FY2020 Project for Ministry of the Environment Japan

FY2020
City-to-City Collaboration Programme for Zero-carbon Society

Project to Promote Green Recovery by Installation of AI and ZEB Technologies in Yangon

Report

March 2021

Nippon Koei Co., Ltd.
Fukuoka City

FY2020
City-to-City Collaboration Programme for Zero-carbon Society
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Report

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Abbreviations

Abbreviation	Description
AI	Artificial Intelligence
AIST	Advanced Industrial Science and Technology
ASEAN	Association of Southeast Asian Nations
BEI	Building Engineering Institute
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon Dioxide
COP	Coefficient of Performance
COVID-19	---
CQHP	Committee for Quality Control of High-Rise Building Construction Project
EMS	Energy Management System
EPC	Engineering, Procurement, Construction
ESS	Energy Storage System
EV	Electric Vehicle
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPS	Global Positioning System
GWP	Global Warming Potential
ID	Identification Data
IMF	International Monetary Fund
JCM	Join Crediting Mechanism
JETRO	Japan External Trade Organization
JICA	Japan international cooperation agency
LED	Light Emitting Diode
LHV	Lower Heating Value
MES	Myanmar Engineering Society
MGT	Micro Gas Turbine
MHIET	Mitsubishi Heavy Industries Engine & Turbocharger, Ltd.
MIFER	the Ministry of Investment and Foreign Economic Relations
MKI	Myanmar Koei International
MOHS	Ministry of Health and. Sports
MOE	Ministry of the Environment, Japan
MOI	Ministry of Information
MOU	Memorandum of Understanding
MRV	Measurement, Reporting and Verification
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization
NOx	Nitrogen Oxides
PCCD	Pollution Control and Cleaning Department
PPP	Public-private Partnership
SOFC	Solid Oxide Fuel Cell
UECC	Urban Environmental Conservation and Cleansing Department
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WEO	World Economic Outlook
WHO	World Health Organization
YCDC	Yangon City Development Committee
ZEB	Net Zero Energy Building

CHAPTER 1 BACKGROUND AND OBJECTIVE

1.1 BACKGROUND OF THE PROGRAMME

In November 2016, the Paris Agreement was entered into force. In FY2020, the Paris Agreement finally entered its implementation stage. As it is expected that not only central governments but non-governmental bodies including regional municipalities and cities accelerate their climate change policies, cities and municipalities are key players to consider and implement concrete regional climate actions and projects. To realize zero carbon society, it is important to accelerate actions to develop sustainable and zero-carbon society and low-carbon society as a passing point especially in Asia, the area of prominent economic growth. International supports for activities for zero-carbon and low-carbon society have been enforced in cities, the place for activities to support socio-economic development.

Yangon City, the largest city in Myanmar, and Fukuoka City, the largest city in Kyushu, entered into a memorandum of understanding (MOU) for a cooperation agreement in the water supply/sewerage and solid waste sectors in 2014, which led to their 2016 signing of a sister city agreement, which has never been signed between Yangon City and any other Japanese municipality, and have built an amicable relationship since then.

The "Project to Promote Green Recovery by Installation of AI and ZEB Technologies in Yangon (hereinafter the "Project")" started in FY2020 is intended to implement a three-year program under a new City-to-City collaboration between the two cities.

The two cities have been seriously affected in all fields, including economics, medicine and education, due to the global spread of novel coronavirus (hereinafter "COVID-19"). Therefore, the **Green Recovery to realize restoration of urban functions from the COVID-19 pandemic as well as decarbonization** is featured as one of the main themes of the Project, in addition to solutions to urban issues on which they have been working so far.

In FY2020, the two cities studied about installation of technologies that contribute to urban decarbonization in the solid waste and energy fields, which are the top-priority issues of Yangon City, in collaboration with companies in Fukuoka City and Japanese/local related companies, through consultation between the cities about the updated information exchanges and specific technologies and efforts regarding Green Recovery.

1.2 CITIES PARTICIPATING IN THE PROJECT

1.2.1 Fukuoka City

Fukuoka City, the largest city in the Kyushu region with a population of about 1.6 million, is a commercial city facing Hakata Bay, where trade and cultural exchanges with the Asian region have been active since ancient times, and has positively provided international support to Asian countries, making use of its geographical advantage.

In particular, Fukuoka City has provided multifaceted support to Yangon City in terms of urban infrastructure such as waterworks and waste disposal since 2012 with unique approaches such as long-term expert dispatches.

The overview of Fukuoka City is as follows:

Photo 1: Landscape of Fukuoka City

Table1.1 Overview of Fukuoka City

#	Item	Overview
1	Area	343.46 [km^2]
2	Population	1,603,043 [people] (as of September 1, 2020)
3	Population density	4,667.33 [people /km^2] (as of September 1, 2020)
4	Number of households	832,635 [households] (as of September 1, 2020)
5	City gross domestic product (nominal)	7.8043 [trillion yen] (in FY2017)

Source: Prepared by Nippon Koei on the basis of the information on the website of Fukuoka City.

Fukuoka City has own platform called " International Business Platform Fukuoka" which 94 companies and 10 organizations are joined as its members as of February 2021. The platform aims to both solve urban issues in overseas cities and activate local economy by making business oportunity in overseas cities for the platform members through the international cooperation activities by Fukuoka City. In the future, it is expected that the member companies join the Project to promote their technologies in Yangon City. The information of this platform is attached as Attachment-1.

1.2.2 Yangon City

Yangon City (population: about 5.2 million), the largest city in Myanmar, is facing issues unique to big cities, such as power outages due to lack of power, chronic traffic congestion and air pollution caused by such congestion and deficiency of waste disposal sites because the existing infrastructure cannot keep up with the rapid population growth after the lifting of the economic sanctions, and is required to resolve them urgently. Myanmar has ratified the Paris Agreement in 2017, however, their Nationally Determined Contribution (NDC) submitted to United Nations Framework Convention on Climate Change (UNFCCC) doesn't mentioned about their goal of Green house gas (GHG) emission reduction clearly.

Source: Prepared by Nippon Koei

Figure1.1 Map of Yangon City

In the NDC, it is desctibed that Myanmar plan to increase hydro power by 9.34GW by 2030, and also increase rate of renewable energy in rural area by 30% by 2030.

The counterpart in the Project is the Urban Environmental Conservation and Cleansing Department (UECC), a subsidiary organization of the Yangon City Development Committee (YCDC), which was reorganized in 2019, causing the Pollution Control and Cleansing Department (PCCD) to be renamed as UECC to let it keep the whole environmental sector under its control. The UECC is motivated to make efforts towards not only waste disposal but also green recovery, one of the countermeasures against climate change through the City-to-City collaboration with Fukuoka City.

The overview of Yangon City is as follows:

Table1.2 Overview of Yangon City

#	Item	Overview
1	Area	Approx. 580 [km^2]
2	Population	Approx.520 Million [people] (as of March 2014)
3	Population density	Approx. 6,272[people/km^2] (as of March 2014)
4	Number of households	Approx. 1,1000,000 [households]
5	City gross domestic product (nominal)	Approx. 8.00 [billion USD] (in FY 2016/2017)

Source: Prepared by Nippon Koei on the basis of "The 2014 Myanmar Population and Housing Census Yangon Region (Census Report Vol. 3)."

1.3 OBJECTIVE OF THE PROGRAMME

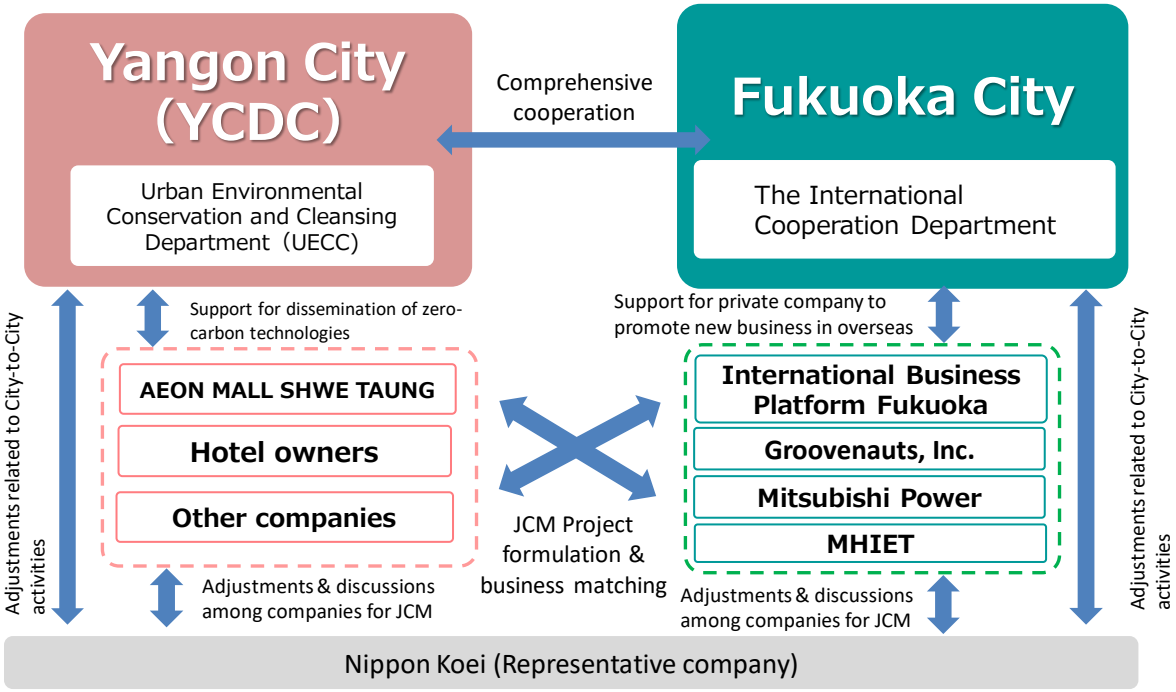
The objective of FY2020 City-to-City Collaboration Programme for Zero-Carbon Society (hereafter "the Programme") is that Japanese research institutes, private companies, universities etc. conduct studies to support for development of zero-carbon and low-carbon society in overseas municipalities and installation of technologies which contributes to zero/low-carbon society development together with Japan's cities with experiences and knowledges for development of zero-carbon and low-carbon society.

1.4 IMPLEMENTATION STRUCTURE OF THE PROJECT

In the Project, UECC and International Cooperation Section, International Affairs Department, General Affairs & Planning Bureau, Fukuoka City, served as the sections in charge and collaborated with each other towards the resolution of the urban issues of Yangon City and the formation of a zero-carbon society (Green Recovery) after COVID-19, under the City-to-City collaboration between YCDC and Fukuoka City.

Furthermore, GHG were reduced, and the Joint Crediting Mechanism (JCM) projects that contribute to such reduction were formed in the fields of energy saving and renewable energy, solid waste and transit utilizing Artificial Intelligence (AI) technologies and system establishment which were greatly needed in Myanmar and in Yangon City, under the City-to-City collaboration between the cities.

The private companies, such as Groovenauts, Inc. that owns technologies optimized by AI, Mitsubishi Power, Ltd. that owns fuel cells (MEGAMIE) with multi-use capabilities for various fuels including liquefied natural gas (LNG) and hydrogen gas, Mitsubishi Heavy Industries Engine & Turbocharger, Ltd. (hereinafter "MHIET") that has a track record of triple hybrid power generation systems and Aeon Mall Myanmar (AEON MALL SHWE TAUNG Co., Ltd.) that plans to have commercial facilities in Yangon City, participated in the surveys on site and in Japan and studied/proposed installation of technologies based on the assumptions of the JCM Model Project in each field. The organization for implementing the Project is as follows:



Source: Prepared by Nippon Koei

Figure1.2 Organization Chart for Implementation of the Project

1.5 SCHEDULE OF THE PROJECT

The implementation period of the Project is between December 10, 2020 and March 10, 2021. The main process is as follows:

#	Item	Person in charge	Nov	Dec	Jan	Feb	Mar
A：Intercity collaboration				Contact period (10 Dec ～10 Mar)			
1	Intercity discussion（WEB meeting）	City/ Consultant		▼	▼		
2	Consideration of next activities for FY2021	City/ Consultant					▼
B：Feasibility study for JCM Model Project formulation							
1	Discussion with companies（WEB meeting, mail etc.	Consultant/ Companies	▼	▼	▼	▼	▼
2	Data collection and its analysis	Consultant/ Companies			→	→	
3	Preparation of applying for JCM Model Project	Consultant/ Companies				→	→
C：Field survey and seminar							
1	Field survey by local staff	Consultant/ Companies		→	→	→	
2	Online workshop (introduction of the technologies)	Consultant/ City			▼		▼
3	Participation in JCM seminar organized by MOE	Consultant/ MOE				▼	
D：Others							
1	Monthly report	Consultant			▼	▼	▼
2	Meeting with MOE	Consultant/ City		▼			▼
3	Meeting with relevant persons in Japan	Consultant/ City/ Companies	▼		▼	▼	▼
4	Final report	Consultant					▼

Source: Prepared by Nippon Koei

Figure1.3　Schedule of the Project

1.6　SITUATION OF COVID-19/NOVEL CORONAVIRUS IN FUKUOKA AND YANGON CITIES

The infection of COVID-19/novel coronavirus (hereinafter "COVID-19") which has continued to spread worldwide since January 2020 has seriously affected the administration and civil life of Fukuoka City and Yangon City.

In Myanmar, the rapid increase in the number of infected people since September 2020 caused the announcement of a lockdown. The total number of infected people reached about 140,000 at the end of January 2021, and there are hundreds of infected people a day even in February 2021.

On the other hand, although the number of infected people subsided after the state of emergency was declared in April 2020 in Japan, it increased again in August and November. The number of infected people reached about 400,000 in total at the end of January 2021 and is currently around 2,000 to 3,000 a day. The government declared a state of emergency due to an increase in infection in January 2021, and it has been extended to early March in some prefectures, including Fukuoka City.

CHAPTER 2 CITY-TO-CITY COLLABORATION FOR REALIZATION OF ZERO-CARBON SOCIETY

2.1 BACKGROUND AND OBJECTIVE OF CITY-TO-CITY COLLABORATION

2.1.1 Background

In Myanmar, international trade has become active upon the transition from military rule to democratic government in 2011, and the construction boom to build public works and private commercial facilities due to the domestic and foreign investments has continued since then, resulting in rapid economic growth.

In Yangon City (population: about 5.2 million), the largest city in Myanmar, the existing infrastructure has been unable to keep up with the rapid population growth after the lifting of the economic sanctions. As a result, the city has faced the issues unique to big cities, such as power outages due to power shortages, chronic traffic congestion and resultant air pollution and deficiency of waste disposal sites, and requires urgent measures.

Fukuoka City (population: about 1.6 million), the largest city in the Kyushu region, has recently provided positive international support to Asian countries, making use of its geographical advantage. The city has provided multifaceted support especially to Yangon City by such means as sharing its knowledge in urban infrastructure such as waterworks and waste disposal in its unique approach since 2012, and thus Fukuoka City and Yangon City entered into a sister city agreement in 2016.

The past records of the two cities' City-to-City collaboration are as follows:

Table2.1 Achievements of Fukuoka City's Support for Yangon City

#	Month/Year	Achievement
1	May 2014	Conclusion of "Memorandum of Understanding on cooperation and support for urban development" (Water & Sewage, Waste management sectors)
2	2014-	Start of long-term training of Yangon City Officers in Fukuoka
3	May 2015	Pre-feasiblity study on water supply in Yangon City by public-private partnership (PPP)
4	Jun 2015	Start of Japan International Cooperation Agency (JICA) Partnership Program (Phase 1) on food disaster prevention
5	Dec 2016	Conclusion of MOU on Friendship and Cooperation between Fukuoka City and Yangon City
6	Apr 2019	Start of joint project with United Nations (UN) Habitat (Utilization of "the Fukuoka Method" in Htein Bin landfill disposal site)
7	Dec 2019	Technical seminar and business matching for Yangon City
8	Dec 2019	Conclusion of Memorandum of understanding on water supply sector

Source: Based on information provide by Fukuoka city, compiled by Nippon Koei

Furthermore, Fukuoka City has dispatched expert personnel in the fields of waterworks and urban development to Yangon City as direct support. The past records are as follows:

Table2.2 Dispatch of Fukuoka City's officers to Yangon

#	Month/Year	Achievement
1	2012 Apr	JICA long-term expert (Water sector, 1st)
2	2015 Aug	JICA long-term expert (Water sector, 2nd)
3	2017 Feb	Individual Dispatch (Supporting adviser for urban development)
4	2018 Aug	JICA long-term expert (Urban development sector)
5	2018 Dec	JICA long-term expert (Water sector, 3rd)

Source: Based on information provide by Fukuoka city, compiled by Nippon Koei

Receiving Yangon City Staff for Long-term Training

Signing of MOU for Cooperation Agreement in Water Sector

2.1.2 Objective

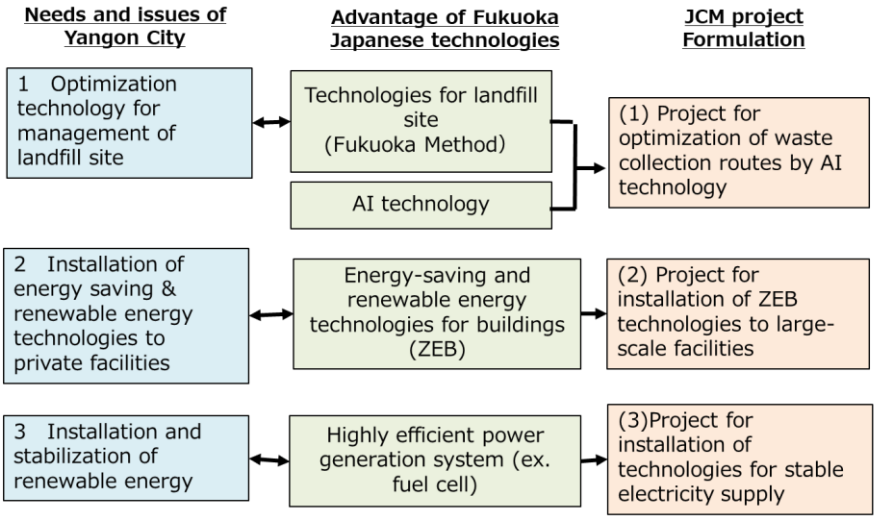
The objective of the Project is to provide broad-based support under the theme of the Green Recovery to realize the recovery of urban functions from the COVID-19 pandemic along with decarbonization under a new City-to-City collaboration between Fukuoka City and Yangon City. It aims to be realized in 3 years including FY2020.

Particularly in FY2020, the feasibility of the following three projects was studied for the solid waste and energy fields, which are the top priority issues of Yangon City, in collaboration with companies in Fukuoka City and Japanese and local related companies:

(1) Installation of an optimization system for the waste collection routes utilizing AI technologies;

(2) Installation of Net Zero Energy Building (ZEB) technologies to large commercial facilities; and

(3) Installation of equipment that contributes to power stabilization, such as fuel cells.



Source: Prepared by Nippon Koei

Figure2.1 Image of the proposed applicable technology of Japanese company toward demands and issues in Yangon City

2.2 IMPLEMENTATION POLICIES FOR CITY-TO-CITY COLLABORATION

Because there were physical restrictions on activities such as field surveys and consultations in Japan due to the influence of COVID-19 in FY2020, the main activities were carried out according to the following policies:

1) Field surveys: The conducted surveys included information gathering through utilization of the local subsidiary of Nippon Koei (Myanmar Koei International (MKI)), the related policies of Myanmar and Yangon City, review of the plans, questionnaire surveys on the issues and requests in Yangon City under the circumstances of the COVID-19 pandemic and field surveys on waste collection. The document is attached as Attachment-2

2) Consultations on site and in Japan: Consultations with the local and Japanese parties concerned through online meetings, information exchanges and feasibility studies were performed.

3) Online workshop: With consideration for current governmental situation in Myanmar, presentation materials and videos which were planned to be shown in online workshop for introducing Japanese technologies have been shared with YCDC. And in FY2021, they will be explained directly by Japanese companies when it is possible to come to Yangon City. The relevant documents are attached as Attachment-3.

Some of the materials prepared for these activities were documented in the Myanmar version as well, and consecutive Japanese-Myanmar interpreters were arranged at the online meetings. Thus, ingenuity was exercised so that the activities might be carried out in the same way as the local ones assumed in the normal situation.

2.3 OVERVIEW OF ACTIVITIES RELATED TO CITY-TO-CITY COLLABORATION IN FY2020

2.3.1 Field Surveys and Information Sharing, etc.

For the field surveys, the following information was gathered and organized by utilizing the local subsidiaries with some of the work.

Table2.3 Items of Field survey

#	Items
1	Infomration collection regarding facilities in Yangon City
1.1	Local large-scale companies which implement and appeal their activities regarding energy saving and renewable energy
1.2	Installation cases of energy-saving technologies and renewable energy into large-scale hotels/commercial facilities in Yangon City
1.3	Organization of certification system for green building and their activities (governmental body, international organization, Non-Governmental Organization (NGO), etc)
1.4	Cases of green building certificate in Yangon
2	Infomration collection regarding Energy supply
2.1	Latest price of fuels (petrol, diesel etc.) and electricity (by category such as household, industrial facility)
2.2	Status of electricity supply in Myanmar and Yangon (number and scale of plants, distribution data)
2.3	Cases of existing microgrid (≒small-scale power producer projects) in Myanmar. (not only remote islands and rural area but also closed grid such as industrial parks)
2.4	Information related to power shortage areas surrounding Yangon City
3	Local situation of before and current COVID-19 (to consider green recovery)
3.1	Effects on economic activities, trend of countermeasures to COVID-19 pandemic by governments (Jan to Dec 2020)
3.2	Situation of construction sector in Yangon (effects on building construction by private body, effects on public works, etc.)
3.3	Energy trend in Yangon (frequency of blackout, change of electricity usage, citizen's opinions)
3.4	Sectors which citizens and enterprises currently have interests (medical equipment, communication technologies)

Source: Prepared by Nippon Koei

2.3.2 Surveys in Japan and Online

The corporate and technical information mainly on the companies located in Fukuoka City was gathered, making use of the network of Fukuoka City's "International Business Development Platform," in order to search for potential Japanese companies and technologies. Online questionnaire surveys were conducted as required to check whether or not they are interested in participating in the following fiscal year's activities for the Project and inquire about any possibility of installing technologies in Yangon City.

2.3.3 Summary of Activity Records

The studies, meetings, workshops and other activities performed in FY2020 are as follows:

Table2.4 Efforts for City-to-City Collaboration

Activity	Date(s) and Period	Overview
Kick-off meeting between Fukuoka City and Yangon City for City-to-City collaboration	December 28, 2020	Fukuoka City explained the counterpart (UECC) about the overview of the Project. Agreed upon various activities in FY2020, including the information gathering and local workshops to be held to realize the formation of the Project.
Kick-off meeting with the Ministry of the Environment (MOE)	December 28, 2020	The project summary, activity progress and future schedule were explained. Information was exchanged about the method of and ingenuity in the field survey under the circumstances of the COVID-19 pandemic.
Field survey	From December 14, 2020 to January 29, 2021	The local subsidiary of Nippon Koei (Myanmar Koei International) started the field survey, information was collected on such matters as power/ energy consumption, economic trends and facilities for JCM under the circumstances of the COVID-19 pandemic.
Participation in online seminar on City-to-City collaboration	February 1, 2021	MOE, related organizations, local governments and private companies participated online in the seminar, where information was provided about the trends/tendencies of the City-to-City Collaboration Programme, JCM Model Project and Japan Fund for JCM, and a panel discussion was run to discuss how to proceed with City-to-City collaboration and how to implement the Project with ingenuity under the circumstances of the COVID-19 pandemic. In relation to the seminar, a video introducing 20 city-related projects in FY 2020 was also released only to the parties concerned.
Organization of online workshop (introduction of Japanese technologies to YCDC)	From February to March, 2021	Materials prepared by Japanese companies for introducing AI, ZEB, and technologies contributing to power stabilization were shared with YCDC
Final report meeting with MOE	March 4, 2021	Outcome of the Project in FY2020 and tentative plan in FY2021 was reported to MOE by Nippon Koei

Source: Prepared by Nippon Koei

2.4 SUPPORT FOR ESTABLISHMENT OF SYSTEMS FOR GREEN RECOVERY

2.4.1 Study on Decarbonization Policy through in City-to-City Collaboration

The Project is themed as the "Green Recovery" to help with the recovery of the economic activities of the two cities in an approach from the angle of decarbonization in collaboration with each other. Originally, it was supposed that the impact of COVID-19 would be grasped and analyzed from the viewpoint of urban environment and energy, and then specific accuracy and efforts would be studied. However, since it was difficult to travel to Myanmar in FY2020, it was decided to share information and exchange opinions within a limited range.

It is planned that the two cities will discuss the proposals with positive utilization of AI and IT technologies of the companies in Fukuoka City, including the activities that could not be physically performed, and more environmentally- and hygiene-friendly technologies and policies in the next fiscal year.

2.4.2 Support for Formation of JCM Model Projects

Fukuoka City and Nippon Koei provided the companies in Fukuoka City with the summary of the City-to-City Collaboration Programme and JCM Model Project, and the feasiblity studies for JCM Model Project formation. In addition, Fukuoka City and Nippon Koei held a joint web conference for the companies to collaborate with each other's technologies and exchange information, in expectation of synergistic effects between the companies.

Table2.5 Companies for Support in Formation of JCM Projects

#	Company	Main Support Items
1	Groovenauts, Inc. (company in Fukuoka City)	• Asked the company to prepare technical materials for business matching with local companies in Myanmar and supported it in preparing the English and Myanmar translation versions to facilitate remote consultations. • Provided the company with the overview of the JCM Model Project and the information about other potential funding schemes for use. • Exchanged opinions and introduced a case in another country on an approach other than the solid waste sector.
2	Mitsubishi Power, Ltd. and MHIET	• Asked the company to prepare technical materials for business matching with local companies in Myanmar and supported it in preparing the English and Myanmar translation versions to facilitate remote consultations. • Provided the company with the overview of the JCM Model Project and the information about other potential funding schemes for use.
3	Company A (Member company in Fukuoka City International Development Business Platform)	• Explained about the overview of the City-to-City Collaboration Programme and JCM Model Project. • Asked the company to prepare technical materials for Myanmar and supported it in preparing the English and

#	Company	Main Support Items
		Myanmar translation versions to facilitate remote consultations. • Will continue consultation with the company about our efforts for City-to-City collaboration in the next fiscal year.
4	Company B (Member company in Fukuoka City International Development Business Platform)	• Explained about the overview of the City-to-City Collaboration Programme and JCM Model Project. • Will continue consultation with the company about our efforts for City-to-City collaboration in the next fiscal year.

Source: Prepared by Nippon Koei

2.5 CITY-TO-CITY COLLABORATION SEMINARS HELD BY MOE

On February 1, 2021, MOE organized "Seminar on City-to-City Collaboration for Creating a Zero-carbon Society" online, with over 100 participants from Japanese and overseas cities carrying out City-to-City Collaboration Programme, and its representative entities and partner companies

After the organizer gave an opening speech, International Cooperation and Sustainable Infrastructure Office of MOE, Office of Market Mechanisms of MOE, and Asian Development Bank gave presentations entitled "Overview of support menus for development of zero carbon society", on developments and trends of City-to-City Collaboration Programme, JCM Model Project, and Japan Fund for the Joint Crediting Mechanism. In the following panel discussion, City of Kitakyushu, Oriental Consultants Co., Ltd. and Nippon Koei discussed how to carry out the City-to-City Collaboration Programme during COVID-19 pandemic, and on the approaches and means required for overseas business development.

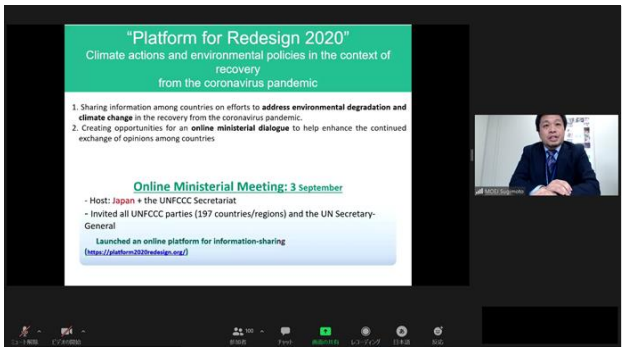
Principal Deputy Director of International Cooperation and Sustainable Infrastructure Office of MOE made a closing speech, saying that Japan will enhance its alliances and support the new needs arising from green recovery activities, and how it is important for Japan and other countries to share each other's experiences.

The overview of the seminar is shown in the table below. (See Attachment-4)

Table2.6 Outline of the City-to-City Collaboration Seminar

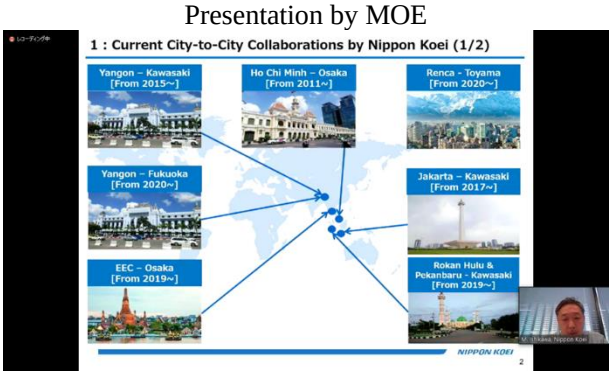
#	Date & Time	Contents	Participants (viewers)
1	January 27 (Wed) – February 3 (Wed)	1. Introduction of the 20 collaboration projects for FY2020 ■On-demand video viewing	Project members & Public (registered people only)
2	February 1 (Mon), 14:00-16:00	2. 2. Closed online seminar (Zoom meeting) ■Information sharing on the Japanese government support and open call for the next fiscal year ■[Panel discussion] How can we proceed projects in the corona era?	Project members only

Source: Quoted from a material created by IGES

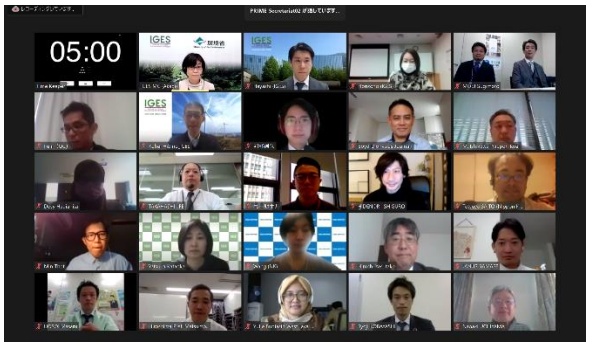


Presentation by MOE

Panel discussion



Presentation by Nippon Koei



Participants in the seminar

CHAPTER 3 STUDY FOR JCM MODEL PROJECT FORMATION

3.1 FEASIBILITY STUDY IN ENERGY SAVING FIELDS

3.1.1 Overview of Study

In recent years, many large commercial facilities, such as Junction City and Myanmar Shopping Center, and large-scale foreign-capital hotels have been constructed in large numbers in Yangon City, which has been increasing the demand for energy such as electricity and fuel every year.

If the ZEB technologies introduced in large commercial facilities scales out and causes an increase in private facilities independent of systems, it will be possible to partially solve the power shortage problem in Yangon City, along with the decarbonization of cities. In addition, if a ZEB project utilizing JCM is realized, it can be expected to lead to enlightening the citizens of both cities about decarbonization as the results of the activities of Fukuoka City and Yangon City.

Therefore, the installation of energy-saving equipment such as high-efficiency chillers and energy-saving technologies such as solar power generation in new large commercial facilities to be constructed, which would lead to the wide use of ZEB was explored in this study. Furthermore, a field survey was conducted on the installation status of energy conservation and renewable energy systems in the existing commercial facilities and hotels.

Table3.1 Study Items and Overview for Installation of ZEB Technologies in Large Commercial Facilities

#	Study Item	Overview
1	Study on local companies	A study was conducted on the companies mainly related to renewable energy equipment (sale or installation of solar panels) in Yangon City.
2	Study on installation of energy saving and renewable energy equipment in the existing facilities	A study was conducted on the installation cases and penetration rate of energy conservation and renewable energy in the commercial facilities and houses in Yangon City.
3	Study on applicable ZEB technologies	The applicable equipment and technologies were analyzed in the current Yangon, and the applicable technologies in a JCM Model Project were studied.
4	Study on specifications of equipment to be installed	The validity of the specifications, quantities, etc., of the technologies to be installed was confirmed.
5	Development of business plan and evaluation of feasibility	The rough project cost, energy saving effects, years of investment payout and CO2 emissions reductions were estimated.
6	Consideration of international consortium	The international consortium and its organization for implementation were reviewed for the purpose of applying for a JCM Model Project.

Source: Prepared by Nippon Koei

3.1.2 Study on Local Companies

A study was conducted on the companies which mainly sell and/or install solar panels at the existing facilities in Yangon City. Since they may play a role as engineering, procuring and construction (EPC) companies or suppliers in implementing a JCM Model Project, such information as their performances and products to handle were confirmed through the information on the web and in the field surveys.

Table3.2 Information of local companies on ZEB

#	Company	URL
1.	Multi Engineering Trading	https://www.multiengtrading.com/energy-management-system/
2.	Titan Power	https://www.tpc-myanmar.com/services/
3.	EAM Myanmar	https://www.eammyanmar.com
4.	Asia Solar	https://www.asiasolarmm.com/company-profile/
5.	Myanmar Solar Power Trading	https://www.myanmarsolarpower.net
6.	Earth Renewable Energy	https://www.earthgroupofcompanies.com/our-business/renewable-energy/
7.	Myanmar Solar	http://www.myanmar-solar.com/en-us/index.php
8.	Mandalay Yoma	https://yomamandalay.com
9.	Sun Power	https://spsolarstation.com
10.	Shwe Taung Solar Energy	https://www.shwetaunggroup.com/solar-energy/
11.	Mega Global Green Automation	http://www.megaglobalgreen.com
12.	Myanmar Sustainable Energy Systems (MSES)	http://united-engineering.net/mses.htm
13.	Talent and Technology	https://www.talentntech.com
14.	Techno-Hill Engineering	https://www.techno-hill.com/index.html
15.	Yoma Micro Power	https://www.yomamicropower.com/#projects
16.	Kinetic Myanmar Technology	https://www.kineticmyanmar.com

Source: Prepared by Nippon Koei

3.1.3 Study on Cases of Installing Energy Saving and Renewable Energy Equipment in Existing Facilities

A study was conducted on some cases of introduction of energy-saving and renewable energy equipment at the existing facilities in Yangon City. In many cases, mainly rooftop solar power systems were observed, and the commercial facilities constructed in recent years were found to have an output between 100 kW and 400 kW. It was also confirmed that the solar panels of private houses were also increasingly becoming popular in some townships. It was also confirmed that various types of solar street lights were installed.

Solar Power System in Junction Square

Solar Power System in Junction City

Solar Street Lights

Rooftop Solar Power System of Private House

Source: Prepared by Nippon Koei

3.1.4 Study for the Green Building Certificate System in Myanmar

Study for Green building certification system in Myanmre was conducted. Green Building Certification System of Myanmar has been introduced by Building Engineering Institute (BEI). BEI was established by the Myanmar Engineering Society (MES) and the Committee for Quality Control of High-Rise Building Construction Project (CQHP) on 23 November, 2014 in Yangon. Six committees are co-founded under BEI, including (1) Architecture, (2) Structure, (3) Geotechnical, (4) MEP (M&E), (5) Construction, Quality Control & Safety, and (6) Green Building. The Myanmar National Building Code 2016 is the green building criteria and basic requirements for Myanmar Construction Industry.

Although the government has not set rules and regulations for green building, there are some buildings (such as Sedona Hotel and Inya Wing) in Myanmar which are qualified under the certification of Green Mark, Building Construction Authority.

In addition, “Asia Property Awards” described that Junction City acquired the internationally recognised Green Mark certification from the Building and Construction Authority in Singapore. It was the first shopping mall in Myanmar to receive such certification

Novotel Hotel and Melia Hotel in Yangon have been selected to confer Association of Southeast Asian Nations (ASEAN) Green Hotel Award in 2018 which meet the requirements of Green ASEAN hotel standard including 11 criteria.

In the future, when supporting roll out of ZEB technology in Yangon City, further study is needed on the introduction method of the green building certification system in Yangon City. In addition, it is necessary to consider the consistency with the existing construction standards of Yangon City regarding the utilization of the Green Mark, which has been introduced by foreign companies in advance.

3.1.5 Study on Applicable ZEB Technologies

The information on the ZEB-related technologies that the companies in Fukuoka City own was collected in the study in Japan, and then the technologies which can be installed in Yangon City were sorted out as follows:

Table3.3 Applicable ZEB Technologies

#	Technology	Assumed Applications
1	High-efficiency chiller	Hotels and commercial facilities
2	High-efficiency boiler	Hotels and commercial facilities
3	High-efficiency air conditioning/ventilation system	Hotels and commercial facilities
4	High-efficiency filter	Hotels and commercial facilities
5	Energy-saving toilet/lavatory	Public facilities, hotels and commercial facilities
6	Light Emitting Diode (LED) lighting	Indoor lighting: Hotels and commercial facilities Street lights: Public roads, industrial parks, etc.
7	High-efficiency transformer	Power generation facilities, commercial facilities, factories, etc.
8	Energy management system (EMS)	Public facilities, hotels and commercial facilities
9	Solar power system	Public facilities, hotels and commercial facilities
10	Storage cell	Public facilities, hotels and commercial facilities

Source: Prepared by Nippon Koei

3.1.6 Specifications of Equipment to be Installed

In this study, a rough study was conducted on the specifications and scales of the high-efficiency chillers and solar power systems at the new large commercial facilities which are planning to install them. The details will be determined through the studies in the next and following fiscal years. Currently, the candidate technologies under study are solar power systems (about 500 kW) and high-efficiency turbo chillers (about 3 chiller units each with a capacity of 600 tons of refrigeration). The assumed Japanese manufacturers and the features of their products are summarized below.

Table3.4 Features and Superiorities of Technologies to be Installed

Technology	Features and Superiorities of Assumed Technology
1) Solar panel	• Japanese products which have been sold in overseas countries. • The products have been applied in several JCM Model Projects. • Since stable power generation effect, as well as high quality and performance, can be expected, they are superior to the products of other companies in Myanmar.
2) High-efficiency turbo chiller	• Japanese products which have been sold in overseas countries. • The products have been applied in five JCM Model Projects, including the 2015 Project "Installation of High Efficiency Centrifugal Chiller for Air Conditioning System in Clothing Tag Factory" in Bangladesh. • High efficiency: COP 6.4 (in case of a capacity of 1,440 US tons of refrigeration) • Use of a new refrigerant with low GWP. • The products can be effectively maintained by continuous remote monitoring.
3) High-efficiency once-through boiler	• Japanese products which have been sold in overseas countries. • High efficiency (98%) • Power consumption reduced by 75% due to the smaller blower, speed increase and use of inverter-type motor. • Combustion is started immediately, and rapid start-up even during sudden load changes. Production efficiency can be increased because of high-speed follow-up, stable pressure and stable steam supply, with less fluctuation in steam pressure. • The industry's top-level, low-NOx and low-CO technology because of low temperature change of flame. • A wide load operation region is secured with the turn down ratio of 1 to 5, which enables stable operation even at a low load. • Fuel consumption is minimized by applying a control system that controls many boilers and performs priority combustion in a high-efficiency load area.

Source: Prepared by Nippon Koei

The business plan and feasibility evaluation were reviewed, aiming to apply for a JCM Model Project in the next or following fiscal year. GHG emissions reductions and cost-effectiveness were estimated on the basis of the results of collected information from the companies. The estimation results are as follows:

Table3.5 Estimation Results of Candidate Technologies

#	Equipment to Be Installed	Lifetime	Annual GHG Emissions Reduction	Cost-Effectiveness
1	Solar power system	About 10 years	225 tCO2	3,999 yen per tCO2 or less for the whole project
2	High efficiency chiller	About 10 years	177 tCO2	
3	High efficiency once-through boiler	About 10 years	155 tCO2	

Source: Prepared by Nippon Koei

3.1.7 Study on International Consortium for Application for JCM Model Project

The assumed implementation structure is as follows: The representative entity in the international consortium is assumed to be a Japanese company that has experienced working for the previous JCM Model Project(s), with the partner entity assumed to be the owner of commercial facilities, which sufficiently meets the conditions of application. Therefore, the details of the technologies to be installed and the business schedule will be continuously reviewed, and study on the Measurement, Reporting and Verification (MRV) will be continued for the purpose of applying for a JCM Model Project in the next or following fiscal year.

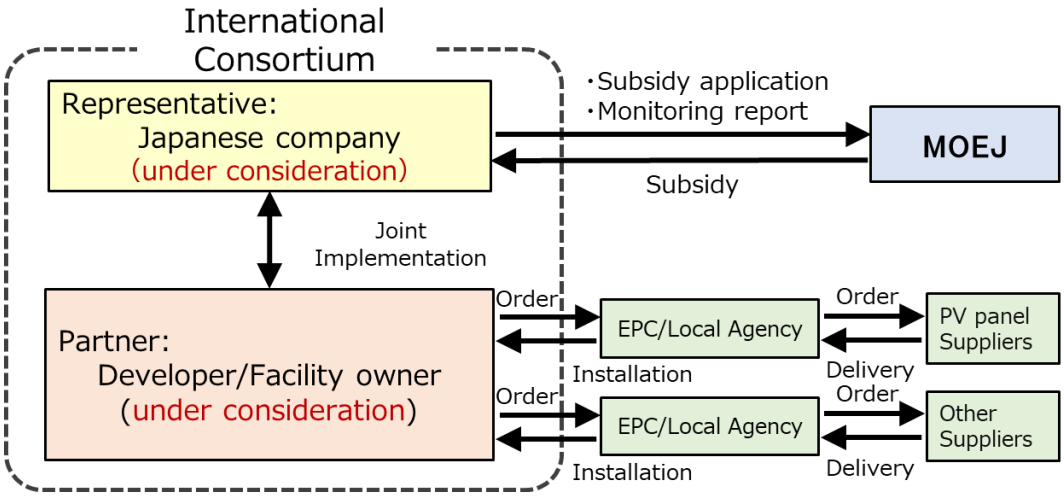


Figure3.1 Image of Implementation Structure of ZEB Project

3.2 FEASIBILITY STUDY IN RENEWABLE ENERGY FIELD (FUEL CELLS)

3.2.1 Overview of Study

In FY2020, a feasibility study was conducted to install fuel cells developed by Mitsubishi Power, Ltd. (hereinafter "Mitsubishi Power") in Yangon City, in cooperation with the same company.

In Yangon City, the demand for electricity is increasing due to its rapid economic growth after the transition from military rule to a democratic government in 2011. On the other hand, the supply of electricity cannot keep up with the demand, and the constant shortage of electricity has become an issue. The power generation facilities in Myanmar heavily depend upon hydro and gas power, and the power supplies have not been diversified. Hydro power, the main power source, has a problem in that water shortages occur in the dry season, causing a significant reduction in the amount of power generation, which is one of the causes of the power shortage. According to the Survey on Business Conditions of Japanese Companies in Asia and Oceania (Japan External Trade Organization (JETRO), December 2020), 60% of the Japanese companies doing business in Myanmar mentioned "power shortage/outage" as a management problem in the country. Many private facilities have diesel generators to prevent power outages. Thus, a stable supply of electricity is one of the top priority issues for the country's economic growth.

This study included the study work in Japan and online consultations with Mitsubishi Power, and information collection utilizing the local employees as follows, in order to grasp the needs for fuel cells that will contribute to the stabilization of electric power in Yangon City and formulate a project.

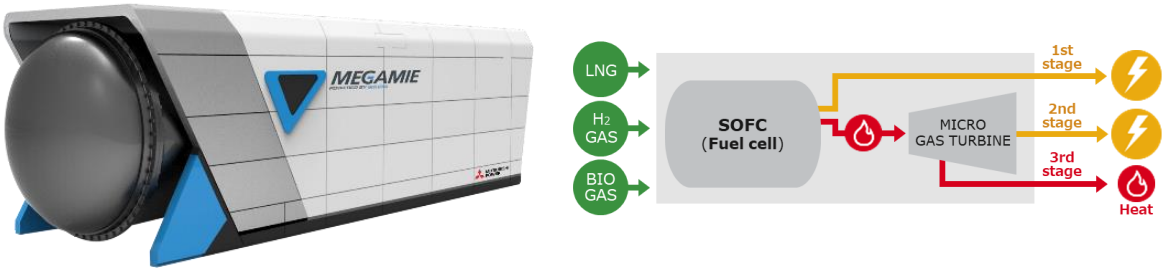
Table3.6 Study Items and Overview for Fuel Cell Installation

#	Study Item	Overview
1	Information gathering about local electric power situation	A study was conducted on the electric power situation in Yangon City, in collaboration with the local employees.
2	Study on specifications of equipment to be installed	The specifications of technologies to be installed were studied.
3	Development of business plan and evaluation of feasibility	The energy saving effects and CO2 emissions reductions were estimated.
4	Consideration of international consortium	The international consortium and its organization for implementation were reviewed for the purpose of applying for a JCM Model Project.
5	Inspection tour of facilities with fuel cells installed	Nine (9) units of the fuel cells produced by Mitsubishi Power are already installed in Japan. The visitors observed one of them, which is a commercial equipment installed in Marunouchi Building in front of Tokyo Station. (November 2020)

Source: Prepared by Nippon Koei

3.2.2 Specifications of Equipment to be Installed

A fuel cell produced by Mitsubishi Power (Product name: MEGAMIE) which is assumed to be installed in Yangon City is a hybrid system of solid oxide fuel cells (SOFC) and micro gas turbines (MGT). The right figure below shows an overview of the system configuration of MEGAMIE: Power is generated by the fuel cell body in the first stage; additional power is generated by the MGT which is driven by using the ejected fuel of the fuel cell in the second stage; and steam or heated water can be produced, using the heat from the MGT exhaust gases in the third stage.



Source: Mitsubishi Power

Figure3.2 Image of Fuel Cell (MEGAMIE) (left) and Overview of System Configuration (right)

The specifications of the equipment which is assumed to be installed are as follows:

Table3.7 Main Specifications of Fuel Cells Assumed to be Installed

Items	Expected Specification (210kW Class)
Electrical Output	210kW class
Electrical Efficiency (Lower Heating Value (LHV))	53 %
Hot water/ Steam Output	86kW/54kW
Total Efficiency (LHV) Electrical + Thermal	73%/65%
Noise Level (Estimated value)	≦65dBA (at 10m far distance)
Unit Size	W 3.2m x L 11.4 m x H3.3 m
Weight	33 ton
NOx (16% O2)	Low Concentration (Depends on the fuel)

Source: Mitsubishi Power

The superiorities of MEGAMIE are as shown in the following table. GHG emissions reductions are expected because the installation of this technology enables high-efficiency power generation without depending on fossil-fuel consumption.

Table3.8 Superiorities of Equipment (Fuel Cells) to be Installed

#	Superiority	Overview
1	High power-generation efficiency	Fuel cells enable direct conversion into electricity without burning fuels and achieves high-efficiency power generation. Therefore, the fuel consumption required for power generation and fuel costs can be reduced, compared with the conventional power generation equipment.
2	Use of a wide range of fuels	A wide range of fuels can be used for power generation, including natural gas, biogas, hydrogen.
3	Flexible responses to load fluctuations	Can operate flexibly in response to load fluctuations, according to the operating environment.
4	Low noise	Low noise, not higher than 65 dBA, is achieved.

Source: Prepared by Nippon Koei on the basis of the data provided by Mitsubishi Power

As power generation equipment for the energy of the next generation, 9 cells (210-kW cells) of MEGAMIE have already been delivered in Japan, among which six units of 210-kW cells, the same type as the one under study for installation in Yangon City, were delivered for verification tests, and three as commercial cells. Additionally, it was decided in October 2020 that the fuel cell would be installed at the Gas- und Wärme-Institut Essen (GWI) in Germany, which will be the first delivery to an overseas country. The designing and fabrication of the product were started so as to be in time for the operation commencement scheduled for March 2022. The fuel cell has attracted attention both in Japan and abroad as power generation equipment that will contribute to decarbonization.

3.2.3 Study Results

In this study, the information necessary for identifying the installation destination of the fuel cell (MEGAMIE) in Yangon City is listed in the following table. A questionnaire will be distributed to local companies in the next fiscal year to collect the information.

Table3.9 Information Necessary for Study of MEGAMIE Installation

#	Required information
1	Applicable code and standard
2	Installation area (xx m^2)
3	Installation condition (Ambient temp., Altitude)
4	Utilities: Fuel condition (Flow rate, Pressure, Composition)
5	Utilities: Water condition (Flow rate, Pressure, Composition)
6	Utilities: Other utilities (Compressed air, N2 gas)
7	Demand of Heat (Hot water or Steam)

#	Required information
8	Planned operation hour (per year)
9	Planned operation mode
10	Price of Fuel and Electricity from the grid

Source: Mitsubishi Power

In addition, the GHG emissions reduction effect which would be realized by installation of MEGAMIE was estimated for reference information. An annual GHG emissions reduction of about 630 tCO2 can be expected when compared with the GHG emissions from the thermal power generation facility with an equal output in Japan, assuming an electric output of 200 kW, heat output of 86 kW and annual operation of 8,500 hours as shown in the following table. These values will be recalculated after the specific destination of installation is fixed.

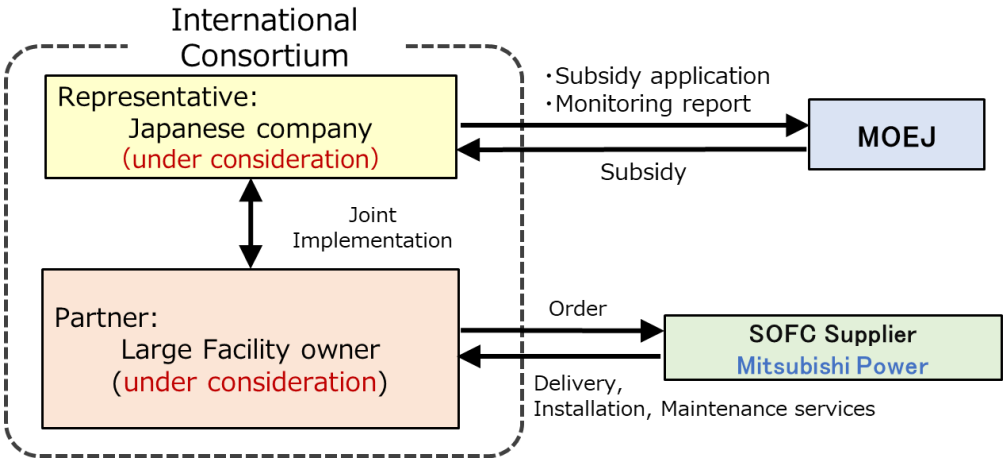
Table3.10 Estimation of GHG Emissions Reduction Effect by MEGAMIE Installation

#	Item	Value	Unit	Remarks
1	Design lifetime	15	[year]	---
2	Reducing CO2 emissions (per year)	630	[tCO2/year]	Calculation base – SOFC output: 200 kW – Heat output: 86 kW (Hot water) – O.H.: 8,500 hr./year
3	Reducing CO2 emissions (Total)	9,450	[tCO2]	

Source: Mitsubishi Power

3.2.4 Study on Organization of International Consortium

For installation of MEGAMIE, the utilization of a project for creation and spread of a low carbon technology for developing countries through a JCM Model Project or by co-innovation is under study. The implementation structure of an assumed JCM Model Project is as follows:



Source: Prepared by Nipppn Koei

Figure3.3 Image of International Consortium in MEGAMIE Installation Project

3.3 FEASIBILITY STUDY IN RENEWABLE ENERGY FIELD (TRIPLE HYBRID POWER GENERATION SYSTEM)

3.3.1 Overview of Study

In FY2020, a feasibility study was conducted to install a triple hybrid power generation system developed by Mitsubishi Heavy Industries Engine & Turbocharger, Ltd. (hereinafter "MHIET") in Yangon City, in cooperation with the same company.

In Yangon City, the demand for electricity is increasing due to its rapid economic growth after the transition from military rule to a democratic government in 2011. On the other hand, the supply of electricity cannot keep up with the demand, and the constant shortage of electricity has become an issue. The power generation facilities in Myanmar heavily depend upon hydro and gas power, and the power supplies have not been diversified. Hydro power, the main power source, has a problem in that water shortages occur in the dry season, causing a significant reduction in the amount of power generation, which is one of the causes of the power shortage. According to the Survey on Business Conditions of Japanese Companies in Asia and Oceania (JETRO, December 2020), 60% of the Japanese companies doing business in Myanmar mentioned "power shortage/outage" as a management problem in the country. Many private facilities have diesel generators to prevent power outages. Thus, a stable supply of electricity is one of the top priority issues for the country's economic growth (as described in section 3.2.1).

This study included the study work in Japan and online consultations with MHIET, and information collection using local employees as follows, in order to grasp the needs for the technology that will contribute to the stabilization of electric power in Yangon City and formulate a project.

Table3.11 Study Items and Overview for Installation of Triple Hybrid Power Generation System

#	Study Item	Overview
1	Information gathering about local electric power situation	A study was conducted on the electric power situation in Yangon City, in collaboration with local employees.
2	Study on specifications of equipment to be installed	The specifications of technologies to be installed were studied.
3	Development of business plan and evaluation of feasibility	The energy saving effects and CO2 emissions reductions were estimated.
4	Consideration of international consortium	The international consortium and its organization for implementation were reviewed for the purpose of applying for a JCM Model Project.

Source: Prepared by Nippon Koei

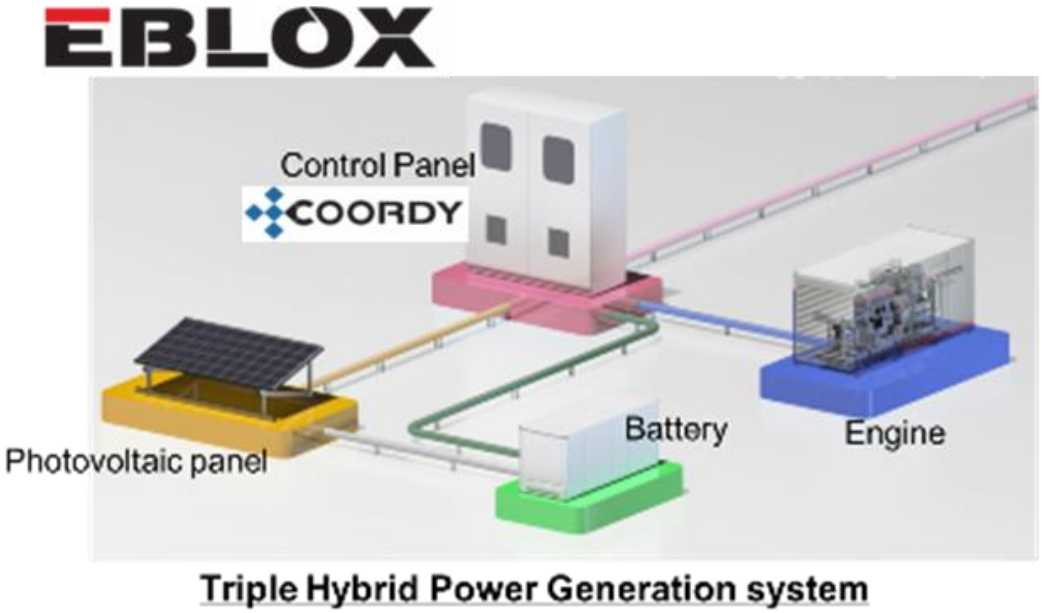
3.3.2 Local Electrification Rate

The Myanmar government aims to bring the domestic electrification rate to 100% by 2030. Although the electrification rate of the country has been improved every year to 16% in 2006,

26% in 2011 and 34% in 2015, it is still low, especially in rural areas. The electrification rate in Yangon City is about 80%, the highest in the country, and the aim is to achieve 86% by fiscal 2021. However, there are still issues in such aspects as securing of funds to achieve 100% electrification in the country, including Yangon City.

3.3.3 Specifications of Technologies to Be Installed

A triple hybrid power generation system produced by MHIET (Product name: EBLOX), which is assumed to be installed in Yangon City, is a power generation system that utilizes three different power sources and is equipped with an engine generator in combination with renewable energy sources such as solar power and an energy storage system (ESS). MHIET has a control system (Product name: COORDY) to control a combination of these three power sources, assign the power outputs for 3 electrical sources optimally and stabilizes the local grid when its frequency fluctuates. This study was performed, aiming at installation of EBLOX equipped with COORDY. EBLOX can supply stable power by using renewable energy in off-grid areas the power system has not reached.



Source: MHIET

Figure3.4 Image of Triple Hybrid Power Generation System

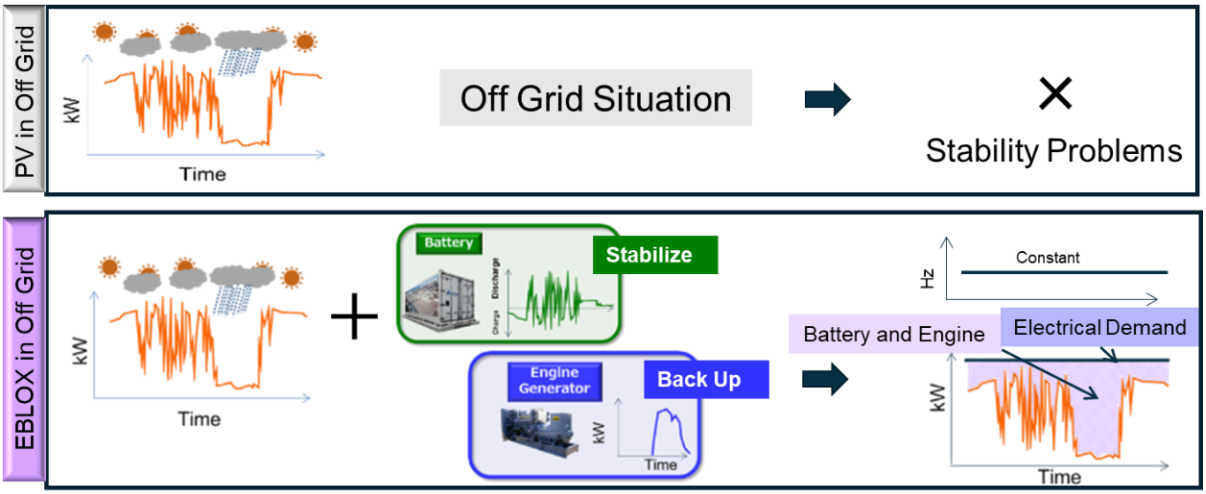
The superiorities of the technologies used in EBLOX are as follows:

Table3.12 Superiorities of Technologies to be Installed (Triple Hybrid Power Generation System)

#	Superiority	Overview
1	Stabilization of micro-grid system	The output of a solar power system affected by the weather can be stabilized by the discharging/charging of the battery. The engine generates backup power, which enables continuous power generation.
2	Automatic power supply management	It is possible to make the best use of solar power generation stably. Storage in the battery is also possible.
3	Optimal control of battery	Optimal control of the electricity storage amount is enabled while stabilizing the system, which prevents the battery from draining and eventually increases its lifetime.

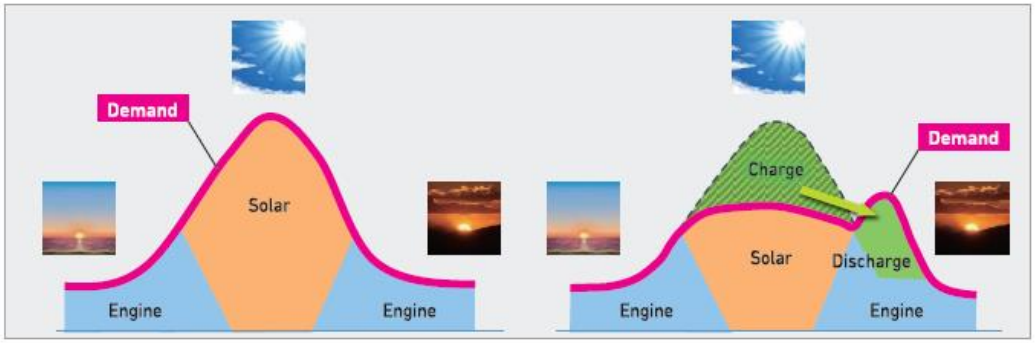
Source: Prepared by Nippon Koei on the basis of the data provided by Mitsubishi Heavy Industries Engine & Turbocharger, Ltd.

The details of the three superiorities listed in the above table are as follows:



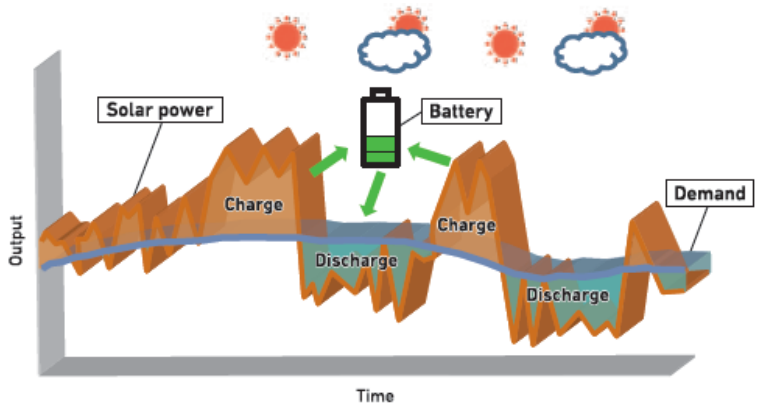
Source: MHIET

Figure3.5 Stabilization of Micro-Grid System through Utilization of Battery and Engine



Source: MHIET

Figure3.6 Automatic Power Supply Management by Using Control System



Source: MHIET

Figure3.7 Optimal Control of Battery

The verification tests of these technologies have been already performed at the Sagamihara Plant of MHIET. MHIET has started the development and efforts for the practical application of a hydrogen engine based on the conventional diesel engine and gas engine through joint research with the National Institute of Advanced Industrial Science and Technology (AIST) since FY2019, and aims to change the gas engine generator used in EBLOX to a hydrogen engine in the future.

3.3.4 Study Results

The GHG emissions reduction effect which would be exerted by installation of EBLOX was estimated for reference information. An annual GHG emissions reduction of about 1,200 tCO2 can be expected when installed in a power generation facility with an annual power generation of 3,800 MWh, as shown in the following table. These values will be recalculated after the specific destination of installation is fixed.

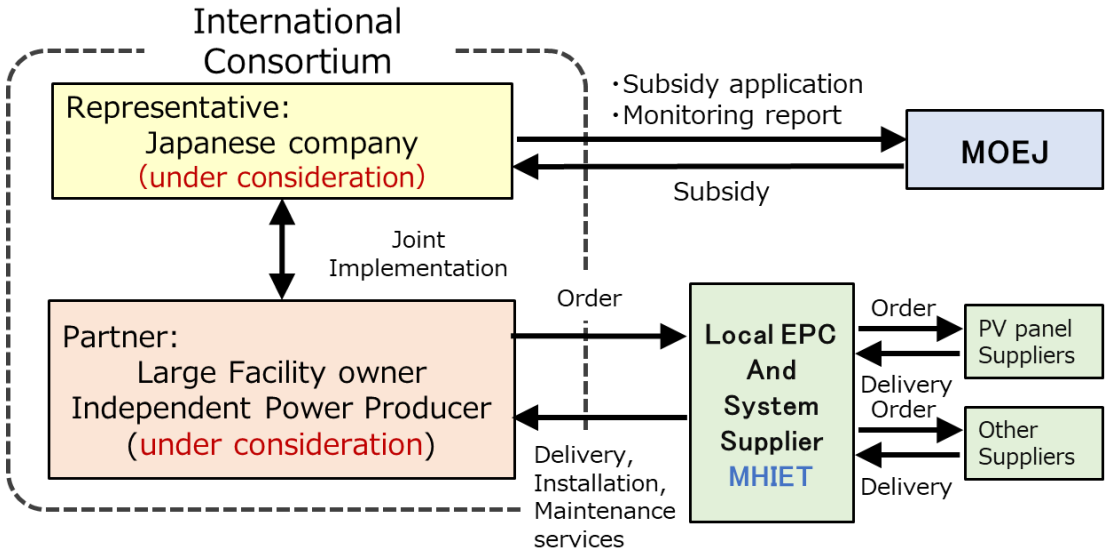
Table3.13 Estimation of GHG Emissions Reduction Effect by EBLOX Installation

#	Item	Value	Unit	Remarks
1	Design lifetime	15	[year]	To be confirmed
2	Reducing CO_2 emissions (per year)	1,200	[tCO2/year]	Condition: – Generation capacity: 3,800MWh/year
3	Reducing CO_2 emissions (Total)	18,000	[tCO2]	

Source: Prepared by Nippon Koei

3.3.5 Study on Organization of International Consortium

For installation of EBLOX, the utilization of a project for creation and spread of a low carbon technology for developing countries through a JCM Model Project or by co-innovation is under study. The organization for implementation of an assumed JCM Model Project is as follows:



Source: MHIET

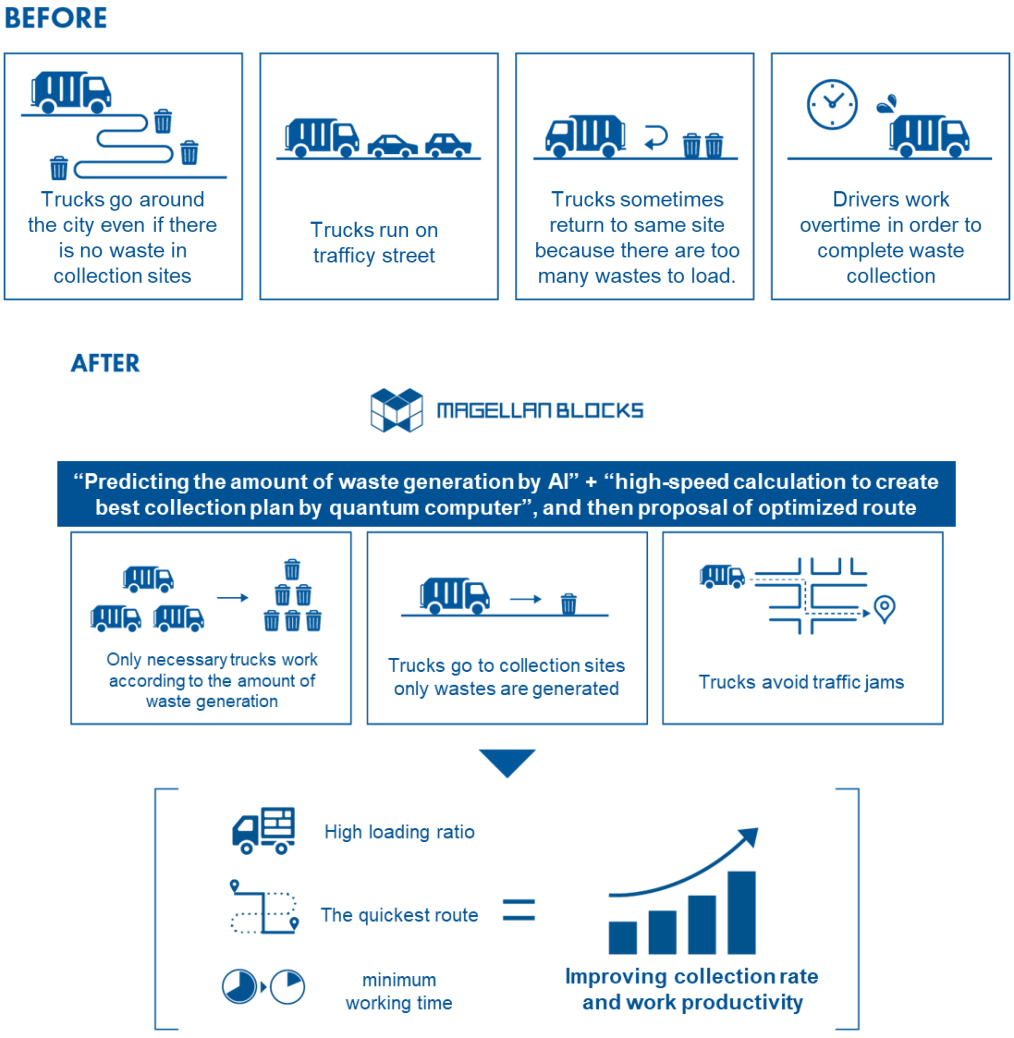
Figure3.8 Image of International Consortium in EBLOX Installation Project

3.4 SUPPORT FOR JCM MODEL PROJECT FORMULATION IN SOLID WASTE AND TRANSPORTATION SECTORS UTILIZING AI TECHNOLOGIES

3.4.1 Overview of Study

A study was conducted on the optimization of the waste collection routes using the AI and quantum computing owned by Groovenauts, Inc., a company in Fukuoka City, for the purpose of reducing GHG emissions by reducing the fuel for waste collection vehicles in Yangon City.

"MAGELLAN BLOCKS" developed by the same company has been already demonstrated in some cases of waste collection in Japan, which is similar to a case in Yangon. As shown in the following figure, the proposed technology is based on the assumption of the flow in which AI will be used to predict the amount of waste, and then a vehicle will be efficiently sent to a point full of waste, and furthermore instructions on the shortest route that avoids traffic jams will be given in real time by quantum computing, on the premise that the current waste collection rules and procedures are very inefficient.



Source: Excerpted from the joint press release of Groovenaut and Nippon Koei

Figure3.9 Image of Optimization of Waste Collection Routes

In FY2020, a study was conducted on the following items to estimate the possibility of optimizing the waste collection routes in Yangon City by using AI and the scale of GHG emissions reductions.

Table3.14 Study Items and Overview for Optimization of Waste Collection Routes

#	Study Item	Overview
1	Gathering of local data on waste collection	We made inquiries about the data owned by the Yangon City side and made a data list.
2	Extraction of necessary data and study on field survey method	Necessary data items were reviewed and identified on the basis of the cases in Japan. A study was also conducted on what procedure and method to be used to gather data in the future field surveys.
3	Study on other technologies to be installed	A study was conducted on the equipment, products and/or systems with waste collection technologies, which can be installed in a package with AI.

Source: Prepared by Nippon Koei

3.4.2 Study Results

1) Gathering of local data on waste collection

We asked for the data of the townships as follows through the YCDC/UECC and were able to obtain some of the data in FY2020. It is necessary to obtain the local data continuously in the next fiscal year to review the operation routes for optimization. Therefore, we plan to ask them for information through consultations in City-to-City collaboration.

Table3.15 List of Gathered Data Related to Waste Collection

#	Item	Contents	Status
1	Fuel consumption and its cost for waste collection vehicle of UECC(2015～2019)	• Fuel consumption • Fuel cost	To be provided
2	Vehicle data of UECC	• ID • Number of Vihecle • Manufacturer • Capacity etc.	To be provided
3	Waste collection status of each township	• Amount of waste • Frequency of waste collection	To be provided
4	Waste collection method of each township	• Number of Staff • Number of Vhicle and type • Capacity etc. • Daily amount of waste • Location of contener and waste collection method	To be provided
5	Data for predicting the amount of waste:	• Daily amount of waste • Schedule of waste colletion	Requested to data collection by field survey
6	Data for calculating optimized route of waste collection	• Waste collection route • Waste collection point	Requested to data collection by field

#	Item	Contents	Status
		• Condition or rules of waste collection	survey

Source: Prepared by Nippon Koei

2) Data analysis and system review

We studied the structure and output image of the data that can be collected in Yangon City by referring to the similar cases demonstrated in Japan, together with Groovenauts. Currently, we have not obtained essential information for the route optimization, such as the tracking data. Therefore, we will narrow down the 33 townships in Yangon City into some areas, such as average areas or areas having problems with waste collection, and conduct a sample study in the next fiscal year. Furthermore, since the conditions and parameters for optimization need to be set in accordance with the waste collection rules of Yangon City, we plan to ask the local governments and drivers for detailed information, such as the current system and actual operation rules, in addition to the above data.

3) Study on other technologies to be installed

For the technologies to be installed for the project, MAGELLAN BLOCKS developed by Groovenauts will be the core technology. However, it will be necessary to add the technologies and equipment to resolve various issues when feasibility is considered. For instance, there may be a case in which immediate instructions on the exact route cannot be given to the driver no matter how efficient the selected route may be. Or if the amount of waste is manually measured, effective collection may be impossible because accurate predictions cannot be made even if AI is used. Furthermore, the optimization would not work well if the vehicle is old and not fuel-efficient or if its capacity or type is not adequate for the amount of collection in the allocated area.

Therefore, we have a policy to study the feasibility in the form of a package, including MAGELLAN BLOCKS as the core, improving the fuel efficiency of collection vehicles by updating or replacing them with new ones and gathering accurate big-data sets through the use of smart waste collection containers and a monitoring system equipped with a global positioning system (GPS) though it is currently in the review stage.

Table3.16 Study on Technologies which may be Installed

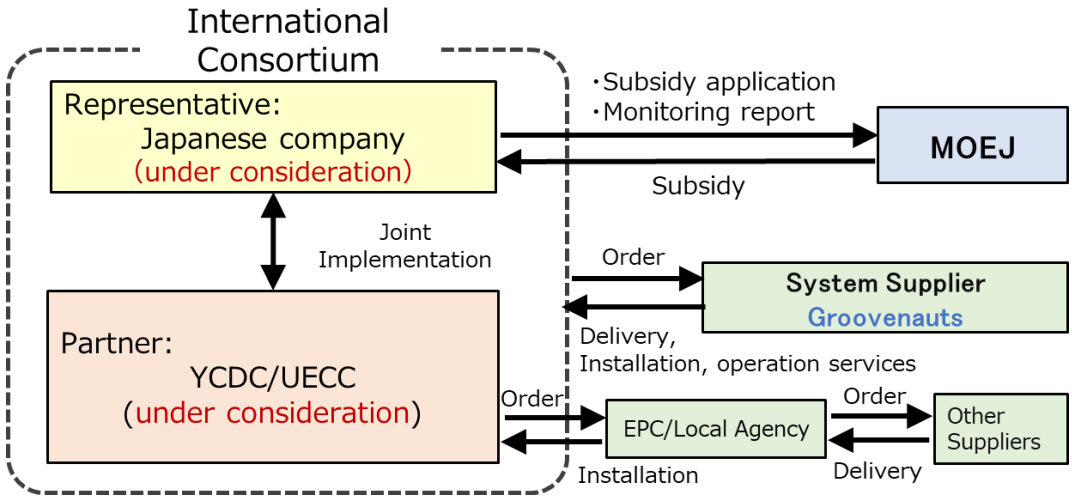
#	Technology Which May be Installed	Overview
1	MAGELLAN BLOCKS	Operating route optimization system by big data analysis, AI predictions and quantum computers
2	Waste collection vehicles	Fuel conversion by introducing such vehicles as compressed natural gas (CNG) vehicles, hybrid vehicles and electric vehicles (EVs).
3	Smart waste collection containers	Waste collection containers equipped with measuring and communication functions

#	Technology Which May be Installed	Overview
4	Monitoring system with GPS	System to collect and analyze the tracking data of collection vehicles.

Source: Prepared by Nippon Koei

3.4.3 Assumed Organization for Implementation and Funding Scheme

The organization for implementation of an assumed JCM Model Project is as follows:



Source: Prepared by Nippon Koei

Figure3.10 Image of International Consortium in Waste Route Efficiency Increase Project

Although we plan to continue the feasibility study for the project formation by optimizing the waste collection route in the next fiscal year, simultaneously a study will be conducted on applying these technologies to the transit sector in Yangon City, which has an issue with traffic congestion by making use of their general-purpose properties.

In addition, assuming that the budget of Yangon City cannot be expected for this project, we also plan to explore other exit strategies, such as the utilization of the technical cooperation, grant aid and other schemes of JICA.

CHAPTER 4 ISSUES AND INGENUITY IN CONDUCTING THE PROJECT AGAINST THE BACKDROP OF COVID-19

The field surveys, consultations between the two cities, local workshops, City-to-City collaboration seminars, etc., which should have been major activities if 2020 were a normal year, were held completely online and conducted under physical restrictions due to the impact of the spread of the COVID-19 after January 2020 in the City-to-City collaboration programme of FY2020. However, some of the activities were carried out with ingenuity or replaced by alternative activities even against the backdrop of the COVID-19 pandemic. Or some activities were postponed until a future date. Those activities are summarized below for reference in the next fiscal year.

4.1 AFFECTION TO WORLD ECONOMY BY COVID-19 PANDEMIC

According to a report of the International Monetary Fund (IMF) in June 2020, the worldwide spread of the COVID-19 will lead to global growth rate of -4.9 % in 2020,which was 1.9 point lower than estimation of World Economic Outlook (WEO) in April 2020. In addition, the aggregate annual growth rate of the East Asia and Pacific region is projected to be slower from 5.8 percent in 2019 to 0.5 percent in 2020.

Due to the impact of COVID-19 pandemic, Myanmar's Gross Domestic Product (GDP) forecasts for 2019 and 2020 are expected to have fallen from 6.4% to 0.5% overall, although the intensity of impact in each sector.

4.2 EFFECTS ON ECONOMIC ACTIVITIES, TREND OF COUNTERMEASURES TO COVID-19 PANDEMIC (JAN 2020 TO DEC 2020)

COVID-19 pandemic affects on economic development in Myanmar, and the economic growth rate was estimated 1.7 percent in FY2019/2020, down 6.8 percent from FY2018/2019. Due to the pandemic and related countermeasures made national aggregate demand down, the supply of labor and investment were stagnated and negative effects on wholesale and retail trade, tourism-related services, and manufacturing and construction activities.

The growth in the first half of the year was led by constraction sector in the June quarter, but the economy was affected in response to the first wave of COVID-19 and the impact of associated mobility restrictions and disruptions to trade.It was on a recovery trend in July and August, but was severely damaged by the second wave of the pandemic in September.

The construction sector has been particularly affected by restrictions on gathering people and social distance, and economic activity, including the tourism sector, transportation, commerce, hotels, restaurants, and entertainment, has also been severely damaged by measures agenst COVID-19.

First wave of COVID-19 pandemic could be controlled with effective measures and restrictions. Unfortunately, the second wave has significantly affected hotel and tourism sectors since September. In March 2020, the government suspended visas for foreign nationals and restricted the arrival of international flights completely halting international tourism. In addition, according to the notice from the Department of Civil Association issued on the end of December 2020, the earlier restrictions for all international airlines operating air services to and from the Yangon International Airport have been further extended up to the end of January 2021. However, the domestic operations have resumed in December, in compliance with all recommended practices from the authority.

Furthermore, in agricultural sector, the prices of some crops and fruits have changed significantly due to restrictions on transportation in COVID-19 pandemic.

Due to the change of people's behavior, online shopping has been relatively attracting attentions in the retail sector. Compared to January-February 2020, major online site companies have reported that social distance measures have increased online shopping orders by 50%, sales by 60%, and online payments by 50%. It seemed that consumer demand for services has clearly changed by the lockdown of city and so on.

As increasing online consumption, internet data usage increased by 25% from May to October 2020. According to the report of World Bank Group, mobile communications and the consumption of internet services has been growing rapidly. In addition, increased supply and demand had led to further investment in telecommunications infrastructure, driving growth in the telecommunications sector and intensifying competition among internet service providers.

4.3 GOVENMENTAL COUNTERMEASURES TO COVID-19 IN MYANMAR

The National-Level Central Committee for COVID-19 Prevention, Control and Treatment was formed on Jan 30,2020. The government banned mass gatherings on February 28,2020. The government released a management protocol and clinical management guidelines for COVID-19 Acute Respiratory Distress Syndrome on March 6, 2020. The World Health Organization (WHO) declared the COVID-19 to be a pandemic on March 11,2020. The Ministry of Information (MOI) ordered cinemas across the country to close until January, 2021.

The government announced restrictions for arrivals from 17 countries and announced 14-day quarantines for those arriving from high-risk countries on March 20, 2020. All types of visas for foreign nationals from all countries except diplomats, UN officials and ship and aircraft crews were suspended.

Furthermore, Restaurants nationwide are ordered to only provide takeaway services. Government also ordered half of its employees to stay at home and prohibited travelling in order to reduce the risk of spreading COVID-19 until November, 2020.

The Myanmar Union Parliament approved a proposal to borrow a US$50 million emergency loan from the World Bank to improve hospital systems and public health emergency preparedness on May, 2020.

The government extended restrictions, including a ban on public gatherings and the suspension of visas, international flights, and local tourisms, until January 2021. In large cities such as Yangon and Mandalay are restricted according to the Ministry of Health and Sports (MOHS) guidelines. In addition, not only international travelers but also local travelers are requested to go to a quarantine center in the city they arrived according to the updating announcement until January, 2021.

According to U Aung Naing Oo, the permanent secretary of the Ministry of Investment and Foreign Economic Relations (MIFER), the government has spent more than US$2 billion to mitigate the social and economic impacts of COVID-19. That spending includes for poor households and the national disaster fund. According to World Bank Group, total spending on COVID-19 measures so far is equivalent to 4 percent of the country's GDP.

4.4 TRENDS OF CONSTRUCTION SECTOR IN YANGON

The economic damage to the construction sector due to the increase in telecommuting by COVID-19 was greatly concerned. According to a statement by the Central Committee on Corona Prevention, Control and Treatment of COVID-19 in September, 2019, half of the people involved in the construction sector would need to work from home, so that it was concerned a negative impact on construction work in Yangon.

The COVID-19 pandemic presents a major challenge to the construction sector. According to the World Bank Group, growth in construction output slowed to an estimated 1.6 percent in the full year FY19/20, though the construction of telecommunication, electricity and transport infrastructure supported growth in the first half of the year. There was significant growth in the import and production of construction materials including cement, iron and steel material in the first half of the year. But lockdown and transmission mitigation measures led to the temporary closure of construction sites in the second half.

The number of issued construction permits declined by 30 percent in FY2019/2020 as planned projects were suspended. On the other hand, Myanmar has recently digitized its online permit system in order to facilitate quicker administrative processes, which should support approvals over the medium-term.

4.5 ENERGY TREND IN YANGON

There was a government's announcement that households would not need to pay for the first 150 units of electricity they use until the end of May. This announcement was extended until December, 2020. Therefore, the electricity charges were free in charge for most of the households because they did not use electorcity over the monthly limit. Electricity charges were set lower in 2020 than in 2019, and it seemed that the financial burden has been lightened even for households that consume a lot of electricity.

There were 80.73% of household population which can access and use the electricity in 2020, therefore, some power outages had happened in Yangon. The need for "power stabilization" remains unchanged even in COVID-19 pandemic in Yangon, it was confirmed that it matches the support contents of this City-to-City collaboration.

4.6 TECHNOLOGY SECTOR WITH HIGH INTEREST

During the COVID-19 pandemic period, there were rapid growth of interest and online survices with greatly emerging demand and it tends to be more intensifying competition among internet service providers. The pandemic has a positive impact on delivery services because most people stay at home. As in Japan, many citizens live at home to prevent infection of COVID-19, which has helped deliver food and other services.

From the perspective of energy and fuel consumption, the introduction of technologies to make these growing service sectors more efficient and optimized can be considered as a "green recovery" approach.

4.7 ISSUES FOR IMPLEMENTATION OF PROJECT BY COVID-19 PANDEMIC

In FY2020, due to travel restrictions, it was not possible to physically collect information, investigate facilities, and have face-to-face discussions with Yangon City and private ompanies. Therefore, it was difficult for both cities to share policies related the green building and exchange information sufficiently, business matching for JCM Model Project formulation, confirmation of technical needs, and consideration of commercialization.

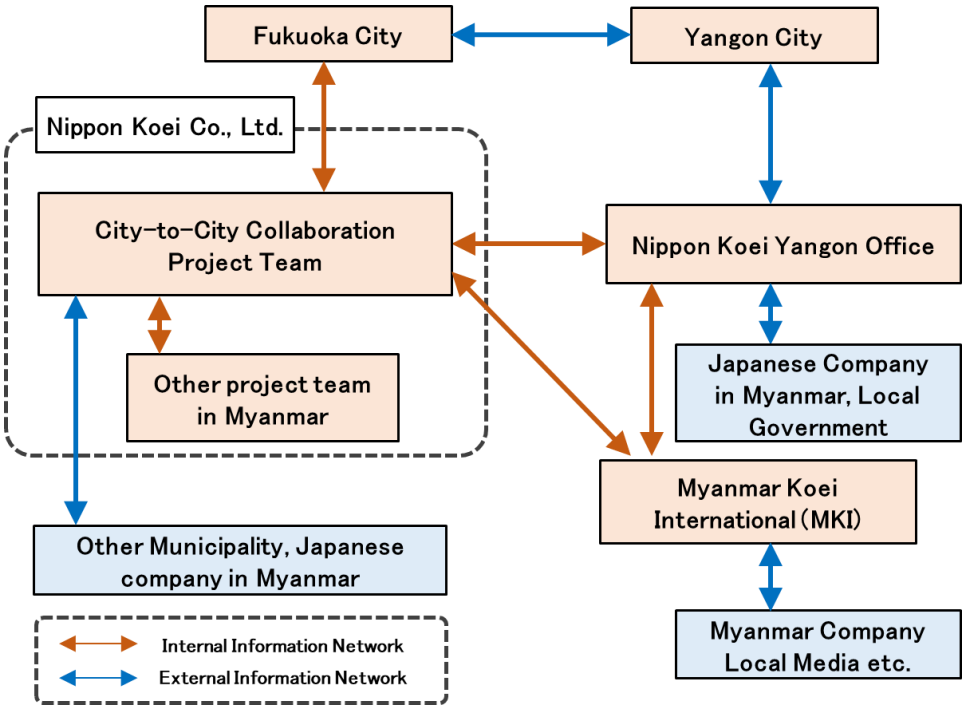
Fortunately, Yangon City had well known the content and purpose of City-to-City Collabortaion because it has similar experience in other project, therefore there was small impact from COVID-19.

On the other hand, it was difficult to conduct enough activities in private sector such as dissemination of advance technologies and concept (AI and ZEB), therefore, it was decided to collect and analyze as much information as possible remotely and the study activities was carried over to next fiscal year.

4.8 INGENUITY FOR SMOOTH IMPLEMENTATION OF PROJECT

The online communication with Yangon City was implemented, similar to face-to-face meeting (until the end of January 2020). In addition, One of the strengths of this City-to-City collaboration is that long-term experts dispatched to Yangon City and has supported communication network.

To be more effectiveness of the study, Nippon Koei Yangon offices and MKI as Nippon Koei’s subsidiary company had supported for data collection related to activities for Green recovery and JCM Model Project formulation by the following organization structure.



Source：Prepared by Nippon Koei

Figure4.1　Internal/External information collection network and division of roles in the COVID-19 Pandemic

CHAPTER 5 FUTURE PLAN

On the basis of results of the Project's activities in FY2020, the following sections describe future plan for FY2021.

5.1 APPLICATION FOR JCM MODEL PROJECT

In FY2020, the feasibility study for JCM Model Project formulation was conducted with the aim of installing the following three (3) technologies.

5.1.1 AI Technologies Utilized for Optimizing Waste Collection Routes

Since there are several similar projects which utilize Groovenaut's AI technologies to optimize a route of waste collection in Japan, necessary study items for installing the same technology in Yangon City and available data from YCDC were confirmed. Also, consideration of a method for implementing the feasibility study in Yangon City and discussion with UECC were conducted. Furthermore, for introducing this AI technologies to YCDC, presentation materials (in both English and Myanmar) and video (in Myanmar) were created. These activities are a first step for implementing the feasibility study in more detail in FY2021.

Because the scale and accuracy of installed system depends on quantity and quality of available data which YCDC will provide, it will be essential to collecting detail information from YCDC and other relevant organization in Yangon City. The followings are an expected study item in FY2021.

- Data collection on waste collection in Yangon City, and its analysis
- Selection of target project site (such as township and route)
- Prediction of generated waste amount utilizing AI technology
- Consideration of optimized collection route by using quantum computer
- Decision of specification and quantity of a monitoring equipment
- Estimation of GHG emission reduction
- Estimation of project cost and subsidy amount
- Calcuration of cost effectiveness
- Consideration of International Consortium and implementation structure
- Consideartion of implemenration structure for MRV and so on

In the future, AI and quantum computer are planned to be utilized for not only waste management sector but also public/ private transportation sector which might be able to contribute to solve urban area's issues such as traffic jam. Furthermore, these technologies will be expanded to energy sectors for GHG emission reduction.

5.1.2 ZEB Technologies to be Installed in Large-scale Commercial Building

In FY2020, information on the buildings in Yangon City which are installed rooftop sloar power system, LED and so on was collected, and also technological information and current building ownwer's needs were confirmed. Furthermore, for introducing this ZEB technologies to YCDC and local companies in Yangon City, presentation materials (in both English and Myanmar) and video (in Myanmar) were created. These activities are a first step for implementing the feasibility study in more detail in FY2021.

In addition, by implementing a desk research on current situation of a green building certification system in Myanmar and YCDC, it was confirmed that several foreign-capitalized hotels and shopping malls have received a certification calld "Green Mark" which is a building certification in Singapore.

In FY2021, in parallel with continuative consideration of installing rooftop solar power system and energy saving technologies into newly-constructed commercial building which is a candidate JCM Model Project identified in FY2020, selecting additional suitable ZEB technologies for Yangon City and promoting the technologies will be conducted. As a way of promoting ZEB technologies in Yangon City, it will be considered to install green building certification system suitable for Yangon City and also utilize existing green building systems. The followings are an expected study item in FY2021.

- Selection of target project site and discussion with relevant persons
- Consideration of installing energy saving technologies and renewable enery
- Data collection on greenbuilding certification system, and its analysis
- Decision of specification and quantity of a monitoring equipment
- Estimation of GHG emission reduction
- Estimation of project cost and subsidy amount
- Calcuration of cost effectiveness
- Consideration of International Consortium and implementation structure
- Consideartion of implemenration structure for MRV and so on

Currently large-scale shopping malls and hotels in Yangon City are main targets, however, other type of buildings not only in Yangon City but also at other cities in Myanmar migth be also target for installing ZEB technologies as a next step. In the future,with the corporation among Japanese companies and local companies, promoting ZEB technologies at buildings in Myanmar is a goal.

5.1.3 Technologies Contributing for Power Stabilization (such as SOFC)

The data on current electoricity situation and trend of energy consumption in Yangon City were collected with consideration for COVID-19's impact. Furthermore, for introducing a SOFC and a triple hybrid power generation to YCDC and local companies in Yangon City, presentation materials (in both English and Myanmar) and video (in Myanmar) were created. These activities are a first step for implementing the feasibility study in more detail in FY2021.

In FY2021, data collection will be continued based on the result of FY2020, and target project site in Yangon City or near the city will be selected. In addition, discussion with stakeholders which are interested in power generation project will be conducted as weel.

The followings are an expected study item in FY2021.

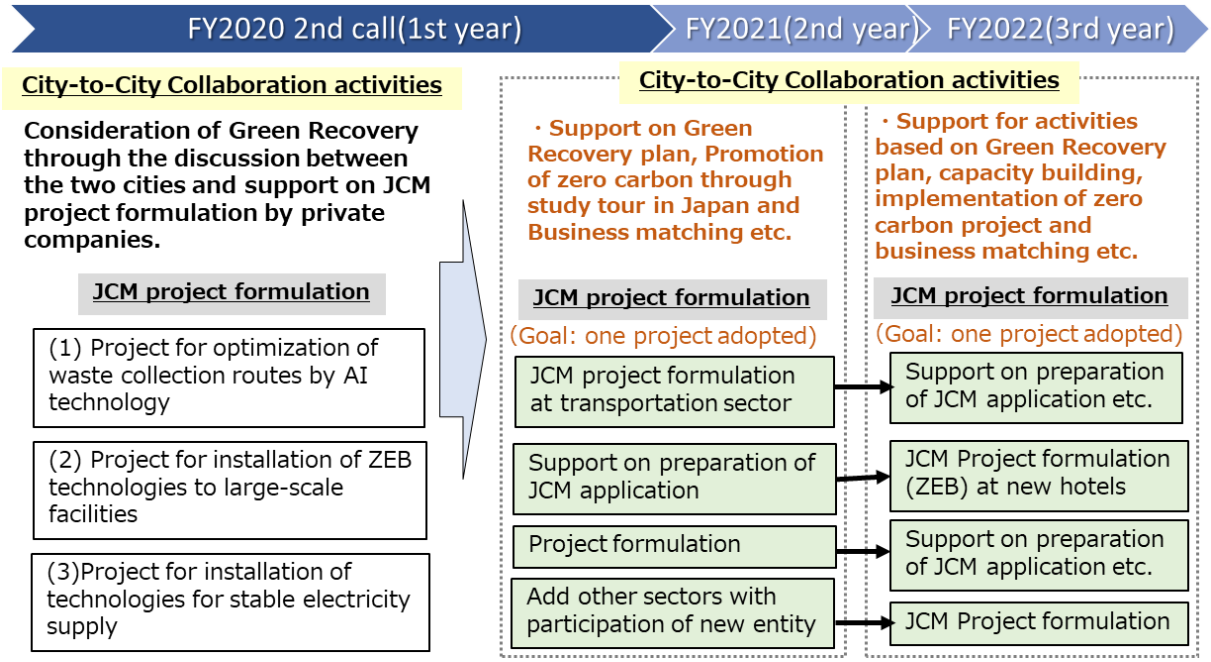
- Data collection on energy condsumption in Yangon City, and its analysis (on-going)
- Selection of target project site and discussion with relevant organization
- Consideration of installing technologies which contribute to power stabilization
- Decision of specification and quantity of a monitoring equipment
- Estimation of GHG emission reduction
- Estimation of project cost and subsidy amount
- Calcuration of cost effectiveness
- Consideration of International Consortium and implementation structure
- Consideartion of implemenration structure for MRV and so on

Since Yangon City has often lost power even under COVID-19 pandemic, the Project has proposed to install SOFC and a triple hyblid power generation for power stabilization. In the future, target area of installing these technologies will be expand in not only Yangon City but also other cities in Myanmar. Especcialy, industry areas, off-grid areas, and remote island have a big potential as a target project site. So, necessary information of Yangon City and near the city will be continuously collected in FY2021 to install the technologies with utilization of JCM subsidy.

5.2 PROPOSED ACTIVITIES IN FY2021

Fukuoka City has provided positive cooperation to Yangon City as a sister city, especcialy on water supply/sewerage, urban development, and solid waste sectors. The City-to-City collaboration between Fukuoka City and Yangon City which started in FY2020 has expand their target sectors, and implemented several activities with the theme of "Green Recovery" to realize restoration of urban functions from the COVID-19 pandemic as well as decarbonization.

However, due to COVID-19 pandemic and coups which has happen since February 2021, it was difficult to implement several activities according to the plan. So, intercity meetings, a online workshop among YCDC, Fukuoka City, and private companies in both city, and finalization of candidate JCM Model Project were pushed back. Therefore, following the three (3) year's plan that was created when the Project started, the above activities will be continued to do.



Source: Prepared by Nippon Koei

Figure5.1 Three (3) Year's Plan of the Project

Table5.1 Proposed Activities in FY2021

Policy	Sector	Description
Feasibility study for JCM Model Project Formulation	Consideration for installing AI technologies for optimization of waste collection routes (on-going)	• Data collection on necessary information to predict amount of waste and optimiszation of collection routes by AI • Estimating amount of fuel reduction, and consideration of necessary technologies such as monitoring system or smart trash boxes to utilize AI • Consideration of implementation structure and project cost
	Data collection for identify need and potential for utilizing AI technologies in transportation sector (new)	• Confirmation of current status, relevant organizations, and their needs on transportation sector • Consideration of a potential of installing newly technologies such as monitoring system or EV as well as AI

Policy	Sector	Description
	Promotion of ZEB technologies in private sector (on-going)	• Selection of applicable renewable energy or energy saving technologies, and calculation of expected GHG emission eduction • Data collection of target project site and field survey • Introduction of Japanese technologies to local companies, and organization of a business matching event
	Consideration of installing technologies for power stabilization (on-going)	• Data collection of target project site • Introduction of Japanese technologies to local companies, and organization of a business matching event
Intercity collaboration for zero-catbon society	Support on activities for Green Recovery	• Identification of needs and potential sectors for realizing zero-carbon, and considering how to support to Yangon City • Support for Green Recovery by utilizing financial support or scheme provided by MOE, JICA, or International donors • Involvement the member companies of International Business Platform Fukuoka in the Project, and support on promoting their tehcnologies in Yangon City for zero-carbon

Source: Prepared by Nippon Koei