FY2016 Project for Ministry of the Environment Japan

FY2016
Feasibility Study of Joint Crediting Mechanism Project by City to City Collaboration
(JCM Feasibility Study for Low-Carbon City in Ayeyarwady Region (Study of a low-carbon water and sewerage treatment system in Pathein Industrial City))
Report

February 2017

Mitsubishi Research Institute, Inc.
Fujita Corporation

Table of Contents

List of Abbreviations

This report uses the following standardized units and abbreviations.

unit

t	ton
kg	kilogram
MJ	Megajoule
MW	Megawatt
kVA	Kilovolt-ampere
MVA	Megavolt-ampere
kW	Kilowatt
kWh	Kilowatt hour
GWh	Gigawatt hour
TWh	Terawatt hour
Mpa	Megapascal
ha	Hectare
m2	Square meter
m3	Cubic meter
t-CO2	Carbon dioxide emissions (t)
kg-CO2	Carbon dioxide emissions (kg)
MMK	Myanmar kyat
USD	U.S. dollar

Abbreviations

ADB	Asian Development Bank
ASEAN	Association of South - East Asian Nations
CDM	Clean Development Mechanism
DHS	Down-Flow Hanging Sponge
DICA	Directorate of Investment and Company Administration
EIA	Environmental Impact Assessment
EIAP	Environmental Impact Assessment Procedure
EMP	Environmental Management Plan
EPC	engineering, procurement, construction
ESE	Electricity Supply Enterprise
FIL	Foreign Investment Law
GHG	greenhouse gas
HPGE	Hydropower Generation Enterprise
IEA	International Energy Agency
IEE	Initial Environment Examination
IFC	International Finance Corporation
IFC EHS	International Finance Corporation Environmental Health and Safety
INDC	Intended Nationally Determined Contributions
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
MCDC	Mandalay City Development Committee

MEPE	Myanmar Electric Power Enterprise
MIC	Myanmar Investment Commission
MOST	Ministry of Science and Technology
MRV	Measurement, Reporting and Verification
NLD	National League for Democracy
O&M	operation and maintenance
PCDC	Pathein City Development Committee
PV	Photovoltaics
SIA	Social Impact Assessment
SPC	Special Purpose Company
UNFCCC	United Nations Framework Convention on Climate Change
YCDC	Yangon City Development Committee
YESB	Yangon City Electric Enterprise
3R	Reduce, Reuse, Recycle

List of Figures

List of Tables

Executive Summary

JCM Feasibility Study for Low-Carbon City in Ayeyarwady Region
(Study of a low-carbon water and sewerage treatment system in Pathein Industrial City)

Executive Summary

1. Background of the examination

A partnership was formed between Ayeyarwady Region and Fukushima City as the platform for a new city-to-city collaboration under the collaborative scheme (framework) between the two, and discussions were conducted among stakeholders from both parties. In concrete, the status quo and the needs of Pathein City in Ayeyarwady Region were studied and comprehended, various initiatives by Fukushima City and related technologies were presented as reference, and examinations were performed concerning the possibility of collaboration between both Cities, as well as the possibility of deploying the Joint Crediting Mechanism (JCM) for realization of a low-carbon township in Ayeyarwady Region, in the fields of waste treatment and water treatment, in particular, through joint activities such as the holding of workshops in both Pathein City in Ayeyarwady Region and Fukushima City, mutual visits by members of both Cities (including on-site investigations), and exchange of opinions concerning the policy trends of both Cities.

Ayeyarwady Region, Myanmar
Ayeyarwady Region is the largest agricultural area in Myanmar, and the Region has been promoting new initiatives in recent years, including the development of new industrial parks, in order to promote the industrialization of the Region. This Region is considered to be one of the local areas in Myanmar where a rapid economic development is anticipated towards the future, and accordingly, the experience and knowhow held by Japan that experienced a rapid economic growth in the past are expected to be positively utilized in the Region.

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

2. Awareness of the issues, and the direction towards the realization of a low carbon partnership

All members of the "Partnership", through discussions thus far, came to share the awareness about the importance of building a sustainable, low-carbon-type, vigorous, well-advanced township in Ayeyarwady Region, and the direction (roadmap) towards the realization of such township, as stated below.

Goal Image of the Region

It is important to aim at realizing an "environmentally most advanced City of Ayeyarwady (tentative name)", a city, which is full of vigor, yet low-carbonized and environmentally friendly, with its local features well preserved, by making the most of advanced technologies and knowhow, while preventing the occurrence of various social problems (environmental pollution, natural disaster, etc.) from the increase in the volume of waste materials, increase in the environmental load including deterioration of water quality, increase in the amount of energy consumption, loss of the rich natural environment of the Region and so forth, which could occur as a result of the economic growth.

It is indispensable for the administration, citizens and business operators to work together for the preservation of the environment and for the promotion of low-carbonization, and it is important to gradually expand the sphere of deployment, by firstly proceeding with a model-type approach based on a pair of wheels of "deployment by business operators" and "deployment of institutional efforts: i.e. creation of a proper mechanism to support business deployment".

In bringing the model-type approach into practice, it is indispensable to utilize the experience and knowhow of Japan that experienced a rapid economic growth in the past, as well as the framework of the JCM, through discussions within the Partnership, which is the platform of the city-to-city collaboration.

The fields of waste treatment, recycling of resources, water treatment and energy sources, in particular, are the priority areas in the development of townships, and it is important to aim at the below-stated directions in both fields of waste treatment and water treatment (which were the discussion themes of this time).

3. Direction of deployment in individual fields

Field of water treatment measures: Promotion of water treatment measures (i.e. energy-saving, low-carbon and low-cost measures), corresponding to the progress of the economic growth"

Vision

In light of the actual situation of Ayeyarwady Region (such as the status quo of the level of urbanization, economics, time/labor required for the maintenance of facilities, etc.), it is important in the first place to aim at creating a well advanced township, which is considerate of the preservation of the water environment, by utilizing a small-scale, decentralized-type waste-water treatment system.

Future Perspectives

In Japan, small-scale waste-water treatment measures are also adopted and they are proved to be quite effective as the measures for local communities, in particular. Thus, based on the experience in Japan, utilization of the small-scale, decentralized-type waste-water treatment system, corresponding to the situation of Ayeyarwady Region, will be quite promising. In applying such system there, the securing of required electricity will be a big issue. Thus, it is important to aim at adopting a stand-alone power system, which is based on energy-saving-type, decentralized power sources (such as solar power generation).
It is also important to change the awareness of people in the local community about the preservation of the water environment, and accordingly, we need to enhance the promotional activities. (e.g. to promulgate the habit of preserving the water environment. As the environmental education approach is thought to be effective here, we will utilize the place of education for that purpose.)

Development in other areas

Hereafter, it is important to bring into practice a model-type approach of "environmentally most advanced township" in Ayeyarwady Region, by also proceeding with the deployment in related fields (e.g. promotion of renewable energy sources, recycling of resources, energy efficiency, etc.) and in other regional areas (e.g. other townships in the Region, other industrial parks, etc.) in a well coordinated manner, by making good use of the approach from the city-to-city collaboration.

[Details of recognized issues, future perspectives and action plan (draft)]

~ "Promotion of water treatment measures (i.e. energy-saving, low-carbon and low-cost measures), corresponding to the progress of the economic growth" ~

Recognition of issues

In Ayeyarwady Region, introduction of a new treatment system for fresh water as well as waste-water has been a serious issue, in relation to the progress of the economic growth. However, the introduction of the system has various obstacles, such as financial problems associated with the construction of treatment facilities and their maintenance, procurement of electricity required for the treatment, and so forth.
In municipalities in Japan, small-scale, waste-water treatment measures such as the promulgation of sewage facilities for agricultural villages and community waste-water treatment tanks have been effectively and successfully adopted as the waste-water treatment measures in local communities, in parallel with the introduction of large-scale sewage treatment facilities elsewhere.

Direction of deployment for the solution of the issue

In light of the actual situation of Ayeyarwady Region (such as the status quo of the level of urbanization, economics, time/labor required for the maintenance of facilities), the deployment of small-scale, decentralized waste-water treatment systems is promising in the first place. In pursuing the development, procurement of electricity for the waste-water

treatment facilities is a big issue, and if we consider possible power shortage and the fact that the power supply infrastructure based on the national grid is vulnerable, an energy-saving-type, stand-alone system based on solar power is considered to be an appropriate solution.
And, since the compliance with regulations will become important in order to proceed with proper waste-water treatment, transfer from Japan of the knowledge acquired from the experience and the knowhow about regulatory countermeasures in Japan will be utilized as good reference.

Proposed action plan (draft)
For the action plan to promote proper water treatment measures, it is important to (1) examine the feasibility of deployment of a small-scale, decentralized-type waste-water treatment system corresponding the actual situation of Ayeyarwady Region, and (2) create an institutional mechanism to preserve the quality of water and enlighten people's awareness (in order to gain their cooperation to the environmental education approach to promulgate the habit of preserving the water environment).

(1) Examination of the deployment of a small-scale, decentralized-type waste-water treatment system corresponding to the actual situation of the Region.
- Promotion of a small-scale, decentralized-type waste-water treatment system (utilization of Japanese technologies) ~ Energy-saving-type, solar power- combined, stand-alone power-type system ~
- Examination of institutional systems for the small-scale, decentralized-type water treatment measures (Reference: Institutional system in Japan for agricultural village waste-water treatment business).

(2) Creation of an administrative mechanism for the preservation of water quality and enlightenment of people's awareness.
- Clarification of the vision on the preservation of the water environment (Reference: "Vision of Fukushima City on the Fresh-Water and Waste-Water Treatment Measures").
- Creation of a mechanism for the preservation of water quality (Reference: Mechanism of supervision and guidance in Japan).
- Change of people's awareness towards the compliance with regulations (Reference: Study meetings conducted by commercial and industrial groups in Japan; enlightenment activities).
- Environmental education approach to promulgate the habit of preserving the water environment (Reference: Activities on the level of elementary schools).
- Water environment preservation activities with the participation of the administration, business operators, citizens (families), schools and communities (environment beautification activities).

1 Purpose and Implementation Arrangement

1.1 Purpose

Japan proposed its INDC (Intended Nationally Determined Contributions) to UNFCCC (United Nations Framework Convention on Climate Change) in July 2015. Japan's INDC towards GHG emission reductions is at the level of a reduction of 26.0% by FY2030 compared to FY2013 (25.4% reduction compared to FY2005 (approximately 1.042 billion t-CO2 eq), ensuring consistency with its energy mix, set as a feasible reduction target. It further states that the Joint Crediting Mechanism (JCM) is not included as a basis of the bottom-up calculation of Japan's emission reduction target, but the amount of emission reductions and removals acquired by Japan under the JCM will be appropriately counted as Japan's reduction.

Furthermore, in December 2015, Paris Agreement was adopted at 21st COP21 in UNFCC held in Paris, France. Stakeholders besides national government, such as municipalities and industries are becoming more important.

This project aims to support projects that aim to achieve low-carbonization of cities, by formulating projects that can reduce CO2 emissions from energy consumptions, and acquire JCM credit in foreign cities and regions; it aims to do so through city-to-city collaboration with Japanese municipalities that possess know-how in forming low-carbon societies. JCM Feasibility study for low-carbonization of cities was conducted to formulate JCM projects in cities or regions that city-to-city relationship and to establish operation and maintenance structure for Japanese technologies and policies with Japanese research

1.2 Survey Items

The research surveyed the following items for a low-carbon water and sewerage treatment system (rice husk power generation) in the new industrial zone under construction (Pathein Industrial City) in Pathein City, Ayeyarwady Region.

(1) Overview and local needs
(2) Selection of Japanese experiences, know-how, and technologies to be utilized
(3) Project feasibility
(4) Local survey, workshops, and other meetings

1.3 Survey Arrangement

The research was conducted by Mitsubishi Research Institute (MRI), as the representative, cooperating with Fujita, its research partner, Fukushima City and Fukushima Chamber of Commerce and Industry Companies. The research was conducted in coordination with the local partner, Ayeyar Hinthar (a local company developing businesses in various sectors including rice industry, urban development industry, and financial industry).

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 formulation of JCM projects, and supported policy dialogue between Fukushima City and the local government, in addition to its role of the overall project management.
Fujita Corporation, with its knowledge and experiences in industrial, urban, and regional development, further considered the possibility of specific candidate projects.
Fukushima City had policy dialogue with the officials of the local government to discuss policy-side approach for low carbonization of the industrial zone. It also introduced policy-side aspects of “industrial city” including its whole surrounding area, by sharing Japanese experiences. It utilized its experiences and knowledge in creating renewable energy promotion plan, waste treatment plan (with a focus on approaches to recycling, development in waste power generation, waste treatment policies, approaches to low-carbonization, etc.), and in building industrial zones.
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 related to Fukushima City.

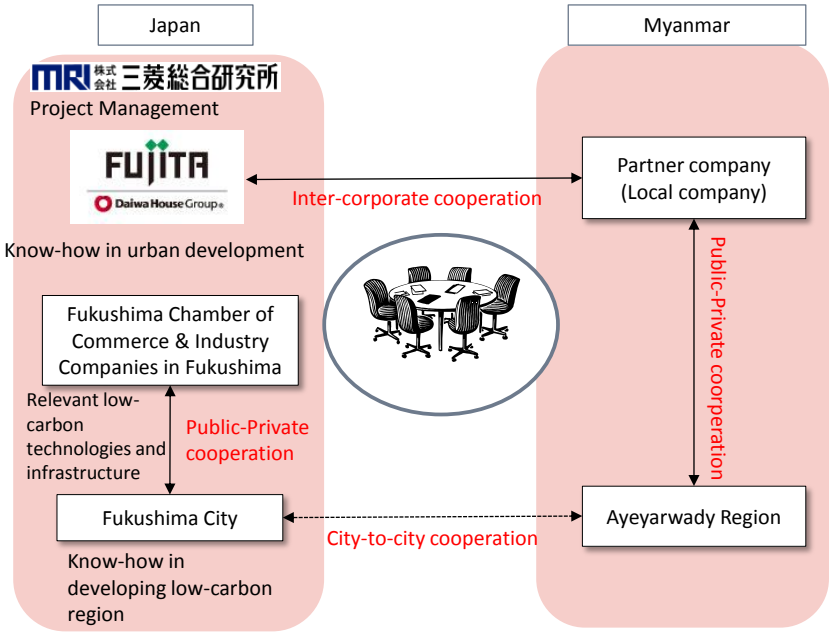


Figure 1-1 Organizational Structure

1.4 Overview of City-to-City Cooperation

In order for Pathein Industrial City, which is currently under development, to achieve a comprehensive development, there are still many issues to overcome, such as procurement of stable supply of power and installation of waste treatment facilities. We can expect a unique development of Pathein Industrial City and its surrounding areas, if we utilize the experience and knowhow of Japan's municipalities and companies for the solution of these issues. And it is also important to proceed with such regional development with certain distinctive features for the promotion of industrial clusters and industrial development. Myanmar has high expectations for the utilization of the experience and technologies of Japan which experienced a rapid economic growth in the past. When the Chief Minister of Ayeyarwady Region visited Japan towards the end of April 2015, he learned about the activities related to energy efficiency and renewable energy in Fukushima City. Then, in June of the same year, the Chief Minister sent an official letter of intent to the Mayor of Fukushima City asking for support and cooperation in the development of Pathein Industrial City (letter asking for support and cooperation for the creation of a sustainable low-carbon city under an inter-city cooperation scheme) .

In response to such a request for support and cooperation, Fukushima City, the Fukushima Chamber of Commerce & 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 inter-city cooperation, and decided to perform activities for the inter-city cooperation. 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 making the project applicable to the subsidies under JMC scheme. And furthermore in February 2016, when government officials of Fukushima City visited the site in Ayeyarwady Region, they handed to the Minister in charge of the Region a letter from the Mayor of Fukushima City responding to the request for support and cooperation, and expressed Fikushima City's willingness to cooperate with Ayeyarwady Region not only in the secctors 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.

- First workshop in Pathein City (September 2016, Pathein City)
- Workshop in Fukushima City (October 2016, Fukushima City)
- Discussions with visitors to Japan, site visits (January 2017, Tokyo)
- Second workshop in Pathein City (January 2017, Pathein City)

The initiatives of inter-city cooperation through this Partnership were studied in two feasibility studies conducted in FY 2016 to examine the feasibility of utilizing JCM scheme towards the realization of low-carbonization of Ayeyawady Region; namely, in both "Feasibility study of introducing low-carbon water and sewage treatment systems in Pathein Industrial City" and "Feasibility study of introducing low-carbon waste treatment systems in Pathein Industrial City".

- Outline of the workshops and field surveys by Fukushima City

When government officials of Ayeyawady Region visited Fukushima City from October 20 to 22, 2016, a workshop was held in Fukushima City. They also made a survey of Fukushima City's initiatives by visiting final disposal facilities as well as water treatment facilities.

They made a courtesy visit to the Mayor of Fukushima City, and exchanged opinions on future cooperation between Ayeyawady Region and Fukusima City with persons in charge of the Fukushima Chamber of Commerce & Industry at the seminar held to welcome the visitors from Myanmar.

Courtesy visit to Fukushima City Mayor

Discussions with the Mayor

Presentation of commemorative item from Fukushima City

Presentation of commemorative item from Myanmar

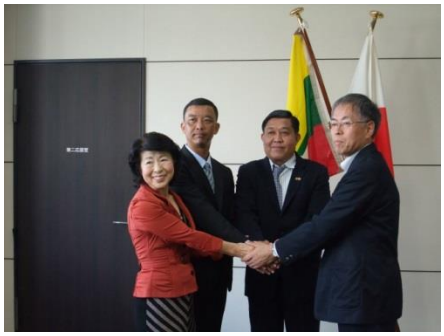


Photo with Fukushima City officials and Fukushima Chamber of Commerce and Industry member

Policy lectures from Fukushima City officials

Lecture

Photo

Networking Event by Networking Event by Partnership for a Low-Carbon Initiative in Ayeyarwady

Opening Note by Vice President

Opening Note by Mr. Aung Min Naing

In September 2016, the first on-site workshop was held in Pathein City with participation of government officials of Ayeyawady Region and of members from Japan (Mitsubishi Research Institute and Fujita), and a field survey was conducted. At the on-site workshop (held on September 20), the Chief Minister of Ayeyawady Region took the trouble of attending the first part of the workshop. In the field survey, the members from Japan paid a visit to the Development Division of the Region and conducted interviews with General Manager and persons in charge of the Division in order to gather the most up-to-date information about the current situation and future development trend. In addition, the members exchanged opinions about the situation of the new industrial zone, by visiting related facilities.

2 Overview and Needs of the Project Area

2.1 Overview of Myanmar and Ayeyarwady Region

Myanmar has been undergoing a rapid economic development in recent years, and it is one of the most attention-gathering regions in Asia. It consists of seven divisions and seven states. Ayeyarwady Region is an administrative region located in the delta along the Ayeyarwady River. It is in the south of Myanmar; in its north is Bago, in its east is Yangon, in its south is the Bay of Bengal.

Table 2-1 Overview of Myanmar and Ayeyarwady Region

	Myanmar	Ayeyarwady Region
Area	676,579 km2 (1.8 times that of Japan)	35,000 km2
Climate	Most of the land belongs to tropical or sub-tropical zone with great difference of temperature and precipitation depending on the location. A year can be divided into three seasons: wet season (mid-May to October), dry season (October to February), and hot season (March to May)	Delta area located in the south of Myanmar
Population	51.48 million (as of 2015.5.29) *Source: Ministry of Labour, Immigration and Population	6.18 million
Population Density	74 people/km2	177 people/km2
Households	10.88 million households	1.49 million households
Local Administration System	Composed of seven Divisions and seven States. Divisions are mainly inhabited by Burmese, while States are mostly populated by other minority people.	Capital: Pathein City
Correnrt situation	On March 30th, 2016, Htin Kyaw was declared as the new President. On March 31st, Htin administration by NLD (National League for Democracy) was established. Responsibilities of the ministers were approved. New administration by NLD has been initiated with high expectation from the citizens.	New Chief Minister,and Ministers were appointed.

Source: Ministry of Foreign Affairs, JETRO

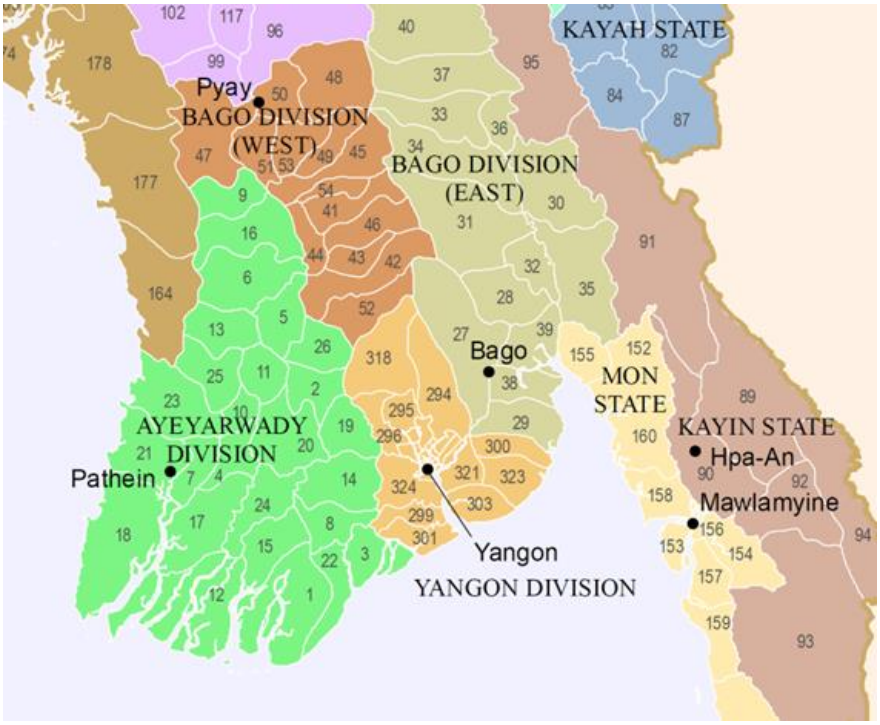


Figure 2-1 Location of Ayeyarwady Region and Pathein City

Source: Myanmar Information Management UNit

2.2 Overview of Pathein City and Pathein Industrial City

This survey focuses on Pathein City, the capital of Ayeyarwady Region; its population is approximately 0.3 million and 0.14 million live in the central part of the city. The size of the city is approximately 25.8 square miles and the altitude is 11.53 feet. The city is situated at the bank of Pathein River, which is a tributary of the Ayeyarwady River. It is the second largest port city in Myanmar after Yangon. It is attracting increased attention as the base for new development area; development of deep-sea port which is accessible by large ships is planned in the future, and construction of access road and rails from Yangon is underway. Pathein City has established its vision towards 2040; within the vision, it aims to achieve three pillars for development. It aims to establish itself as the hub for tourism, logistics, and green agriculture. The overview of Pathein City is shown below.

Table 2-2 Overview of Pathein City

Area	10,898 km2
Population	1,636,716
Population Density	150/km2
Labor population rate	61.9%
Unemployment rate	3.8%
Literacy rate	93.8%
Main agricultural products	Rice, beans, etc.
Main manufacturing products	Textile

Source: http://www.patheinic.com/dev/

In addition to Pathein Industrial Park (approximately 250 acres) Hinthada Industrial Zone (approximately 86 acres), and Myaungmya Industrial Zone (approximately 58 acres), construction plan for new industrial zone called Pathein Industrial City is proceeding with the leadership of the Minister of Ayeyarwady Region, to achieve further industrial development. The milestone of Pathein Industrial City is shown in the figure below. The support from the region was determined in November 2012, and a feasibility study begun within the same month. In March 2014, land acquisition started to take place, and a report for design of the industrial park was proposed in November. In April 2015, reports for EIA (Environmental Impact Assessment) and SIA (Social Impact Assessment) were turned in, and with the completion of these reports, MIC application was proposed in November 2015. Completion of phase 1 is planned in March 2019.

Figure 2-2 Milestone of Pathein Industrial City

Note: Recent material shows that the phase completion will be in March 2019
Source: http://www.patheinic.com/dev/

Pathein Industrial City is an industrial zone with an area of approximately 1,000 ha, placed three hours away from Yangon by car and five minutes from Pathein by car. It is expected that the industrial city would serve as the center for economic development in Ayeyarwady Region, due to its high accessibility from Yangon and construction plan for large port. Basic information of Pathein Industrial City is shown in the table below.

Table 2-3 Overview of Pathein Industrial City

Area	1770 acre
Power supply	106.5 MW (by 2017)
Water supply	24,000m3/day (by 2018)
Wastewater	22,000m3/day (by 2019)
Access to main road	21km (Papawaddy Main Road)
Access to port	4km (Pathein Port)
Access to rail station	5km (Pathein Station)
Access to airport	10.9km (Pathein airport)

Source: http://www.patheinic.com/dev/

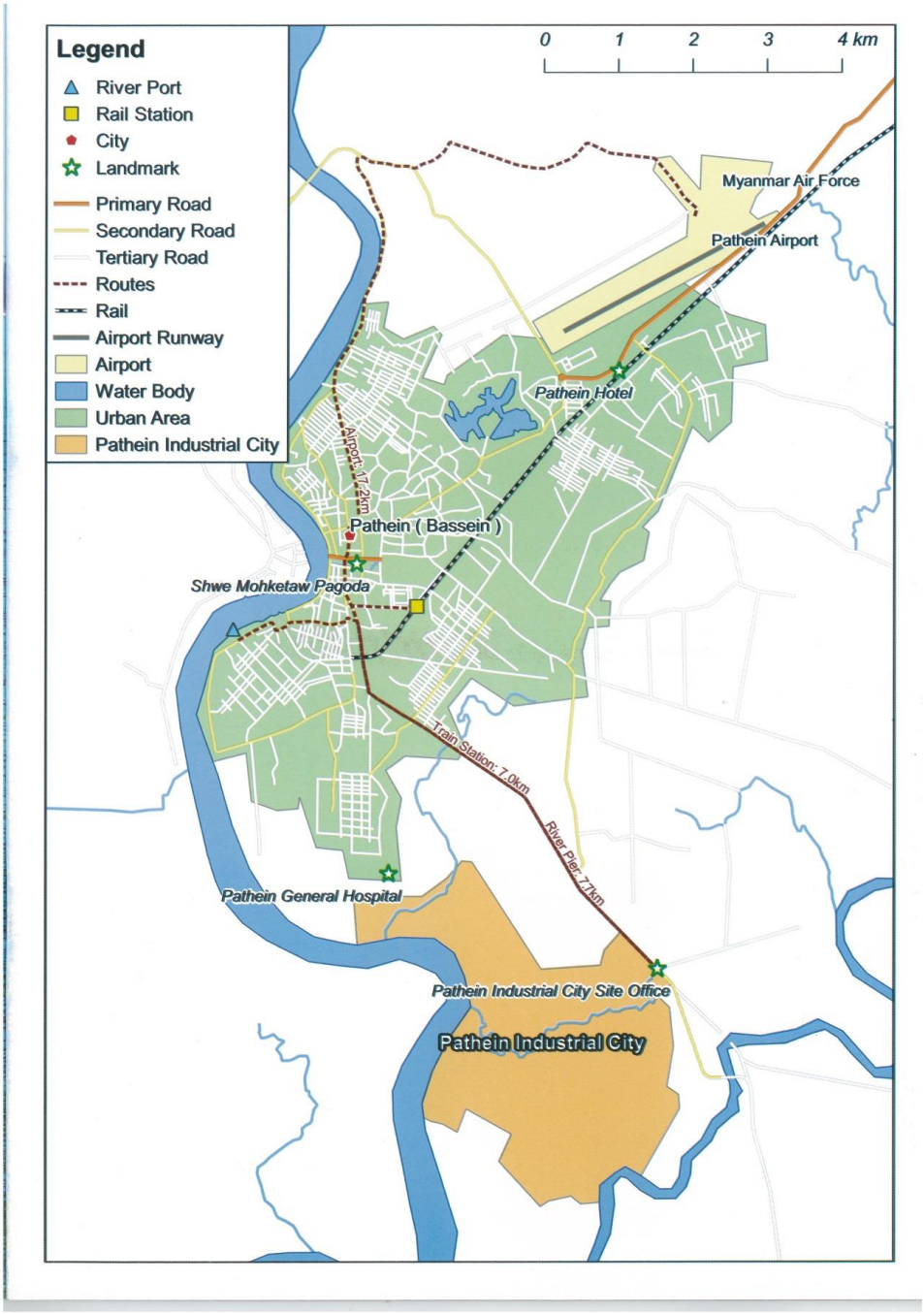


Figure 2-3 Map of Pathein Industrial City

Source: Pathein Industrial City

With the industrial zone at the center, Pathein Industrial City is to comprehensively develop related infrastructure such as housings, large commercial facilities, hotels and leisure facilities, and to develop the area as an export base. Various social and economic impacts in the area, including industrial accumulation, employment, development of regional economy, and decreased poverty, are expected with the development of Pathein Industrial City.

2.3 Overview of Water Treatment in Myanmar

2.3.1 Policies and Regulations for Water and Sewerage Treatment

Areas equipped with the infrastructure of water and sewerage treatment system are very limited in Myanmar. Pathein City does not have water treatment facility. Water is supplied from the well; bottled water is used as drinking water. Sewerage is treated by first storing them in the septic tank; after its upper layer is released, the sludge at the bottom of the tank is drawn by vacuum. The drawn sludge is brought to the suburbs, where it is infiltrated into the ground, and the rest of the dry solid material is used as fertilizer. Industrial effluent is released directly through the city's gutter.

Figure 2-4 Waste Water Treatment in Myanmar

Environmental policies in Myanmar are based on Environmental Conservation Law (2012) and Environmental Conservation Rules (2014). However, there are no environmental standards at the national level. Therefore, standards for waste water may be established at the municipal level, such as YCDC (Yangon City Development Committee) and MCDC (Mandalay City Development Committee), but PCDC (Pathein City Development Committee) does not possess any standards of its own.
In December 2015, National Environmental Quality (Emission) Guidelines that regulate the maximum amount of materials released into the environment were established. The guideline sets emission regulations for the air and water by sector. However, no rules for adhering to the guideline (e.g. reporting, monitoring, penalties, etc.) have been made clear yet; in the future, such laws and guidelines are likely to be established.
As there is no seweragetreatment facility in Pathein City currently, treatment is done by individuals with their own treatment tanks.

2.3.2 Key Issues for Water and Sewerage Treatment

In the workshop held in September, Pathein City officials showed their intention of providing water and sewerage treatment facilities in a timely manner to form healthy and sanitary city. Key issues discussed in the workshop are explained below.

(1) Lack of knowledge in the process for providing water and sewerage treatment facilities
There are no detailed plans for providing sewerage treatment plants. There are numerous items to be considered in prior to starting a sewerage treatment plant project, such as

areas that need sewerage treatment facilities, their size and their treatment method. As there is no experience of formulating a plan for water and sewerage treatment facilities in Myanmar, the officials have not been able to grasp the items that they need to study. Therefore, key challenges for providing such facilities are not clear in detail.

(2) Lack of knowledge in the treatment method for water and sewerage treatment
Pathein City does not have sewerage treatment system, and industrial effluent is released directly into the gutter without treatment. The city has intentions to proceed with providing sewerage treatment facilities in factories, but the factories do not have knowledge on the treatment method of effluent.

(3) Lack of knowledge in operation of water and sewerage treatment plants
In operating water treatment plants, there are numerous items to be considered for their operation, such as collecting bills and maintaining facilities, but the city is not able to start considering them due to its lack knowledge in operation of these plants.

(4) Lack of electricity infrastructure
Concern for the lack of electricity supply in Pathein City was strongly expressed at the workshop. To consider new water treatment facility means that there will be more demand for electricity. Therefore, while there is recognition for the need of water treatment facility to improve public health, deployment of new facilities is being carefully considered upon officials.

2.4 Overview of the Electricity Sector

Policies on electricity and energy are managed by Ministry of Electricity and Energy, The departments under the ministry are roughly categorized into two; one overseeing the electricity sector and the other overseeing the energy sector.
The departments in the electricity sector originally belonged to the Ministry of Electric Power under the former government. Department of Electric Power Planning is in charge of electricity policies and plans. Department of Electric Power Transmission and System Control is in charge of various projects related to transmission and grid control. Plans for new power plants are overseen by the Department of Hydropower. Electric Power Generation oversees power generation. Distribution is conducted by Electricity Supply Enterprise. Electricity distribution in Yangon City and Mandalay are conducted by Yangon City Electricity Corporation and Mandalay City Electricity Corporation.
Myanmar Oil and Gas Enterprise, Myanmar Petrochemical Enterprise, Myanmar Petroleum Products Enterprise are in charge of various projects in the energy sector.
The organizational structure of the Ministry of Electricity and Energy is shown below.

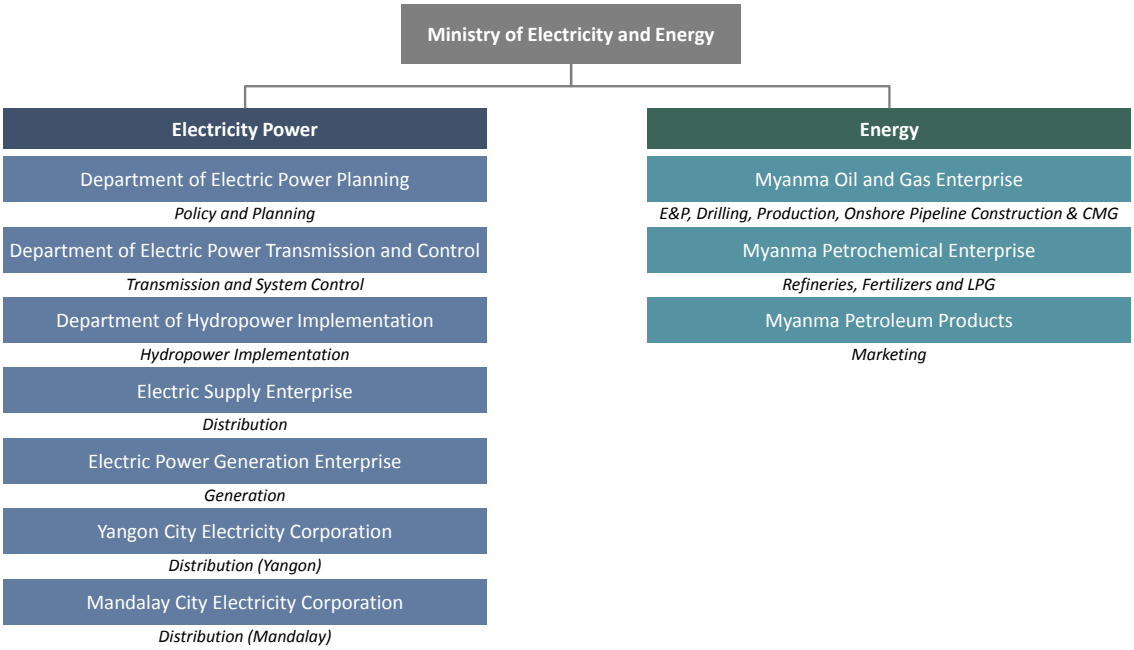


Figure 2-5 Organizational Structure of the Ministry of Electricity and Energy in Myanmar
Source: Current Status & Opportunities for Myanmar Electricity and Energy Sector

2.4.1 Electricity Tariff in Myanmar

Electricity tariff in Myanmar was raised in April 2014, in order to save the power sector from its financial deficit, although there were oppositions from the citizens during the former government. It was the first tariff rise in two years since January 2012. The current government raised residential tariff by 15% and industrial tariff by 40%. The current tariff is shown below.

Table 2-4 Electricity Tariff in Myanmar

	Consumption kWh/month			Tariff MMK/kWh
Residential	1	~	100	35
	101	~	200	40
	201	~		50
Industrial	1	~	500	75
	5,001	~	10,000	100
	10,001	~	50,000	125
	50,001	~	200,000	150
	200,001	~	300,000	125
	300,001	~		100

Source: Infromation from local government

According to the current electricity tariff table, rate for households with the least amount of electricity consumption (1~100 kWh/month) is set at 2.8 JPY/kWh (0.08 MMK/JPY), which amounts to monthly bill of approximately 140~280 JPY. Households with such consumption, less than 3 kWh/day, would be of a low income class.

Compared to Japan, of which average household daily consumption is approximately 20 kWh, consumption standard in Myanmar is less than sixth of that in Japan. Furthermore, rate for high-income households in Myanmar (possessing a living environment of one air-conditioner per room) is as little as 4 JPY/kWh. Considering that the Japanese tariff is 13~20 JPY/kWh, the electricity tariff of Myanmar is set at a very low level.

While large industrial customers have a lower tariff rate in Japan, they bear a larger burden for electricity in Myanmar. Small rice millers (monthly consumption of 288,000 kWh) in Ayeyarwady Region, for example, must pay the second highest rate of 10 JPY/kWh (125 MMK/kWh), and smaller millers must pay the highest rate of 12 JPY/kWh (150 MMK/kWh). Under such circumstances, there is a large possibility for these smaller rice millers to be screened out by larger businesses.

It is not certain whether the financial deficit of the power sector has been cleared with the aforementioned tariff raise, as no official comments have been made by the government. Nevertheless, to accomplish sustainable economic growth win accordance with the increasing electricity demand, electricity tariff in Myanmar inevitably needs to be raised again, or restructured.

2.4.2 Electrification Policy in Myanmar

Electricity generation in Myanmar for the past few years is shown in the figure below. The amount has been increasing annually; generated amount of 8,625 GWh in FY2010 increases to 14,156 GWh in FY2014.

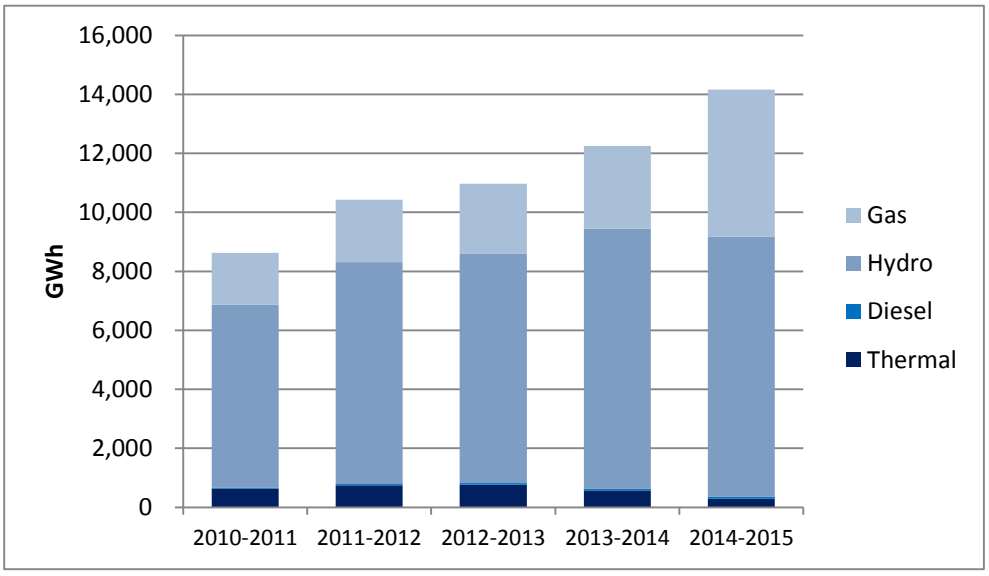


Figure 2-6 Electricity Generation in Myanmar

Source: Central Statistical Organization

While electricity generation from hydropower plants holds a large portion of the total generation, the share is annually decreasing. While these plants can cover the peak demand during the rainy season, power demand from the commercial and industrial sector must be curtailed as hydropower generation decreases in the dry season.

In accordance with the economic development in Myanmar, its power demand is expected to grow rapidly. To achieve sustainable economic growth, it is vital for power supply to be able to meet such increase in demand. Projection of energy consumption is shown in the figure below.

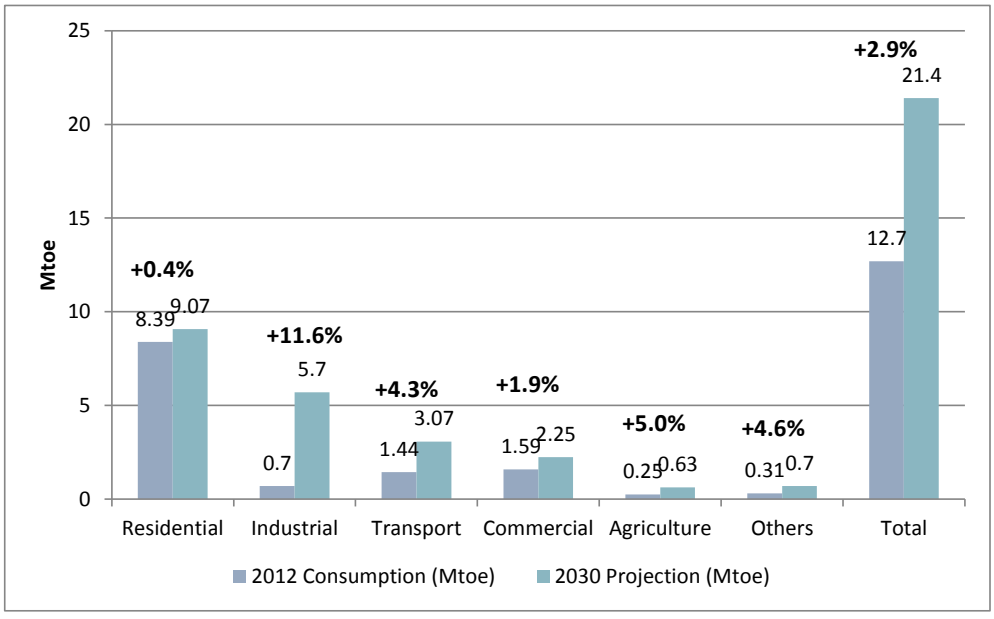


Figure 2-7 Projection of Energy Consumption by Sector

Source: Central Statistical Organization

Although rise in power demand is expected, electrification rate in Myanmar is significantly lower than the other South Asian countries. Electrification in the rural area in particular is recognized as an issue in Myanmar. With the support of international organizations such as the World Bank, a National Electrification Plan was formulated in Myanmar, which aims to accomplish 100% electrification rate by 2030.

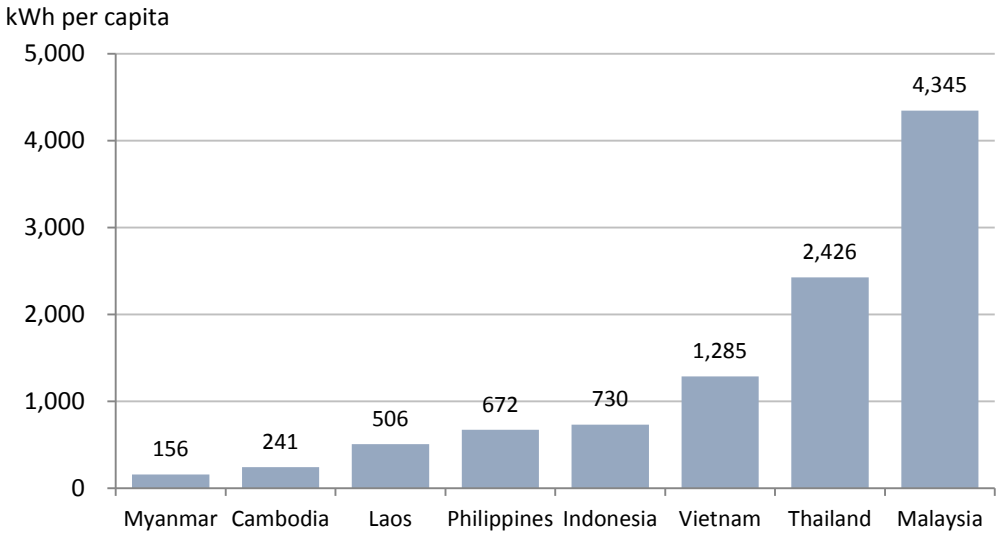


Figure 2-8 Electricity Consumption per Capita in ASEAN Countries

Source: ADB Economics Working Paper Series "Power Sector Development in Myanmar" (October 2015)

While the main grid is planned for a large scale rollout, in the short term, rural areas are planned to be supplied from off-grid, as stated in the National Electrification Plan. Generation in off-grid is mainly from diesel generators and small-scale hydropower, but solar systems are planned to be utilized as well in the plan.

	Installed Capacity (MW)	Generation (GWh)
Diesel Generator	78.999	50.743
Small Hydropower	33.33	44.114

Table 2-5 Power Generation of Off-Grid (2012-2013)

Source: National Energy Policy (2014)

2.4.1 Renewable Energy in Myanmar

There is a high demand for renewable energy, as distributed energy for use in off-grid and from the environmental aspect. However, there is no policy to subsidize for the high cost of renewable energy in Myanmar, such as the Feed-in-Tariff scheme. Therefore, while small-scale solar systems in the rural areas are relatively popular, larger renewable energy projects (e.g. wind and solar) are still underdeveloped. Research of renewable energy potential in Myanmar is conducted by the Ministry of Science and Technology (MOST).

To strengthen power supply from off-grid in the rural area, utilization of distributed energy such as renewables is highly effective.
Renewable energy project in Myanmar has been gathering increased attention in the past few years. U.S. compay, Convalt Energy, has a project plan of 300 MW solar power plant (480 million USD project) in Mandalay Region, and the project was permitted by MIC (Sourece: Conval Energy website). In addition, it has been reported that Thailnd's Green Earth Power is planning to develop a 220 MW solar power plant (350 million USD project) in Magway Region(Sourece: Myanmar Times, 20 May 2016). While there have been several press releases about such projects, as wholesale cost of electricity is at a very low level in Myanmar, making it difficult to gain enough revenue to cover for the project cost. Power Purchase Agreement would be the key to establishing renewable energy project in Myanmar.

3 Utilizing Japanese Experiences, Know-How, and Technologies

In this chapter, policy-making experiences, cases, and promising technologies for waste treatment in Japan are identified.

3.1 Policies

3.1.1 Fundamental Policy for Waste Water Treatment

To realize an environmentally-friendly and beautiful region, which are proposed in the comprehensive plan for Fukushima City, “Vision for Waste Water Treatment in Fukushima City” was established to clarify necessary programs for waste water treatment from 2016 to 2025.

The three main principles in this vision are: (1) city with beauty, (2) city with safety, and (3) city with sustainability. To accomplish the first vision of “city with beauty,” deployment of waste water treatment system, improvement in combined sewerage treatment, and utilization of waste water resources are proposed to achieve a city with low environmental damage. To accomplish the second vision of “city with safety,” construction of rainwater management system and earthquake-withstanding sewerage treatment system are proposed to achieve a city with disaster resiliency. To accomplish the third vision of “city with sustainability,” efficient management of sewerage treatment facility and its asset life extension, strengthening of sewerage treatment management, and cooperation with residents are proposed to achieve a city with sustainability. Under these principles, there are 28 detailed action programs in the vision.

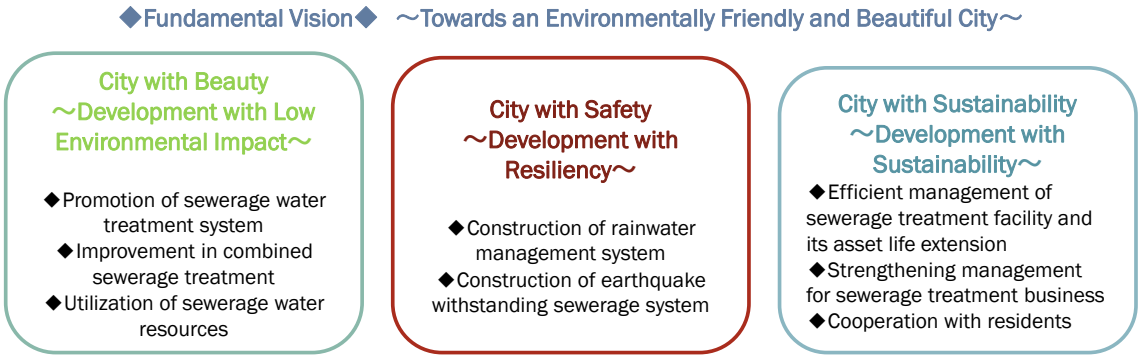


Figure 3-1 Fundamental Principles in Vision for Waste Water Treatment in Fukushima City

Source: Vision for Waste Water Treatment in Fukushima City

Monthly water quality inspection for major rivers in Fukushima City is conducted to monitor water quality contamination. In 2014, the inspection was conducted at 23 points for 17 rivers.

There may be on-site inspection for effluent at certain business sites. In 2014, there were 84 on-site inspections for effluent quality monitoring survey in total (at 74 business sites).

In addition to the national effluent quality standard, effluent standards at the prefecture level are posed. Guidance and monitoring is conducted for business sites that are not under the legislative regulation, according to the prefectural ordinances.
Even when inspection is not conducted by the city, for particular business owners, measurement of effluent and recording of the results is necessary.

3.1.2 Educational and Guidance Activities for Water Treatment

(1) Environmental Education
Fukushima City conducts environmental education using its own textbook called “Our Fukushima.” There are various educational programs in addition to lectures; the findings through such programs are presented in the end.

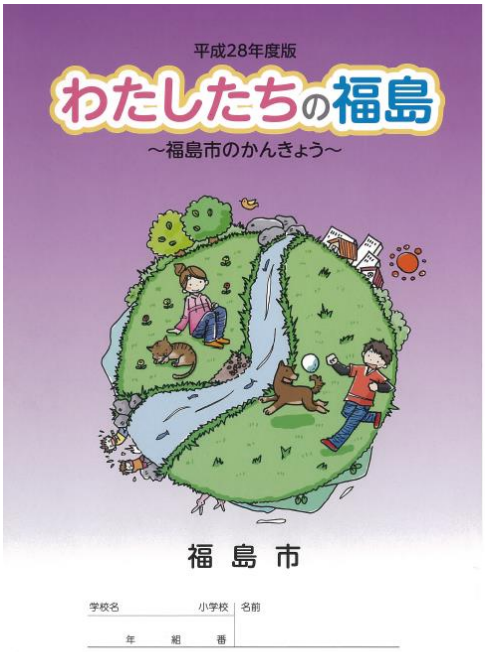


Figure 3-2 Textbook Cover for “Our Fukushima”
Source: Textbook “Our Fukushima” by Fukushima City

For instance, at elementary and middle schools in Fukushima City, educational programs that involve visit to neighboring rivers and discussions on environmental measurement are provided. Additionally, for students to consider saving water in their daily lives, water used for washing brushes and palettes for paint is compared between cases of using the whole sink and a bucket.

(2) Guidance for Business Owners and the Community
Various activities are conducted together among the city, business, and the community to improve awareness for water treatment, in addition to environmental education. There is a supporting scheme for volunteer groups involving beautification activities. Groups that have been engaged in beautification and cleaning activities at public

places (including rivers) for more than three times a month over a year are registered by the city and are able to promote the group and their activities through the city's website. In addition, registered groups are able to receive insurance for their activities. There are currently 273 registered groups as of February 2017. Overview of such supporting scheme is shown below.

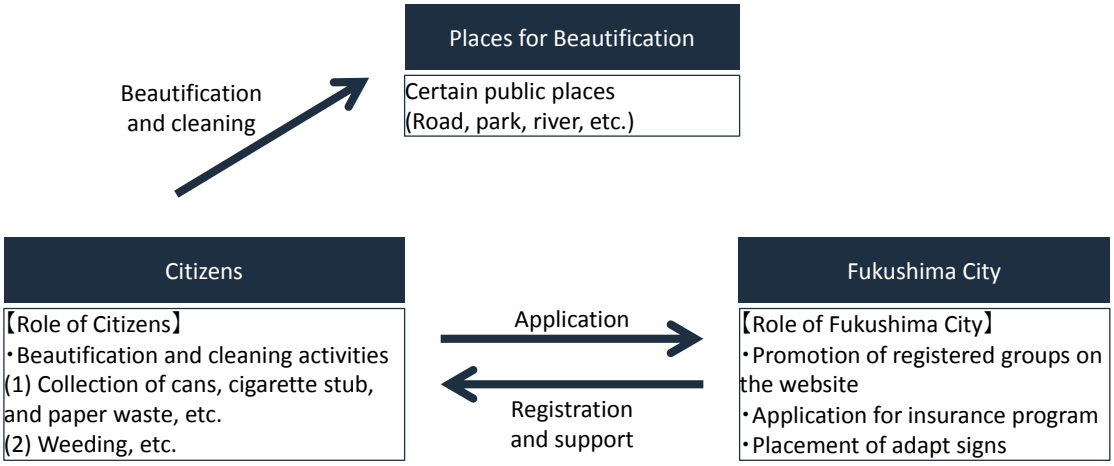


Figure 3-3 Overview of Supporting Scheme for Beautification Activities

Source: Fukushima City website

3.2 Cases

Fukushima City promotes agricultural community effluent treatment programs for agricultural regions outside of the sewerage treatment area under water quality contamination. Such programs are conducted in the Oda District and Yamaguchi District. In Oda District (99 ha) located in the southwest of Fukushima City, agricultural community effluent treatment was prepared from 1995 to 1999 at a project total cost of 2.4 billion yen. This project is planned to process water for 1,520 people.

Location	Part of Oda, Yamada, and Omori (Approx. 99ha)
Treatment Type	Separated system (only treats sewerage within the agricultural community)
Treatment of sewerage	Sewerage pipe of approx. 17 km is constructed. Sewerage collected through these pipes is treated at the treatment site in Oda District. The treated water is released into Nigori River.
	

Figure 3-4 Agricultural Community Effluent Treatment Program in Oda District

Source: Vision for Waste Water Treatment in Fukushima City

Location	Part of Yamaguchi and Okajima (Approx. 213ha)
Treatment Type	Separated system (only treats sewerage within the agricultural community)
Treatment of sewerage	Sewerage pipe of approx. 21 km is constructed. Sewerage collected through these pipes is treated at the treatment site in Yamaguchi District. The treated water is released into Kurumi River.
	

Figure 3-5 Agricultural Community Effluent Treatment Program in Yamaguchi District

Source: Vision for Waste Water Treatment in Fukushima City

3.3 Promising Technologies

3.3.1 Non-Aeration Sewerage Treatment Facility

(1) Conventional Sewerage Treatment System

Sewerage treatment are composed of primary treatment which physically removes solid substances from the sewerage, secondary treatment which removes organic substances from the sewerage using microorganisms, and tertiary treatment which removes nutrients such as phosphorus and nitrogen with higher removal capability of organic substances.

There are roughly two ways to supply oxygen for microorganisms in the secondary process: through aeration and through carriers of trickling filter. There are mainly three methods for supply through aeration: air diffusion, surface stirring, and machinery stirring.

At sewerage treatment facilities in Japan, aeration system through air diffusion is the most popular as it can adjust the amount of aeration and meet fluctuating demand. Assuming that necessary amount of electricity for sewerage treatment is 0.49 kWh/m3, water treatment process would require approximately 0.24 kWh/m3, which is approximately 48% of the whole process. Most of the consumption comes from the blower, which increases the electricity use for the whole treatment process as well.

At the sewerage treatment facility under YCDC that has been in operation since 2003 in Yangon, surface mixing method is utilized. This method is one type of lagoon method which supplies oxygen by surface mixing without aeration; it is necessary to maintain a low load. Furthermore, there may be a gap between the surface and the lower layer when mixing. The method used at the Thilawa Industrial Park uses the conventional activated sludge process; this process is expected to become the major method in Myanmar. In this study, we will compare the proposed non-aeration type to the conventional activated sludge process.

(2) Characteristics of Non-Aeration Type Sewerage Treatment

Non-aeration sewerage treatment system with trickling filter proposed in this study, DHS (Down-Flow Hanging Sponge) System, was developed by Sanki Engineering, Tohoku University, and Japan Sewage Works Agency. The demonstration projects have been conducted in Japan (final treatment site in Susaki City, Kochi Prefecture) and overseas (Agra, India). Waste water flows through the carriers, and the bacteria that the carriers possess break down the organic substances within the sewerage.

The system possesses the following characteristics.

- Aeration is not necessary.
  Air is taken in when the sewerage flows through the carriers; using this bacteria break down substances.
- Treated water quality is stable
  There is high water retention capability within the carriers of the sponge, and the carriers are able to hold sludge at a high density. Even when the amount of sewerage decreases, it is able to maintain a stable level or treated water quality.
- There are very few items for maintenance.
  Sludge treatment is not necessary, as sludge is not generated from self-digestion, and carriers do not close; it is unnecessary to change carriers at least for 10 years.
- The system can be designed based on the amount of treated water
  The amount of carriers can be calculated from the quality and amount of water, and additional equipment is not necessary. Therefore, even for small scale treatment facility, initial investment can be reduced.

DHS system does not require aeration, and it is able to largely reduce electricity consumption. Especially from the point of view of constructing sewerage facility in a developing country with unstable power supply, there are high expectations for its promotion.

Furthermore, necessary equipment for treatment system, such as pumps, is not manufactured in Myanmar and usually requires import; therefore, acquirement of necessary equipment and engineers must be done overseas. On the other hand, as DHS system requires very few equipment, it is less likely for troubles to occur. Additionally, it does not involve sludge treatment process, so necessary maintenance is reduced. As Pathein City currently does not own any sewerage treatment facility, PCDC workers do not have any experiences in managing the treatment facility. Therefore, simplicity in management would be an important benefit for deployment in Pathein City.

3.3.2 Installment of Photovoltaic System

(1) Overview of PV System

This study proposes to install PV panels on the tanks at the sewerage treatment facility, to utilize the space and to improve the water quality through shading effects. Such system is used in Japan as covering system. There are various types of such system; removable covers made of aluminum, floating type PV panels, etc. The detailed design for Pathein Industrial City will be made in the future, but it is expected that there will be a large reservoir of which top can be utilized.

Figure 3-6 Pathein Industrial City Water Treatment Facility (Image)

Source: Pathein Industrial City brochure

(2) Considerations for Installed Capacity

The scale of PV system proposed in this study will be able to cover the necessary amount of electricity in water and sewerage treatment facility. It is assumed that necessary electricity is 0.23 kWh/m3 for water treatment facility and 0.49 kWh/m3 for sewerage treatment facility.

Facility	Electricity Consumption	Notes
Water treatment	0.23kWh/m^3	43% of 0.53kWh/m^3 (Water intake, flow, and treatment)
Sewerage treatment	0.49kWh/m^3	Includes aeration

4 JCM Project Formulation and its Feasibility Study

4.1 JCM Project Formulation

Possible project for JCM, its project site, and installed technologies were considered for low carbon water and sewerage treatment system (PV system and energy efficient water treatment) at Pathein Industrial City is considered.

4.1.1 Project Overview

At the water treatment facility and the sewerage treatment facility to be constructed in Pathein Industrial City, energy efficient treatment equipment and renewable energy will be implemented. Pathein City suffers from unstable power supply and frequent power outages; stable water treatment that does not rely on power supply from the grid will be possible by reducing the amount of electricity consumption as much as possible and introducing power generator within the facility.
The proposed low carbon water and sewerage treatment system could serve as a model case to promote future construction of water and sewerage treatment facility within Pathein City, which would lead to future GHG reductions as well.

4.1.2 Project Site

The project site will be the planned construction site of water and sewerage treatment facility within Pathein Industrial City. The site is being determined by Ayeyar Hinthar, the developer of the industrial park. The water is taken from and released into Pathein River.

4.1.3 Applied Technology

The total area of Pathein Industrial City is 1,770 acres (approximately 7,000,000m2), and its water process amount is planned to be 24,000 m3/day and its sewerage process amount is planned to be 22,000 m3/day. Factories to be located within the industrial park are under determination. It is expected that the construction of water and sewerage treatment facility will be conducted in several phases, not all at once. This study assumes that the construction will be done in four phases. The process amount is estimated as below. Based on this estimate, installment of non-aeration sewerage treatment system and PV system, reduction in electricity consumption, and their cost are considered.

Table 4-1 Assumptions for Water and Sewerage Treatment Facility

Project Phase	Phase 1 (Phase 1-4 in total)
Scale	Approximately 442 Acres (Total area 1,770 acres)
Water process amount	6,000m^3/day (Final process amount: 24,000m3/day)
Sewerage process amount	4,800m^3/day (Final process amount: 22,000m3/day)

(1) Installment of Non-Aeration Sewerage Treatment Facility

Installment of DHS system is studied as a non-aeration sewerage treatment system. The system configuration, differences in electricity consumption and cost were compared with conventional activated sludge process.

i. System configurations

System configurations for DHS system and conventional activated sludge process are shown in the table below. The DHS filter serves as the aeration tank in a conventional activated sludge process, breaking down the organic substances. In this study, the BOD (biochemical oxygen demand) concentration of the original water is assumed to be 250 mg/L, the goal BOD concentration is set at 20 mg/L (based on National Environmental Quality (emission) Guidelines), and after treatment of DHS System is considered unnecessary.

DHS system that treats sewerage after the first sedimentation tank generates very small amount of sludge; therefore, final sedimentation tank is not necessary. The small amount of sludge generated can be cleaned up at the time of periodical maintenance.

Table 4-2 System Configurations

	Conventional Activated Sludge Process	DHS System
First Sedimentation Tank	Necessary	Necessary
Aeration Tank	Necessary (385m3)	Necessary (DHS filter 130m3)
Final Sedimentation Tank	Necessary (290 m3)	Unnecessary
Facility for Sludge Treatment	First sedimentation tank: necessary Final sedimentation tank: necessary	First sedimentation tank: necessary Final sedimentation tank: unnecessary

ii. Electricity consumption

Electricity consumption for DHS system and conventional activated sludge process are shown below. Aeration blower for the aeration tank becomes unnecessary with the installment of DHS system; the final sedimentation tank becomes unnecessary as well, which takes away the need for sludge scraping machine as well. In addition, since sludge is not generated in the aeration process, facility for sludge treatment (dehydration) is no longer necessary. Assuming that the aeration blower and sludge scraping machine operates for 24 hours and that the sludge treatment facility operates for 7 hours a day, electricity consumption of 733 kWh can be reduced per day, and 267,000 kWh can be reduced per year.

Table 4-3 Electricity Consumption

	Conventional Activated Sludge Process (4800m3/day)	DHS System (4800m3/day)
Aeration tank	Aeration blower: 37 kW*0.8*24h/day*365 days =259,300 kWh/year	-
First sedimentation tank	Sludge scraping machine: 0.4 kW*0.8*24h/day*365 days =2,800 kWh/year	-
Sludge treatment facility	2.7 kW*0.8*7h/day*365 days =5,500 kWh/year	-
Total	267,600 kWh/year 733 kWh/day	-

iii. Installment cost

As DHS system has not been installed in Myanmar in the past, cost of the systems is compared using the domestic price in Japan.

Since there is no aeration process for a DHS system, air diffusing equipment and aeration blower are unnecessary. In addition, since there is no sludge generated from the aeration process, final sedimentation tank and dehydrator are not necessary.
Comparing the installment cost of the two systems, the cost for a DHS system is cheaper by approximately 5 million yen.

Table 4-4 Installment Cost (Equipment)

	Conventional Activated Sludge Process	DHS System
Aeration tank	Air diffusing equipment: 18 million yen	Sponge carriers: 160 million yen
	Aeration blower (including spares): 17 million yen	-
Final sedimentation facility	Sludge scraping machine: 65 million yen	
Dehydrator	65 million yen	-
Total	165 million yen	160 million yen

(2) Installment of PV System

i. System configurations

Locations for placing PV panels in a water and sewerage treatment facility are listed below. When installing a non-aeration sewerage treatment facility (DHS system), the size of aeration tank is smaller and the final sedimentation tank is no longer necessary; therefore, available areas for installing PV panels become smaller as well.

Table 4-5 Locations for PV Panels a Water and Sewerage Treatment Facility

	Location	Available area	Note
Water treatment facility	Sedimentation basin	420 m2	
	Filtering basin	50 m2	Filtering rate of 120m/day
	Distribution reservoir	750 m2	Water storage of 12 hours and sink height of 4 m
Sewerage treatment facility	Aeration tank (DHS filter)	100 m2 (30 m2)	Capacity of 385 m3 and height of 4 m *DHS filter is assumed to be 130 m3 in capacity and 5 m in height

	Final sedimentation tank	75 m2	Capacity of 290 m3 and height of 4 m *Final sedimentation tank is not necessary for a DHS filter
Total		1395 m2	For a conventional activated sludge process system
		1250 m2	For a DHS system

The installed capacity for the PV system is assumed to be just enough for the necessary electricity at water and sewerage treatment facility, as described below.

Table 4-6 Electricity Consumption at Water and Sewerage Treatment Facility

Facility	Electricity Consumption	Note
Water treatment facility	1,380 kWh/day	0.23 kWh/m3*6,000m3/day
Sewerage treatment facility	2,352 kWh/day	0.49 kWh/m3*4,800m3/day
Total	3,732 kWh/day	

Approximately 10,000 m2 is necessary for installment of PV system of a 1 MW scale, which exceeds the amount of available area in water and sewerage treatment facility (1,395 m2 with conventional activated sludge process); therefore, covering type and ground type PV systems are both necessary.

Table 4-7 Overview of the PV System

Installed Capacity	1,000	kW
Average radiation	19	MJ/m2/day
	5	kWh/m2/day
Annual accumulated radiation	1,928	kWh/m2/year
Radiation intensity	1.0	kW/m2
Availability	0.8	
Annual generation	1,542,344	kWh/year
Area	10	m2/kW
Necessary area	10,000	m2

ii. Installment cost

Cost without the base is approximately 0.25 billion yen in total, as shown below.

Table 4-8 Cost for a 1 MW Scale PV System

	Approximate cost
PV panel	80 million yen
Inverter	15 million yen
Installment	140 million yen
Others	15 million yen
Total	250 million yen

4.2 GHG Emission Reduction

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

Table 4-9 Grid Emission Factor based on IEA Data (t-CO2/MWh)

	Coal	Oil	Gas	Average
2009	1.055	0.864	0.729	0.202
2010	1.057	0.786	0.729	0.265
2011	0.979	0.853	0.729	0.192
2012	0.961	0.826	0.729	0.219
2013	0.956	0.825	0.729	0.195
2014	0.969	0.848	0.729	0.280
Emission factor (2009～2013)	-	-	-	0.215
Emission factor (2010～2014)	-	-	-	0.230

Furthermore, installation of gas power plant is under discussion in Myanmar; in the future such thermal power plants will hold a higher share in Myanmar's generation mix from hydropower plants. Therefore, reduction from the proposed project is likely to increase as well. Therefore, estimation of grid emission factor will be treated as ex post.
It is important to keep in mind that monitoring point must be established which can appropriately monitor the amount of electricity sold to the grid, not including the electricity consumed within the plant. In addition, when conducting heat supply as well, it is assumed that boiler with the highest energy efficiency at the thermal supply site or in Myanmar is to be altered. On the other hand, when altering conventional rice husk drying process under the sun, the amount of emission reduction will not be accounted for.

Project of Non-Aeration Wastewater Treatment System

Emission reduction is calculated as follows.

Table 4-10 Result of emission reductions calculation(Non-Aeration Wastewater Treatment System)

saving energy by introducing Non-Aeration Wastewater Treatment System	733	kWh/day
Annual power generation (Net)	268	MWh/year
Emission factor	0.230	kg-CO2/kWh
Emission reductions (planned)	62	t-CO2/year

MRV Methodology (Draft) and Joint Crediting Mechanism Project Design Document Form (Draft) were attached in Appendix V

Project of solar power system

Emission reduction is calculated as follows.

Table 4-11 Result of emission reductions calculation (Solar power)

Capacity (Net)	1,000	kW
Annual power generation (Net)	1,542	MWh/year
Emission factor	0.8	kg-CO2/kWh
Reference emission	1,234	t-CO2/year
Project emission	0	t-CO2/year
Emission reductions (planned)	1,234	t-CO2/year

MRV Methodology (Draft) and Joint Crediting Mechanism Project Design Document Form (Draft) were attached in Appendix V

Issues related to MRV Methodology

In respect of our proposed methodology worked out in this study, issues to be examined before submitting applications for subsidies under JCM scheme are as follows:

Consideration for avoidance of methane gas generation in the reference scenario
In our proposed methodology, we assumed water treatment based on the conventional activated sludge process as the reference scenario. However, in light of the present situation of water treatment in Myanmar, it seems to be also appropriate for us to assume

the avoidance of methane gas occurring at each of the anaerobic treatment of wastewater and the sewage sludge treatment. Thus, when we assume the avoidance of methane gas as the reference scenario, we should design MRV methodology by referring to CDM methodology AM0080 “Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants”, and the like.

Estimate of energy consumption efficiency in the water treatment system
In our proposed methodology, an important point is the volume of reduction owing to the difference in the energy consumption in different water treatment facilities, and accordingly, it is necessary for us to estimate the amount of energy consumption in each water treatment system. As a method of estimating the amount of energy consumption, a JCM feasibility study similar to our study is proposing an estimation formula using a Monod-type curved line formula as the approximation formula, as the energy consumption tends to increase in proportion to the removal load in the range of low CODcr removal load, while the energy consumption tends to gradually decrease in the range where the removal load is relatively high as a result of increase in the treatment efficiency. It will be necessary for us, too, to design this kind of approximation formula when establishing energy consumption efficiency of the reference water treatment system in Myanmar, by conducting a separate study.

4.3 Business and Policy Proposals

4.3.1 Environmental and Social Assessment

Foreign investment must undergo investment approval procedures at MIC (Myanmar Investment Committee) under Foreign Investment Law and Foreign Investment Rules.
In order to acquire approvals for foreign investment, project categories identified under the EIAP (Environmental Impact Assessment Procedures) must conduct EIA (Environmental Impact Assessment) or IEE (Initial Environmental Examination), or prepare an EMP (Environmental Management Plan).
EIAP identifies the following project categories to conduct IEE or EIA: 1) Project in which investment is decided by the Parliament or the government cabinet or the President, 2) energy sector development, 3) agriculture, livestock and forestry development, 4) manufacturing (food and beverage manufacturing, garments, textiles and leather products, wood manufacturing, chemicals manufacturing, manufacture of glass and ceramics, manufacture of construction materials, metal, machinery and electronics), 5) waste management, 6) water supply, 7) infrastructure and service development, 8) transportation, and 9) mining.
There is no compulsory environmental standard referenced in EIA. National Environmental Quality (Emission) Guideline was established in 2015 with reference to Environmental Health and Safety Guideline established by IFC (International Finance Corporation), but this standard is only a reference standard. Therefore, currently, EIA must be conducted with regards to international standards (e.g. JICA, IFC, ADB, etc.).
The PV system installed sewerage treatment project proposed in this study falls under the category of “Wastewater Treatment Plants (centralized systems)” under EIAP. Projects of all scales must conduct EIA under this category.

4.3.2 Project Scheme

(1) System Configuration

i. Non-aeration sewerage treatment facility

- Weather conditions
  The system is suited for regions with temperature above 15 degrees Celsius, as it breaks down organic substances using microorganisms. Pathein City well suits such weather conditions.

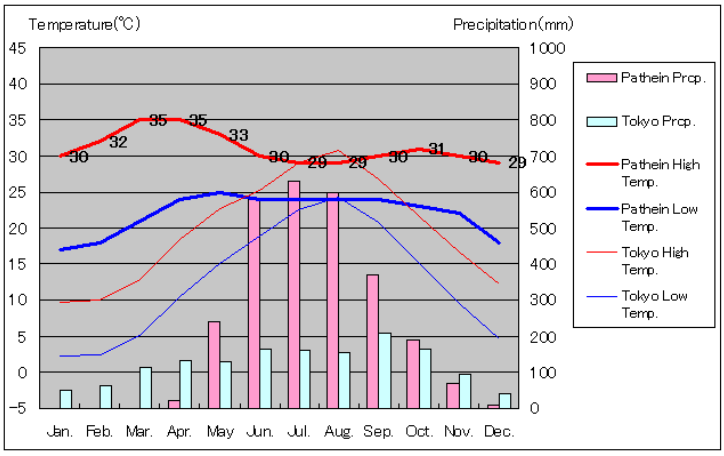


Figure 4-1 Weather Conditions in Pathein City

Source: Zen Tech Website

- Original water quality
  This study assumes that the non-aeration sewerage treatment facility (DHS system) treats inflow water quality of BOD 250mg/L. As most of the water inflow will consist of industrial effluent in Pathein Industrial City, inflow water quality should be considered again at the project formulation phase.

ii. PV system
When placing PV panels on the ground, ground investigations of Pathein Industrial City should be conducted. Soil bearing of 20 kPa and N>60 is necessary at 1.5 m ground level. In addition, 3 acres of land is necessary for a 1 MW system, with wind speed less than 32 m/sec.

(2) Project Investment
Project investment will be according to the SPC investment.

(3) Project Organizational Structure
SPC will be formulated with Ayeyar Hinthar (developer of the industrial city) to install an energy efficient water and sewerage treatment system in Pathein Industrial City. EPC and O&M will comprise of local subsidiaries of Japanese companies, as the non-aeration system proposed under this survey is a Japanese technology. Partner company for PV system is not restricted to Japanese companies; partner selection will be conducted in the future.

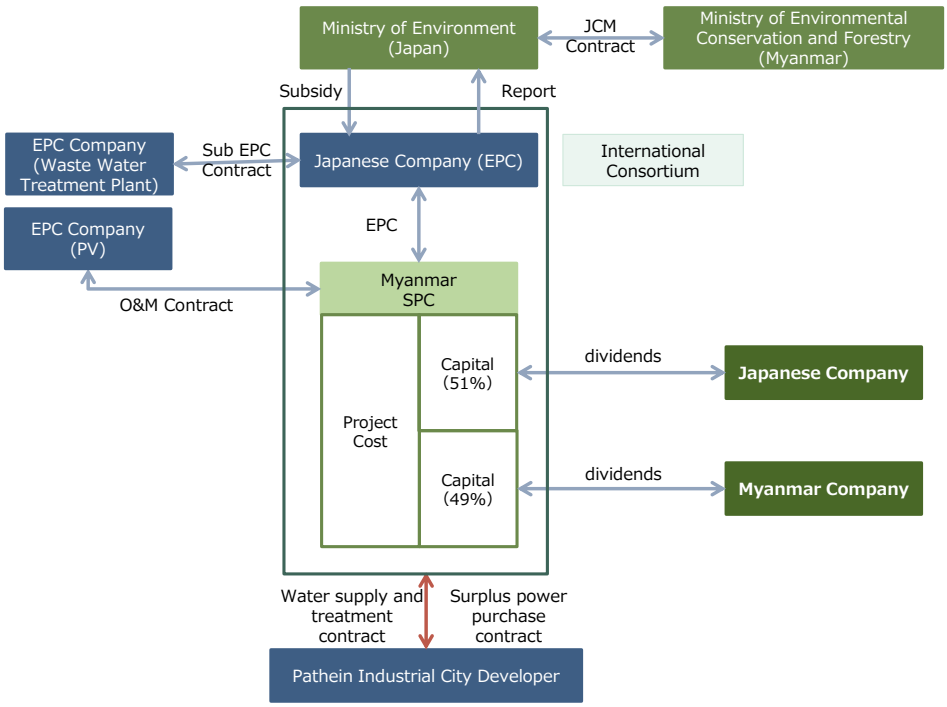


Figure 4-2 Project Organizational Structure (Tentative)

(4) Cost Improvements

Most of cost in a DHS system comes from sponge carriers in trickling filter. This survey assumes that most of the manufacturing work is done in Japan to be transported to Myanmar. However, transportation cost may be reduced with further considerations. In addition, most of the manufacturing work related to sponge carriers comes from personnel expenses; if this technology is further promoted in Myanmar, manufacturing may be conducted in Myanmar as well, from which we can expect cheaper system cost and employment.

Furthermore benefits are expected.

(1) Reductions from Concrete Consumption (Conservation of resources)

Necessary capacity for tanks becomes smaller, or tanks may not be necessary at all with the proposed sewerage treatment system. Reduction in the amount of concrete to be consumed can be estimated as below. When installing the non-aeration system, concrete amount can be reduced by 90m3 compared to the conventional activated sludge process.

Table 4-12 Necessary Amount of Concrete

Conventional Activated Sludge Process	Non-Aeration System
Necessary concrete: 145 m3 Aeration tank: 100 m3 (400 m3 capacity with wall of 350 mm thick) Sedimentation tank: 45 m3 (314 m3 capacity with wall of 350 mm thick)	Necessary concrete: 55 m3 DHS filter: 55 m3 (150 m3 capacity with wall of 350 mm thick)

(2) Reduction of Sludge Generation

Conventional activated sludge process precipitates the sludge from the aeration process in the final sedimentation basin and treats it with dehydration. There is no incineration system for sewerage sludge in Myanmar, so dehydrated sludge is expected to be landfilled under anaerobic environment.

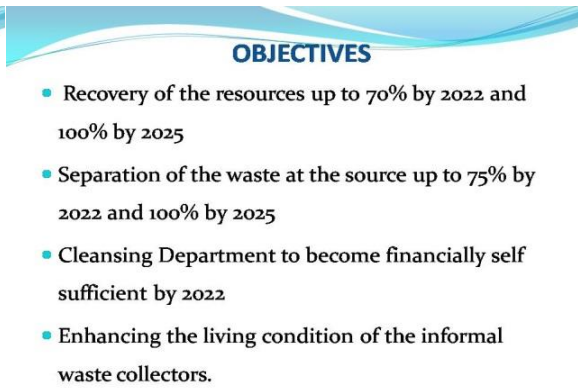
Assuming that the amount of sludge generated under BOD 250 mg/L and 4800m3/day is 750 kg-ds/day, methane gas from landfilled sludge can be estimated as below.

4.3.3 Necessary Measures for Project Establishment

In achieving a low carbon, resilient and sustainable regional development in Pathein City and Ayeyarwady Region, realization of individual project (JCM project) and development through policies with regard to past experiences in Fukushima City through city to city collaboration is important (development through business and development through policies). In particular, to proceed with individual projects utilizing schemes including JCM, cooperation between public and private sectors (administration, companies and residents) is essential. In Japan, there is an established framework to first prepare a comprehensive regional development plan at the national and municipal level ("fundamental plan" or "master plan"), and to create individual action plans based on the basic strategy. Conducting individual projects under such framework (grand design for regional development) enables promotion of various programs from long-term perspective, which accelerates implementation of advanced activities.

Pathein City has been discussing its goal image of the region (vision), and it has been promoting "Vision for Pathein in 2022" as its regional development vision; goals such as "to become 'the Clean City' and "no waste, more resources" are proposed under this vision. Activities for realizing this vision are to be discussed in detail at this point in time.

Vision in Pathein City



Proposed Objectives

Source: Ayeyarwady Region presentation in January workshop

Through policy dialogues at the local workshop and in Fukushima City (discussions under Inititative for Low Carbon Ayeyarwady Partnership), future perspectives of cooperation for formulation of low-carbon city establishment in Ayeyarwady Region have been summarized and common understanding has been achieved.

Proposed Direction of Collaboration in the Building of a Low-carbon Township in Ayeyarwady Region through City-to-City Collaboration

1. Background of the examination

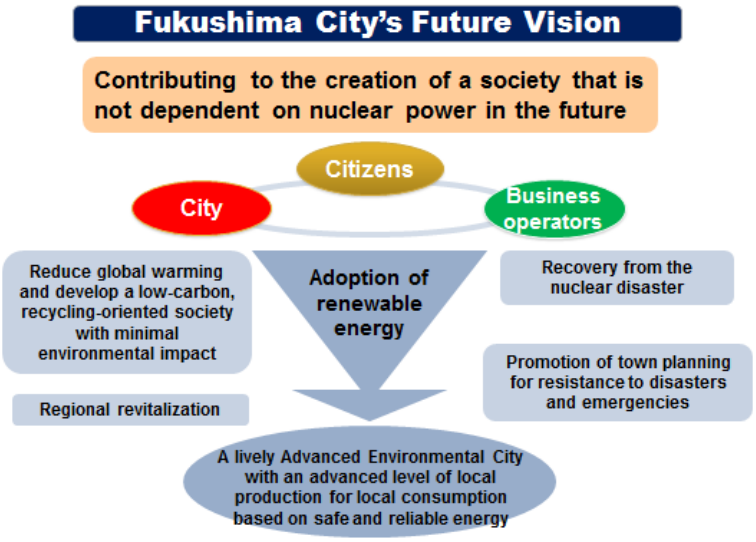
A partnership was formed between Ayeyarwady Region and Fukushima City as the platform for a new city-to-city collaboration under the collaborative scheme (framework) between the two, and discussions were conducted among stakeholders from both parties. In concrete, the status quo and the needs of Pathein City in Ayeyarwady Region were studied and comprehended, various initiatives by Fukushima City and related technologies were presented as reference, and examinations were performed concerning the possibility of collaboration between both Cities, as well as the possibility of deploying the Joint Crediting Mechanism (JCM) for realization of a low-carbon township in Ayeyarwady Region, in the fields of waste treatment and water treatment, in particular, through joint activities such as the holding of workshops in both Pathein City in Ayeyarwady Region and Fukushima City, mutual visits by members of both Cities (including on-site investigations), and exchange of opinions concerning the policy trends of both Cities.

Ayeyarwady Region, Myanmar

Ayeyarwady Region is the largest agricultural area in Myanmar, and the Region has been promoting new initiatives in recent years, including the development of new industrial parks, in order to promote the industrialization of the Region. This Region is considered to be one of the local areas in Myanmar where a rapid economic development is anticipated towards the future, and accordingly, the experience and knowhow held by Japan that experienced a rapid economic growth in the past are expected to be positively utilized in the Region.

Fukushima City

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



2. Awareness of the issues, and the direction towards the realization of a low carbon partnership

All members of the "Partnership", through discussions thus far, came to share the awareness about the importance of building a sustainable, low-carbon-type, vigorous, well-advanced township in Ayeyarwady Region, and the direction (roadmap) towards the realization of such township, as stated below.

Goal Image of the Region

It is important to aim at realizing an "environmentally most advanced City of Ayeyarwady (tentative name)", a city, which is full of vigor, yet low-carbonized and environmentally friendly, with its local features well preserved, by making the most of advanced technologies and knowhow, while preventing the occurrence of various social problems (environmental pollution, natural disaster, etc.) from the increase in the volume of waste materials, increase in the environmental load including deterioration of water quality, increase in the amount of energy consumption, loss of the rich natural environment of the Region and so forth, which could occur as a result of the economic growth.

It is indispensable for the administration, citizens and business operators to work together for the preservation of the environment and for the promotion of low-carbonization, and it is important to gradually expand the sphere of deployment, by firstly proceeding with a model-type approach based on a pair of wheels of "deployment by business operators" and "deployment of institutional efforts: i.e. creation of a proper mechanism to support business deployment".

In bringing the model-type approach into practice, it is indispensable to utilize the experience and knowhow of Japan that experienced a rapid economic growth in the past, as well as the framework of the JCM, through discussions within the Partnership, which is the platform of the city-to-city collaboration.

The fields of waste treatment, recycling of resources, water treatment and energy sources, in particular, are the priority areas in the development of townships, and it is important to aim at the below-stated directions in both fields of waste treatment and water treatment (which were the discussion themes of this time).

3. Direction of deployment in individual fields

Field of water treatment measures: Promotion of water treatment measures (i.e. energy-saving, low-carbon and low-cost measures), corresponding to the progress of the economic growth"

Vision

In light of the actual situation of Ayeyarwady Region (such as the status quo of the level of urbanization, economics, time/labor required for the maintenance of facilities, etc.), it is important in the first place to aim at creating a well advanced township, which is considerate of the preservation of the water environment, by utilizing a small-scale, decentralized-type waste-water treatment system.

Future Perspectives

In Japan, small-scale waste-water treatment measures are also adopted and they are proved to be quite effective as the measures for local communities, in particular. Thus, based on the experience in Japan, utilization of the small-scale, decentralized-type waste-water treatment system, corresponding to the situation of Ayeyarwady Region, will be quite promising. In applying such system there, the securing of required electricity will be a big issue. Thus, it is important to aim at adopting a stand-alone power system, which is based on energy-saving-type, decentralized power sources (such as solar power generation).
It is also important to change the awareness of people in the local community about the preservation of the water environment, and accordingly, we need to enhance the promotional activities. (e.g. to promulgate the habit of preserving the water environment. As the environmental education approach is thought to be effective here, we will utilize the place of education for that purpose.)

Development in other areas

Hereafter, it is important to bring into practice a model-type approach of "environmentally most advanced township" in Ayeyarwady Region, by also proceeding with the deployment in related fields (e.g. promotion of renewable energy sources, recycling of resources, energy efficiency,etc.) and in other regional areas (e.g. other townships in the Region, other industrial parks, etc.) in a well coordinated manner, by making good use of the approach from the city-to-city collaboration.

[Details of recognized issues, future perspectives and action plan (draft)]

~ "Promotion of water treatment measures (i.e. energy-saving, low-carbon and low-cost measures), corresponding to the progress of the economic growth" ~

Recognition of issues

In Ayeyarwady Region, introduction of a new treatment system for fresh water as well as waste-water has been a serious issue, in relation to the progress of the economic growth. However, the introduction of the system has various obstacles, such as financial problems associated with the construction of treatment facilities and their maintenance, procurement of electricity required for the treatment, and so forth.

In municipalities in Japan, small-scale, waste-water treatment measures such as the promulgation of sewage facilities for agricultural villages and community waste-water treatment tanks have been effectively and successfully adopted as the waste-water treatment measures in local communities, in parallel with the introduction of large-scale sewage treatment facilities elsewhere.

Direction of deployment for the solution of the issue

In light of the actual situation of Ayeyarwady Region (such as the status quo of the level of urbanization, economics, time/labor required for the maintenance of facilities), the deployment of small-scale, decentralized waste-water treatment systems is promising in the first place. In pursuing the development, procurement of electricity for the waste-water treatment facilities is a big issue, and if we consider possible power shortage and the fact that the power supply infrastructure based on the national grid is vulnerable, an energy-saving-type, stand-alone system based on solar power is considered to be an appropriate solution.

And, since the compliance with regulations will become important in order to proceed with proper waste-water treatment, transfer from Japan of the knowledge acquired from the experience and the knowhow about regulatory countermeasures in Japan will be utilized as good reference.

（Reference）Experience in Japan: Policies for water quality conservation in Fukushima City

Water Conservation Policy in Fukushima City

Monthly water quality measurement and water contamination surveillance are conducted for major rivers (17 rivers and 23 points) in Fukushima City.

Checking drainage from the office during on-site inspection

Source: Fukushima City presentation in January workshop

Proposed action plan (draft)

For the action plan to promote proper water treatment measures, it is important to (1) examine the feasibility of deployment of a small-scale, decentralized-type waste-water treatment system corresponding the actual situation of Ayeyarwady Region, and (2) create an institutional mechanism to preserve the quality of water and enlighten people's awareness (in order to gain their cooperation to the environmental education approach to promulgate the habit of preserving the water environment).

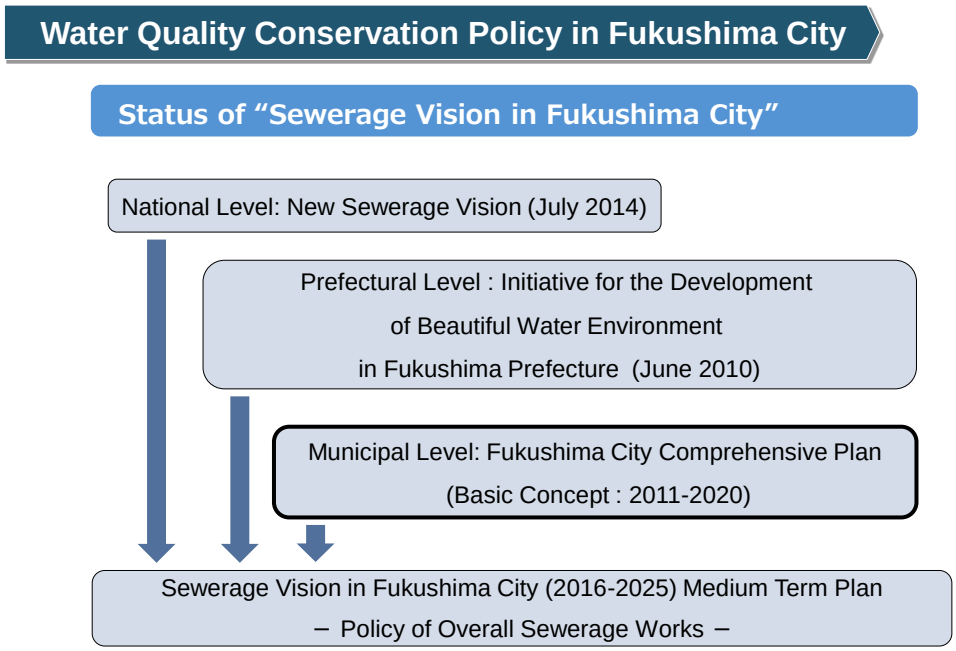
(3) Examination of the deployment of a small-scale, decentralized-type waste-water treatment system corresponding to the actual situation of the Region.

- Promotion of a small-scale, decentralized-type waste-water treatment system (utilization of Japanese technologies) ~ Energy-saving-type, solar power- combined, stand-alone power-type system ~
- Examination of institutional systems for the small-scale, decentralized-type water treatment measures (Reference: Institutional system in Japan for agricultural village waste-water treatment business).

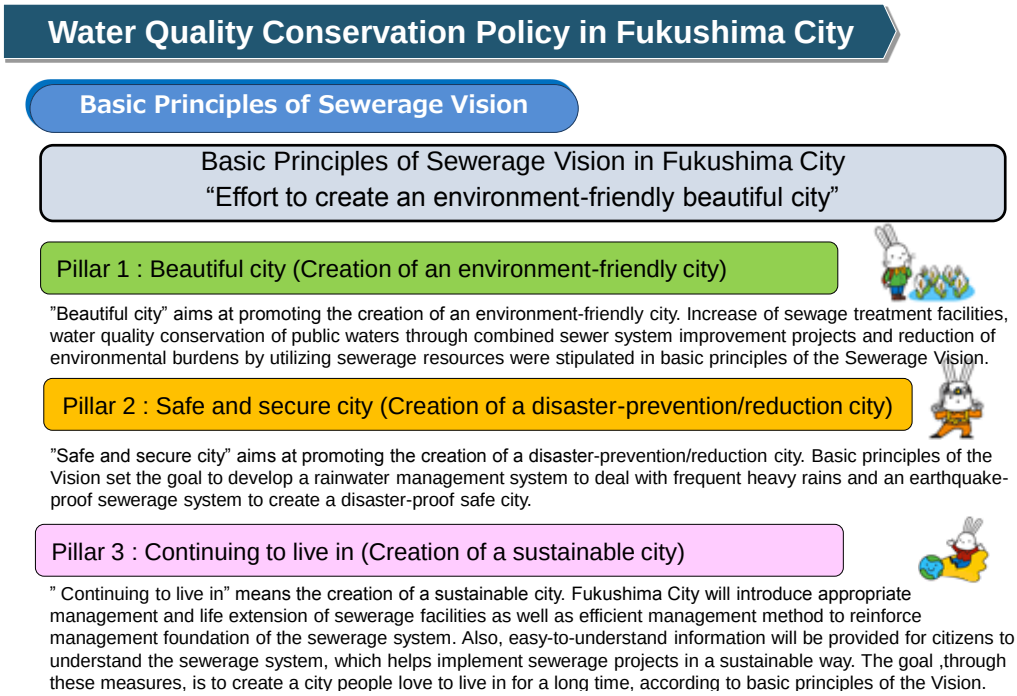
(4) Creation of an administrative mechanism for the preservation of water quality and enlightenment of people's awareness.

- Clarification of the vision on the preservation of the water environment (Reference: "Vision of Fukushima City on the Fresh-Water and Waste-Water Treatment Measures").
- Creation of a mechanism for the preservation of water quality (Reference: Mechanism of supervision and guidance in Japan).
- Change of people's awareness towards the compliance with regulations (Reference: Study meetings conducted by commercial and industrial groups in Japan; enlightenment activities).
- Environmental education approach to promulgate the habit of preserving the water environment (Reference: Activities on the level of elementary schools).
- Water environment preservation activities with the participation of the administration, business operators, citizens (families), schools and communities (environment beautification activities).

(Reference) Experience in Japan: Vision in Fukushima City



Source: Fukushima City presentation in January workshop



Source: Fukushima City presentation in January workshop

(Reference) Experience in Japan: Cooperation between administration, citizens, and business in Fukushima City

(Reference) Experience in Japan: environmental education

Source: Fukushima City presentation in January workshop

(Reference) Visit to and discussions with elementary school in Pathein City (January)
The project members introduced examples of environmental education at public elementary schools in Fukushima City. Interest was shown from the elementary school on environmental education.

Local elementary school

Materials for environmental education at the local elementary school

Classes

Explanation of environmental education in Fukushima City

5 Summary and Future Perspectives

Individual (JCM) project proposal and future perspectives for city to city collaboration are summarized below.

Correspondance with Pathein City Vision

Under cooperation with local stakeholders, possible JCM projects under Pathein Industrial City will be investigated. On consideration, correspondence with “vision for Pathein in 2022” (including contents such as to become “the Clean City” and “no waste, more resources”), and development through business and development through policies will be aimed.

Low carbonization of the whole region through city to city collaboration between Fukushima City and Ayeyarwady Region

Low carbonization of the whole region in various fields will be aimed, by utilizing the city to city collaboration in Pathein Industrial City, and conducting activities in relevant sectors (e.g. promotion of renewable energy, resource circulation, energy conservation) and other areas (e.g. other cities in the region or other industrial cities). In particular, the Partnership for a Low-Carbon Initiative in Ayeyarwady will aim to be a model for low carbon regional development with regional characteristics of a regional hub city (e.g. economical development, improvement in standard of living, measures against climate change, well-balanced development model for environmental measures).

Project development using JCM

~Approach through public-private cooperation~

In realization of individual projects, JCM scheme is an extremely effective scheme in terms of economic feasibility improvement (subsidy support), cooperation between Japanese and local companies, and utilization of Japanese technologies and know-how. In September 2015, agreement towards establishing JCM was made between Myanmar and Japan for low carbon development

This study identified the following project as promising JCM project within Pathein Industrial City, and considered measures for project establishment.

<Possible JCM project in the water treatment (sewerage treatment) sector>

Non-aeration water treatment system with PV generation: developed as water treatment facility within Pathein Industrial City

Candidates for JCM projects in the field of water treatment (sewage treatment)

“Anaerobic water treatment system, linked with photovoltaic power generation system”: This type of system for water treatment facilities needs to be deployed in Pathein Industrial City.

< Local needs as the background for industrialization >

- In Pathein Industrial City, facilities for the supply of industrial water and those for the treatment of industrial wastewater are planned to be constructed in sequence, and

thus, installation of water treatment facilities is required there. Besides the fact that the enhancement of environmental regulation is an important issue in Myanmar, Pathein City aims at realizing a clean city, and a new industrial zone need to introduce water treatment systems that satisfy international environmental standards.

- Amid the situation where economic development is advancing, chronic shortage of power has been a big issue, and thus, realization of energy-saving and stand-alone water treatment systems has been strongly looked for.
- Water and sewage systems in the Region (including Pathein City) are still undeveloped. As there are concerns about the deterioration of water environment in association with the economic growth, a proper treatment of filthy water (human excreta and domestic sewage) not only in the industrial zone but also at business offices and residents is required, and accordingly, there are strong needs for low-carbon and decentralized sewage treatment systems corresponding to the actual situation of the Region.

< Concept for industrialization >

- Stand-alone power-generation water treatment system utilizing photovoltaic power generation.
- Anaerobic, energy-saving water treatment system (based on Japanese technologies).
- To make a model of the energy-saving, small-scale decentralized sewage treatment system, linked with photovoltaic power generation.
- To make a model for the change in awareness towards water environment preservation, in coordination with environmental education at schools in the neighboring area.

< Outline of business plan >

- Place of installation: In the sewage treatment area in the industrial zone.
- Capacity of water treatment:
- Size of photovoltaic power generation: Around 1 MW
  - The optimal size of power generation is to be determined, taking into account the demand for power in the neighboring area for other purposes than that for water treatment system, its economics, expected CO2 reduction effect, etc.
- Power supply: To be basically supplied to sewage treatment facilities. Excess power will be allotted for power needs in the neighboring area.
- Business scheme: SPC is assumed (e.g. Japanese company + local partner). Use of equipment subsidy under JCM is planned.

< Direction of policy coordination >

- To enhance activities to induce initiatives to install proper sewage systems in industrial plants, etc. (regulatory guidance, initiatives by business operators, etc.)
- As the change in awareness in local communities towards water environment preservation is important, environmental education needs to be provided, utilizing the place of school education.
- In realizing the concept of industrialization, coordination with activities contemplated in the future vision worked out by the Region aiming at a clean city is pursued.