FY 2019 Project for Ministry of the Environment, Japan

FY2019
City-to-City Collaboration Program for Low Carbon Society

Promotion Project for Formulation of Circulating and Ecological Economy in Ayeyarwady Region

Project Report

March 2020

Mitsubishi Research Institute, Inc.
Fujita Corporation

FY2019

City-to-City Collaboration Program for Low Carbon Society

Promotion Project for Formulation of Circulating and Ecological Economy in Ayeyarwady Region

March 2020

Mitsubishi Research Institute, Inc. & Fujita Corporation

Table of Contents

List of units and abbreviations

This report uses the following standardized units and abbreviations.

Units

t	Ton
Kg	kilogram
MW	Megawatt
kW	Kilowatt
kWh	Kilowatt 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
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
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
MAPCO	Myanmar Agribusiness Public Corporation
MIC	Myanmar Investment Commission
MIMU	Myanmar Information Management Unit
MRV	Measurement, Reporting and Verification
PV	Photovoltaics
Regional CES	Regional Circular and Ecological Sphere
SDGs	Sustainable Development Goals
SPC	Special Purpose Company

List of figures and tables

List of figures

List of tables

Executive Summary

Through city-to-city cooperation, the project promotes regional development for the achievement of low-carbon emissions and sustainable development goals (SDGs). It aims to solve the challenge of achieving universal energy access and creating a “Regional Circular and Ecological Sphere (Regional CES)” in Ayeyarwady. In particular, a step-by-step approach toward building a local distributed power system with the help of biomass power projects and other technologies like solar energy management systems will be examined. Additionally, activities for achieving SDGs like formulating the concept of the Regional CES, proposing an institutional system, and capacity building of alternative sources of electricity will be undertaken.

Issues discussed through policy dialogue

The regional government of Ayeyarwady has placed the highest priority on improving the electrification rate, with a strong emphasis on the implementation of measures to utilize regionally distributed electricity systems using regional resources. As the region is one of Myanmar’s largest rice-growing areas, a large amount of rice husks is generated. However, they are not used effectively as they are considered as waste. Instead, it is necessary to consider rice husks as local resources, and to promote local production and local consumption of electricity through rice husk power generation.

As the Ayeyarwady region is located at the edge of the national power grid, the development of the grid to reach that region requires significant expenditure and time. A small distributed power system is the best solution to overcome this problem, as it can supply electricity to unelectrified areas without waiting for the installation of a power grid. Using distributed power sources also contributes to the reduction of the total infrastructure expenditure of the national power grid.

Development plan for the concretization of basic policy

Local governments in Japan have formulated a “master plan” that is a top-level plan. They are making efforts to formulate individual plans for each field in order to follow the guidelines for community development while taking into consideration the characteristics and issues of the region. They aim to practice the measures presented in the master plan. After these initiatives were introduced during policy dialogue, the regional government proposed the formulation of a master plan for future city-to-city cooperation . We decided that the master plan will be concretized under the policy dialogue.

Key components of the policy dialogue:

1) Roadmap of power generation project development

2) Means of funding sustainable business development

3) Awareness and consensus building of citizens and businesses on ways to achieve SDGs

4) Training of electrical engineers and other required human resource development

Development plan of a distributed power system using locally sourced materials:

Medium-scale model: For the rice husk power generation system, the basic plan for the second project (3.6 MW) was formulated and candidate sites were selected.

Small-scale model: A combination of biogas and solar power was considered as a distributed power system (50 kW) for rural communities, and candidate sites for pilot projects were selected.

Efforts to promote commercialization:

In order to create a Regional CES for the region, we proposed the concept of “resource recycling in local communities” and a “virtuous cycle between the environment and the economy,” with rice husk power generation at the core of the concept, based on the characteristics of a rice-growing area.

The training of electrical engineers and the improvement of technical standards are indispensable for the implementation of a decentralized power generation project in Myanmar. Thus, a Japanese electrical engineering system was introduced, and ideas formulated for a qualification system for electric engineers.

In Japan, a wheeling system is used to supply electricity effectively using the existing distribution network. In Myanmar, such a system has not yet been developed. We shared the view that the introduction of a wheeling system is essential for expanding the use of decentralized electricity and decided to proceed with a pilot deployment in the region.

It was confirmed that under the joint crediting mechanism project, the rice husk power generation project was positioned as a pilot project for commercialization and system development of the decentralized power grid. It was deemed necessary that the Japanese government and the regional government should work together to create successful working models and expand the project to other regions in Myanmar.

1. Objectives and outline of implementation

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. Subsequently, at the COP 24 held in Katowice, Poland, in December 2018, a rulebook was adopted setting out specific obligations of each country from 2020.

COP21 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 of circulating and ecological economy in Ayeyarwady based on city-to-city cooperation.

1.2 Survey items

Based on the background mentioned above, in the field of renewable energy, where there is a high demand in the Ayeyarwady Region, Myanmar, the following was examined for the purpose of supporting the reduction of greenhouse gas emissions and the formation of JCM projects that contribute to the reduction, as well as the establishment of systems for the creation of a Regional CES in the Ayeyarwady Region.

(1) Overview of the area and finding the regional issues
(2) Examination of project feasibility and deployment measures
(3) Examination of concrete support measures through City-to-City cooperation
(4) Local surveys, workshops and other meetings

1.3 Outline of implementation

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 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 (Ayeyarwady Region), 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 system). Fujita Corporation is implementing rice husk power generation in Myaungmya , 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.

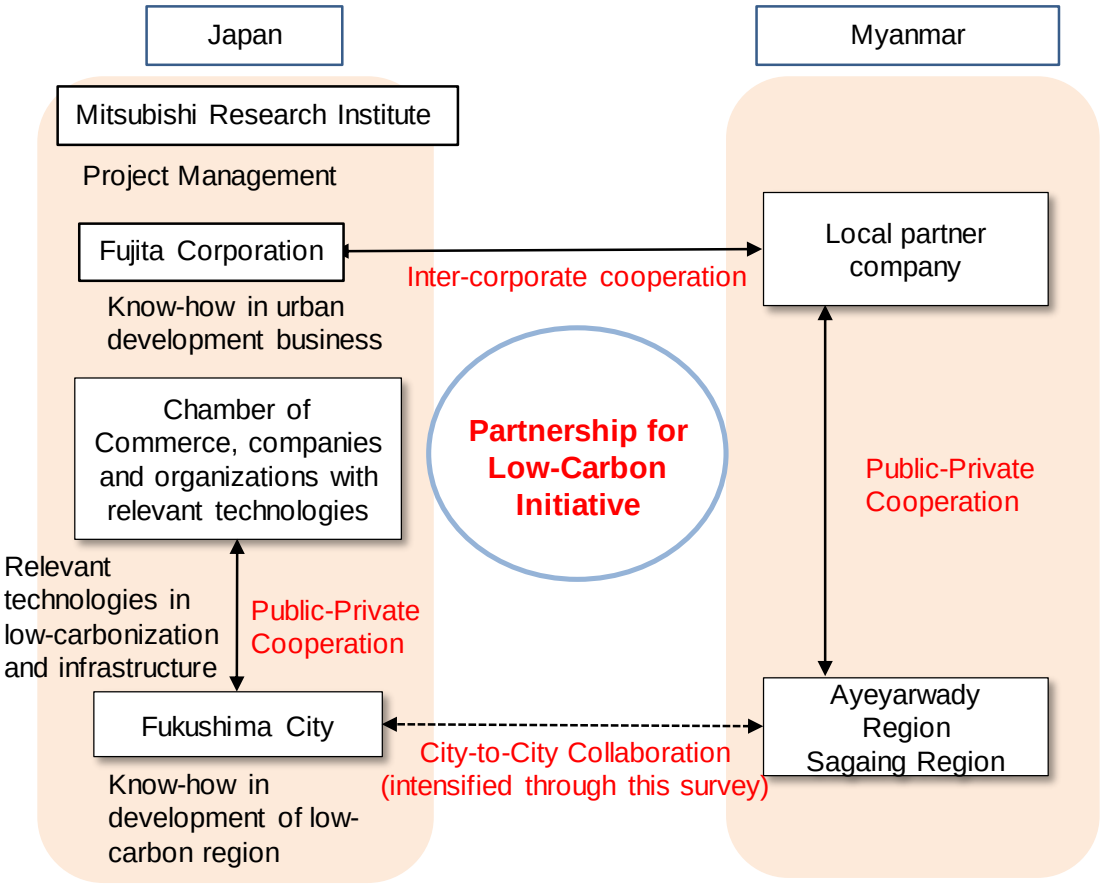


Figure 1-1 Organizational structure

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 city-to-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, Sagaing Region). We expanded the low carbon partnership with Ayeyarwady and Sagaing Regions.

Table 1-1 Overview of Ayeyarwady Region

	Myanmar	Ayeyarwady Region
Area	about 680 thousand km2 (1.8 times the area of Japan)	about 35 thousand km2
Population	51 million	6 million
Overview	Consists of 7 Regions and 7 States	Located adjacent to Yangon; located in the delta of Ayeyarwady River

Source: Area, and population are based on Department of Population Ministry of Immigration and Population "The 2014 Myanmar Population and Housing Census", May 2015.
https://www.themimu.info/census-data
(Last accessed: 26 February, 2020)

<Past activities>

FY2015

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.

FY2016

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.)

FY2017

July 2017	Responsible Minister of Ayeyarwady Region made a request to Mayor of Fukushima City for expansive cooperation 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 (Nay Pyi Taw)

FY2018

July 2018	The first meeting to share the year's activities among concerned parties and to start this project in Fukushima.
October 2018	Fukushima Program with officials in Ayeyarwady region and Sagaing region. We also participated the City-to-City seminar in Tokyo.
January 2019	Local workshops and field surveys in Yangon, Myanmar.
February 2019	The second meeting to share the year's activities among concerned parties and discussed further activity of City to City Collaboration.

<Activities conducted this year>

- December, 2019: Field research (at Wakema District, etc.), workshop (At the Patin City)

- December, 2019: Fukushima City Invitation Program (Regional Ministers and Others)
  As part of the above, a courtesy call (Vice Minister for Global Environmental Affairs, and International Cooperation and Sustainable Infrastructure Office) was made to the Ministry of the Environment.

- January, 2020: Invitation Program in Fukushima City
  (Joint implementation with studies of Ayeyarwady and Sagaing Regions)

- February, 2020: Field survey and workshop (in Nay Pyi Taw)
  (Joint implementation with studies of Ayeyarwady and Sagaing Regions)

- February, 2020: Review meeting (in Fukushima city)
  (Joint implementation with studies of Ayeyarwady and Sagaing Regions)

(Background and purpose of the study)

Background: Improving rural electrification is a top policy priority in Myanmar.

- In April 2017, Aung San Suu Chi, the Supreme National Adviser, announced to the people that the country would promote the development of electric power and road infrastructure. In June 2017, the Myanmar Investment Commission (MIC) designated 10 sectors, including electric power, as priority investment areas. Electrification measures have become a top priority for the central government.

- In particular, the Ayeyarwady Region has a low electrification rate in Myanmar. The Ayeyarwady Region is located at the far end of the National Grid, and the biggest problem in the Region is electricity shortage, which makes it difficult to secure electricity for economic development.

・The population distribution is 30% urban and 70% rural. The suburbs are particularly vulnerable to electricity supply.

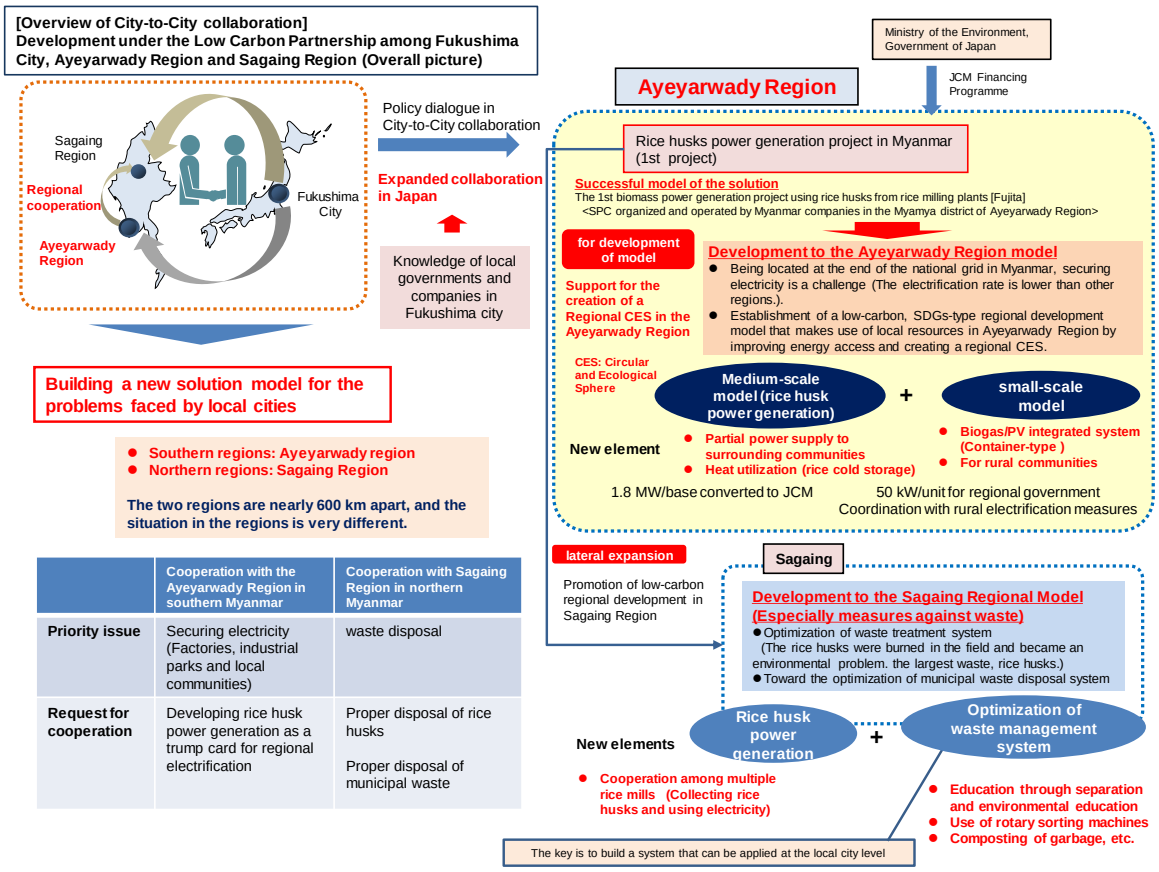
Key concerns: Concrete measures for the use of decentralized electricity

・Is the use of decentralized electricity effective in promoting rural electrification? What business model is effective? For example, the Ayeyarwady region is one of the largest rice-producing areas in Myanmar and is not used effectively due to the large amount of rice husks. It is possible to promote local production and consumption of electricity by using rice husks as a local resource rather than waste (The first project has already been realized.).

・The development of the grid requires a large amount of cost and time. Small distributed power systems in rural areas can provide electricity to unelectrified areas without waiting for the grid to be installed. The effective use of distributed power sources may also contribute to a reduction in the total infrastructure costs (Reduction of transmission network maintenance costs) associated with electricity supply.

・Is it possible to devise a rural business model that combines the profitability of the electric power supply business alone with economic development through the development of rural areas and the creation of various opportunities for profit along with regional development?

・On the policy front, what kind of approach would be effective in creating an environment that fosters local power business? For example, in Japan, a wheeling system is in place to supply electricity virtually using the existing distribution network. Myanmar does not have such a system in place.



	Cooperation with the Ayeyarwady Region in southern Myanmar	Cooperation with Sagaing Region in northern Myanmar
Priority issue	Securing electricity (Factories, industrial parks and local communities)	waste disposal
Request for cooperation	Developing rice husk power generation as a trump card for regional electrification	Proper disposal of rice husks Proper disposal of municipal waste

Figure 1-2 Overall of study

(Establishment of an implementation plan)
An annual three-year plan was established and discussed for the following three items. This fiscal year corresponds to the first year, and the following goals were set.

Medium (Rice husk power generation project)

- Develop deployment roadmap (business modeling for the second project)
- Realization of the second project in Ayeyarwady Region

Small Model (For rural communities)

- Examination of business model
- Identification of usable biomass
- Extraction of model rural community

Realization of Regional CES (System development and human resource development)

- Concept study
- Policy study of power wheeling systems utilizing the national grid
- Introduction of human resource development activities

Table 1-2 Overall of study plan

<table>
<tr><td>Future direction of development</td><td colspan="4">●Based on the results of in-depth dialogue with the Regional government side regarding the concept of regional development as a basis for the promotion of individual projects (since April), there is a strong interest in the approach; the concept of so-called "regional circular and ecological sphere (Regional CES) at the regional level (Core cities and peripheral areas) with advantage of the regional resources. Therefore, we aim to materialize the creation of Regional CES in Ayeyarwady Region" referring to the efforts of Japanese local governments.
●As the basis of the formation of the Regional CES in Ayeyarwady Region, measures for regional electrification by self-reliant and decentralized regional energy utilizing regional resources shall be established. (Identify priority areas)</td></tr>
<tr><td rowspan="3">Concrete plan for future development</td><td colspan="4">Acceleration by both feasibility study and institution building through City-to-City cooperation</td></tr>
<tr><td>Feasibility study</td><td colspan="3">Establish a business model that can be widely deployed in rural areas by combining two systems that can flexibly respond to local conditions.
• Medium scale model: Rice husk power generation (Use of JCM)
• Small scale model: Biogas-PV integrated container (Cooperation with Regional Governments)</td></tr>
<tr><td>Policy dialogue (institution building)</td><td colspan="3">● Supporting the establishment of systems for the creation of Ayeyarwady Region ‘s model of Regional CES that utilizes local resources.
• Materialization of the concept of a low-carbon, Regional CES at the regional level
• Proposal of systems for electric power systems such as wheeling using grids
• System for training electrical engineers and raising awareness
• Fostering understanding among officials of regional governments (Invited to Japan for tours and consultations)
● Collaborating with local governments in the Fukushima area (Japan side).</td></tr>
<tr><td rowspan="4">Annual plan</td><td>Year</td><td>Medium scale model (rice husk power generation business)</td><td>Small-scale model (for rural communities)</td><td>Realization of Regional CES (institution building and human resource development)</td></tr>
<tr><td>FY2019</td><td>• Development of roadmap (2nd project business modeling)
• Realization of the 2nd project in Ayeyarwady Region</td><td>• Examination of business model
• Identification of available biomass
• Extraction of model community</td><td>• Concept study
• Institutional considerations (Electric power consignment systems utilizing the national grid)
• Introduction of human resource development activities</td></tr>
<tr><td>FY2020</td><td>• Realization of the 3rd and 4th projects in Ayeyarwady Region</td><td>• Implementation of project schemes in model community</td><td>• Development of road map
• Institutional proposal
• Proposal of qualification systems for human resource development</td></tr>
<tr><td>FY2021</td><td>• Further study of measures for lateral expansion</td><td>• Introduction in a model community
• Deployment roadmap
• Examination of business schemes for wide-area expansion</td><td>• Consider action plans in model areas
• Implementation of the system in model areas</td></tr>
</table>

2. Overview of the area and finding the regional issues

2.1 Overview of the area and regional trend

2.1.1 Economic and social situation

This project arranges the social and economic situations of Ayeyarwady Region and Wakema Township which is one of the agricultural villages in the region.

(1) Overview of Ayeyarwady Region

According to the Myanmar Information Management Unit (MIMU), Ayeyarwady Region is the most populated region in Myanmar, next to the Mandalay, 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.

Myanmar consist of States/Regions, Districts and Townships. Ayeyarwady Region has 6 districts (PATHEIN, PHYAPON, MAUBIN, MYAUNGMYA, LABUTTA, and HINTHADA).

(References) Village organizations

- The names of the administrative divisions in Myanmar are shown below. Within a region (or State), there are multiple district, and each district is composed of multiple Township. Under the counties, urban areas have multiple Ward and rural areas have more than multiple villages (Ward and Village Tract fall into a similar category).
- There are several village officials (Village Tract Chairman) in Township. They are paid by the local government. Each Village under Village Tract Chairman has an elected Village Chairman. They are not paid by local governments and are mostly farmers. In addition to Village Chairman, each Village has a group of people called Village Patron. They are not elected, nor are they paid. As a role, they were like elder village volunteers who consulted on ceremonial occasions.

Table 2-1 Administrative divisions in Myanmar

Region/State
District
Township
City/Town
Wards
Village tract
Villages

(Traffic conditions and transportation infrastructure)

The Ayeyarwady Region is the delta of the Ayeyarwady River and its tributaries extend like a net. Many of the bridges over the rivers are narrow and have low load-bearing capacity, making them impassable for large trucks. Rural villages in Ayeyarwady Region were originally developed along these rivers, and boats were the main means of transportation.

Many of these bridges are aging and in very dangerous situations, and measures have been taken to reduce the load by reducing the number of lanes from two to one. However, in April 2018, a bridge collapsed in Myaamya, resulting in deaths. If the bridge is not available, they have to rely on traditional shipping, and their transportation and transportation are severely limited.

(Energy access)

Myanmar is predominantly a hydropower producer, most of which is located in the northern region. Thus, Ayeyarwady Region is at the far end of the National Grid, and there are many unelectrified areas. Rural areas, especially those surrounded by tributaries of the Ayeyarwady River, are particularly difficult to install.

(Trend of industry)

The Ayeyarwady Region is the leading producer of rice in Myanmar, and rice production and milling are important industries. In addition, there are active movements for industrial development in Ayeyarwady Region, and a new industrial park (Pathein Industrial City) is being constructed.

In this way, the Ayeyarwady Region is actively developing infrastructure to promote industrialization, and there is a possibility that it will become one of the economic centers of Myanmar in the future.

On the other hand, most of them are primary industrial regions consisting mainly of rice and beans. There are few attractive elements for young people to live in. Farmers are aging. Young people are flowing into cities such as Yangon and then into neighboring countries, and there is concern about the decline of agriculture, which has supported national development.

(2) Wakema Township

Wakema County (Wakema Township), which was surveyed as a case of rural area, belongs to Myaungmya District. It is adjacent to Myaungmya Township and Maubin Township.

(Reference) Fundamental data of Wakema Township

Wakema Township Figures at a Glance [1]

Total Population	**289,106 [2]**
Population males	**140,698 (48.7%)**
Population females	**148,408 (51.3%)**
Percentage of urban population	**7.7%**
Area (km^2)	**1190.2 [3]**
Population density (per km^2)	**242.9 persons**

Note: [1] Population figures for Wakema Township are as of 29th March 2014.

[2] Includes both household population and institution population.

[3] Settlement and Land Record Department, Ministry of Agriculture, Livestock and Irrigation, (2014-2015)

Number of wards	**14**
Number of village tracts	**126**
Number of private households	**67,448**
Percentage of female headed households	**21.2%**
Mean household size	**4.2 persons [4]**

Note: [4] Calculated based on conventional household population

Percentage of population by age group	
Children (0 – 14 years)	**30.3%**
Economically productive (15 – 64 years)	**64.1%**
Elderly population (65+ years)	**5.5%**

Ownership of housing unit (Tenure)	**Number**
Owner	**64,928**
Renter	**1,152**
Provided free (individually)	**875**
Government quarters	**320**
Private company quarters	**75**
Other	**98**

Main source of energy for cooking	Number	Per cent
Electricity	1,303	1.9
LPG	27	< 0.1
Kerosene	672	1.0
Biogas	40	0.1
Firewood	60,598	89.8
Charcoal	1,791	2.7
Coal	83	0.1
Other	2,934	4.4

Main source of energy for lighting	Number
Electricity	6,075
Kerosene	33,824
Candle	8,446
Battery	12,339
Generator (private)	4,688
Water mill (private)	32
Solar system/energy	1,837
Other	207

Main source of drinking water	Number
Tap water/piped	69
Tube well, borehole	4,233
Protected well/spring	2,119
Bottled/purifier water	4,390
Total Improved Water Sources	*10,811*
Unprotected well/spring	370
Pool/pond/lake	6,922
River/stream/canal	49,142
Waterfall/rainwater	187
Other	*
Total Unimproved Water Sources	*56,637*

Note: * Less than 20.

Main source of water for non-drinking use	Number
Tap water/piped	438
Tube well, borehole	6,557
Protected well/spring	1,496
Unprotected well/spring	422
Pool/pond/lake	1,421
River/stream/canal	57,004
Waterfall/rainwater	41
Bottled/purifier water	55
Other	*

Note: * Less than 20.

Type of toilet	Number
Flush	291
Water seal (Improved pit latrine)	53,230
Total Improved Sanitation	*53,521*
Pit (Traditional pit latrine)	2,781
Bucket (Surface latrine)	3,633
Other	555
None	6,958

Availability of communication amenities	Number
Radio	31,750
Television	26,500
Landline phone	2,647
Mobile phone	11,395
Computer	415
Internet at home	863
Households with none of the items	23,174
Households with all of the items	68

Availability of Transportation equipment	Number
Car/Truck/Van	123
Motorcycle/Moped	6,966
Bicycle	20,807
4-Wheel tractor	1,347
Canoe/Boat	13,410
Motor boat	6,717
Cart (bullock)	7,624

Source) Department of Population, Ministry of Labor, Immigration and Population: Ayeyawady Region, Myaungmya District, Wakema Township Report, The 2014 Myanmar Population and Housing Census
https://themimu.info/sites/themimu.info/files/documents/TspProfiles_Census_Wakema_2014_ENG.pdf
(Last accessed: 26 February, 2020)

(Reference) Current situation of villages in Wakema Township

2.2 Local policy trans and issues

Through policy dialogues with regional governments, the policy trends related to renewable energy and regional electrification, as well as regional policy issues and needs were reviewed. The outline is as follows.

- The government of Ayeyarwady Region considers the improvement of the electrification rate to be the top policy priority, and there is a strong interest in the implementation of measures to use regional distributed power utilizing regional resources. Ayeyarwady Region is located at the end of the National Grid, and the construction of the grid requires a large amount of money and time (Electrification rate in Ayeyarwady Region is about 20%).
- The small distributed power supply system is a means to supply electric power to non-electrified areas without waiting for the establishment of the nationl grid, and it is considered necessary to implement the project in accordance with the regional situation. It will also help reduce total infrastructure costs (Reducing the cost of national grid development) for electricity supply by making good use of distributed power sources.
- The rice husk power generation project in the Myaungmya is a power generation project using renewable energy as well as connecting electric power to the national grid. This is also the first attempt in this regard. Ayeyarwady Region is one of the major rice-growing areas in Myanmar, where rice husks are produced in large quantities and are not used effectively. It is necessary to promote local production for local consumption by using rice husks as local resources rather than waste.
- In the Ayeyarwady Region there are many rice mills along the river. Many rice husks from rice mills are discarded in rivers, causing environmental problems. Electricity generated from rice husks will lead to the idea of Regional CES and will be beneficial to the local community.
- Currently, the promotion of small and medium enterprises is an important issue in Myanmar. The rice husk power generation project in the Myaungmya is a project in which a Japanese company and a local company in Myanmar have cooperated to establish an SPC and are proceeding with the project.
- Since Myanmar's new government took office, there has been a great deal of interest in decarbonization and cyclical economies. We would like to introduce Japanese technology and conduct localization so that we can respond to it in Myanmar. We would like to share the results of our efforts in Ayeyarwady Region with the whole of Myanmar (sharing good practices).

The following shows the expected investment approval and environmental measures for the implementation of the rice husk power generation project.

Table.2-1 Expected investment approval and procedures for environmental measures

Item	Main Content
investment authorization procedure	In accordance with the Myanmar Investment Act, investment approval procedures by the Myanmar Investment Commission (MIC: Myanmar Investment Committee) are required.
Procedures for environmental measures	・In order to be approved for investment by MIC, an environmental impact assessment (EIA) or initial environmental assessment (IEE), or an environmental management plan (EMP) must be established and approved for projects that meet the industry and scale requirements specified in the environmental impact assessment procedure (EIAP: Environmental Impact Assessment Procedures). ・The EIAP specifies the industries in which IEE or EIA is required, and specifies nine industries including energy and waste treatment. ・The 3.6 MW rice husk power generation project proposed in this study falls under the category of "Power generation plants using waste materials (Power Plants from Waste Products)" among the specific industries of EIAP. Plants with capacity of 50 MW or more are subject to IEE, and this project is not considered to be subject to IEE or EIA.
Compliance with individual environmental standards	・Currently, there is no enforceable environmental value referred to in the EIA. Although the National Environmental (discharge) Guidelines (National Environmental Quality (Emission) Guidelines) were prepared at the end of 2015 with reference to the Environmental Health and Safety Guidelines issued by the International Finance Corporation (IFC: International Finance Corporation), they are treated as reference only. Therefore, at present, it is necessary to examine it in accordance with international standards (JICA Guidelines for Environmental and Social Considerations, IFC Performance Standards, ADB Safeguard Policy Statements 2009, etc.). ・Respective environmental standards such as ambient air quality, air emissions, industrial wastewater, wastewater, and noise shall be in accordance with the small-scale combustion facility exhaust emission guidelines of the IFC EHS (International Finance Corporation Environmental Health and Safety) Guidelines (thermal power generation) and the IFC EHS Guidelines (General).

Environmental measures to be taken at power plants are shown below.

At present, there are no regulations concerning the landfill of incinerated ash from rice husk power generation. However, it is important to cooperate with regional organizations, if necessary, by considering landfill standards that do not cause environmental impact, such as measures against heavy metals. The application for connection to the National Grid requires the submission of an appropriate disposal plan for incinerated ash, although it is not stipulated in the law.

Rice husk incineration ash contains silica (Silica accounts for about 90% of the total, and carbides and the like account for the rest.) derived from rice husks, and it is considered necessary to extract purified silica and use it as a high value-added raw material. As a result, there is a possibility of business development, including the recycling of silica resources, and we believe that this will contribute to the formation of a Regional CES based on the rice industry.

Table.2-2 Main environmental measures at rice husk power plants

Exhaust emission	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)
Rice husk incineration ash	Fly ash	Considering the introduction of bag filter or electrostatic precipitator. About 90% is fly ash.
	Main ash	Purified silica was extracted together with fly ash for use as a high value-added material (Rice hull incineration ash contains approximately 90% silica).

Up until about two years ago, Myanmar was rather lax about the formulation and approval of EIA, IEE or EMP, but recently it has been required to submit EIA, IEE or EMP in accordance with the rules.

In order to operate a chaff power plant, it is necessary to submit a construction completion notice, fire inspection, etc., which are carried out in general construction. In addition, boiler inspection and electric safety inspection are somewhat special for boilers, turbines, and power generation facilities. In particular, boiler inspections shall be carried out every six months.

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 the new industrial park (Pathein Industrial Park), Pathein city, 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 new industrial park (Pathein Industrial Park), achievement of an operation of about 3.6 MW scale biomass power plant using rice husks under the SPC established between Japanese and Myanmar local companies is aimed.

3.1.2 Applied system

Technology to be applied in the proposed project (system and scale) is considered from the regional conditions such as collectable amount of rice husks, generation system, and rice husk supply perspectives such to sustainably operate the project.

(Features of this technology)

・Typically, a 2 ~ 3 MW direct-fired power plant (BTG) would be less than 20% efficient. Recently, however, Japanese engineers and manufacturers have constructed a system that can achieve a power generation efficiency of 20% even in a power generation system with a direct combustion system of 2 ~ 3 MW or less, and this system has actually been demonstrated with 1.8 MW of rice husk power generation.

Figure3-1　Outline of rice husk power generation facility in Myaungmya

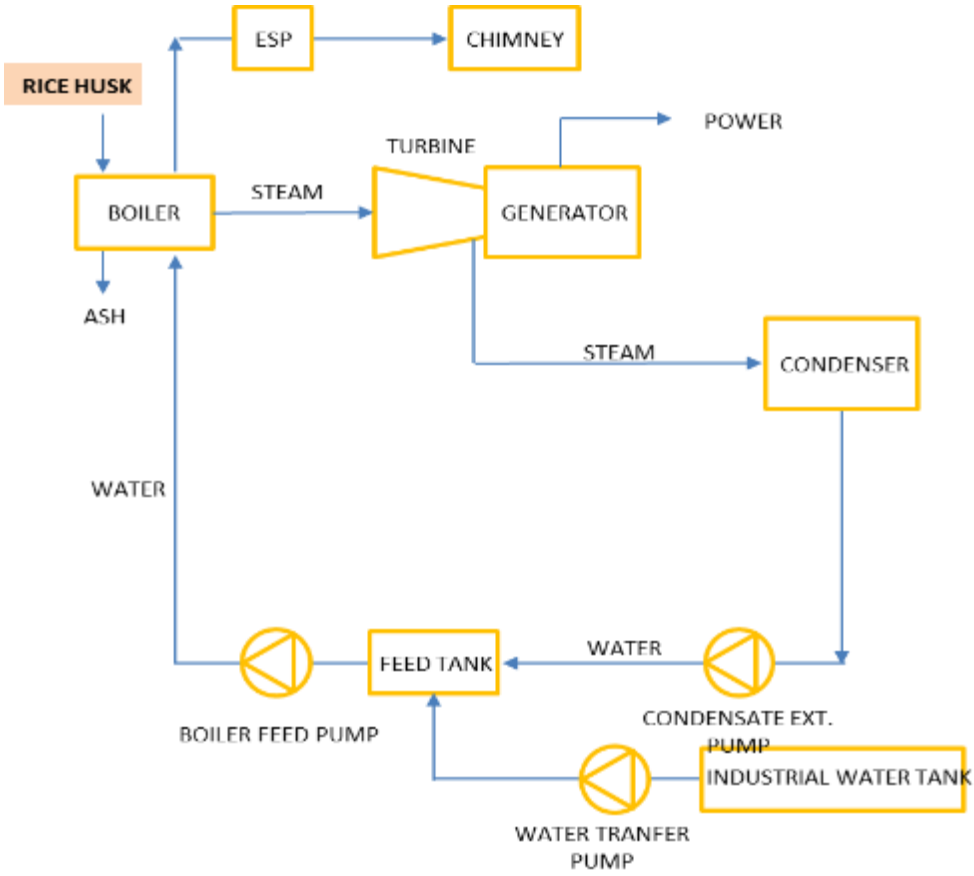


Figure 3-1 Flow of Boiler Turbine Generator (BTG)

3.1.3 Challenges of rice husk power generation

Based on the experience in the rice husk-fired power generation project in Myaungmya, which was the first project, the challenges of commercialization and countermeasures are summarized below.

(Organizing issues)

Although the power generation efficiency meets the target, the following two problems remain.

For one thing, it is necessary to reduce the construction cost a little more in order to spread and expand. The JCM scheme can be used to provide subsidies for up to the first or several projects, but it is essential to reduce construction costs in order to promote further lateral expansion.

The other is an increase in operating and operating costs that was not initially anticipated. It cannot be concluded whether this is a problem specific to Myanmar, but at least there is a serious shortage of engineers who can be employed as operators if direct combustion power plants of 2 MW class or more are to be operated in Myanmar at

present. As an operator, engineers are required for each part such as boilers, turbine generators, water treatment, and control. This requires a certain number of personnel even on a small scale.

(Solution to the problem)

One way to solve these two problems is to achieve a certain scale up. In the initial planning stage of the rice husk power generation system, as with other biomass power generation systems, securing a stable supply of fuel was a major issue, and the idea was to collect fuel as small as possible from within the range of operators' eyes.

The basic idea was that rice husks over about 80% could be secured in a large rice mill. With this in mind, the first project (Rice husk power generation project in Myaungmya) was implemented with a capacity of 1.8 MW.

(Potential for business development)

Recently, there have been cases of large-scale rice milling companies trying to expand their business scale. From the stage in which large, medium and small rice mills independently operated their own businesses in areas with a certain rice yield, a new business came up in which the place to harvest rice (unhulled rice) did not always coincide with the place to polish rice, and the unhulled rice was polished in other areas.

Much of the grain is traded by middlemen, so it tends to be more concentrated in areas of higher purchase.

Rice milling companies are expected to shift from sole proprietors to corporate organizations, expand in scale, increase profits by increasing export rice, and expand in scale.

3.1.4 Project idea in Pathein industrial city

(1) Status of the target areas

Ayeyar Hinthar is diversifying its business and plans to build a 500 ton rice mill in the "Pathein Industrial City" an industrial park developed by the company in the city of Pathein.

In the industrial park plan, an increase in the power supply of the national grid was initially planned, but it has not progressed as planned, and the securing of independent power sources has become one of the necessary conditions for the sale of industrial parks. In addition, the appropriate disposal of large amounts of rice husks is becoming stricter as administrative guidance.

Source: Pathein Industrial City Corporate Brochure
http://www.picmyanmar.com/wp-content/uploads/2019/02/PIC_CorporateBrochure.pdf
(Last access: 28 February 2020)

(2) Equipment size and main specifications

BTG of 3.6 MW scale with 2 times of power generation capacity was examined on the basis of the first project of 1.8 MW. A plan to construct 2 lines of 1.8 MW and a plan to construct 1 line of 3.6 MW were compared and examined. As a result, a 3.6 MW per plant was selected because economies of scale are expected. The specifications are shown below.

Table 3-1 Specifications of the rice husk power plant

	3.6 MW	
Installed capacity	3,600	kW
Self-consumption	360	kW
Sold electricity	3,240	kW
Availability	24	hrs/day
	330	days/year
Generated electricity	77,760	kWh/day
	25,660,800	kWh/year
Rice husk (approximate)	4.6	t/h
	110	t/day
	36	1,000 t/year

(3) Identification of project risks

1) Rice husk procurement

Ayeyar Hinthar was originally established as a rice milling company in the Ayeyarwady region, and since it has a strong influence in the area around Pathein, it is determined that it can secure a necessary amount of unhulled rice.

2)Environmental and social considerations

The planned site is located within the industrial park of the industrial park development company (Pathein Industrial Development) of Ayeyar Hinthar Co., Ltd., and shall comply with the standards established for industrial park development, etc.

3) Power supplier

Basically, self-consumption within an industrial park is assumed. However, considering the possibility that power generation may not match the demand forecast within the industrial park, the option of connecting to a national grid and conducting business based on the concept of "consignment" is also considered.

3.1.5 Challenges of rice husk power generation

The scheme of this project is as follows.

Table 3-2 Project scheme

Implementation Site	New industrial park (Pathein Industrial park)
Size	3.6 MW Scale: Confirmed based on the amount of rice husk availability
Fuel	Rice Husk
Applied Technology	Boiler Turbine (Biomass Power Generation)
Power Supply	Basically, self-consumption within an industrial park is assumed. At the same time, consider the option of connecting to the national grid and conducting business based on the concept of "consignment".
Project Scheme	Assumption: Establishment of SPC (e.g. Japanese company and local partner) Utilization of JCM Subsidy

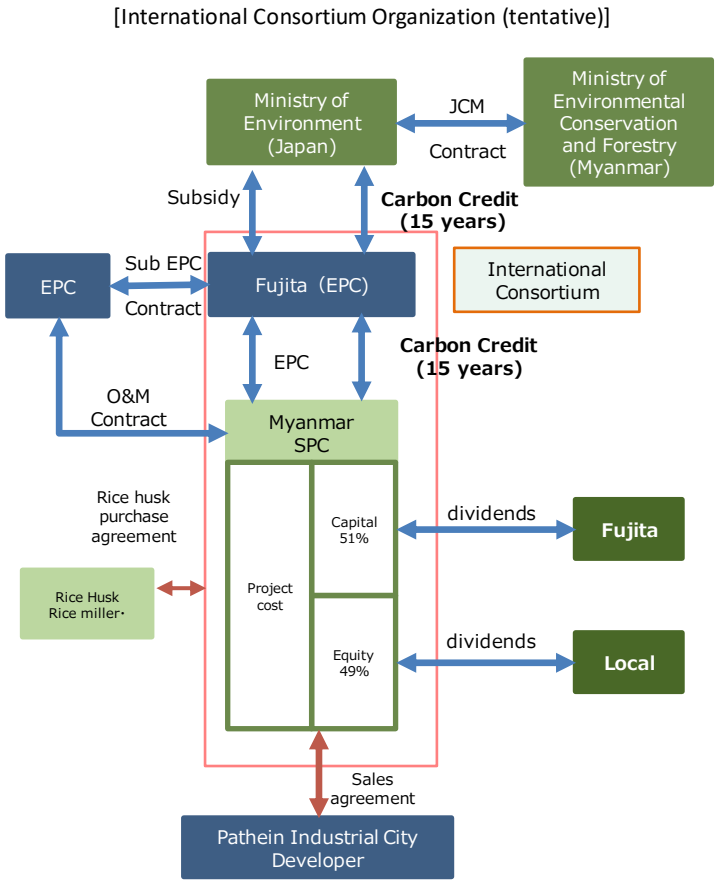


Figure 3-2 Project organizational structure (Proposal)

3.2 Study of small scale power project

3.2.1 Review of operations

(1) Organizing the potential of sustainable, decentralized power sources in Wakema County (preliminary examination)

(Awareness of problems and assignment)

- In Myanmar, only small-scale solar panels have been installed as a sustainable distributed power source, and there is little experience with other energy sources such as biomass, small hydro, wind, and geothermal.
- This time, the possibility of the development was arranged mainly in small biomass power generation and photovoltaic power generation in which the initial investment is comparatively small and the installation is technically easy even if it is installed in the remote place.

(Subject of consideration)

・A preliminary study was conducted on the feasibility of using biomass energy and solar energy mainly from rice husk fuel in Wakema District, Ayeyarwady Region.

(Characteristics of the region)

・Wakema County is located in the Ayeyarwady Region, a rice-producing district, and has 34 large rice mills.[1]

・There are also strong calls for the establishment of an in-house power generation system to operate a rice polishing facility.

・Since it is far from the main power line, improvement of the power situation is an issue.

・The energy sources used for lighting and cooking are mainly firewood, and there is a high possibility of developing sustainable, decentralized power sources.

(Conditions of agriculture)

・In Ayeyarwady Region, rice cultivation is the largest in area, followed by ketsuru azuki beans and mungbean, accounting for about 75% of the total production.

・According to data for Wakema County in 2011, there were 352 farmers, and the average cropping area per farmer was 352 Acres/House, which is the average size in Ayeyawady Region.

Implication:

・As with other areas in Ayeyarwady Region, rice cultivation is the main industry in Wakema City, and rice husks can be distributed throughout the year for two seasons, so there is a high possibility that agricultural biomass can be used for rice cultivation such as rice husks.

(Climatic condition)

・The climate of Myanmar is divided into the dry season (11 to March), the rainy season (June to October) and the hot season (April to May). As it was difficult to obtain meteorological data in Wakema County, the results of sunshine measurements in Patein, also in Ayeyarwady Region, are shown below (Wakema and Patin are only about 50 km apart in a straight line, and the climate is similar.).

・From May to October, when the rainy season begins, the daily average value of the

[1] JICA: Figure 2.4. 4 (Locations of Large Rice Mills in Ayeyarwady Area), PREPARATORY SURVEY FOR INTENSIVE AGRICULTURE PROMOTION PROGRAM IN THE REPUBLIC OF THE UNION OF MYANMAR FINAL REPORT (FEBRUARY 2016)

http://open_jicareport.jica.go.jp/pdf/12250759.pdf

(Last access: 28 Febrary 2090)

hours of sunlight fell significantly, and the rainy season seems to have affected the hours of sunlight. The illuminance on a clear day was approximately 350,000 to 400,000 [W/m2/day].

Implication:

・Wakema District in Ayeyarwady Region has a tendency to decrease the amount of sunshine in June and July when precipitation increases, but it is considered to be a suitable place for solar power generation because it is possible to obtain sufficient sunshine at least in the non-rainy season.

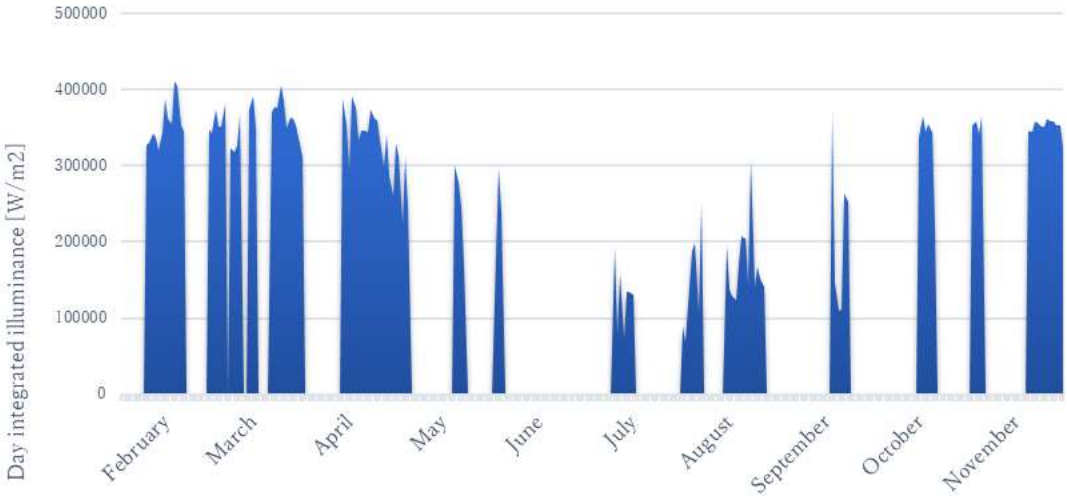


Figure3-2　Estimated illuminance (Pathein) from February to November 2018

(Summary of possible deployment in Wakema Districtf

・In this study, we explored the possibility of sustainable decentralized power generation in Wakema District, as an example of rural areas in Ayeyarwady Region.

・Although the amount of solar power generation decreases during the rainy season, the problem can be solved by increasing the operating time of biomass energy during this period, and since the combination of solar energy and biomass power generation is strong against energy fluctuation (Base load and peak power supply), it is technically harmonious.

・Also, in order for the region to develop economically, it is necessary to operate more than 30 large rice milling machines stably. We believe that Wakema County, which combines biomass energy and solar energy, is a promising region for the development of business models for local production and local consumption energy.

(For the establishment of small-scale models)

Naturally, the proposed small-scale model alone would not be viable. The main reason is the low cost of electricity for people's use. Until now, 35 MMK (Approximately ¥2.6)

was charged for up to 100 kwh, which was almost the same rate for rural households. Last year (2019), the price was kept unchanged until 30 kWh, but households that use more electricity increased the price 1.4 ~ 3 times.

Myanmar's primary grid power source is hydropower, and the cost of electricity production is said to be around 55 MMK. The government has compensated for the deficit. If electricity rates are not raised gradually, the nation's finances will inevitably become tight, but it is difficult to win public support for a sharp increase in electricity rates.

The small-scale model considered this time is high in electricity because it does not benefit from the scale of power generation facilities, and if it is to secure business only by electricity charges, it has to charge the same rates as in the industrial sector. Naturally, it is difficult for rural residents to pay such fees. The solution is to look at new business models. The main points are as follows.

- The first is the idea of organically combining small and medium models.
- The second is the idea of using paddy fields and rice as elements to combine small-scale and medium-scale models. At present, there is a tendency to merge or abolish rice polishing bases in the Ayeyarwady Region. In other words, unhulled rice harvested in a paddy field in the hinterland of a farming village is not necessarily polished by a rice polisher in the surrounding area. In many rural villages, it is difficult to foresee the future of rice farming, harvesting the unhulled rice, and then having brokers buy it. Rice from the hinterlands of small model villages is polished in surrounding medium model villages. Some of the electricity from the mid-range model is distributed through grid lines. In addition, a system will be created in which a certain amount of income is used for soil improvement, the purchase of fertilizers and agricultural chemicals, and the purchase of agricultural machinery and equipment. In other words, it is a model in which medium-scale model districts lead and support the economic development of small-scale model rural communities. It is important to establish a system in which small-scale rural residents can actively participate, rather than compensating for differences in electricity rates such as subsidies. This is the second important point.
- However, the establishment of this scheme requires a certain initial level of financial and operational capacity. This is the third point, and organizations with these qualifications should participate with the support of local governments. It may be a little unattractive as a payback year, but we can surmise that this organization has the potential to become a business, not a volunteer organization.

Sources of revenue other than electricity charges for the operating organization can be assumed to include (1) profits from sales of refined silica, (2) dividends associated with increased yields from the conversion of paddy fields to dry fields, (3) profits from rice milling, (4) profits from sales of agricultural materials and equipment, and (5) profits from various infrastructure projects. In the next fiscal year, we plan to work with the regional governments to formulate and plan a master plan in more detail.

(2) Idea of system of small model (for rural communities)

As mentioned above, the installation of the distributed power source of 900 kWh/d scale in Village of average 300 households was examined. The power generation system of the scale of about 40 ~ 50 kW is examined.

Photovoltaic power generation system

Photovoltaic power generation is considered to be relatively easy to install. The climate of Myanmar is divided into the dry season (11 to March), the rainy season (June to October) and the hot season (April to May). As there is no data on Wakema this time, the authors used the results of their measurements of sunlight in Pattinarea in Ayeyarwady Region as a reference. (Wakema and Patin are only about 50 km apart in a straight line, and it is judged that there is no significant difference in climate.)

The daily average value of sunshine hours declined from May to October, when the rainy season started, especially in June and July. However, in May, August and September other than those 2 months, the rate was 60% to 70%, which was less than expected. The illuminance on a clear day was approximately 350,000 to 400,000 [W/m2/day].

A power conditioner is a type of inverter that converts "direct current" electricity generated by a solar power generation system into "alternating current" electricity that can be used at home. A power conditioner is a type of inverter that converts "direct current" electricity generated by a solar power generation system into "alternating current" electricity that can be used at home. A power conditioner is a type of inverter that converts "direct current" electricity generated by a solar power generation system into "alternating current" electricity that can be used at home.

Because the life of power conditioners is shorter than that of solar panels, they must be replaced once or twice in order to operate solar power generation. Electrical equipment originally driven by direct current can be used without conversion to alternating current (AC). This would reduce the power loss associated with "DC/AC conversion". The application of a system in which batteries are directly charged by the direct current of solar power generation will be a key to its popularization.

Photovoltaic power generation has the disadvantage of being able to supply electricity only during daylight hours. In order to complement this, it is important to secure storage batteries and a base power supply.

(View of securing a small base power supply)

Potential base power sources include biomass, biogas, and small hydro. However, in deltas such as the Ayeyarwady region, the necessary power generation cannot be expected unless the height difference is artificially established. The possibility of Biomass power generation and Biogas power generation were examined.

1) Biomass power generation

Rice husks and wood chips are possible fuels. Each of these fuels has its own challenges. Rice husks have not been technically verified as a practical system for small-scale power generation.

<Rice husks>

In addition, when solid fuel such as briquettes and pellets is used, reduction of equipment cost and operating cost required for solidification is a major problem.

<Wood chip>

As for the price, gasification power generation facilities capable of operating almost fully automatically with a woody chip capacity of 40 kW are also on the market, as mentioned above.

The Ayeyarwady region is a delta region as a whole and the mountainous region is only in the western region, which is a disadvantageous condition for the collection and transportation of wood chips.

There are some trees in the delta, but in areas without grid connections, firewood is a valuable fuel for cooking. Therefore, the use of wood for the firing of bricks was even prohibited.

Therefore, it was decided to consider a compact wood gasification facility only when considering a power source in the west area.

2) Biogas power generation

Since there are many problems related to the procurement of methane fermentation raw materials (transport), methane fermentation is mainly conducted on a relatively small scale.

In addition, there are many examples of various raw materials such as livestock manure, garbage, and human waste sludge. In addition, since methane gas storage equipment (like a balloon) is installed to increase the pressure when the fuel cell is brought to the gas engine, the fuel cell has the advantage of being relatively easy to follow the electric load.

(Proposed power supply plan)

After a comprehensive review, the power supply plan was as follows.

Solar power generation was set at an average of 5.6 hours per day, taking into account the amount of solar radiation (in Pathein) measured by the authors and other factors.

Table 3-3 Power plan for small models

	kW	Net kW	hr/d	kWh/d
Biogas	40	36	24	864
PV	10	10	5.6	56
Total	50	46	-	920

"Net kWh" for biogas power generation excludes on-site consumption.

<Photovoltaic power generation system>

- If 10 kW scale solar power generation is planned with a 200 w module (As a unit area of 1.2 m2), the installation area will be approximately 60 m2 (10,000 ÷ 200 × 1.2 m2).

<Biogas power generation system>

- Install a 40kW biogas power generation system. Raw material receiving equipment and fermenters can be constructed at low cost on site.
- In addition, all gas engines, control devices, and pumps shall be loaded in a 40 ft container (12.0 m × 2.3 m × 2.3 m) and transported by ship from overseas to Yangon Port before being transported by truck to the site. After the arrival, the piping was connected to the site construction equipment and completed.
- As for fermentation raw materials, household food waste, septic tank sludge, and livestock manure are assumed, but sufficient calories have not yet been verified.

Reference: Biogas power generation

- The principle of biogas power generation is that organic matter is digested under anaerobic conditions (Circumstances where air is blocked) to generate combustible methane gas, which is used as fuel for power generation. There are three methods of methane fermentation. It is divided into two types according to the difference in organic matter concentration. One is the wet fermentation method, in which the solid content is adjusted to around 10%, and the other is the dry fermentation method, in which the solid content is adjusted to around 15 ~ 40%. The dry fermentation system has a higher solid content and therefore a smaller reactor capacity. However, fermentation at high temperature (Around 55 degree Celsius) is necessary, and cost-effectiveness must be examined.
- There are two types of fermentation methods depending on the reaction

temperature, a medium temperature fermentation method at around 35 degree Celsius and a high temperature fermentation method at around 55 degree Celsius. The high-temperature fermentation method has the advantage that the reaction time is shorter and the volume of the fermenter is smaller because the reaction activity is higher. On the other hand, energy is required to maintain high temperatures, and cost-effectiveness must be determined.

- Since the wet medium temperature fermentation method is the most widely used method, medium temperature fermentation will be used in this project.

Table 3-4 Classification of methane fermentation

Type of fermentation	Wet type fermentation		Dry type fermentation
	Middle-temperature fermentation	High-temperature fermentation	
Overview	Solid content: about 10% Fermentation temperature: About 35 degree Celsius	Solid content: about 10% Fermentation temperature: About 55 degree Celsius	Solid content: about 15 ~ 40% Fermentation temperature: About 55 degree Celsius

Anaerobic fermentation (Methane fermentation and biogas treatment)

There are two types of treatment: "wet fermentation" in which treatment is carried out at a fixed substance concentration of about 6 ~ 10%, and "dry fermentation" in which treatment is carried out at a solid substance concentration as high as about 25 ~ 40%. However, many of the systems actually used are "wet fermentation". In this document, only "wet fermentation" is described.

Methane fermentation is a method to decompose organic matter into methane, carbon dioxide, etc., in an atmosphere where air is shut off. Methane generated in this process occupies about 60% of generated gas, and it is possible to generate electricity by gas turbine.

The decomposition residue can be directly sprayed on farmland as a slurry or can be returned to farmland by solid-liquid separation. If farmland cannot be returned to farmland, processing and disposal of slurry requires additional costs.

<Power storage system>

- **Power-assisted bicycle battery**

  The main means of transportation for residents in the Ayeyarwady region are motorcycles and bicycles. Motorcycles are expensive and fuel is expensive. In general, there are many bicycles. The battery of a used electric power-assisted bicycle is set to have a storage capacity of about 280 wh (25 V × 16 Ah × 70%). If 1 battery is secured per household, it has a storage capacity of 84 kWh (280 × 300 = 84 kwh) (Approximately 10% of daily demand).

- **Use of car batteries**

  The battery capacity of the car is set to 470 wh (12 V × 56 Ah × 70%). If 1 battery is secured per household, it has a storage capacity of 141 kWh (470 × 300 = 141 kwh) (15% of the daily demand). When combined with the battery of the electric power assisted electric car, it is 225 kwh, and it can store 1/4 of the daily demand.

  This capacity is equivalent to about 6 hours of biogas power generation (860 kW × 6 h = 216 kW), with little electricity use.

Outline of facilities

In general, almost all parts are procured locally, excluding control panels, etc., and assembled locally. However, not all parts are yet available in Myanmar, and the country often has to rely on imports. In addition, there are many cases in which the knowledge and experience of installation engineers of facilities are insufficient. Therefore, most of the mechanical and electrical components are imported and transported in containers.

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 Power supply to industrial parks (connected to the National Grid) by biomass power generation projects utilizing rice husks.

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

(1) Reference emission

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.

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.

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

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.

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.

List of CO2 emission factors for electricity in the guidelines for submitting proposals of financing programme for JCM model projects from FY2019 to FY2021 (Global Environment Centre Foundation, April 5, 2019 and Revised on June 19, 2019)[2,3], in the case of renewable energy (PV, wind power, hydropower, etc.) in Myanmar, 0.533 t CO2/MWh (for displacement of on-site generation only); and 0.319 t CO2/MWh (for other). In this trial calculation, the grid emission intensity was set based on this figure and the calculation was carried out.

Table 3-5 Result of emission reductions calculation (Biomass power plant project)

Capacity (Net)	3.6	MW
Annual power generation (Net)	25,660	MWh/year
Grid emission factor	0.319	kg-CO2/kWh
Reference emission	8,186	t-CO2/year
Fuel transport (approximate)	36	1,000 t/year
Project emission	0 *	t-CO2/year
Emission reductions (planned)	8,186	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.

[2] Global Environment Centre Foundation website, the guidelines for submitting proposals of financing programme for JCM model projcts in FY 2019 (in Japanse version)
http://gec.jp/jcm/jp/kobo/h31/mp/jcmsbsd31_koboyoryo.pdf
(Last access: 28 Febrary 2020)

[3] It is noted that "This list is used for the examination of the JCM financial program"

4. Examination of concrete support measures through City-to-City cooperation

4.1 Implementation of policy dialogue and business dialogue

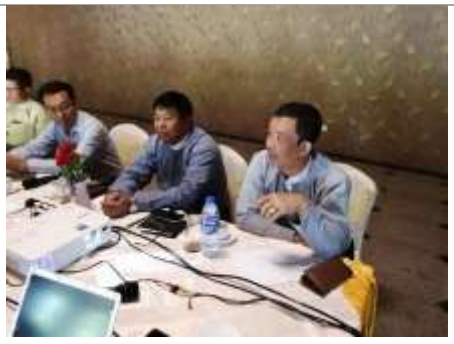
4.1.1 Invitation wokshop and field survey in December

On December 13, 2019, a workshop was held in Pathein with regional officials (Director of the Environmental Conservation Bureau, members of the electric power sector, etc.) to explain the policy for consideration and ideas for commercialization.

The following comments were received from the region side, and discussions were advanced toward implementation.

- In the region, electrification measures for rural areas are being promoted by utilizing electrification measures of the World Bank.
- Securing raw materials for biogas is an issue. If it is a village, the amount is limited.
- It is possible to provide necessary data in the future, and we would like to discuss the details.
- In addition to the regional electrification measures, there was a comment that they would like to receive cooperation on urban waste measures.

On December 12, a field survey was conducted in Wakema, a rural village in Ayeyarwady Region.

Workshop (Photo)


Field survey in Wakema (Photo)

4.1.2 Invitation program in Fukushima City in December

On Friday, Wednesday, December 18, 2019 and 20, the Ayeyarwady Region invited relevant parties (Two persons in total including attendants) to Fukushima City. The day before the meeting, the Ministry of the Environment of Tokyo paid a courtesy call to the Vice-Minister for Global Environmental Affairs, and then moved to Fukushima to pay courtesy calls to the Mayor of Fukushima City, the chairman of the city council, and the chairman of the Chamber of Commerce and Industry, conduct on-site inspections, conduct inter-city collaborative workshops, and hold exchange meetings with members of the Chamber of Commerce and Industry.

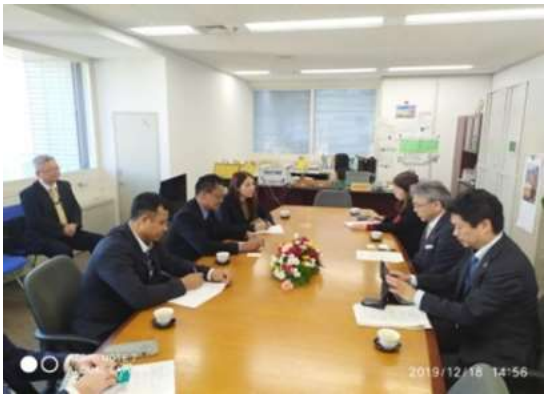
[Ayeyarwady Region]
Minister of Electricity, Energy and Industry, Regional Government
Executive Engineer for Myanmar Electricity Supply Authority

Overall schedule

Date	Schedule	Place, etc.
12/18 (Wed)	12/17 leaving Yangon 12/18 Morning: Arrive in Japan	
	Courtesy Call on Vice-Minister for Global Environmental Affairs	Ministry of the Environment, etc.
12/19 (Thu)	Travel from Tokyo to Fukushima	
	Courtesy call on the president of the Fukushima Chamber of Commerce and Industry Courtesy Call on Chairman Courtesy Call on Mayor Intercity Collaboration Workshop interaction with schoolchildren Exchange meetings with regional representatives Shimanuki Honke Guide Meeting with Regional Invitees	Chamber of commerce Fukushima City Hall Shinmachi Children's Club Senoue Shimanuki Honke
12/20 (Fri)	Study and exchange of opinions	Iitate Electric Power Co., Inc. Fukushima Office
	Fukushima to Tokyo	
12/21 (Sat)	Wrap Up	
12/22 (Sun)	Returning to Yangon	

[Courtesy Call on Vice-Minister for Global Environmental Affairs

Date	Wednesday, December 18, 2019 14:50 -15:15
Venue	Vice-Minister for Global Environmental Affairs, Ministry of the Environment
Attendee	Vice-Minister for Global Environmental Affairs International Cooperation and Sustainable Infrastructure Office, Global Environment Bureau, Ministry of the Environment



A courtesy call on (Photo)

[Exchange of opinions with the Strategy Office for International Cooperation and Environmental Infrastructure of the Ministry of the Environment]

Date	Wednesday, December 18, 2019 15:20 -15:50
Venue	Ministry of the Environment meeting room
Attendee	International Cooperation and Sustainable Infrastructure Office, Global Environment Bureau, Ministry of the Environment

An interview with International Cooperation and Sustainable Infrastructure Office (Photo)

[Courtesy call on the mayor of Fukushima]

Date	Thursday, December 19, 2019 13:40 ~ 14:00
Venue	Reception room at Fukushima city hall
Attendee	Fukushima City: Mayor, Environment Department Director, Deputy Environment Department Director, Environment Department Fukushima-Myanmar Economic Exchange Association


A Courtesy Call on (Photo)

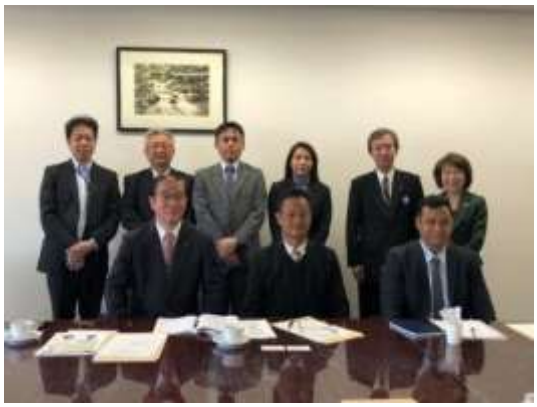
[Courtesy call on the chairman of the Fukushima City Council]

Date	Thursday, December 19, 2019 13:10 ~ 13:25
Venue	Chairman's Office at Fukushima City Hall
Attendee	Fukushima City Assembly: Chairperson, Executive Secretary of the Assembly, Deputy Executive Secretary of the Assembly Fukushima City: Deputy Director, Environment Division, Environment Division Fukushima-Myanmar Economic Exchange Association

A Courtesy Call on (Photo)

[Fukushima chamber of commerce and industry]

Date	Thursday, December 19, 2019 11:45 ~ 12:10
Venue	Fukushima Chamber of Commerce and Industry
Attendee	Fukushima Chamber of Commerce and Industry: vice president, managing director, business promotion department manager, business support department manager, business support department manager Fukushima City: Environment Section Chief, Environment Section Fukushima-Myanmar Economic Exchange Association



A courtesy call on (Photo)

[Intercity collaboration workshop]

Date	Thursday, December 19, 2019 14:00 ~ 15:20
Venue	Fukushima City Hall Conference Room
Attendee	Fukushima Chamber of Commerce and Industry: Manager, Business Support Division, Business Promotion Department Fukushima City: General Manager of the Environment Department, Deputy Manager of the Environment Department, Manager of the Environment Section, Manager of the Environmental Planning Section of the Environment Section, Manager of the Renewable Energy Promotion Section of the Environment Section, and Manager of the Intercity Exchange Section of the Settlement Exchange Section Fukushima-Myanmar Economic Exchange Association

(Photo) Workshop

[Exchange meetings with regional ministers]

Date	Thursday, December 19, 2019 16:00 ~ 17:30
Venue	Senami Shimanuki Honke in Fukushima City
Attendee	several private companies in the city


(Photo) Exchange meeting

[Exchange with schoolchildren]

They visited an after-school day-care center in Fukushima City to interact with Japanese children.


(Photo) Exchange with children

[Visit to Iitate Electric Power Co.]

Date	Friday, December 20, 2019 9:15 ~ 10:15
Venue	Iitate Electric Power Co., Ltd.
Attendee	Iitate Electric Power Co., Ltd. (Executive Vice President,)

An interview with (Photo)

4.1.3 Program in Fukushima City in January

From Monday, January 13, 2020 to 15 (4 persons in total), officials from Ayeyarwady Region and Sagaing Region were invited to Fukushima City. They made courtesy calls to Fukushima's deputy mayor and the chairman of the Chamber of Commerce and Industry, made on-site inspections (Industrial waste intermediate treatment facilities, etc.), held inter-city collaborative workshops, and held exchange meetings with business people, including members of the Chamber of Commerce and Industry.

The following two people from Ayeyarwady Region participated.

- Secretary General of Regional Governments
- Deputy Director of Regional Government

This program was implemented jointly with the low-carbon regional development promotion project in Sagaing Region, which was implemented as an inter-city cooperation project for the realization of a low-carbon society in FY 2019, with the aim of promoting cooperation between the two regions.

Entire schedule of the invitees

Date	Schedule	Place, etc.
1/13 (Mon)	1/12 leaving Yangon 1/13 Morning: Arrive at Narita	
	PM: Move (Tokyo - Fukushima)	
1/14 (Tue)	[Site vists] Fukushima Municipal Local Wholesale Market	Fukushima City
	Iitate Electric Power Co., Inc.	In Iitate Village
	Environmental education program with schoolchildren	Shinmachi Children's Club
	Exchange meetings with region officials Meeting with Regional Officials	city conference facility
1/15 (Wed)	Courtesy Call on Deputy Mayor	Office Assembly Room
	Courtesy call on the president of the Fukushima Chamber of Commerce and Industry Intercity Collaboration Workshop	conference room
	[Site vists] Food processing plants (Jurakuri Plant); Industrial waste intermediate treatment facilities (Keiwa Recycling Center Fukushima);	Fukushima City
	Move (Fukushima to Tokyo)	

- **About the Courtesy Call**

Courtesy Call on Fukushima Deputy Mayor	・Date: January 15, 2020 10:00 ~ 10:20 ・Venue: Fukushima City Hall Assembly Office ・Attendees: Deputy Mayor of Fukushima City, Director and Deputy Director of the Environment Department, Director of the Environment Department, and employees of the Environment Department
Courtesy Call on the Chairman of the Fukushima Chamber of Commerce and Industry	・Date: January 15, 2020 10:40 ~ 11:00 ・Venue: Fukushima Chamber of Commerce and Industry ・Participants [Chamber of commerce] Chairman of the Fukushima Chamber of Commerce and Industry, Manager of the Business Promotion Department, Manager of the Business Support Department, Manager of the Business Support Department [Fukushima City] Environment Section Manager, Environment Section Environment Planning Section Manager

Visit by deputy mayor (Photo)


(Photo) Visit to the president of the Fukushima Chamber of Commerce and Industry

- **City-to-City Collaboration Workshop**

Date	Wednesday, January 15, 2020 11:00 ~ 12:00
Venue	Fukushima Chamber of Commerce and Industry Conference Room
Attendee	[Fukushima City] General Manager of Environment Department, Deputy General Manager of Environment Department, Manager of Environment Department, Environment Department, etc. [Fukushima Chamber of Commerce and Industry] Business Promotion Department Manager, Business Support Department Manager, Business Support Department Manager [Other concerned parties] Fukushima Myanmar Economic Exchange Association


(Photo) Workshop

(Workshop overview)

- Opening remarks (Japan side: Fukushima City, Myanmar side)
- Attendee introduction (self introduction) Attendee introduction (self-introduction)
- Overview of the study, key binding, discussion note Introduction to the survey overview and past discussions (Mitsubishi Research Institute, Fujita)

・ Introduction of activities in Fukushima City (Fukushima)
・ Presentation from Myanmar
・ Discussion (Questions and answers/Exchange of opinions)
・ Closing remark and summary
・ Group photo, commemorative photo

・In the discussion, Ayeyarwady Region made the following comments.
1)Miaumya constructed a rice husk power plant with the cooperation of Fujita. The expectation was expressed that this project would not only contribute to the power shortage in Ayeyarwady and the whole of Myanmar, but also develop rural areas, construct new rice mills and become a new model (Rice production, effective use of rice husks, etc.) of the rice industry.
2)It was proposed that a regional prime minister with decision-making authority be invited to the program.

(Visits and exchanges of views)

Inspections of relevant facilities in Fukushima City and Iitate Village and exchanges of views with relevant parties were conducted.

・ Field trip to Fukushima Municipal Local Wholesale Market
・ (Status of waste treatment, etc.)
・ Field Visit and Exchange of Opinions on Iitate Electric Power's Efforts (site of Iitate Village)
・ Meeting with Fukushima Chamber of Commerce and Industry

food processing facility

Intermediate treatment facility for industrial waste

(Photo) Visit to relevant facilities in Fukushima City and exchange of opinions

We also visited a school children's club in Fukushima City to exchange information on environmental education. In addition, in collaboration with the Fukushima Chamber of Commerce and Industry, a business dialogue was held with visiting officials of the regions.

4.1.4 Field workshop and field survey in January

Local joint workshops were held with the participation of officials from both regions (The schedule of the local program in Myanmar is as follows).

In addition to the participants from Fujita and Mitsubishi Research Institute, the chief of the Environment Section and the chief of the Environment Section from Fukushima City participated. Participants from the Myanmar side are as follows.

<Participants from Ayeyarwady Region>

- Minister of Electricity, Energy, and Industry of the Government of Ayeyarwady Region: * Visitor to Fukushima City in December
- Director, Ayeyarwady Regional Environmental Protection Bureau

<Participants from Sagaing Region>

- Sagaing Regional Government Director: * Invited to Fukushima City in January
- Government officials from Monywa, the provincial capital of the region: * Invited people from Fukushima City in January

<Schedule>

Date	Schedule
Tuesday, February 4	Fukushima City official: Travel from Fukushima to Narita
Wednesday, February 5	from Narita to Yangon
Thursday, February 6	Site vists (Industrial parks, waste disposal, etc.) (Yangon City and its vicinity)
Friday, February 7	Travel to Yangon and Naypyidaw AM: Attending policy dialogue with Japan (Only Ayeyarwady Minister), preparing for WS Afternoon: Joint workshop between Ayeyarwady Region and Sagaing Region (MAPCO Conference Room) Departure from Naypyidaw
Saturday, February 8	from Yangon to Narita

- **Overview of Local workshop in Myanmar**

Date	Friday, February 7, 2020 12:40 ~ 16:00
Venue	MAPCO Conference Room
Attendee	[Japanese side] Fukushima City: Manager of Environment Division, Manager in Environment Planning in Environment Division Mitsubishi Research Institute: Fujita: [Myanmar government officials] ・Ayeyarwady Regional Government: Minister of Electricity, Energy and Industry and other person ・Sagaing Regional Government Director and two others

(Workshop Agenda)

Joint Workshop of Partnership for Low Carbon Initiative
with Fukushima City, Ayeyarwady Region and Sagaing Region
7th (Friday) February 2020, Nay Pyi Taw, Myanmar

Background and Objective

Partnership for Low Carbon Initiative between Fukushima City (Japan) and Myanmar Region Governments (with Ayeyarwady region: starting from in 2015, and with Sagaing Region: starting from 2017) aims to follow;

- Accelerating action for low-carbonization and SDGs localization of cities, by formulating the Joint Crediting Mechanism (JCM) projects (feasibility study) and institutional building.
- Facilitating regulation of institutional mechanisms (e. trials and pilot projects) by policy dialogue under city to city cooperation with Fukushima City, Ayeyarwady Region and Sagaing Region governments.

Under the Partnership for Low Carbon Initiative between Fukushima City, Ayeyarwady Region and Sagaing Region governments, various workshops were implemented in both of Fukushima city, Pathein city, Monywa city etc, and we are sharing future goals.

One of key outcomes of our partnership is development of Rice Husk Power Generation project in Myaungmya Township (The plant facility has been constructed in MAPCO's industrial area). This project is one of the JCM projects in Myanmar. This JCM project is the pilot project as the new problem-solving approach for solving energy access and waste management in Ayeyarwady Region, also in Myanmar. This approach is expected to spread in many rural communities in Myanmar.

In this year (FY 2019), we are challenging following key topics:

- Promotion project for formulation of Circulating and Ecological Economy in Ayeyarwady Region: i.e. Supporting formula of local distributed power system (e. biomass power projects), the concept of a regional circular and ecological sphere.
- Promotion project of low-carbon regional development in Sagaing Region: i.e. Supporting formula of waste management system of urban waste (e. separation and waste treatment systems, environmental education) and rice husks power generation system.

The workshop will facilitate city to city cooperation for each topic through sharing experiences of policy planning in Fukushima city, key binding of previous Japan program (in Dec. and Jan.) and discussion on pathways for regulation of project formation, institutional mechanisms (e. key strategy for actions, idea of roadmap).

Program

Opening remarks
Mr. Win Htay, Minister for Electricity, Energy and Industry (Ayeyarwady Region)
Mr. Kato Naoki, Manager of Environment, Environment Division, Fukushima City

Attendee introduction (self introduction)

Presentations from Japanese side
Overview of the activities, summary of previous workshops in Fukushima City (in Dec. and Jan.)
Research Director, Environment and Energy Division, Mitsubishi Research Institute

Lessons of Policy Planning in Fukushima City
Manager of Environment, Environment Division, Fukushima City

Idea of new solution model (i.e. power generation system in Ayeyarwady region, waste management in Monywa city)
Senior Manager Project Planning Office, Overseas Development Division, Fujita Corporation
Coffee break

Presentations from Myanmar side:
from Ayeyarwady region
- Key binding of Japan program in Dec.
- Expectation to our partnership and idea of further collaboration
Minister for Electricity, Energy and Industry (Ayeyarwady Region)

from Sagaing region
- Key binding of Japan program in Jan.
- Expectation to our partnership idea of further collaboration
Director, Sagaing Region Development Affairs Committee

Discussion:
Q & A, exchanging ideas and comments, wrap up

Closing Remarks:
Minister for Electricity, Energy and Industry (Ayeyarwady Region)

The Ministry of the Environment of Japan and the Ministry of Natural Resources and Environmental Conservation of the Republic of the Union of Myanmar held the "Third Japan-Myanmar Environmental Policy Dialogue" in Nay Pyi Taw on Friday, February 7. The Parliamentary Vice-Minister of the Environment (Japan), who visited Nay Pyi Taw for policy dialogue, delivered a speech during the workshop.

(Photo) Local workshop

At the workshop, the Regional Headquarters made the following comments.

- The inter-city collaboration programme, with the cooperation of MRI, Fujita and Fukushima City, is seeing positive results across Myanmar.
- This activity started in 2015 and has been progressing every year. Starting with Ayeyarwady, Sagaing will also participate, and we hope to expand to other regions in the future.
- He reported his visit to Fukushima in December to the federal government.

(About the master plan)

- The Fukushima City government's announcement made us understand the importance of preparing a master plan. I would like to propose the creation of a master plan as an inter-city cooperation project.
- There will be elections in Ayeyarwady in November 2020, which could lead to a new government. Even if the person in charge changes, I want to make it a plan so that I can continue what I have done.
- I would like to draft each master plan in Ayeyarwady and Sagaing, collect data and hold joint workshops.
- We would like to include the training of engineers, including environmental education, in our master plan.
- It is hoped that the report, which was compiled from the Ayeyarwady Region, will spread to other regions.

(Development of rice husk power generation business)

- In the future, it will be necessary to investigate in detail how many rice mills there are in the Ayeyarwady Region and how much rice husk is produced.
- We also want to conduct a survey on the spread of electricity in the region, which will lead to a pilot project.
- We would like to pass on good practices from Ayeyarwady Region to Sagaing Region, including the National Grid connection.

(WS summary)

- Ayeyarwady wants to create a master plan for rice husk power generation and Sagaing wants to create a master plan for waste treatment, both of which incorporate elements of environmental education.
- We hope that the regional governments will cooperate with the G-to-G dialogue.

(Field survey of rural areas in Ayeyarwady Region)

The day before the on-site workshop in Myanmar, the Prime Minister visited a rural village in Ayeyarwady Region and observed the situation there.

(Photo) Situation of rural areas (Maubin) in Ayeyarwady Region

4.1.5 Summary of policy dialogue

(Results of the Fukushima Program in January)

- During the field visit, the participants learned about Iitate Electric Power's efforts for renewable energy (solar sharing) (Business sites in Iitate Village).
- We visited a school children's club in Fukushima City and observed its environmental education efforts. The Schoolchildren's Club has an SDGs education program, and exchanges were conducted as part of the program.
- At the Intercity Collaboration Workshop, the current status of electrification measures in Ayeyarwady Region was explained, and short- and medium-term roadmaps were discussed (We explained the concept of Regional CES advocated by Japan and its significance in regional development, and deepened our understanding.).

(Results of a local workshop in Naypyidaw in February)

- The Regional Minister reported that in the Ayeyarwady Region, he would like to create a master plan for inter-city cooperation activities, and that since citizens and businesses have not yet gained an understanding of the environment, it is necessary to raise awareness and reform awareness among citizens and businesses.

4.2 Study team meeting in Fukushima City

4.2.1 Study group (February 2020)

Based on the results of the on-site WS and the on-site investigation, a meeting of relevant parties was held in Fukushima City as follows, and opinions were exchanged on future developments in addition to the compilation for this fiscal year.

Date: Monday, February 17, 2020 15: 30 ~ 17: 00
Venue: Meeting room of Fukushima Chamber of Commerce and Industry (Corasse Fukushima 8th floor)
Attendees: Fukushima City (General Manager of the Environment Department, Deputy Manager of the Environment Department, Manager of the Environment Department, Manager of the Environment Department, etc.), Fukushima Chamber of Commerce and Industry (Deputy General Manager, Business Promotion Department, Assistant General Manager, Management Support Division), staff members specialized in the management section of Fukushima Prefectural Industrial Promotion Center, President of Fukushima Prefectural Housing & Living Association (Representative of the organizers of the Myanmar Invitational Committee), CEO of Cliff Corporation, Fujita (General Manager, International Branch), Mitsubishi Research Institute (Senior Researcher, Environment & Energy Division)
Items of considerations:

- Progress of the study
- Status of cooperation between cities based on field visits
- Business Development Plan for the Next Fiscal Year

(Photo) A review meeting in Fukushima City

4.2.2 Direction of system construction and human resource development toward the realization of a Regional CES

In the Fifth Basic Environment Plan adopted by the Cabinet in April 2018, the Regional

CES was proposed, taking into account international trends involving the world, such as the United Nations "Sustainable Development Goals" (SDGs) and the "Paris Agreement" as well as the increasingly complex environmental, economic, and social issues. Regional CES is a concept that aims to maximize the vitality of each region by creating an independent and decentralized society while making the most of local resources such as beautiful natural landscapes, and by supplementing and supporting resources in accordance with the characteristics of each region.

This concept was developed by our country after various experiences, and one direction of development in the present country, especially the farming villages in Ayeyarwady Region, is to follow this concept.

So, what are the strengths of rural communities in Ayeyarwady Region, and what are regional resources? It can be said that agriculture centered on rice cultivation. It is necessary to build an independent and decentralized society starting from rice cultivation. In this report, we propose a model.

Basic concept for improving rural life

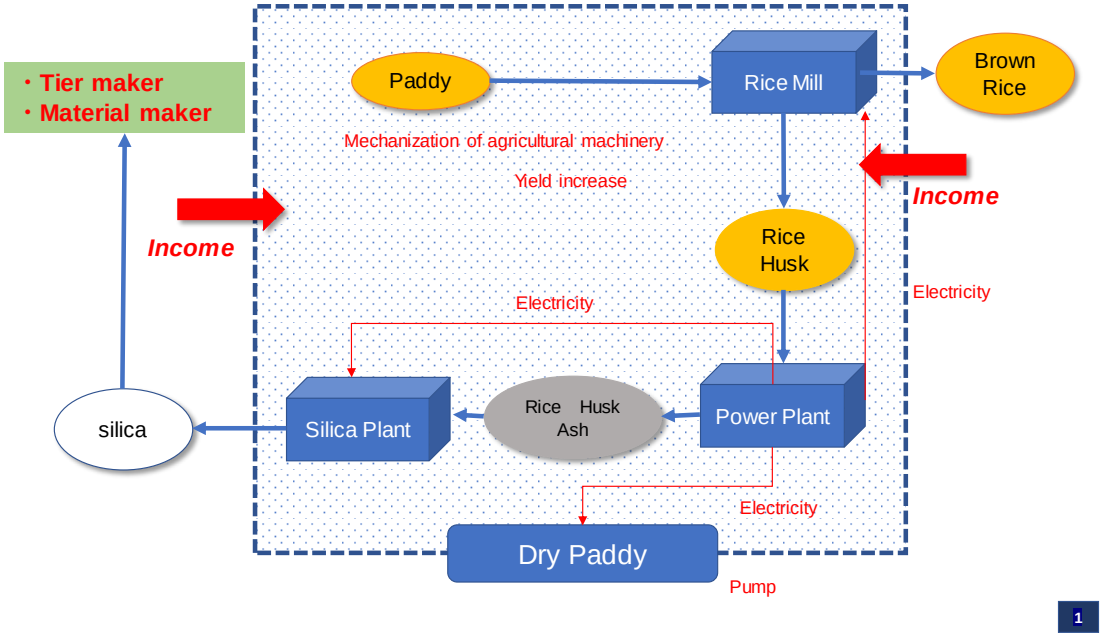


Figure4-1 Concept of a community of Regional CES

Rice husks, which are naturally produced as a result of rice cultivation, are used as fuel for biomass power generation, and electricity and heat are supplied to the region. Since rice hull incineration ash is rich in silica, silica is extracted to make various industrial materials. Since stable electricity and heat can be secured and silica sales income is received in addition to sales income of rice, the income can be increased by replacing the rice polishing equipment with a modern one and exporting it as premium rice. Cold storage also allows exports to be tailored to market price trends.

It will be possible to improve the management efficiency of the rice milling business which has been conducted as a private business until now by joint management of the company organization. It can be said that rice cultivation itself can be practically developed by introducing varieties suitable for premium rice, increasing revenue through mechanization, soil improvement and land readjustment, adjusting market prices of rice, increasing revenue through expansion of rice exports, and securing regionally distributed power sources. As a result, farming villages will become independent and young people will be attracted to them.

In order to realize a Regional CES in Ayeyarwady Region, the first step is to organically link the rice husk power generation business, which is the medium-scale model described above, with the small-scale model (For rural communities). In order to achieve sustainable development, it is essential to establish a qualification system for engineers in the relevant fields and to develop human resources through this system in order to become self-reliant in the region in terms of technology.

Institution building

Currently, the engineer qualification system in Myanmar is mainly based on training, and we believe that it is necessary to promptly study and introduce the examples of the qualification system (electrical engineer) in Asian countries including Japan where the engineer qualification system has been established. This paper presents a case in Japan concerning the qualification of engineers for thermal power generation facilities.

Examples of Engineer Qualifications Required for Thermal Power Plants

Especially, the qualification system related to electricity was arranged.

Electrical Qualifications Classification

<table>
<tr><td rowspan="3">Electrical Chief Engineer</td><td>First Class</td><td rowspan="3">Security management</td><td colspan="2">>170kV</td></tr>
<tr><td>Secand Class</td><td></td><td><170kV</td></tr>
<tr><td>Third Class</td><td colspan="2"><50kV</td></tr>
<tr><td rowspan="2">Electrical Worker</td><td>First Class</td><td rowspan="2">Construction</td><td></td><td><500kw</td></tr>
<tr><td>Secand Class</td><td colspan="2"><600v</td></tr>
</table>

Human resource development

Myanmar lags behind other Southeast Asian countries in various fields due to the lack of interaction with other countries during its long military rule. Education, especially in higher education, especially in the field of technology. Most of the technical books sold at major engineering university campus bookstores are copies of books published mainly in Britain. It seems that it is quite common for professors who are educated solely on textual information to give lectures to students in almost the same book. Japan has been hampered by the national system for a long time, and the fact that it has become possible to study and work experience in advanced countries has led to a shortage of engineers throughout the country.

In Myanmar, because various exchanges with foreign countries and the import of goods have been restricted for a long time, old cars, machines, etc., which were introduced before then, are used by skillfully repairing or modifying them. In that sense, the Myanmar people may be dexterous.

Even if the aforementioned qualification system for engineers is established and engineers are discharged, it will be difficult to secure engineers who work in the vicinity of rural communities if they are concentrated in urban areas such as Yangon and Mandalay. Even if the system is introduced in a hard way, it will not be an independent and sustainable system if it relies only on companies and engineers in urban areas for operation and maintenance.

One way to solve this problem is to create a situation that is economically comparable to that of cities, and to make rural areas attractive. However, even in our country, there are not many examples of young people becoming attracted and settling down in rural areas. Unfortunately, the solution has not been obtained yet.

5. Summary and future developments

The future development was examined based on the point of the result of the examination.

(Field of policy dialogue)

At the WS in February, the Minister of State for Regional Affairs of Ayeyarwady proposed to formulate a master plan for intercity collaboration before the next election (Scheduled for November this year). The master plan should include the following key components.

1) Roadmap of power generation business development in regional areas

2) Financial mechanism for sustainable business development

3) Awareness, Awareness Reform and Consensus Building (citizens and businesses)

4) Human resource development (Training of electrical engineers)

Table 5-1 Summary of results and future plans (Field of policy dialogue)

<table>
<tr><th>Item</th><th>Results for the current fiscal year</th><th>From April to June</th><th>From July to October</th><th>From November to February</th></tr>
<tr><td rowspan="2">Creating a master plan for inter-city cooperation</td><td rowspan="2">・Master Plan Formulation Agreement with Regional Ministers
・Extracting candidate locations
・Concept formation of Regional CES in rural areas</td><td colspan="2">[Roadmap of power generation business development in regional areas]
・Realization of projects (2nd, 3rd and 4th)
・Realization of future development (Incorporating the concept of Regional CES)
・Direction of creating a foundation for realization (Funding, Enlightenment, Human Resource Development, etc.)</td><td>[Approach within the region]</td></tr>
<tr><td>Create a draft</td><td>Draft (Working with Regional Governments)</td><td>Discussions for development and implementation to relevant parties</td></tr>
<tr><td rowspan="2">Supporting the implementation of initiatives</td><td rowspan="2">・Realization of consignment system (1st project)
・Formation of ideas for training electrical engineers</td><td colspan="2">Preparation of concrete plans based on the 1st project</td><td>Discussion in Union level</td></tr>
<tr><td>Creating a draft</td><td>Discussion in Union level</td><td>Discussion in Union level</td></tr>
</table>

(Field of project)

Table 5-2 Summary of results and future plans (Field of project)

Items	FY 2019 Achievements and Issues	Plans for FY 2020	Plans for FY 2021
Medium scale model (Rice husk power generation business)	**[Outcomes]** ・2nd Basic Project Plan formulated (3.6 MW) **[Challenges]** ・Business participants (Japanese descent)	・formation of the entity ・Review of the Basic Plan ・JCM entry (Considering the second half of the fiscal year) ・Narrowing down of projects (3rd and 4th)	・Construction of rice husk power generation plant in the second project
Small-scale model (For rural communities)	**[Outcomes]** ・Basic survey of model candidate sites ・Primary review of model power supply **[Challenges]** ・low electricity rate	・Study of mini-grid system model ・Drafting of a basic plan ・Study of business entities and fee collection system ・Planning of region model (Working with Regional Governments)	・Discussion in Union level ・Finance inspection revenge
Proposal of qualification systems for human resource development	**[Outcomes]** ・Introduction to the Japanese engineer examination system **[Challenges]** ・Unrecognized existing qualification system ・Not clear who is responsible	・Clarification of the existing qualification system canonicalization ・Preparation of draft of qualification system for related organizations ・Finance consideration ・Discussion in Union level	・Establishment of a part of the system
Transportation systems, etc.	**[Outcomes]** ・Improving the level of understanding of regional leaders in charge of this area **[Challenges]** ・Sharing a common understanding	・Planning of specific systems (Working with Regional Governments) ・Identifying issues and discussion in Union level	・Implementation of model consignment (Use of the Myamya project) ・Problem extraction and solution planning

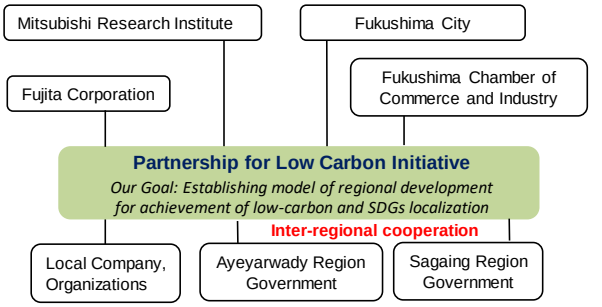
Appendix

Overview of project

City-to-City Collaboration for Low Carbon Initiative
with Fukushima City (Japan), Ayeyarwady Region and Sagaing Region (Myanmar)

Policy dialogue between Fukushima City and Region Governments
(Supporting through knowledge of Japan's institutional aspects)

"Partnership for Low Carbon Initiative" between Fukushima City (Japan) and Region Governments in Myanmar (with Ayeyarwady Region: starting from 2015, and with Sagaing Region: starting from 2017)



Workshops and site visits for facilitating policy formulation


Dec. 2019, Fukushima City
Meeting with Mayor of Fukushima City


Dec. 2019, Tokyo
Meeting of Minister for Electricity, Energy and Industry (Ayeyarwady Region) and Vice Minister for Global Environmental Affairs (MOJ)

Key topics

Promotion project for formulation of Circulating and Ecological Economy in Ayeyarwady Region

i.e. Supporting formulation of local distributed power system (e.g. biomass power projects), the concept of a regional circular and ecological sphere

Promotion project of low-carbon regional development in Sagaing Region

i.e. Supporting formulation of waste management system of urban waste (e.g. separation and waste treatment systems, environmental education) and rice husks power generation system

Feasibility study of JCM project

Example of achievement;

Rice husk power generation PJ (JCM) in Myaung Mya Township

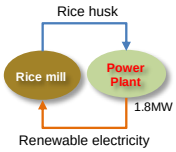
Project Title：Promotion Project for Formulation of Circulating and Ecological Economy in Ayeyarwady region

Project Overview

- **"Rice husk Power generation" at industrial park (new), and power supply to not only rice milling facilities but also the entire industrial park**
- **Support the examination for low carbonization of whole industrial park (Myaung Mya industrial park etc.)**

Difficult to secure electricity in a new industrial park — **Enhancing the universal energy access by small size model in rural communities**

First project only supply to rice mill only



Attention from the central and regional governments

<Challenges> Evolution of business models, depending on the situation in regions.

<Goal>
- To the development model in various parts of Myanmar
- Aim for autonomous dissemination

Development Model

Development to Ayeyarwady region-type model
- Ayeyarwady Region is located at the end of national grid in Myanmar, hence, securing electricity accesses is one of the key issues (Lower electrification rate as compared to other regions)
- Establishing a business model that can be widely deployed in rural areas by combining two systems that can flexibly respond to local conditions

JCM project 3.6 MW

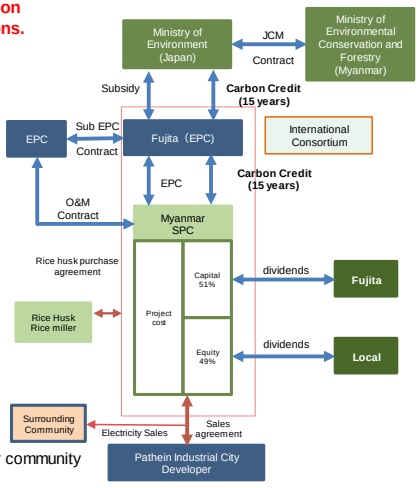
Medium size model (Rice husk Power generation)

Developing with new elements
- **Selling power to the national grid with wheeling system**

50 kW scale per unit

Small size model
- **Integrated container type with biogas system and PV**
- **Small-scale decentralized power systems (for rural community)**

[International Consortium Organization (tentative)]



Benefit for community

Establishing model of regional development for achievement of low-carbon & SDGs with solving key challenges of **achievement of universal energy access, and creation of a circulating and ecological economy**

Leading the a circulating and ecological economy in Asia rural area
Spreading to Other rural communities in Myanmar and other Asia countries.

Materials of Workshop

Joint Workshop of Partnership for Low Carbon Initiative

7 February 2020

Overview of our collaborative activity

City-to-City Collaboration for Low Carbon Initiative with Ayeyarwady Region and Sagaing Region (Myanmar)

1

Partnership for Low Carbon Initiative

Our Goal: Establishing model of regional development for achievement of low-carbon & SDGs with solving key challenges of **achievement of universal energy access, and creation of a circulating and ecological economy**

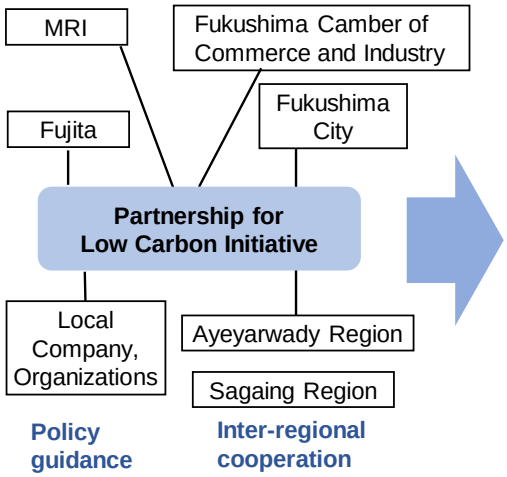
	JAPAN	Myanmar
Policy dialogue	Fukushima City	Ayeyarwady Region Sagaing Region
Business dialogue	Fukushima Chamber of Commerce & Industry Mitsubishi Research Institute	Business organizations
Development of project	Fujita Corporation	Myanmar companies

Workshops and site visits for facilitating policy formulation

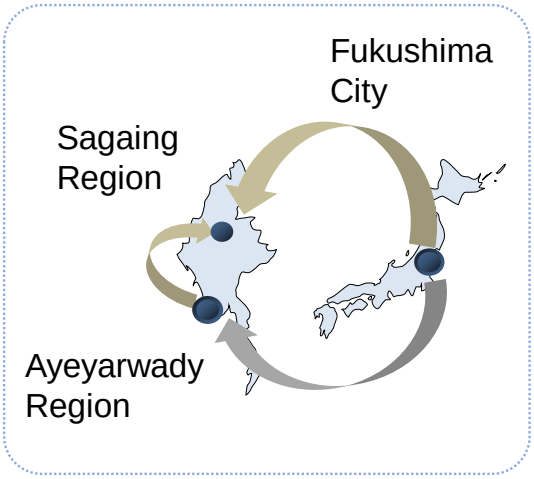
Feasibility study:
Example of achievement;
Rice husk power generation PJ in Myaung Mya Township

2

Policy dialogue between Fukushima City and Regional governments
(Support through knowledge of Japan's institutional aspects)



Expansion in Myanmar through inter-regional cooperation
(approach of promotion in Myanmar)



3

Partnership for Low Carbon Initiative

Horizontal Cooperation

Workshop in Sagaing Region
Nov. 2019, Monywa

Joint Workshop in Fukushima City
December. 2019, Fukushima

Workshop in Ayeyarwady Region
Dec. 2019, Pathein

Networking meeting with business organizations
December. 2019, Fukushima

4

Partnership for Low Carbon Initiative

Vertical Cooperation

With city development committee
Nov. 2019,

With region government officials

Dec. 2019, Pathein

Meeting in MOEJ
Dec. 2019, Tokyo

Minister for Electricity, Energy and Industry (Ayeyarwady Region) and Vice Minister for Global Environmental Affairs (MOJ)

With site manager
Nov. 2019, Monywa

With school principal
Nov. 2019, Monywa

5

Reference 1

Overview of Key Achievements

6

1 Key achievements of city-to-city collaboration : Enlightenment by environmental education

Ayeyarwady Region

Sagaing Region

Introducing environmental education activities in Fukushima City at a local elementary school

Introducing video letter from students at an elementary school in Fukushima City to Elementary school in Ayeyarwady Region

Receiving return video letter from students in Ayeyarwady Region to students in Fukushima

Introducing exchange activity between elementary school students in Ayeyarwady Region and Fukushima City

7

2 Key achievements of city-to-city collaboration

Waste landfill site in Pathein (Ayeyarwady Region)

Waste is treated by landfill in Pathein City.

After the city-to-city dialogue, segregation of waste has been started in the treatment site .

Waste landfill site in Monywa (Ayeyarwady Region)

The problem of waste disposal is a common issue in other regional cities.

We are currently discussing measures to deal with waste disposal in Monywa City during policy dialogue.

8

3 Key achievements of city-to-city collaboration : Expansion to cities

Joint Workshop with Ayeyarwady Region & Sagaing Region (Feb. 2018, Yangon)

Courtesy visit to the Minister of Agriculture, Livestock and Irrigation(Feb. 2018)

Booth presentation of City-to-City Collaboration activities in Naypyidaw (Mar. 2018. Conference of Myanmar Rice Federation)

State Counsellor Dew Aung San Suu Kyi visited the booth, and we had a chance to explain the activity.

9

Reference 2

Overview of Current Discussion

in Policy Dialogues

10

Sharing Key Concepts for Low Carbon Society

Key global trends towards to sustainable development

Policy Goals

Key Challenges

- Facilitating policy formulation for achievement of **universal energy access**.
- Facilitating policy formulation for regional development for achievement of **low-carbon & Sustainable Development Goals (SDGs), circular economy in rural development**.

11

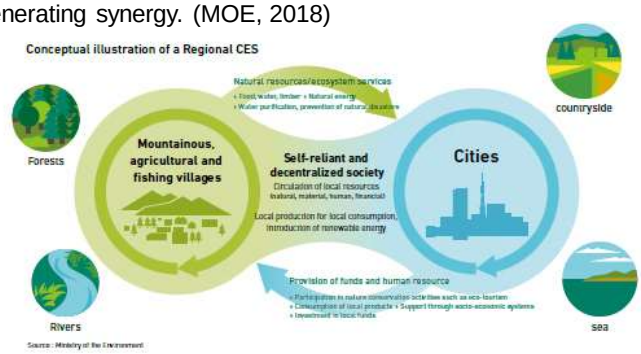
Sharing Key Concepts for Low Carbon Society

Circular and Ecological Sphere (CES)

Reference

- **Regional CES that complements and supports regional resources by building broader networks**, which is composed of natural connections (forests, the countryside, rivers and the sea) and, economic connections (human resources, funds, and others), thus complementing each other and generating synergy. (MOE, 2018)

- In order to form Regional CES, it is important to **circulate resources that can be circulated in the region as much as possible**, and the same applies to waste treatment.



Source) MOEJ (2018) Annual report on the environment in Japan 2018

12

Partnership for Low Carbon Initiative

Key approach for Low-Carbon City

Promoting a low-carbon city and building a sustainable low carbon city (Local city model)

Policy side

Partnership for Low Carbon Initiative

City

Citizens

Business side

Business operators

Knowledge (i.e. policy) transfer

Technology transfer

Reduce global warming and develop a low-carbon, recycling-oriented society with minimal environmental impact

Formulation of JCM projects

Adoption of new approach

RE introduction, waste to energy, waste management and 3R system

Promotion of town planning Low-carbon & sustainability

Vision

13

Partnership for Low Carbon Initiative

Idea note of policy roadmap for decarbonization and SDGs localization

Key strategy for actions in local level

- **Business model** for realizing a low-carbon, resilient and sustainable rural city: using renewable energy technologies, such as power plant and heat utilization using biomass resources (e.g. rice husks)
- **Social model (institutional mechanism development)** for smooth project implementation
- **Capacity building** for low-carbonization of industrial park

New industrial park model (Rice complex)

Rural community model (Biomass to energy)

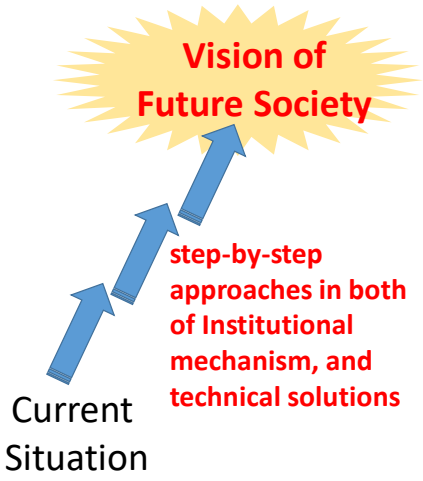
To formulate a master plan (i.e. vision, regional model, approaches)

Leading the a circulating and ecological economy in Myanmar and Asia rural areas

14

Key Items of Institutional Mechanisms in Communities

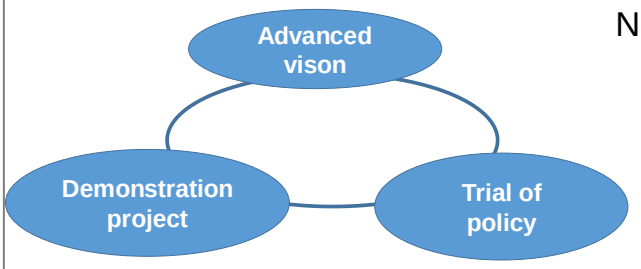
1. **Setting the policy targets (Short-term and Long-term)**
   - Sharing visions
   - Identify actions
   - Check and reviews
2. **Enhancing the success stories**
3. **Role (Partnerships) and responsibility**



15

Approach for Setting of Policy Target

Short-term → **Long-term**



- Environmental education in schools
- Activities in industry associations
- Cultivation of human resources development
- Incentive to investment for demonstration project

Next 10 years:Y2030

Setting target
- Electrification rate %
- RE rate %

Taking action (step-by-step)

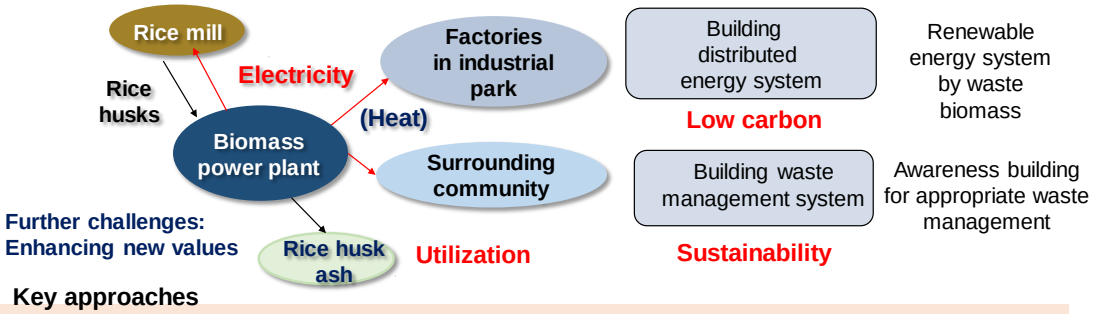
Model city of sustainable rural development
- Making vision
- Enhancing partnerships

16

Idea Note of Policy Roadmap: Low-carbon energy

Regional model — **Creating new regional electric power supply system by biomass power plant using rice husks**

Combination of business model & social model



Key approaches

Project by collaboration of Japanese companies and local companies, not only focusing of Japanese technology and products.

- Combination of appropriate technologies (Cost and performance through the project life cycle)
- O&M system (by localization, training)
- Project management

17

Idea Note of Policy Roadmap: Steps in Building Circular Economy

Changing Mind

STEP 1

Education
Awareness building

Appropriate sorting system

Showing win-win approach

STEP 2

Waste to energy etc.
(Power + Heat)

Enhancing partnerships
Promotion & Regulation

STEP 3

Creating venous industry

PPP principles, especially for business sector

18

Reference

Support for initiatives of environmental measures

In order to contribute to the further development of environmental measures in the regions, we introduce Fukushima City's plans for environmental measures and the future vision of Fukushima City in the "Fukushima City Promotion Plan for Renewable Energy Introduction".