of construction work.

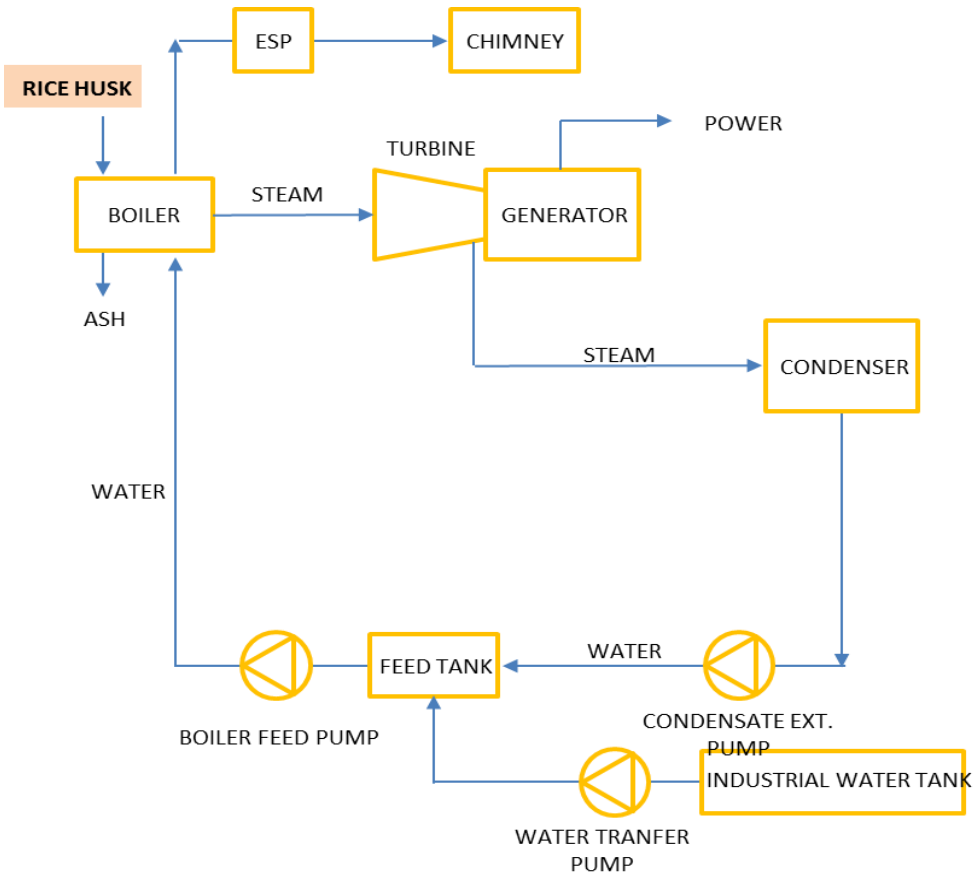


Figure 3-1 Boiler Turbine Generator (BTG) Power Generation Flow

The aforementioned system is used in the first JCM project by Fujita Corporation and MAPCO in Myaung Mya District in Ayeyarwady Region. This system will be used as a base with some modifications to construct an optimized system for the region.

Based on the experiences in the first JCM project, the optimal system will be created (from the aspects of equipment cost and generation efficiency).

Differences between the first JCM project in Myaung Mya District in Ayeyarwady Region are shown below:

- It is assumed that the increase of the construction cost is reduced because the ground is assumed to be better than the first project.
- Initially, since the site for power plants and the destination site is not adjacent, it is necessary to lay the cable on the site of others, it is assumed that the land owner and the administration and negotiation of the distribution business (Restricted to Foreign company) is required. It was found to be adjacent by this field study.
- Negotiation of the selling electricity to the adjacent industrial park (Issues are mainly selling electric method and the selling price) is need for the surplus electric power.
- The sales electric method and the sales electricity rate are main issues.
- It is necessary to negotiate with other ground owners and the administration (intake permission) because there is a little distance to intake water from the Pyapon River.
- It is necessary to negotiate with the administration to take water from groundwater in boiler water. (if it is not feasible together, modified to air-cooled is needed. It is equipment cost-up factor)

Challenges of Rice Husk Power Generation in Myanmar

Based on the experience of the first project in Myaung Mya District, we have pointed out the following issues and countermeasures for promotion of further projects.

In the project planning and implementation of rice husk power generation the Maubin Industrial Park, following issues and countermeasures will be considered.

<Approval and System>

(Challenges)

Not so much time has passed since democratization and liberation; therefore, old systems and customs adopted during the military regime are still combined with new ones introduced under the new regime. This has been causing impediments to smooth approval and authorization. While many basic laws and documents have been translated into English, most detailed notices and circulars remain in the Myanmar language. Because translators are not always familiar with specific fields, they sometimes misunderstand. This happens even in the area of news reporting.

The present government has been promoting the transfer of authority to local governments. This is indispensable for smoothly granting approvals and permits. Local authorities, however, sometimes cause confusion because they do not have sufficient experience of dealing with difficult cases. Although senior officials of local authorities may have undergone training in Naypyidaw or Yangon, many officials of junior branches of local authorities have not been given enough opportunities for training. In the case of rice husk -based power generation, because project sites are located in rural areas, the projects are influenced by local officials who do not have sufficient experience and training.

For instance, senior officials of local authorities advise project proposers to submit application documents to junior branches of project sites. On the other hand, officials of the junior branches refuse to receive the documents because of their inability to exercise judgment on the projects, and advise the proposers to discuss with officials of senior departments. This sort of confusion frequently occurred at the early stages of our survey.

[Proposed Solution]

It is important to take the following measures before starting a survey project.

1. Hold preliminary interviews with responsible officers, preferably senior officials, of the department in charge the project items;
2. Hold interviews simultaneously with other related departments. In the case of our survey project, we visited departments handling investments, electric power, industry, environment affairs, etc.
3. Request interpreters to study issues in advance that might be encountered in the course of the survey projects.

Engineering and Construction

(Challenges)

Because Myanmar has not had close contacts with other countries for a long period under the military regime, it has been lagging behind in the fields of engineering and construction. In terms of construction projects, there are few companies with sufficient capabilities. This is more serious if projects are related to very specialized technical fields. There are quite a few firms with elderly engineers who worked for companies in developed countries such as Japan in the past now leading their core engineers.

When we ask for cost estimations, for example, although their documents are usually in good shape, missing items and/or over-estimations are quite often found. This is because of their insufficient practical experience. Apart from firms in Yangon where a lot of construction work has been in progress, the levels of those in local cities are quite low in terms of staff and resources. Although it is possible to seek high-quality construction with inputs from quite a few Japanese engineers, it is never feasible in terms of cost.

[Proposed Solution]

Using Thai and/or Vietnamese firms is one solution. Besides those Southeast Asian countries, many excellent engineering firms are available in India. It is suggested to tie up with those firms upon carefully examining their characteristics.

Operation and Management

(Challenges)

The situation is fairly similar to that of engineering and construction. Elderly engineers who have worked at government offices usually have specific knowledge and experience. Their experience and knowledge, however, are somewhat obsolete, and may have a negative effect. Furthermore, because the wage system is based on seniority, their salaries are comparatively high. On the other hand, young engineers lack experience, and their knowledge is often only based on classroom lectures.

[Proposed Solution]

It is proposed to train young engineers from scratch. Even university engineering graduates (five years study) do not have enough knowledge. The shortcut to success is to employ supervisor-class young engineers with suitable knowledge and experience, and to train them for a certain period, while giving them operational and management opportunities.

Project Participation

(Challenges)

In order to secure stable, long-term supplies of rice husk, and also because of the politically suppressed unit price of power sales to the national grid, relative transactions are the mainstay of the project. This means that most of the project's business partners are naturally limited to arm's length rice polishing businesses. While rice polishers are fairly high-income earners in rural areas, they are mostly individual proprietors, and the amount of funds they can invest as individuals is limited. This could be an impediment to the project, irrespective of their strong interest.

[Proposed Solution]

Possible solutions are as follows:

1. Many small-scale rice-polishing businesses are operated by family members and their relatives. It is necessary to influence them through policy inducements to eliminate and consolidate the current small businesses and replace them with modern rice-polishing plants. This will help increase the rate of high-quality hulled rice, which is suitable for export, bring about higher incomes, and subsequently greater interest among rice-polishers in project investment.
2. Government intervention through agricultural banks to activate lending to rice-polishers.

In view of the fact that the rice industry is a key industry of Myanmar, it is advised to improve capacity for project implementation and engineering management in a partnership between public and private sectors, while replacing assistance funds and technologies from foreign countries with own funds within a certain period.

3.1.4 Project Scheme

The business scheme of the project is shown below.

Table 3-1 Project Scheme

Implementation Site	Maubin Industrial park
Size	3 MW Scale: Confirmed based on the amount of rice husk availability (1.8 MW as a model unit, and multiple construction according to the scale in the condition)
Fuel	Rice Husk
Applied Technology	Boiler Turbine (Biomass Power Generation)
Power Supply	Generated power will be used within the rice mill. Other option: Surplus will be sold to the neighboring community and other factories in the industrial zone (distribution via national grid. Introduction of a new mechanism such as a wheeling system is a challenge.)
Project Scheme	Establishment of SPC assumer (e.g. Japanese company and local partner) Utilization of JCM Subsidy

(1) Technology Specifications

Considering the amount of rice husk supply and power demand in the industrial city, this study proposes the following system.

Table 3-2 Specifications of the Rice Husk Power Plant

	1.8MW	2 units of 1.8MW	
Installed capacity	1,816	3,62	kW
Self-consumption	201	402	kW
Sold electricity	1,615	3,230	kW
Availability	24	24	hrs/day
	300	300	days/year
Generated electricity	38,760	77,520	kWh/day
	11,628,000	23,256,000	kWh/year
Rice husk	2.3	4.6	t/h
	55	110	t/day
	16,560	33,120	t/year

(2) Project Investment

Equipment cost (estimate) excluding civil engineering works is 380 million JPY (gross generation capacity of 1.8 MW unit). Project investment cost will be distributed according to SPC investment.

(3) Project Organizational Structure

<Project Implementation in Industrial Zone>

Since there is a plan to building a rice milling plant in the neighboring area of the Maubin Industrial Park (MAPCO has a plan to building a new rice mill). therefore, operational organization should be MAPCO.

However, considering the past development experiences in Myanmar local companies, establishment of a joint venture with experienced company would be best. Therefore, with possibility of utilizing JCM scheme, establishment of an SPC between a Japanese and Myanmar local company is being considered. The international consortium structure is shown below:

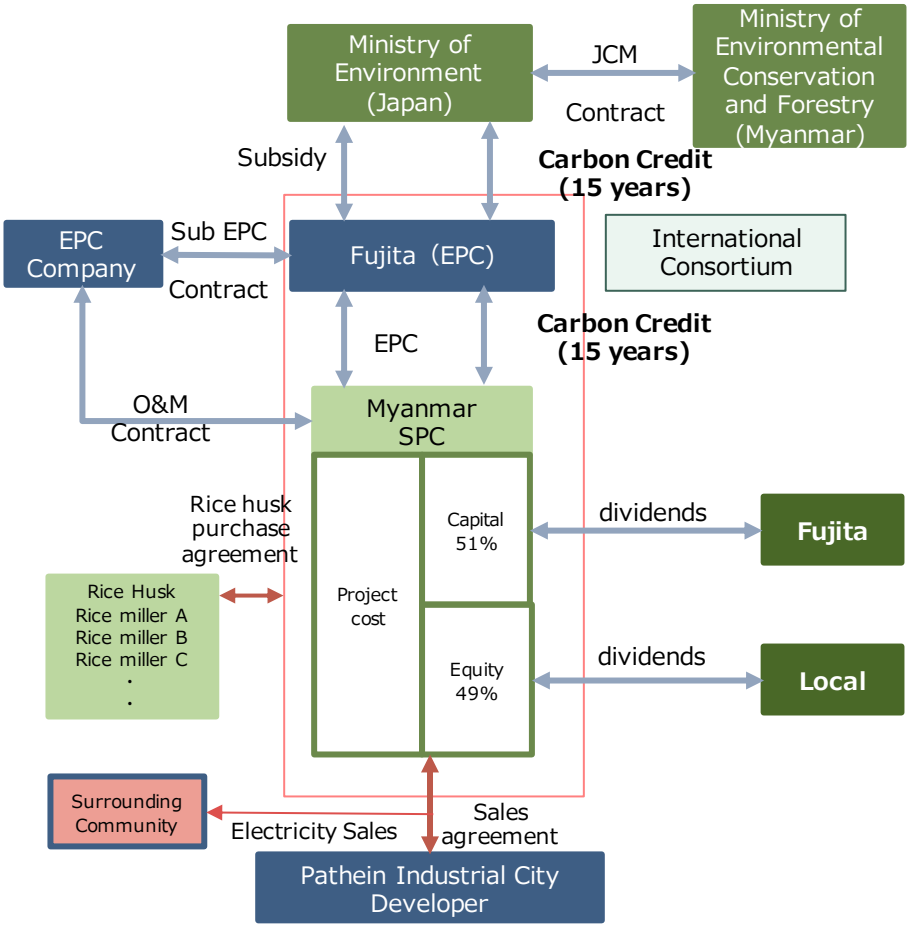


Figure 3-2 Project Organizational Structure (Proposal)

The installed technology requires specific knowledge and experiences. Consigning the whole operation and maintenance process to an EPC company is planned.

(4) Sales of Generated Power

All of the generated power will be sold to rice miller. The power will be supplied to neighboring factories in the Maubin Industrial Park.

(5) Identification of Participating Entities in the Project

Local company from Myanmar assumed to be participating in the project is MAPCO, which has plan of construction of rice mill at adjacent land of the Maubin Industrial Park.

To roll out similar projects in other areas, investment rate of Japanese companies should be gradually lowered; however, at the current economical standard in Myanmar, the project scale is too large for a single entity to participate. Therefore, it is assumed that about several companies will be participating in the project.

Issues	Results
Review of the business in rice husk power plant	As a result of the interview with the local rice milling business, there is no plan that the pickup of paddy increases from the current state (construction of a new rice milling plant, it is difficult to do business)
Coordinating with regional development	Attracting sales has been difficult, and plans are delayed significantly
Coordination with the selling power destination	Attracting sales has been difficult, and plans are delayed significantly A concrete examination about the consignment system with administrative authorities
Coordination with companies participating in business	Due to delays in the development of industrial parks, activities of local companies are sluggish
Coordination with construction site	A promising site is confirmed in the neighboring area. In order to materialize, it is necessary to confirm the administrative authorities
Licensing procedures	Coordinating with the administrative authorities on groundwater intake

Future issues and direction

Although there is no change in the basic stance of the local company, it is judged that it takes time to materialize the business
There is a region where the consolidation of the rice mill is progressing, and the movement of the large-scale rice mill construction is active.

Feasibility study of other candidate locations (e.g., Myaumyau Industrial area and Pathein in industrial city)

3.2 Project Formulation of Heat Utilization

3.2.1 Plan for Low-temperature Storehouses

Rice Storage Volume

One of the essential measures for increasing rice exports is to ensure higher quality rice.

One important item that cannot be ignored in this context is low-temperature storehouses. Our view regarding low-temperature storehouses that will be required in Myanmar in the future is as follows:

The assumed owner of our proposed low-temperature storehouse is a rice-polishing business person who owns the latest large-scale rice-polishing facilities. This is because we believe small and medium-scale rice-polishing businesses do not have the financial strength to introduce low-temperature storehouses.

Our scenario is one rice-polishing plant operating with a capacity of 10 tons/hour for 24 hours a day, 300 days a year. According to our interview survey of rice-polishing businesses, the volume of unhulled rice collected is low for two months in a year. Based on this fact, we plan to store rice for two months. The storage volume is 10,368 tons.

- Rice-polishing capacity (from unhulled rice): 10 t/h
- Unpolished rice (unhulled portion: 20%): 8t/h
- Polished rice (bran rate: 10%): 7.2t/h
- Operation hours: 24hr/day
- Operation days per year: 300 day/year
- Volume of polished rice:51,840 t/year
- Design storage volume (for two months)
- Design assumption: 10,368t (Storage for two months when incoming volume of unhulled rice is low.)

Pallets

In Myanmar, when rice is stored in storehouses, pallets are not normally used, but manually stacking sacks of rice is common. We propose to use forklift trucks together with pallets for increased efficiency in place of manual work. Our defined pallet size is 110 cm x 100 cm, which is the most prevalent size in Myanmar. In terms of pallet material pallet, there are two types: plastic and wood. We propose the use of plastic pallets, because wood-made pallets could cause incidents of wood splinters mixing with rice.

Forklift Trucks

Because forklift trucks move around inside storehouses, we specify using electricity-powered forklift trucks instead of diesel or gasoline-powered trucks, considering the effects of odor on rice quality. The forklift truck's specifications are: lifting capacity of over one ton and lifting height of over five meters. This is based on the assumptions described below. In addition, we specify a 1.5 m minimum turning radius based on the passageway width mentioned below.

Assumption of Rice Sacks Loaded on One Pallet

Based on the rice sack size currently prevalent in Myanmar, we assume loading seven layers with two stacks of sacks on one pallet. This enables 14 sacks to be conveyed on one pallet. Because each sack weighs around 67 kg, a total of 938 kg (67 kg/sack x 14 sacks) of rice can be conveyed on one pallet.

We assume stacking five layers of these pallets for storage. The weight of rice of five layers of these pallets is 4,69 kg (938 kg × 5 layers). Because their height is almost five meters (99 cm/pallet x 5 layers), we specify the height of a storage-house as six meters, which allows nearly one meter of space above five layers of pallets. We call the unit of seven lines and six rows of pallets "one block."

Because each block stores a total of 210 pallets (five layers of pallets x 7 lines x 6 rows), the total weight of rice is 197 tons (938 kg/pallet × 210 pallets). Taking into account spaces among pallets, we specify the size of "one block" as 8.4 m × 6.6 m.

Storehouse Configuration

The storehouse configuration influences the scale of a low-temperature storage facility.

One storehouse accommodates six blocks, with three blocks each on the right and left sides. Passageways can also be used for storage, with the exception of the area near the entrance. The total number of pallets accommodated in one storehouse is 1,455, including those placed on passageways. This makes the total volume of stored rice per storehouse 1,365 tons.

Number of Storehouses

As mentioned earlier, storehouses for accommodating a maximum 10,368 tons of unhulled rice in total are necessary. Because the storage capacity per storehouse is 1,365 tons, eight storehouses are required (10,368÷1,365≒7.6).

Besides the storehouses themselves, connecting passageways with a width of four meters are included in our facility plan. The plan for the proposed low-temperature rice storehouses specifies the dimensions – 84 m x 44 m, height – 6m, area – 3,700 m2, and volume – 22,180 m3.

Construction Cost

The construction cost of the proposed low-temperature storehouses without power generation facilities and refrigeration equipment is estimated to be about 2 million yen.

[Current Rice Storage Situation]

Although rice is mostly dried to the appropriate water content (15%), most of the stored rice is maintained at atmospheric temperature, so the risk of excessive humidity or aridity is significantly high.

[Rice Storage Requirements for Preventing Quality Degradation]

Rice should be stored under conditions with a temperature of below 15 degrees Celsius, and a relative humidity of below 70%.

If rice is stored at atmospheric temperature in Myanmar (Yangon), its quality will definitely deteriorate, because the year-round average lowest air temperature is above 15 degrees Celsius, and relative humidity is above 70% for more than half a year. Low-temperature rice storage is essential for the policy to tackle rice price fluctuations and increase rice exports.

[Temperature-controlled Warehouses Powered by Rice husk -utilized Energy]

The proposed low-temperature storehouses should utilize rice husk , which is universally available in Myanmar, for their power source.

3.2.2 Project Site

As for the possibility of introduction into the Maubin Industrial park, it is difficult considering following present situation

- According to interviews with local rice millers, there are no plans to increase the amount of rice husk pickups (Under current situations, it is difficult to build new rice mills and start business).
- It seems that the uptime ratio of existing nearby rice millers is decreasing and it is becoming difficult to secure the necessary amount of rice husks. Husk pickup sites are being consolidated.
- In discussions among existing rice millers, the idea of jointly constructing low-temperature warehouses has not been agreed yet.

It was identified as a candidate for a place adjacent to the rice mill in a relatively close

location from the first project of the rice husk power generation in the Myaung Mya

3.2.3 Selection of Technology

Although cogeneration is possible, whether by gasification or direct burning, it needs to be selective considering project scale and price.

In the case of rice husk gasification with more than 1 MW, the price is extremely high. In addition, there are very few existing examples of stable operation.

In the case of steam boiler/steam turbine-based heat and power supply, although there are many examples of stable operation, the minimum demand level of 2 MW is required.

It is suggested to establish a facility to supply power and heat in an area adjacent to a large-scale rice-polishing plant considering stable and long-term rice husk supplies.

However, if all the rice husk produced is used for power and heat generation, and if rice-polishing facilities are the sole major energy user, the load factor of power and heat would be insufficient. It is necessary to establish a system plan that takes into account the total power and heat load factor of the project area.

There are very few examples of power generation businesses in the private sector being connected to the national grid in Myanmar. In addition, we have to consider the situation where the unit price of power sales is generally lower than that of power purchases, Therefore, it is necessary to conceive a plan where locally generated power can be locally consumed.

The construction cost of the low-temperature storage warehouse, which does not include power generation facilities and refrigeration equipment, was estimated at approximately 200 million yen.

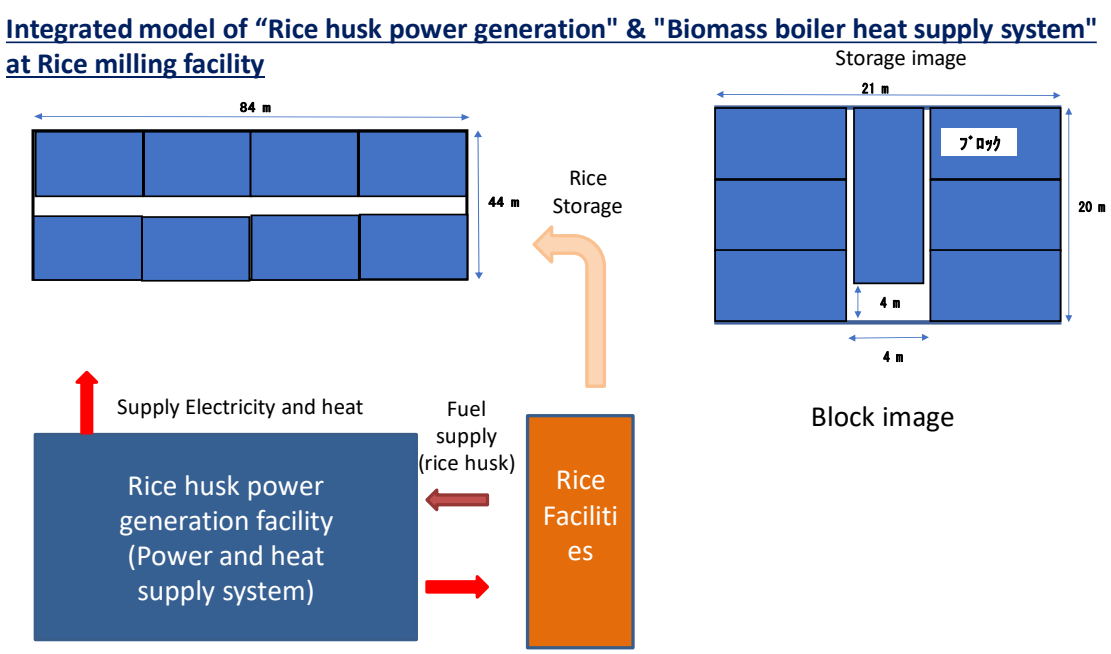


Figure 3-3 Integrated model of “Rice husk power generation" & "Biomass boiler heat supply system" at Rice milling facility

(Reference)

Review of heat supply systems (refrigerators, etc.)

Summary of advantages and disadvantages for each type of refrigerator

Vapor compression refrigerator

<Overview>

- Compress refrigerant gas using a compressor and cool it using a condenser to produce a high-pressure liquid. Then, lower the pressure using an expansion valve and vaporize it at a low temperature using an evaporator. Heat is removed as vaporization heat.
- Refrigerants used are ammonia, carbon dioxide, CFCs, etc.
- To drive the compressor, electric motors are used for an electric type, while gas engines, gas turbine engines, or steam turbines are used for commercial applications.

<Advantages>

- Lower initial cost
- Can manufacture smaller units.
- Mass/volume per capacity is small; inexpensive
- Coefficient of performance (COP) is as high as 4.0 to 6.5; lower heat release from condenser
- Longer inspection intervals

<Disadvantages>

- Slightly more noise
- If an electric motor is used, it becomes a factor increasing maximum demand for electric power.
- Because high-pressure gas is generated, attention to safety is needed.

Absorption refrigerator [water - lithium bromide]

<Overview>

- Refrigerators in which refrigerant (water) is absorbed by a liquid with a high absorption capacity (lithium bromide), and, using the low pressure generated, refrigerant at another location is evaporated, consequently lowering the temperature of the refrigerator. The main application is in refrigerators used for air conditioning.

<Advantages>

- No qualification required to operate the main unit.
- Lower power consumption
- CFCs are not used.

<Disadvantages>

- Compared to vapor compression refrigerators,
- Periodic inspection is complicated.
- Because it exhausts more heat, a larger cooling tower is required.
- Because internal heat quantity is larger, it takes more time to start up.

Absorption refrigerator [ammonia - water]

<Overview>

- Absorption refrigerators using ammonia as a refrigerant and water as an absorption liquid. Used for freezing.

<Advantages>

- Compared to water-lithium bromide refrigerators,
- Can be cooled to -60 °C.
- Air cooling is easily applied.

<Disadvantages>

- Subject to regulations for pressure vessels.
- Because ammonia is a hazardous substance, equipment to discharge it in the case of a leakage is necessary.
- Efficiency is slightly decreased in air-conditioning applications.

Adsorption refrigerator

<Overview>

- Uses phenomena where porous materials such as silica gel adsorb water vapor or gas. Evaporate refrigerant at a low temperature using an evaporator and let cooled adsorbent adsorb refrigerant vapor to generate a low pressure. By switching between pipes, heat is applied to an adsorbent having absorbed refrigerant to separate it from refrigerant. The refrigerant is then cooled and liquefied in a condenser for reuse.
- Water is used generally as a refrigerant. The main application is cold water production using low-temperature exhaust heat.

<Advantages>

- Compared to absorption refrigerators,
- Exhaust heat at a lower temperature can be utilized.
- Because no salt is used, harmful corrosion-proof materials are not needed.
- Inspection intervals are longer.
- Lower power consumption because no compressor is required.

<Disadvantages>

- COP is as low as one or less, which is lower than compression refrigerators.

3.3 GHG Emission Reduction

Methods of emission reduction of CO2 from fuel combustion and greenhouse gas when JCM project considered. The introduction technologies assumed in this project are (a) Power supply to industrial parks (connected to the National Grid) by biomass power generation projects utilizing rice husks, (b) Heat supply to rice cold storage and/or food factory by biomass boiler.

3.3.1 Power supply to industrial parks by biomass power generation projects utilizing rice husks

(1) Reference Emission

1) Substitution of supply power from grid

Generated electricity will fulfill electricity demand. The industrial city is connected to the grid; therefore, reference value will be assumed as power supply from the grid. There is no official emission factor provided by the government of Myanmar, and it is difficult to acquire data on power plants connected to the grid; therefore, emission factor was calculated based on IEA data according to the CDM method. The result is shown below.

Table 3-3 Grid Emission Factor based on IEA Data (t-CO2/MWh)

	Coal	Oil	Gas	Average
2009	1.055	0.864	0.729	0.202
2010	1.057	0.786	0.729	0.265
2011	0.979	0.853	0.729	0.192
2012	0.961	0.826	0.729	0.218
2013	0.956	0.825	0.729	0.195
2014	0.969	0.848	0.729	0.280
2015	0.973	0.825	0.729	0.304
2016	0.792	0.850	0.774	0.352
Emission factor (2009～2013)				0.214
Emission factor (2010～2014)				0.230
Emission factor (2011～2015)				0.238
Emission factor (2012～2016)				0.270

In 2016, there is the significant decrease in coal-fired power generation and the increase in the operation of gas-fired power. Due to the relative thermal power (fossil) power generation ratio to hydropower (non-fossil) power generation, which is the main power source of Myanmar, increases, the average grid emission factor is increasing. Since the introduction of gas-fired thermal power generation is expected to continue in Myanmar, it is supposed that the grid emission factor will also increase. As mentioned above, because the government's grid emission factor has not been published in Myanmar, grid emission factor can be selected as ex post to reflect on the actual situation more precisely Also, with regard to the amount of generated electricity, it is necessary to set monitoring points that can appropriately measure the sales volume of the electricity

to the grid minus the on-site power consumption.

2）Substitution of supply power from captive power

For the substitution of electricity supply by captive power to consumers, who are not connected to the grid, the emission factor is used to 0.8 t-CO2/MWh referred to CDM methodology "AMS-I.A :Electricity generation by the user". In this project, it is not counted because it assumes electricity support to the industrial park connected to the grid.

3）Substitution of heat supply

In the case where heat supply is also performed, it is assumed to replace the highest efficiency boiler which have spread through the market in Myanmar and/or a boiler currently used in the heat supply destination. On the other hand, when replacing the rice drying process with conventional sun drying, it is not eligible because it does not reduce emissions.

(2) Project Emission

1）CO2 Emission from Transport

CO2 emission from fuel use for transporting rice husks and plastic waste used for power generation is estimated. Most of them will be transported by human power, but for conservativeness, default value of CDM tool (for light vehicles), 245g-CO2/t-km may be applied.

2）Fuel Consumption within the Power Plant

When the electricity is supplied for equipment in the rice husk biomass power plant as backup power, the amount of emission from fuel consumption must be considered. Monitoring is done according to the sales receipt of fuel.

Based on the idea of the materiality (The threshold of materiality for verification is set at five (5) percent of emission reductions. etc.), small amount of emission resource will not be considered.

(3) Other Sources of Emission

Methane generated from rice husk disposal:

Methane emissions arising from disposal of rice husk under anaerobic condition may be considered as part of the reduction in this project by utilizing these rice husks. However, rice husk disposals in Myanmar are not always under anaerobic condition; therefore for conservativeness, they are not part of emission reduction in this project.

3.3.2 Emission Reductions

Assuming the above, emission reduction is calculated as follows.

Table 3-4 Result of Emission Reductions Calculation (Biomass Power Plant Project)

Capacity (Net)	3.2	MW
Annual power generation (Net)	23,256	MWh/year
Grid emission factor	0.270	kg-CO2/kWh
Reference emission	6,279	t-CO2/year
Fuel transport	32,120	t/year
Project emission	0 *	t-CO2/year
Emission reductions (planned)	6,279	t-CO2/year

Note) Regarding project emissions, about half of rice hulls are procured from adjacent rice mills and the remaining half are contracts to procure from nearby rice mills, which are considered small amount of emissions resource and are not taken into consideration in calculating reductions.

3.3.3 Heat supply to rice cold storage and/or food factory by biomass boiler

(1) Reference Emission

Emission sources assumed as a reference emission are substitution of electricity supply from a grid / captive power, a cold air/water supply, and a thermal air/water supply. As a methodology related to thermal energy production, there is the CDM methodology "AMS-I.C Thermal Energy Production with or without electricity, version 20.0", and the concepts of parts related to this proposed project are summarized as follows.

1）Substitution of supply power from grid / captive power

Emission factor of grid and captive power is based on the same concept as above "(a) Power supply to industrial parks by biomass power generation projects utilizing rice husks".

2）Substitution of cold heat supply

Reference emission is calculated on the basis of substitution of cooling/ freezing facility (e.g. Chiller) . Reference emissions due to cold air/ water are calculated as follows.

$$RE_{BC,p} = EF_{grid,p} \times \sum \frac{C_{i,p}}{COP_{i,p}}$$

$RE_{BC,p}$	: Reference emission associated with the cooling produced during the period p [t-CO2/p]

$C_{i,p}$	: Cooling output of reference scenario chiller(s) during the period p [MWh_{th}]
$COP_{i,p}$	: Coefficient of Performance (COP) of the reference scenario chiller(s) i (MWh_{th}/MWh_e). [MWh_{th}/MWh_e]
$EF_{grid,p}$	: Electricity emission factor of the grid [t-CO2/MWh]

Cooling output of reference scenario chiller, $C_{i,p,}$, are calculated as follows.

$$C_{i,p} = \frac{\sum m_{i,p} \times C_{pw} \times \Delta T_{i,p}}{3600}$$

$C_{i,p}$	: Cooling output of reference scenario chiller(s) during the period p [MWh_{th}]
$m_{i,p}$	: Chilled water mass flow-rate for chiller(s) i produced by project in hour h during the period p [tonnes/hour]
C_{pw}	: Specific heat capacity water [MJ/tonnes℃]
$\Delta T_{i,p}$	: Differenct temperature of inlet and outlet chillded water for chiller(s) i in hour h during the period p [℃]

As a precaution, this project will be introduced to newly installed facilities and the cold storage warehouse has not confirmed the introduction record in Myanmar. Therefore, it is necessary to continue discussion to set the reference COP of cooling / freezing equipment (e.g. chiller etc.). According to CDM methodology, if the reference scenario is a chiller or chillers that would have been built (i.e. not existing chillers), the COP shall be determined as the highest COP full load performance value provided by two or more manufacturers for chillers commonly sold in the project country for the indicated commercial application.

3）Substitution of heat supply (e.g.: steam and/or hot water）

In this project, we do not assume direct use of heat, but if necessary it is as follows.

$$RE_{BH,p} = EF_{grid,p} \times \frac{\sum m_p \times C_{pw} \times \Delta T_p}{3600}$$

$RE_{BH,p}$	: Reference emissions for hot water produced in the project activity during the period p [t-CO2/p]
$EF_{grid,p}$	: Electricity emission factor of the grid [t-CO2/MWh]
m_p	: The water mass flow-rate from heater(s) during hour h during the period p [tonnes/hour]
C_{pw}	: Specific heat capacity of water [MJ/tonnes℃]

ΔT_p	: Differential temperature of inlet and outlet hot water for heater(s) during hour h [℃]

(2) Project Emissions

Project emission are accounted for same resources such as “CO2 Emission from Transport” and “ Fuel Consumption within the Power Plant according to “Power supply to industrial parks by biomass power generation projects utilizing rice husks”

(3) Other Sources of Emission

Discharge due to physical leakage of refrigerant in the cooling facility to be introduced is assumed. The method of calculating the leakage amount in the CDM methodology is as follows.

- For first year of the monitoring period: $PE_{ref,1} = Q_{ref,PJ,start} \times GWP_{ref,PJ}$
- For rest of the monitoring period： $PE_{ref,p} = Q_{ref,PJ,p} \times GWP_{ref,PJ}$

$PE_{ref,p}$	: Project emissions from physical leakage of refrigerant from new cooling equipment during the period p [t-CO2/p]
$Q_{ref,PJ,start}$	: Quantity of refrigerant charge in new cooling equipment at its start of operation [tonnes]
$Q_{ref,PJ,p}$	: Quantity of refrigerant used in year y to replace refrigerant that has leaked during the period p [tonnes]
$GWP_{ref,PJ}$	: Global warming potential of the refrigerant that is used in new cooling equipment [t-CO2/tonne-refrigerant]

Based on the idea of the materiality (The threshold of materiality for verification is set at five (5) percent of emission reductions. etc.), small amount of emission resource will not be considered.

4. Low-carbon society development support

4.1 Policy Development Support

From October 22th (Mon) to July 24th (Wed), four officers from Ayeyarwady and Sagain Regions were invited to Fukushima City, and courtesy visit to the mayor, Chairman of Fukushima Chamber of Commerce and Industry the City Council. In addition, local site visits and workshops were held.

4.1.1 **Fukushima Program**

(1) Courtesy visit

Courtesy visit to the mayor of Fukushima:

Date and Time: October 24, 2018 9:00-9:30

Venue: Fukushima City Hall

Attendees: Fukushima mayor, Director and Deputy Director of Environmental Department, Manager and chief of Environmental Division etc.

Courtesy visit to the chairman of the Fukushima City Council:

Date: October 24, 2018, 9:45-10:15

Venue: Fukushima City Council.

Attendees: Chairperson, Director General, Office of Parliament, Deputy Director of Environmental Department, Manager and chief of Environmental Division etc.

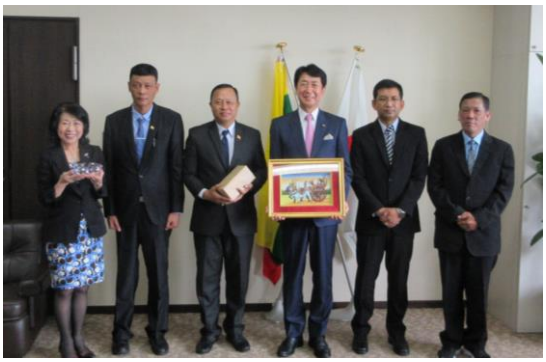
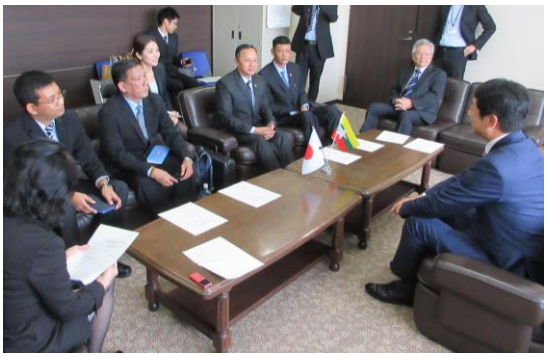
Courtesy visit to Chairman of Fukushima Chamber of Commerce and Industry:

Date: October 24, 2018 11:00-11:30

Venue: Fukushima Chamber of Commerce and Industry

Attendance: Chairman of the Fukushima Chamber of Commerce and Industry, Director, and Deputy Director of Business Promotion Dept. Manager, and chief. Fukushima city (Manager of Environmental Division, Environment Section Staffs.) etc.


(photo) Courtesy visit to the mayor of Fukushima

(photo) A courtesy visit to the chairman of the Fukushima City Council


(photo) A courtesy visit to the chairman of the Fukushima Chamber of Commerce and Industry

(2) **Site visit:**

Arakawa Clean Center

(Local generation and consumption of waste power plant)

Date and time: October 22 (Mon.) 13:20 ~ 14:20

Introduction and sit visit of incineration plant and recycling plants.

Waste Generation Plant at Arakawa Clean Center

PV facility:

Date and time: Oct. 23 (Tue) 12:20 ~ 13:10

Introduction and sit visit of 2MW PV facility, hydrogen filling facility for fuel cell vehicles

(Photo) Site visit at the PV facility

KITASHIBA ELECTRIC CO., LTD.:

Date and time: Oct. 22 (Mon) 15:10 ~ 16:10

Introduction and factory visits of production of transformer, re-energy related equipment, substation facility, small hydro power plant, etc.

(Photo) site visit at Kiteshiba Electric

Discussion points

Because both Ayeyawady and Sagaing Regions have difficulties with urban waste disposal, they showed great interest in the systems of segregated garbage collection and waste treatment (for example, power generation from waste, power consignment, and use of power in schools in the city) of Fukushima City.

It is by no means easy to transition from land-fill to incineration of waste for various reasons, including financial constraints. We shared the importance of practical solutions that are within the reach of local governments in Myanmar.

In the course of discussions between the Myanmar and Japan sides, specific opinions that support the segregation of household garbage as a key to something more important, and also environmental education in schools to teach methods of waste segregation to children were expressed. We also discussed the present situation of urban waste disposal, local needs, and specific solutions. (For example, the promotion of waste segregation, compost treatment, and environmental education)

The Region government has been considering a large-scale, extensive regional plan (a master plan covering the area of the western coastal areas and Pathein, the District capital). The Myanmar side has been expecting cooperation from Japan. It is important to propose a conceptual plan with emphasis on a low carbon society in regional development.

In the Ayeyawady Region, we also exchanged views on the horizontal development of chaff-based power generation in an industrial estate in Myaunmyau making use of the JCM framework. (The Region government has proposed plural candidate sites.)

It is necessary to examine the proposed sites and consider the possibility of project formulation in the next fiscal year. For example, it may be appropriate to consider site prioritization, reorganization and competitiveness enhancement of rice-polishing plants, preparation of development roadmap, etc. Consideration will also take into account possible linkage with the JCM framework.

The officials of the Ayeyawady Region who participated in the Fukushima meeting have proposed a continuation of discussions in advance of a visit by the Region's Prime Minister to Fukushima City and to further develop inter-city collaboration.

We had discussions with them again at the local workshop in Myanmar regarding future possible collaboration (in the areas of chaff-based power generation and waste disposal in particular).

(3) Business dialogue

The exchange of opinions on electricity with business sectors

In cooperation with the Fukushima Chamber of Commerce and Industry, we conducted

a business dialogue with the officials of the regions.

Date: Monday, October 22, 2018 (9:30-12:00)

Venue: Fukushima Chamber of Commerce and Industry

Program: opening remark, lecture, Q&A, closing remark

(Purpose of meeting)

This project comprises investigation and discussion activities that support the formation of a low-carbon city under an inter-city and public-private collaboration partnership. The concept is to contribute to sustainable economic growth and environmentally friendly development in Myanmar through inter-city collaboration and workshops.

First, we started by understanding each other, and are now promoting exchanges on various activities such as power generation using rice husks, the concept of recycling, and the introduction of foods using rice flour.

(Chamber of Commerce and Industry)

The chamber implements activities such as “policy recommendations and requests for the region and companies,” “support for small and medium-sized enterprises,” and “invigoration of regional economies” as major frameworks of its activities.

Under the basic philosophy of "aiming for a prefectural capital of Fukushima having robust fundamentals,” this year it is conducting activities under the slogan of “starting the next 100 years.”

(photo) Exchange of opinions on electricity

(photo) Meetings with corporate stakeholders (in an old house in Fukushima city)

4.1.2 **Joint Workshop in Myanmar** (Jan. 2019)

Joint workshop was held with three officers from Ayeyarwady and Sagain Regions. In addition to Fujita and the Mitsubishi Research Institute, the officials of Fukushima City were participated.

We had in-depth discussions on the field of waste disposal, a common issue to both Ayeyarwady and Sagaing regions, which was also discussed during the Fukushima visit program in October.

Issues concerning garbage reduction are common to regional cities in Myanmar and Fukushima City, a regional city in Japan. We confirmed that Fukushima City and Myanmar cities would continue collaboration to address this issue.

Regarding the field of waste disposal, which was discussed at the workshop during the Fukushima visit program in October as an issue common to both regions, participants from the regions organized and summarized the challenges in advance for discussion at the plenary meeting.

We introduced the policies of Fukushima City and explained our activities to reduce garbage, the need for a plan defining the period and the target values for the period, and the importance of environmental education from childhood.

Government officials of the regions explained that they wished to know more about the activities of Fukushima City; specifically, they wished to have many photos of garbage disposal activities in Fukushima City in order to show them to other government officials and citizens, so that they would learn about the effectiveness of these activities and adopt them as a policy.

Through these discussions, we found that issues related to garbage reduction were common to regional cities in Myanmar and Japan. We confirmed that Fukushima City and the regions in Myanmar would continue collaboration to address these issues.

In addition, as the technologies of Fukushima City that may solve electricity shortage problems in Myanmar, various technologies and products of Kitashiba Electric Co., Ltd., an electric power-related company in Fukushima City, were introduced.

Many people are flowing from rural areas into urban areas of Yangon city. As its population increases, electric power demand is anticipated to increase sharply.

Through the field visits and discussions with government officials of the Ayeyarwady Region, we felt that the technologies of Japanese companies will match the situation of the region in the near future.

Regarding electric power conditions in Yangon city, we recognized that Myanmar was experiencing power shortages and it is the biggest problem for the development of the country.

(photo) Joint Workshop

(photo) Situation of Industrial park in Yangon City

Outline of the Results of the Local Workshop in Yangon in January

The Myanmar side cited difficulties in dealing with ever increasing urban waste in its final treatment plants, and expressed interest in finding solutions through inter-city collaboration with Japan. While sharing experiences of regional cities of Japan with the Myanmar side, we discussed possible ways of collaboration. The Myanmar side showed great interest in approaches that can be addressed in a short period, such as waste separation according to type, environmental education, and waste treatment technology. It seems to consider approaches that take into account local characteristics, especially the experiences of Fukushima City, which shares some commonalities with Myanmar regional cities.

Regarding the Ayeyawady Region, the urgent challenge for the Myanmar side is treating chaff. Both sides agreed to continue discussions on the first project—Horizontal Development of Chaff-based Power Generation (in plural industrial estates in the Region). Prior to the workshop, relevant ministers and staff in the Region discussed the matter from their perspectives, and proposed developing collaboration. (This was done while taking into account the intentions of the Prime Minister of the Region, who had received a report on the workshop conducted in Fukushima City in October 2019.) The Myanmar side indicated plural prospective sites for chaff-based power generation. (It expressed its desire to implement the idea in the course of inter-city collaboration.)

Reference

Outline of Household Waste Collection in Fukushima City

Items	Contents
Volume of Waste Disposal	343 tons/day (125,050 tons/year: 2017)
Waste Accumulation and Collection Points	Around 6,700 sites
Method of Waste Disposal	Segregation of waste into three categories: burnable refuse, non-burnable refuse, plastic refuse, and recyclable refuse. Designated days for collecting specific categories of refuse. Taking specific categories of refuse to specific collection points designated by neighborhood associations.
	Taking refuse wrapped in transparent or semi-transparent plastic bags with a volume of 45 liters.
	Example of Town A Burnable refuse: Tue., Wed. Non-burnable refuse: 2nd and 4th Wed. Plastic refuse: 1st to 4th Thu. Recyclable refuse: 3rd and 4th Thu.
Garbage Collection Vehicles	Packer-type garbage trucks for burnable/non-burnable refuse: 36 units Vehicles for collecting recyclable refuse: 27 units ・Flatbed trucks (for collection of bottles and paper) ・Double packer trucks with two input ports (for cans and PET bottles) ・Packer-type garbage trucks (for plastics and magazines)

Source: “Environment Enlightenment Booklet,” Fukushima City

Local Production and Consumption Business: Waste Generation Plant at Arakawa Clean Center

Electricity is generated from surplus heat generated from waste incineration, which is utilized in the incineration plant and recycling facility. The surplus electricity is supplied to the local elementary and middle schools (71 schools in total), promoting local generation and consumption model of renewable energy.

Environmental Education

In environmental education in Fukushima city, booklets raising awareness of the environment are distributed to all 4th grade students of elementary schools in Fukushima City as an awareness-raising activity related to garbage disposal. The 4th grade students study garbage disposal by, for example, visiting waste incineration factories.

Public servants of Fukushima City Office visit schools to have students experience garbage separation. For example, 4th grade students are taught how to sort garbage. There is an experiential classroom where children put garbage into a garbage truck that is actually used for garbage collection.

There are opportunities to stimulate the interest of children in garbage through special experiences that leave a strong impression. We also let children write in their own words what they felt from the garbage separation experience.

Reference

Joint Workshop of Partnership for Low Carbon Initiative

Background and Objective:

Partnership for Low Carbon Initiative between Fukushima city (Japan) and Myanmar regional governments (with Ayeyarwady region: starting from in 2015, and with Sagaing Region: starting from 2017) aims to following;

- **Accelerating action for low-carbonization of cities, by formulating the Joint Crediting Mechanism (JCM) projects** (feasibility study).
- **Facilitating policy formulation by dialogue under city to city cooperation** with Fukushima city, Ayeyarwady region and Sagaing region (having workshop).

1st stage of partnership

Under the Partnership for Low Carbon Initiative between Fukushima city and Ayeyarwady region, many workshops were implemented in both of Fukushima city, and Pathein city, sharing the experiences of policy planning and activities in Fukushima city and, discussing the candidate JCM Projects and recognized issues, future perspectives and idea of action plan. **One of key outcomes of our partnership is development of Rice Husk Power Generation project in Myaung Mya Township** (now under construction). **The project is the new problem-solving approach for solving energy access and waste management.**

2nd stage of partnership

This approach is expected to spread in many rural communities in Myanmar. Hence, **policy dialogues and cooperation at the second stage, such as supports of developing plans and capacity building in following fields under inter-regional collaboration in Ayeyarwady regional government and Sagaing regional government are highly expected**.

- Creating new regional electric power supply system by biomass power plant using rice husks, and sustainable waste treatment system
- Creating the concept of rice complex as low carbon industry by using green energy from rice husks
- Enhancing the capacity building of low-carbon industrial park

The workshop will facilitate city to city cooperation for improvement of energy access, and sustainable waste treatment system, utilization of rice husks.

- Sharing experiences of policy planning in Fukushima city and achievement of policy dialogue between Ayeyarwady region and Fukushima city.
- Discussion on candidate projects, and approach for enhancing the capacity building of low-carbon industrial park and communities (e.g. capacity building, and

planning support for facilitating the implementation of the JCM project) in the regions.

Agenda of Workshop

Date: 11th (Friday) January 2019. 13:00-16:00

Venue: Yangon

Program:

Opening remark

Greeting & Speech (Myanmar side), and Opening & Greeting (Japanese side)

Presentations from Japanese side

Lessons in Fukushima City (Fukushima City government)

- Waste management, environmental education in Fukushima city, related business activities in Fukushima

Idea note of policy road map (e.g. guidance, incentive) for low carbon city (Mitsubishi Research Institute)

Introduction of policy dialogue

Idea note for partnership for low carbon initiative

Idea of project (Fujita Corporation)

- Recent activities in Myanmar: Introduction of large-scale complex development project in the center of Yangon

- Idea of biomass power project using rice husks generated at rice mills. (as Joint Crediting Mechanism (JCM) Project), and heat utilization using biomass resources (e.g. rice husks)

Coffee brake

Presentations and comments from Myanmar

Both from Ayeyarwady region and Sagaing region

- Current situation and prospective in the region e.g. topics of electrification (including micro-grid), and waste management (solid waste and waste water)

- Expectation to our partnership

Discussion

Closing words

5. Summary and Future Direction

Key Points of Inter-City Collaboration (Policy Dialogue) (Idea consolidation based on results of the meeting in Fukushima and the local workshop in Myanmar)

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We had discussions with them again at the local workshop in Myanmar regarding future possible collaboration (in the areas of chaff-based power generation and waste disposal in particular). (Officials of both Ayeyawady and Sagaing Regions expressed their intention to strengthen inter-city collaboration under the leadership of the Chief minister)

（Reference）

Through the implementation of a city-to-city collaboration project and a proposal for a facility subsidy in the Sagaing region, the district City of Myanmar has been receiving proposals for candidate locations for the rice husk Power generation project.

Based on this situation, Following is the image of expansion of rice husk power generation business with the business mode of 1.8 MW basic unit. In the future, it is important to realize rise husk generation projects through the policy dialogue in cooperation with the regions and other cities.

Expansion of rice husk power generation business (Image)

		2019	2020	2021	2022	2023	2024
Bago 1.8MW*2	Application MIC EPC EPC			MIC EPC		Operation	
Myaung Mya 1.8MW	Application MIC EPC EPC						
Pathein 1.8MW*2	Application MIC EPC EPC						
Sagain 1.8MW*2	Application MIC EPC EPC						