FY2020 Project for Ministry of the Environment Japan

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

Project to Promote Development of Circular Economy for Oil Palm Industry and 2050 Zero Carbon City in Riau Province Region

Report

March 2021

Nippon Koei Co., Ltd.
Kawasaki City

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

Project to Promote Development of Circular Economy for Oil Palm Industry and 2050 Zero Carbon City in Riau Province Region

Report

Table of Contents

Page

List of Tables

List of Figures

List of Attachments

List of Abbreviations

ASEAN	Association of South-East Asian Nations
BaU	Business-as-Usual
BtoB	Business to Business
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
COP	Conference of Parties
EFB	Empty Fruit Bunch
EPC	Engineering, Procurement and Construction
FFB	Fresh Fruit Bunch
F/S	Feasibility Study
GHG	Green House Gas
GIC	Kawasaki Green Innovation Cluster
IGES	The Institute for Global Environmental Strategies
JCM	Joint Crediting Mechanism
LED	Light Emitting Diode
LoI	Letter of Intent
MF	Mesocarp Fiber
MOE	Ministry of the Environment, Japan
MoU	Memorandum of Understanding
NDC	Nationally Determined Contribution
PKS	Palm Kernel Shell
PLN	National Electricity Company (PT Perusahaan Listrik Negara /Persero)
POME	Palm Oil Mill Effluent
PSA	Pressure Swing Adsorption
PT.PN5	PT. Perkebunan Nusantara V(PERSERO)
RAD-GRK	Regional Action Plan for Greenhouse Gas Emission Reduction
RAN-GRK	National Action Plan for Greenhouse Gas Emission Reduction
RUEN	Grand National Energy Plan 2015-2050
RSPO	Roundtable on Sustainable Palm Oil
SDGs	Sustainable Development Goals
WWF	World-Wide Fund for Nature
ZEB	Net Zero Energy Building
ZEH	Net Zero Energy House
ZEV	Zero Emission Vehicle

CHAPTER 1 BACKGROUND AND OBJECTIVE

1.1 BACKGROUND OF THE STUDY

In December 2015, all countries participated in United Nations Framework Convention on Climate Change (UNFCCC)'s 21st Conference of the Parties (COP21) which was held in Paris, France. In COP21, Paris Agreement was adopted as a legal framework of fair and practical countermeasures to climate change after 2020. Paris Agreement aims at keeping global warming below 2 degrees Celsius above pre-industrial level, and it requires efforts to keep it below 1.5 degrees Celsius by promoting activities for decarbonization. Furthermore, at the COP24 held in Katowice, Poland in December 2018, the Paris Agreement Work Programme was adopted for the full implementation of the Paris Agreement for 2020 onwards.

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. In addition, it was decided that activities by non-state actors (including cities) and efforts by all non-governmental entities (cities and other local governments, etc.) are acknowledged and encouraged to be scaled up in COP21. Cities are the places to support social and economic growth since a lot of people live there. Although the total of urban areas is only 2% of all land in the world, approximately half of world population live in urban areas and the percentage is predicted to increase to 70% by 2050. Also, it is estimated that more than 70% of global CO2 emissions are emitted from cities as of 2006; hence, cities have important roles for mitigation of climate change. Thus, implementation of countermeasures to climate change and greenhouse gas (GHG) emission reduction in cities are important for achievement of the goal of Paris Agreement. 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.

In Indonesia, the Government of Indonesia established National Action Plan for Reducing Greenhouse Gas Emissions (RAN-GRK), and each regional government enacted Regional Action Plan for Reducing Greenhouse Gas Emissions (RAD-GRK) in 2013. In addition, Grand National Energy Plan 2015-2050 (RUEN) formulated in January 2017, particularly considers promoting energy saving and utilization of natural gas in Indonesia as priority countermeasures. Furthermore, Indonesian Government has promised to reduce 29% of GHG emission compared to Business-as-Usual (BaU) according to their NDC, and in case international assistance such as JCM is introduced, their target is 41% in NDC. Therefore, Indonesia is expecting to implement JCM, which Indonesia and Japan signed, for achievement of the target in NDC.

This project is implemented between Kawasaki City and municipalities in Riau Province (Pekanbaru City and Rokan Hulu Regency). Riau Province is located in the center of Sumatera Island of Indonesia and core industry there is oil palm. Palm oil is one of 10 key produces

decided by the Ministry of Trade of Indonesia. The percentage of palm oil in export of 2017 was 12% which was larger than any other product. Production amount of palm oil in Indonesia is the largest in the world and 85% of palm oil in the world is produced in Indonesia and Malaysia. (WWF 2017). Also, both production (7.72 million ton) and cultivation area (2.26 million ha) in Riau Province are the largest in Indonesia (Statistik Kelapa Sawit Indonesia 2017).

While oil palm sector is core industry in Riau Province, management of waste generated from production of palm oil is one of the environmental issues there. On the other hand, In Pekanbaru City with rapid economic growth, environmental issues are arising from industrialization and urbanization.

1.2 OBJECTIVES OF THE PROJECT

"The City-to-City Collaboration Programme for Zero-Carbon Society" aims to implement investigations for developing a low carbon society in foreign cities by Japanese cities who have valuable knowledge and experiences. Japanese cities also collaborate with Japanese research institutes, private companies, and universities in order to conduct the surveys in an effective and efficient manner.

This project contributes to promotion of circular economy for oil palm industry in Riau Province Region by utilizing Kawasaki City's experience of promotion of Zero-emission Concept and technologies of companies in Kawasaki. Also, support for development of 2050 Zero Carbon City in Pekanbaru City are carried out.

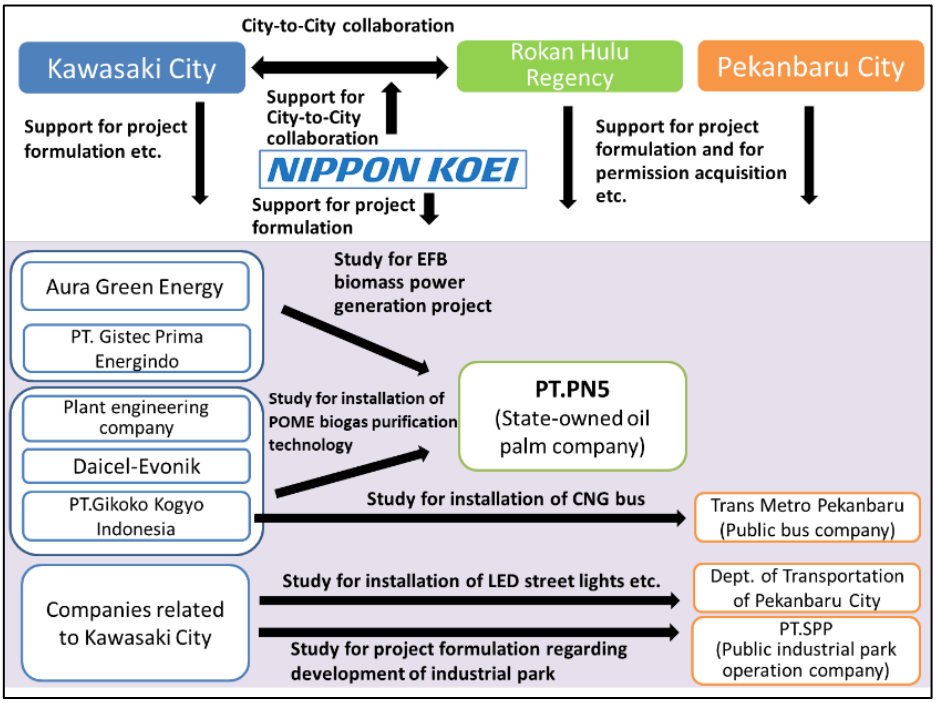
1.3 IMPLEMENTATION STRUCTURE

Implementation structure of this FY is illustrated in Figure 1.1. Kawasaki City carried out discussion of circular economy for oil palm industry and of development of 2050 Zero Carbon City with Pekanbaru City and Rokan Hulu Regency.

Also, under the City-to-City Collaboration, 1) Empty Fruit Bunch (EFB) biomass power plant project and 2) Project for Palm Oil Mill Effluent (POME) biogas utilization. Regarding For 1), Aura Green Energy and its local partner, PT. Gistec Prima Energindo, implemented feasibility study targeting palm oil mills owned by National Oil Palm Company, PT. Perkebunan Nusantara V (hereinafter, PT.PN5), whereas Daicel-Evonik, Japanese Engineering Company A and PT. Gikoko Kogyo Indonesia implemented study of palm oil mills owned by PT.PN5 and considered initial design of biomass purification plant for 2).

In addition, formulation of JCM model project regarding urbanization and industrialization in Pekanbaru City. For this, companies in Kawasaki with technologies matching local needs are introduced when necessary.

This project was implemented without a trip to Riau Province considering COVID-19 pandemic in the world. Thus, information collection, studies and discussions were implemented under cooperation with two local companies above and two local experts.



Source: Prepared by Nippon Koei

Figure 1.1 Implementation structure

1.4 PROJECT SCHEDULE

Project period was from December 4, 2020 to March 10, 2021. Schedule of this project is shown below.

#	Activties	Dec	Jan	Feb	Mar
City-to-City Collaboration Project					
1	Discussion for circular economy				
2	Discussion for 2050 Zro Carbon City				
3	Meeting with local municipality (Online)				
4	Information collection of oil palm sector				
JCM project formulation					
1	EFB biomass power plant project				
2	POME biogas utilization project				
3	Finding potential study targets for later than FY2021				
Others					
1	Monthly report to MOE				
2	Reporting meeting with MOE				
3	Workshop / Preparation of videos				
4	City-to-City Collaboration Seminar				
5	Kawasaki International Eco-Tech Fair				
Field studies/Report					
1	Field studies				
2	Meetings with Kawsaki City				
3	Final report				

Source: Prepared by Nippon Koei

Figure 1.2 Project schedule

CHAPTER 2 ENVIRONMENTAL ACTIONS OF KAWASKI CITY AND ENVIRONMENTAL NEEDS IN RIAU PROVINCE REGION

2.1 ENVIRONMENTAL ACTIONS OF KAWASAKI CITY

2.1.1 Overview of Kawasaki City

Kawasaki City is a government ordinance city located in the northeast part of Kanagawa Prefecture, next to Tokyo across Tama River.

The city underpins Japan's economic growth as the core city of waterfront Keihin Industrial Zone. Kawasaki, with a history and experience on solving environmental

Source: Kawasaki City

Figure 2.1 Map of Kawasaki City

pollutions with citizens, business operators and public services, has attracted many companies with competitive environmental technologies. In addition, the western part of the city boasts large areas of greenery including Ikuta Ryokuchi Park.

Table 2.1 Statistical data of Kawasaki City

#	Item	Statistical data
1	Area	144.35km2
2	Population	1,539,657 (as of June 1, 2020)
3	Number of households	750,256 (as of June 1, 2020)
4	Gross city product (nominal)	6,158.4 billion yen (2016)

Source: Kawasaki City

In addition to activities for environmental improvement and preservation, recently Kawasaki City was appointed to be the ambassador of "RE 100 Declaration RE Action", a new framework for small and medium-scale companies, municipalities, and educational and medical institutions who do not meet the standard for joining RE100[1] (the standard of RE100 is over 10 GWh energy consumption a year) to commit to 100% renewable energy. Through the activities as the ambassador, the city is expanding renewable energy initiatives across Japan. In July 2019, as a result of experience of solving various issues together with citizens and business operators and initiatives for sustainable society were highly evaluated, Kawasaki City was selected by the Regional Revitalization Promotion Office of Cabinet Office as a "SDGs Future City [2]". Through such activities and awards, Kawasaki City has been actively promoting climate change countermeasures and SDGs.

1 RE100 is international business initiative to promote 100% renewable energy consumption by companies, operated by The Climate Group and CDP. RE100 visualizes 100% renewable energy use by companies and aims at promotion of renewable energy. Influential large companies in the world are participating in RE100. (RE100 Platform)

2 SDGs Future City cities and regions with high potential to achieve sustainable development and create new values, especially economic, social and environmental values are chosen from cities and regions promoting the basic and comprehensive activities based on SDGs philosophy, these. In 2019, 31 cities were newly selected (total 60 cities).

2.1.2 Kawasaki City Basic Plan to Promote Global Warming Countermeasures

In 2010, based on Kawasaki City Ordinance for Promotion of Global Warming Countermeasures released in 2009, Kawasaki City enacted the Basic Plan to Promote Global Warming Countermeasures (hereafter "Plan 2010") to drive actions against global warming in a comprehensive and systematic manner, and to set reduction target for FY2020. Plan 2010 was revised in 2018 (hereafter "Plan 2018") to set new reduction target for FY2030, and to illustrate plans to achieve the target.

The overview of Plan 2010 and Plan 2018 is shown in Table 2.2. Plan 2018 is currently being revised in line with the declaration of 2050 Zero Carbon City and release of Kawasaki Carbon Zero Challenge 2050.

Source: Kawasaki City

Figure 2.2 Basic Plan to Promote Global Warming Countermeasures

Table 2.2 Overview of Plan to Promote Global Warming Countermeasures (Plan 2010 and Plan 2018)

Item	2010 Plan	2018 Plan
Period	FY2011-2020	FY 2018-2030
Basic concept	To develop a sustainable low-carbon society based on harmonization and positive cycle of the environment and economy and to preserve positive environment for the next generations.	To develop a low-carbon society with multi-benefit measures against global warming.
Basic policy	(1) To develop a social and economic system leading to reduction of GHG emissions effectively. (2) To use locally available energy resources such as renewable and unutilized energy efficiently and effectively. (3) To reduce GHG emissions by business operators, citizens and the city in their respective capacity. (4) To encourage joint activities. (5) To contribute to reduction of GHG emissions worldwide. (6) To contribute to countermeasures to heat island phenomenon.	(1) To proceed reduction of GHG emissions. (2) To implement of introduction of renewable energy and optimization of energy consumption. (3) To promote adaptation measures for climate change. (4) To contribute with environmental technologies and industries. (5) To encourage collaboration among citizens, business operators and public sector.
Reduction target	To aim at 25% reduction of GHG emissions compared with FY1990, by FY2020.	To aim at 30% reduction of GHG emissions by FY2030, compared with FY1990 (or 20% compared with FY2013).

Source: Prepared by Nippon Koei based on Kawasaki City Plan to Promote Global Warming Countermeasures

2.1.3 Zero carbon strategy “Kawasaki Carbon Zero Challenge 2050”

On February 17, 2020, the Governor of Kawasaki City Norihiko Fukuda announced 2050 Zero Carbon City, stating that by the end of the year, the city will show a future image and a strategy toward zero carbon city. In November, “Kawasaki Carbon Zero Challenge 2050” was released as a starting point for zero carbon initiatives, which illustrates 2030 milestones (medium-term targets), basic concept, and leading activities to reduce 100% of net CO2 emission by 2050.

2030 milestone was calculated by back casting the figures required to achieve zero carbon by 2050. It includes targets from the Basic Plan (reduction of about 2.5 million tCO2 by FY2030 (26% reduction compared with FY2013) and 80% of the emissions by FY2050 compared with FY2013) and aims to reduce additional one million tCO2 in the 10 years to FY 2030.

Source: Kawasaki City

Figure 2.3 Kawasaki Carbon Zero Challenge 2050

The strategy lists images of achievements of zero carbon society in Kawasaki as shown below.

Table 2.3 Images of zero carbon society in Kawasaki in 2050

Sector	Images
Private sector (households and business operations)	(1) Zero-energy buildings (shifting to Net Zero Energy Building (ZEB) and Net Zero Energy House (ZEH)) become general. (2) Power sources based on renewables are widespread, as well as local power supply and consumption by utilizing the potential of the region. (3) Realization of compact city, decarbonization of buildings and realization of urban forest by generalizing wooden buildings. (4) 100% renewable energy utilization for the city’s activities and minimization of energy consumption in public facilities.
Transportation	(1) Replacement of vehicles including cars, buses, taxis and trucks with Zero Emission Vehicle (ZEV). (2) Replacement of all official cars with ZEV.
Waste	(1) Transformation of lifestyle such as to stop using single-use plastics, transformation to biomass materials, generalization of behaviors for food loss by generalizing environmentally friendly manners of citizens and companies.
Industry	(1) More companies in Kawasaki turn to decarbonization voluntarily. (2) Innovation and business model of environmental and energy sectors generated in Kawasaki lead industries inside and outside the city. (3) Promotion of renewable energy as main energy. (4) Realization of technological innovation and industrialization to contribute to zero carbon and contributions to zero-carbon lifestyle of citizens by collaborating with companies in Kawasaki. (5) Development of society based on hydrogen energy networks. (6) Generalization of sustainable finance to contribute to decarbonization.

Source: Prepared by Nippon Koei based on Kawasaki Carbon Zero Challenge 2050

The basic approach of Kawasaki City for realization of zero-carbon society is "to realize zero-carbon society by that consumer activity movement influences on the society. This is based on the role of municipality, "to encourage citizens and companies to act in environmentally friendly manner as a familiar existence in the community" and characteristics and advantages of Kawasaki City "accumulation of environmental technologies, industries and research institutes and existence of a lot of citizens and companies with high awareness on the environment".

"Consumer activity movements" means that consumers select environmentally friendly products and services and dramatically boost their needs (demand). Also, "Influencing society" means to accelerate supply of products and services for zero carbon and to develop new innovations. Furthermore, the city has set three pillars as drivers of these three cogwheels to achieve zero-carbon society by 2050.

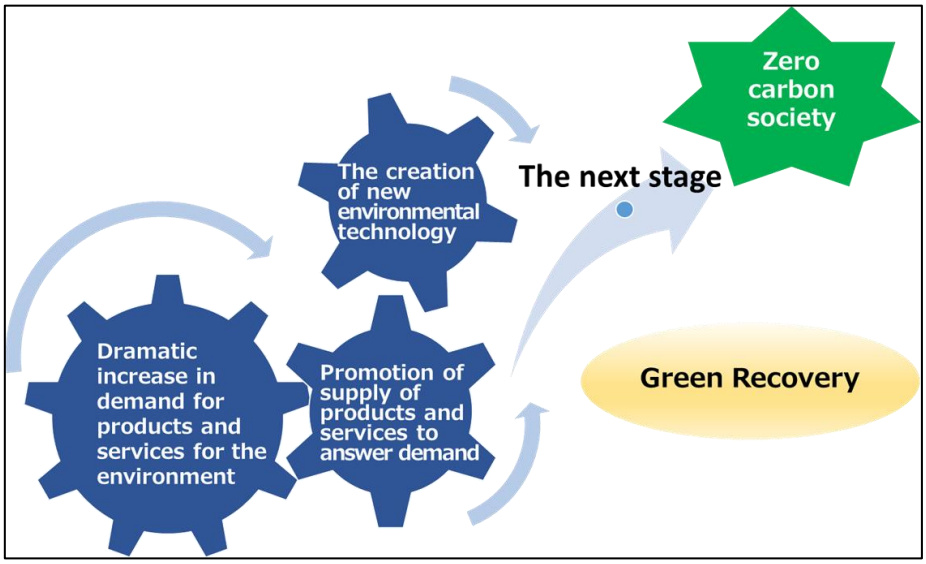


Figure 2.4 Image of the approach to zero-carbon society

Source: Kawasaki Carbon Zero Challenge 2050

Table 2.4 Three activity pillars and unique activities

Activity pillars	Initiatives led by the city (unique activities)
Pillar I (Participation and collaboration of various stakeholders)	Establishment of zero-carbon model district (as a familiar zero-carbon model
Pillar II (Kawasaki City takes initiative)	Introduction of renewable energy to public facilities, thoroughness of energy saving and change of awareness of officers. - To reduce 10% energy consumption in city halls by 2030, by thoroughness of energy saving. - To achieve RE100 in main public facilities such as city halls and ward offices by local generation of renewable energy and procurement of renewable energy.
Pillar III (Promotion of green innovations from Kawasaki)	To consider evaluation supports and evaluation measures for companies implementing activities for decarbonization.

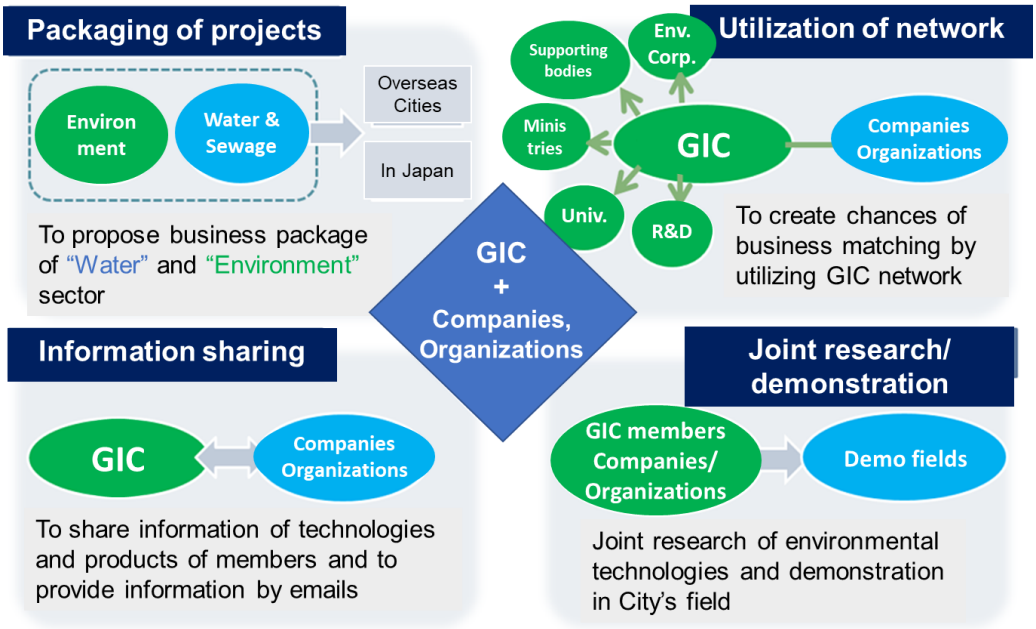
Source: Prepared by Nippon Koei based on Kawasaki Carbon Zero Challenge 2050

2.1.4 Kawasaki Green Innovation Cluster (GIC)

In 2014, Kawasaki City released its Promotion Policy on Kawasaki Green Innovation. It describes basic policies and practices on how to create sustainable cities by taking an advantage of environmental technologies and industries and to develop and extend Green Innovation initiatives more. The four pillars for Green Innovation are:

I. To revitalize local economy by creating and supporting environmental technologies and industries
II. To apply competitive environmental technologies and industries to city life
III. To collaborate with diverse parties to utilize environmental technologies and industries
IV. To contribute to international communities with Kawasaki's environmental technologies and industries

In 2014, Kawasaki Green Innovation Cluster (GIC) was established as a structure to promote these four pillars. It is a network for collaboration among industries, academia, and private and public sectors to improve the environment and to promote industrial development and international contributions. GIC functions to provide "access to utilization of schemes of Kawasaki City and supporting organizations", "promotion and information sharing opportunities" and "support of business development by utilizing environmental technologies, and know-how of public services".



Source: Kawasaki City

Figure 2.5 Image of activities utilizing GIC

2.1.5 Kawasaki Eco-Town

Kawasaki City positions "Zero-Emission Concept" as the basic concept for creating a local circular economy and recognize it as the basis for revitalizing the local community. In 1997, the city developed "the Kawasaki Eco-Town Plan" targeting the entire coastal area of Kawasaki (about 2,800 hectares) and received approval from the government as the first eco-town in Japan. The target areas are working on resource circulation activities, with companies circulating and reusing resources and waste emitted in the city among themselves by taking an advantage of the high concentration of companies and environmental technologies in the coastal area. Also, resource circulation activities are carried out not only in the city, but in wider in Japan and overseas.

Shown below are the four pillars and concrete measures based on the Kawasaki Eco-Town Concept.

Table 2.5 The four pillars and concrete measures based on the Kawasaki Eco-Town concept

Pillars of the activities	Measures
Promoting eco-friendly measures by each company	- To organize advanced recycling facilities - To encourage resource circulation based on characteristics and strengths of companies - To realize zero-emission of industrial waste and wastewater
Promoting eco-friendly measures with other companies	- To develop Kawasaki Zero-Emission Industrial Park - To implement joint recycling in the district
Undertaking researches for environment-based, sustainably developing districts	- To research on effective energy usage - To research on advancing Eco-Town initiatives - To vitalize the research and development industry

Pillars of the activities	Measures
Documenting the achievements of the companies and districts and contributing to developing countries	- To provide study tours - To hold Kawasaki International Eco-Tech Fair

Source: Prepared by Nippon Koei based on Kawasaki City website

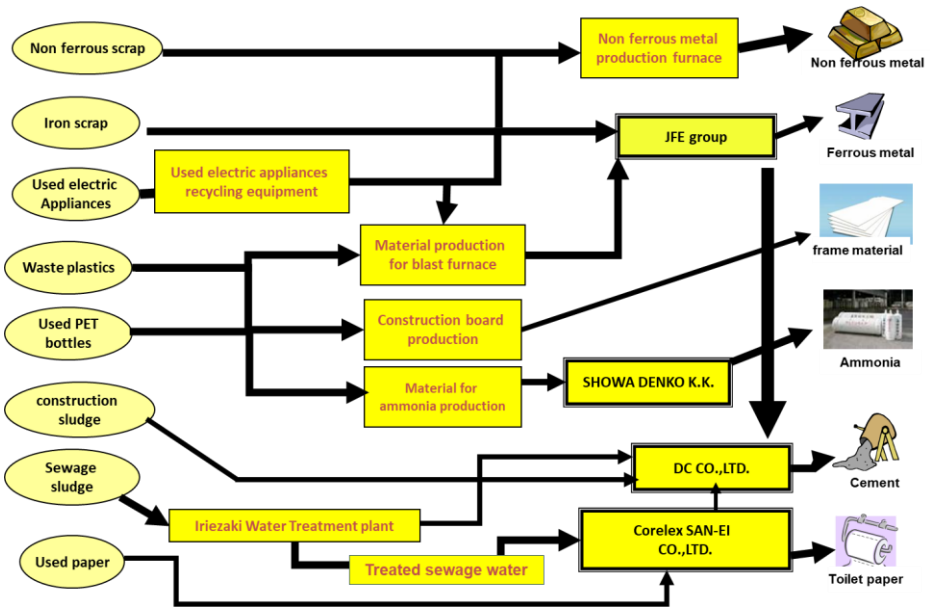
In 2002, in Kawasaki Eco-Town target areas, Kawasaki Zero-Emission Industrial Park started operation as a model facility of the Kawasaki Eco-Town Concept. It saves waste from business activities and aims to minimize environmental burden by reusing and recycling resources and utilizing circulated energy.

The concept and concrete measures of the Zero-Emission Industrial Park are as follows.

Table 2.6 The concept and concrete measures of Zero-Emission Industrial Park

Concept	Measures
- To set own basic environmental policies by each company. - To set a higher goal (zero-emission) than the emission criteria. - To work together with other companies in the industrial park to make the activities more efficient. - To integrate factors of environmental burden into processes by cooperation among companies. - To realize total zero emission by linking things, difficult to be made zero emission in the industrial park, - with surrounding circulation function	- They set waste reduction targets for and actively save internally generated waste - The industrial park's union collects all paper waste from the companies to be recycled - To reuse waste heat energy from incineration plants - To reuse highly treated water from Kawasaki Iriezaki Water Treatment Center in the industrial park, as well as water treated in the plants - To recycle as much water as possible and reduce the work of waste treatment facilities - To reuse incineration fly ash as a raw material for cement - To compost organic waste from the companies and use as a fertilizer for communal green area in the industrial park - To use rainwater as fire protection water and irrigation water - To share each self-generated power among companies

Source: Prepared by Nippon Koei based on Kawasaki City website



Source: Kawasaki City

Figure 2.6 Resources circulation in Kawasaki Eco-Town including Zero Emission Industrial Park

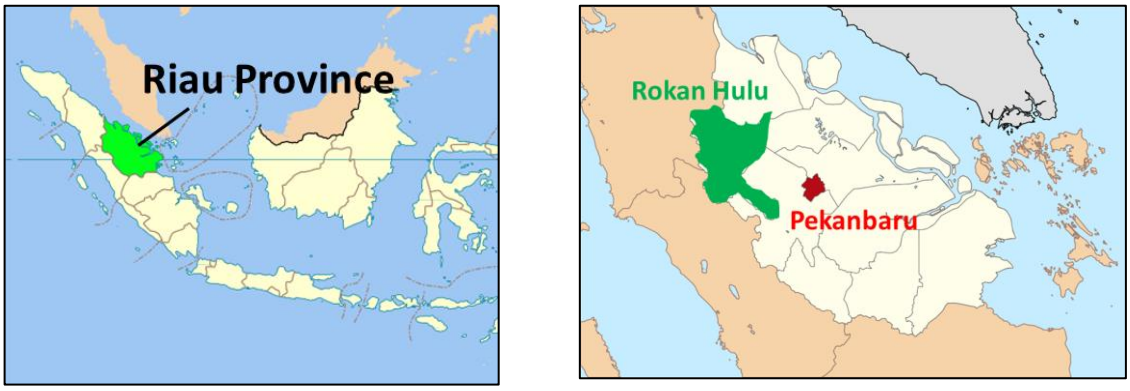
2.2 ENVIRONMENTAL NEEDS IN RIAU PROVINCE REGION

2.2.1 Overview of Riau Province Region

Riau Province is located in the center of Sumatera Island of Indonesia and core industry in the area is oil palm sector. Palm oil is one of 10 key produces decided by the Ministry of Trade of Indonesia. The percentage of palm oil in export of 2017 was 12% which was larger than any other product. Both production (7.72 million ton) and cultivation area (2.26 million ha) in Riau Province are the largest in Indonesia (Statistik Kelapa Sawit Indonesia 2017). Also, production and cultivation area in Rokan Hulu are the biggest in Riau Province, 1.49 million ton and 0.41 million ha, respectively.

On the other hand, Pekanbaru City, the capital city of Riau Province, has been developing its economy and industry rapidly with the population of more than one million and been promoting various policies and projects such as development of an industrial park, development of new city center and introduction of new transportation system etc.

Locations of Riau Province, Pekanbaru City and Rokan Hule Regency and overview of them are as shown below.



Source: Prepared by Nippon Koei

Figure 2.7 Locations of Riau Province, Pekanbaru City and Rokan Hulu Regency

Table 2.7 Overview of Riau Province Region

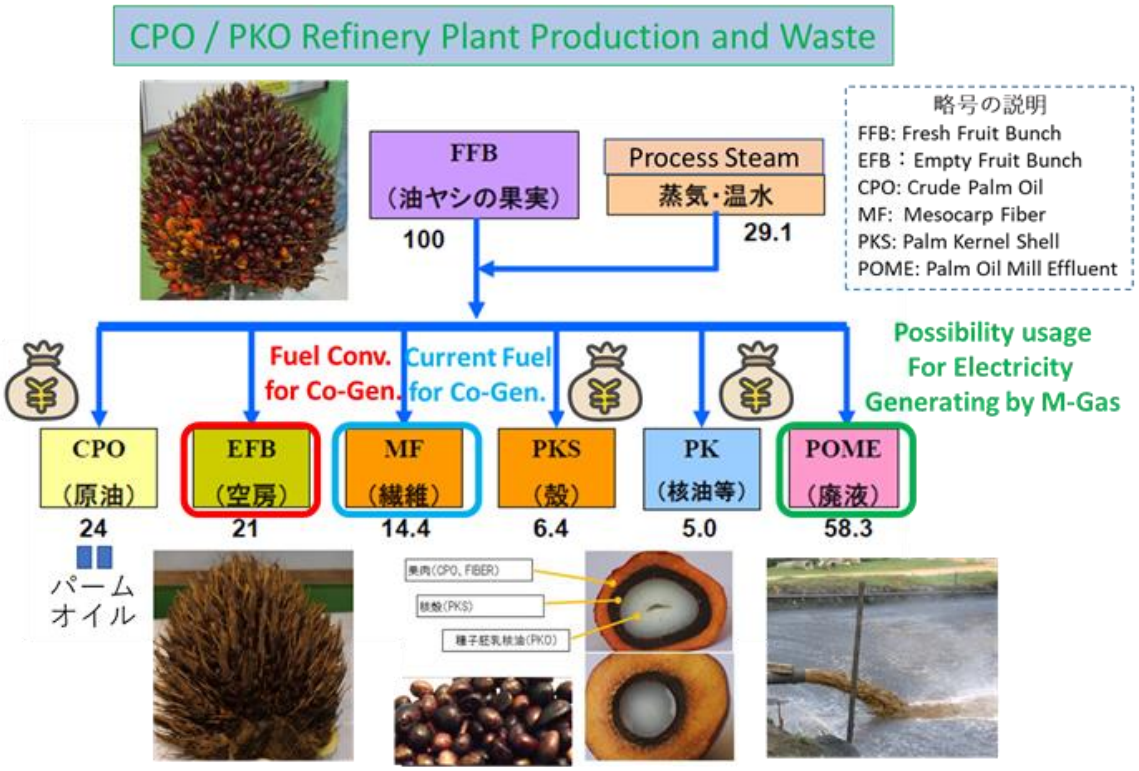
Items	Riau Prov.	Pekanbaru	Rokan Hulu
Population (2019)	6,835,098	1,121,562	679,665
Area (km2) (2019)	87,023	632	7,588
Density (person/km2) (2019)	79	1770	90
Gross Regional Product (USD million) (2020)	54,120	8,430	---

Source: Prepared by Nippon Koei based on reports of Statistics Indonesia

2.2.2 Residues generated from palm oil production

Production of palm oil from Fresh Fruit Bunch (FFB) generates multiple residues in processes. While Palm Kernel Shell (PKS) and Palm Kernel Oil (PKO) are utilized as biomass fuels and chemical materials, EFB is left in plantation and putrefied, which frequently causes environmental issues such as soil and ground groundwater pollution, emission of methane and forest fire. Also, POME is only treated by open lagoon method, which emits much methane to the air and possibly leads to river pollution.

Thus, management of residues from oil palm sector is a serious problem in production area such as Rokan Hulu and management measures and technologies for utilization of the residues are required in this area.



Source: Project for conversion of POME to fuel in Indonesia

Figure 2.8 Residues generated from palm oil production

2.2.3 Development of 2050 Zero Caron City

Pekanbaru City is promoting formulation of smart city as one of prioritized policies. When activities of Kawasaki City for decarbonization of Kawasaki City were introduced in the City-to-City Collaboration Conference between Pekanbaru City and Kawasaki City held in February 2020, representatives of Pekanbaru City showed their interests in development of 2050 Zero Carbon City. In addition, Mayor of Pakanbaru City also agreed with promoting 2050 Zero Carbon City in this City-to-City Collaboration project and as a result, 2050 Zero Carbon City was set as the theme of Letter of Intent between Pekanbaru City and Nippon Koei.

2.2.4 Development of Tenayan Industrial Park

Pekanbaru City is currently developing Tenayan Industrial Park (Total development area: 2,66 km2) which was designated as prioritized industrial parks by the Indonesian Government. The industrial park is along with Siak River and will be nearby new city center being developed with relocation of City Councils, which shows that the area is very strategic in terms of business development.

Pekanbaru City has a plan to develop the industrial park as "Eco Industrial Park" and has an interest in experiences of Kawasaki City who has been promoting eco town concept. Also, Pekanbaru City tries to invite foreign companies including Japanese to set up their business base in the industrial park and has an interest in installation of Japanese energy-saving and renewable energy technologies as infrastructures in the park.

Source: Pekanbaru City

Figure 2.9 Tenayang Industrial Park

2.2.5 Siak River Rehabilitation

Siak river flows from the center of Sumatera Island to the Strait of Malacca through Pekanbaru and is 370 km long. The river is famous as the deepest river in Indonesia and tankers and container ships can access to Pekanbaru. For this reason, there are many factories such as palm oil mills, paper and pulp, wood processing and rubber processing factories along the river.

Source: PekanbaruCity

Figure 2.10 Siak River

While Siak River supports economy of Riau Province, pollution of the river by industrialization of urban areas is one of the largest issues. Considering this situation, Peknabaru City has a strong interest in experiences of Kawasaki City on rehabilitation of Tama River and Citarum River purification through cooperation with Bandung City and in technologies of companies in Kawasaki for purification of water environment.

CHAPTER 3 STUDY FOR JCM MODEL PROJECT FORMULATION

3.1 CITY-TO-CITY COLLABORATION ACTIVITES IN FY2019

City-to-City Collaboration project between Kawasaki City and Riau Province Region was selected as "FY2019 City-to-City Collaboration Program for Low-Carbon Society" and officially started in July 2019. Discussion between municipalities and JCM model project formulation regarding circular economy in Riau Province region has been carried out.

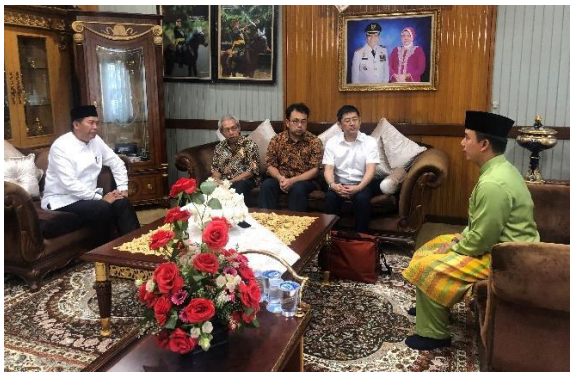
Main activities in FY2019 are as follows.

Table 3.1 City-to-City Collaboration activities in FY2019

Year/Month	Activity (Location)	Overview
April 2019	Selection as FY2019 City-to-City Collaboration Program for Low-Carbon Society	"City-to-City Collaboration Project Between Rokan Hulu Regency and Kawasaki City (Project to Promote Circular Economy for Palm Industry in Riau Province Region)" was selected as "FY2019 City-to-City Collaboration Program for Low-Carbon Society" and the project started officially in July.
August 2019	Kick-off meeting with Rokan Hulu Regency (Rokan Hulu)	In the seminar, theme of collaboration between Rokan Hulu Regency and Kawasaki City was discussed and have reached basic agreement to decide circular economy for oil palm industry as one theme.
August 2019	Mini seminar targeting staff of Rokan Hulu Gov. and companies related to oil palm industry (Rokan Hulu)	Staff of Rokan Hulu Gov and 22 companies of oil palm industry in Rokan Hulu participated in the mini seminar. Kawasaki City officer presented about overview of their city and activities for development of circular economy of Kawasaki whereas company based in Kawasaki City explained about their EFB biomass power generation technology.
August 2019	Courtesy visit to Pekanbaru City Mayor (Pekanbaru)	Kawasaki City officer implemented courtesy visit to Pekanbaru City Mayor and explained about overview of Kawasaki and city-to-city collaboration. The mayor showed his interest in collaboration with Kawasaki city.
January 2020	Japan Visit and City-to-City Collaboration Seminar (Kawasaki and Tokyo)	Mayor and 6 city officers of Pekanbaru visited Japan and implemented site tour in Kawasaki and discussion about potential of city-to-city collaboration with Kawasaki City. Then, the Pekanbaru delegation participated in "Seminar on City-to-City Collaboration for Zero-Carbon Society".
February 2020	City-to-city Collaboration Conference between Pekanbaru City and Kawasaki City (Pekanbaru)	City-to-City Collaboration Conference between Pekanbaru City and Kawasaki City was held. From Pekanbaru side, represented by Ms. Shabrina, Assistant II of the city government, 25 staffs attended the seminar from Cooperation Office, Department of Transportation, BAPPEDA, Department of Public Works and Housing, PT SPP (Public company to manage the industrial park) etc. From each department in charge, following presentations on potential collaboration topics were made, namely, smart city, industrial park development, transport and wastewater treatment. From Kawasaki side, the general information

Year/Month	Activity (Location)	Overview
		and city-to-city collaboration of Kawasaki City (with DKI-Jakarta and Yangon City), and zero-emission industrial park were presented. During the conference, Pekanbaru City chows their interest in 2050 Zero Carbon City and it was agreed to make it theme of City-to-City Collaboration after the event
August 2020	Conclusion of LOI between Pekanbaru City and Nippon Koei	Pekanbaru City and Nippon Koei concluded LOI on 2050 Zero Carbon City in August 24, 2020.

Source: Prepared by Nippon Koei



Courtesy visit to Pekanbaru City Mayor (August 2019)

Japan Visit (January 2020)

3.2 THEMES OF CITY-TO-CITY COLLABORATION IN FY2020

Considering know-how and experiences of Kawasaki City and environmental needs in Riau Province Region, shown in Chapter 2, City-to-City Collaboration activities were implemented based on the four themes below.

Table 3.2 Themes of City-to-City Collaboration activities

#	Theme	Overview
1	Support for development of 2050 Zero Carbon City	Videos introducing the context of Kawasaki City's declaration of 2050 Zero Carbon City and Zero Carbon Strategy "Kawasaki Carbon Zero Challenge" developed in November 2020 was prepared and shared (Section 3.3.5).
2	Support for Siak River rehabilitation	Videos introducing know-how and experiences on Tama River rehabilitation and on Citarum River rehabilitation under collaboration with Bandung City was prepares and shared (Section 3.3.5) Also, GIC member companies introduced their technologies for water purification in the Online Business Seminar between GIC Members and Pekanbaru City (Section 3.2.2).
3	Support for development of circular economy and energy saving and renewable energy project	As JCM model projects for development of circular economy, studies for 1) EFB power plant project and 2) Project for POME biogas utilization were carried out. (Chapter 4) In addition, to identify JCM project candidate regarding urbanization and industrialization of Pekanbaru City, information exchange with related departments were implemented.

#	Theme	Overview
4	Promotion of Pekanbaru City	Exhibition booth of this project was prepared in 13th Kawasaki International Eco-Tech Fair to proceed the three themes above to concrete projects. Tenayan Industrial Park and current status of Siak River etc. were exhibited. (Section 3.3.3)

Source: Prepared by Nippon Koei

3.3 RESULTS OF CITY-TO-CITY COLLABORATION ACTIVITIES

3.3.1 Overview of the activities

The details of activities in FY2020 are summarized in the table below.

Table 3.3 City-to-City Collaboration Activities

Activity	Date	Overview
Meeting with officers in charge	December 9, 2020	Activities in FY2020 were explained and agreed by Pekanbaru City in the meeting. In addition, Pekanbaru City agreed to participate in Kawasaki International Eco-Tech Fair and to cooperate for preparation of exhibition.
Meeting between Nippon Koei and Kawasaki City	December 16, 2020	Pre-meeting for Kick-off meeting with the Ministry of the Environment Japan (MOE) was carried out with Kawasaki City and presentation materials were checked. In addition, how to prepare Online business seminar between GIC members and Pekanbaru City was discussed.
Kick-off meeting with MOE	December 18, 2020	MOE, Kawasaki City, and Nippon Koei held a face-to-face kick-off meeting. Nippon Koei reported on the progress since pre-kick-off meeting in May and explained the study schedule.
Meeting with officers in charge	January 22, 2021	Meeting with Pekanbaru City was carried out and Nippon Koei explained about "Online business seminar between GIC members and Pekanbaru City" and "City-to-City Collaboration Seminar" and requested their participation.
Online business seminar between GIC members and Pekanbaru City	January 28, 2021	An online business seminar was held between GIC member companies and Pekanbaru City during the Kawasaki International Eco-Tech Fair (January 21-February 5). Four GIC companies introduced their technologies and products and discuss possibility of installation with Peknabaru City.
Meeting among Peknabaru City, Kawasaki City and Nippon Koei	January 28, 2021	After the online business seminar above, meeting among Kawasaki City, Pekanbaru City and Nippon Koei was implemented. While activity schedule was confirmed, collaboration with related departments for project development in Pekanbaru was requested.
Kawasaki International Eco-Tech Fair	January 20, - February 5, 2021	"Introduction of Tenayan Industrial Park", "Current status of Siak River and technical needs for rehabilitation", and "Support for circular economy in oil palm sector" were exhibited in online booth of Kawasaki International Eco-Tech Fair.
City-to-City Collaboration Seminar held by MOE	February 1, 2021	"Seminar on City-to-City Collaboration for Creating a Zero-carbon Society" was held online by MOE. A total of over 100 representatives attended the meeting from Japanese and overseas cities carrying out City-to-City Collaboration Programme, and its representative entities and partner

Activity	Date	Overview
		companies. Presentations on City-to-City Collaboration Programme and JCM Model Project trends and a panel discussion on how to execute projects in the COVID-19 pandemic.
Know-how and experience sharing by videos	February 16, 2021	Videos of actions of Kawasaki City for 2050 Zero Carbon City (Environmental Dept.) and for river purification (Kawasaki Environment Research Institute) were taken and dubbed in Indonesian. The videos were shared in March.
Final report meeting with MOE	March 1, 2021	This fiscal year's activities and plans for the next fiscal year's activities were reported to MOE

Source: Prepared by Nippon Koei

3.3.2 Online business seminar between GIC members and Pekanbaru City

An online business seminar was held between GIC member companies and Pekanbaru City on January 28, 2021, during the 13th Kawasaki International Eco-Tech Fair (January 21-February 5, 2021).

In the meeting, Kawasaki City International Economic Affairs Office gave a brief summary of the Kawasaki International Eco-Tech Fair and how to visit the fair to encourage participants from Pekanbaru City to visit the Fair. GIC companies, J&T Recycling Corporation, Nanofuel Co., Ltd., Japan Thread Co., Ltd. and MT Aqua Polymer presented on their respective technologies and products, followed by questions and answers from Pekanbaru participants and discussions about possibility of installation of technologies to Pekanbaru. Presentation materials of this seminar is attached as Attachment 1.

【Overview】

Date: January 28, 2021 (Thu) 15:00-17:00 (Japan time)

Venue: Online meeting

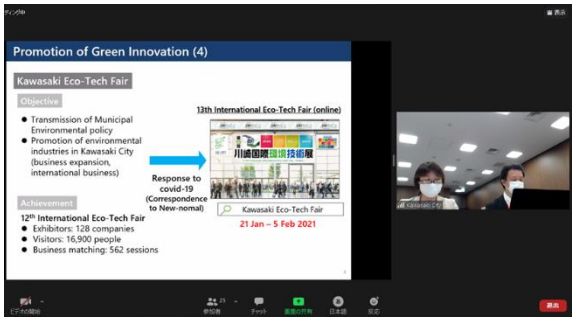
participants: Pekanbari City: Vice-Mayor, International Cooperation Officer, Head of BAPPEDA, Head of Public Works etc. (Total 13)
Kawasaki City (International Economic Affairs Office)
GIC member companies: J&T Recycling Corporation, Nanofuel Co., Ltd.
Japan Thread Co., Ltd., MT Aqua Polymer, Inc.,
Tepia Corporation Japan (GIC administrative office)
Convention Linkage, Inc. (Kawasaki International Eco-Tech Fair's administrative office)
Nippon Koei Co., Ltd.
2 interpreters (Japanese - Indonesian)
Total approximately 40 participants

Table 3.4 Agenda of Online business seminar between GIC members and Pekanbaru City

Time	Agenda	Speaker
15:00-15:05	Opening remark	Vice-Mayor, Pekanbaru City
15:05-15:10	Opening remark	Manager of International Economic Affairs Office, Kawasaki City
15:10-15:20	Explanation of Kawasaki International Eco-Tech Fair	Assistant Manager of International Economic Affairs Office Kawasaki City
15:20-16:40	Presentation from 4 GIC member companies and Q&A (5min PR and 15 min Q&A for each company) 13:20-13:40 J&T Recycling Corporation (Food waste recycling) 13:40-14:00 Nanofuel Co., Ltd. (Nano-emulsion, Liquefied biomass) 14:00-14:20 Japan Thread Co., Ltd. (Purification of water environment) 14:20-14:40 MT Aqua Polymer, Inc. (Purification of water environment)	GIC member companies
15:40-16:45	Closing remarks	Vice-Mayor, Pekanbaru City
15:45-16:50	Closing remarks	Manager of International Economic Affairs Office, Kawasaki City

Source: Prepared by Nippon Koei

Opening remarks by Pekanbaru Vice-Mayor



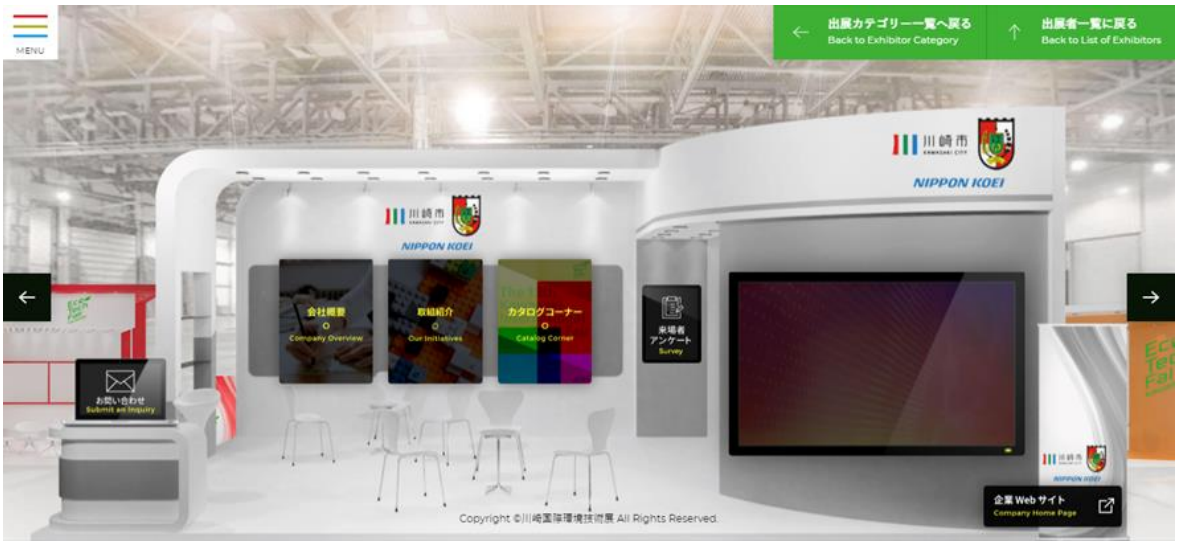
Presentation by Kawasaki City

Presentation by MT Aqua Polymer

A scene from the online seminar

3.3.3 Kawasaki International Eco-Tech Fair

Online booth of this project was prepared in 13th Kawasaki International Eco-Tech Fair held during the period from January 20 to February 5, 2021. By cooperating with Pekanbaru City, "Introduction of Tenayan Industrial Park", "Current status of Siak River and technical needs for rehabilitation", and "Support for circular economy in oil palm sector" were exhibited. Exhibited materials are attached as Attachment 2.



Source: Kawasaki International Eco-Tech Fair

Figure 3.1 Online booth (Screen of booth entrance)

Source: Kawasaki International Eco-Tech Fair

Figure 3.2 Online booth (Screen of activity introduction)

3.3.4 City-to-City Collaboration Seminar 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.

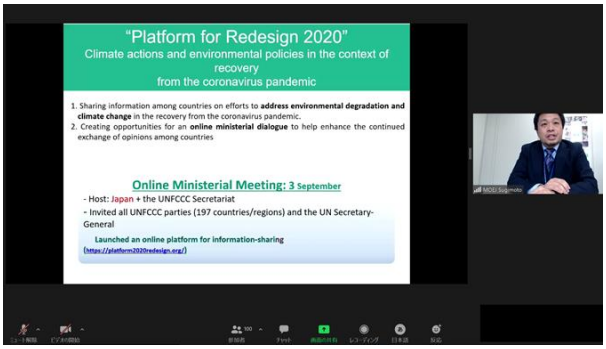
Principal Deputy Director of International Cooperation and Sustainable Infrastructure Office of MOE made a closing speech, saying that Japan will enhance its alliances and support the new needs arising from green recovery activities, and how it is important for Japan and other countries to share each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

The overview of the seminar is shown in the table below. And, presentation materials in this seminar are attached as Attachment 3.

Table 3.5 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. 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

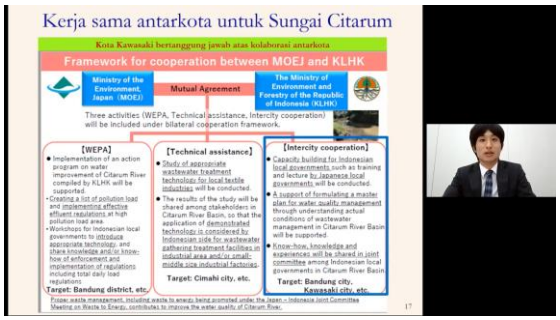
3.3.5 Know-how and experiences sharing by videos

Videos of actions of Kawasaki City for 2050 Zero Carbon City (Environmental Department) and for river purification (Kawasaki Environment Research Institute) were taken and dubbed in Indonesian. The videos were shared with Pekanbaru City in March.

Environmental Department of Kawasaki City explains the context of Kawasaki City's declaration of 2050 Zero Carbon City and overview of Zero Carbon Strategy "Kawasaki Carbon Zero Challenge 2050" while Kawasaki environment Research Institute introduces history of Tama River pollution and rehabilitation, Current method for sewage control and activities for Citarum River rehabilitation under collaboration with Bandung City in the videos.

Materials used in the videos are attached as Attachment 4.

Video of Zero Carbon Strategy



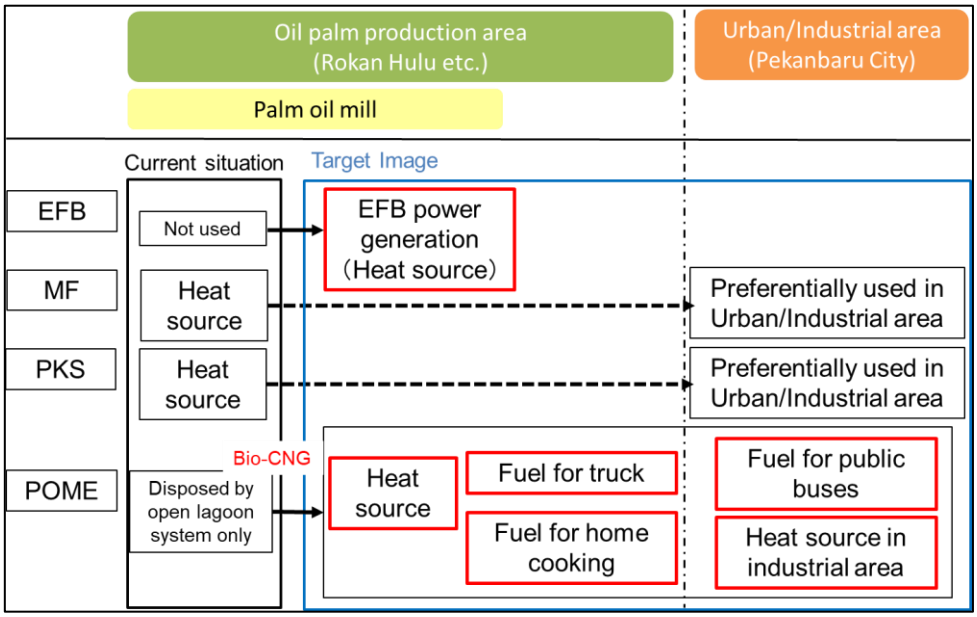
Video of river purification

CHAPTER 4 CONSIDERATION OF JCM MODEL PROJECT FORMULATION

4.1 CONSIDERATION OF JCM MODEL PROJECT CONTRIBUTING TO DEVELOPMENT OF CIRCULAR ECONOMY IN OIL PALM SECTOR

As JCM model project contributing to development of circular economy in oil palm sector, EFB biomass power plant project, which utilize EFB as biomass fuel, and project for POME biogas utilization, which purifies biogas emitted from POME and produces bio compressed natural gas (hereinafter bio-CNG), were studied with targeting palm oil mills owned by PT.PN5. Details of the studies are discussed in following sections

The two potential projects can contribute to realization of circular economy in oil palm sector illustrated below. EFB biomass power plant project enables utilization of EFB for electricity consumed in a palm oil mill, which was generated by PKS and MF to date. Also, PKS and MS can be combusted in thermal power plant in Pekanbaru or in new biomass plant, which lead to effective utilization of energy source of residues generated by palm oil production in the region and GHG emission reduction in urban area as well. Although it is difficult to use EFB in urban areas due to difficulty of transportation and utilization, PKS, MF and bio-CNG is easy to be transported and utilized. Thus those projects are expected to contribute to circulation of resources in whole Riau Province Region.



Source: Nippon Koei

Figure 4.1 Circular economy in oil palm sector in Riau Province Region

4.2 EFB BIOMASS POWER PLANT PROJECT

Aura Green Energy (hereinafter, Aura) is implementing JCM model project "12MW Biomass Power Plant Project in Aceh Province, Sumatera" with local company, PT. Gistec Prima Energindo (hereinafter, Gistec).

As a roll-out project of the project in Ache Province, feasibility study for EFB biomass power plant project, which utilizes EFB generated in palm oil mills owned by PT. PN5 in Rokan Hulu, was implemented.

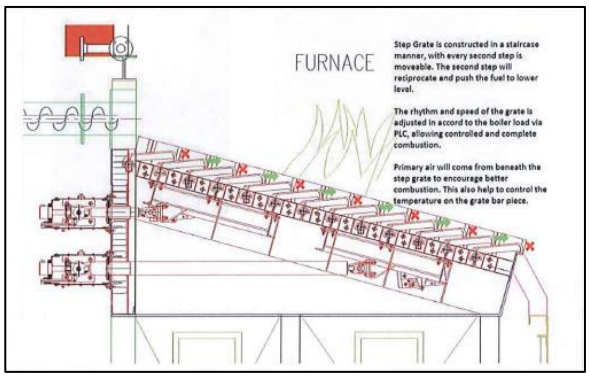
4.2.1 Overview of "12MW Biomass Power Plant Project in Aceh Province, Sumatera"

Aura and Gistec are implemented JCM model project "12MW Biomass Power Plant Project in Aceh Province, Sumatera" adopted in FY2018 and will start operation of the plant in 2021. The plant is assumed to generate 73,500MWh and will lead to GHG reduction of 31,322 tCO2 annually.

EFB has characteristics such as (1) difficulty of processing due to size and hardness, (2) low calory, (3) High moisture rate, (4) easiness to formulate clinker, (5) Low melting point and amount of ashes and (6) sedimentation of soot, and is difficult to utilize as fuels. Because of those characteristics, heat utilization of EFB has not been proceeded to date. However, the boiler installed to the plant in Ache has movable staircase stoker with automatic ash removal function and optimization controlling system for internal temperature of the furnace, which reduce generation of clinker and enable to stable and complete combustion by equally combusting EFB with rotating EFB continuously.

Source: Aura Green Energy

Figure 4.2 Image of biomass power plant in Aceh Province



Source: Aura Green Energy

Figure 4.3 Movable staircase stoker with automatic ash removal function

4.2.2 Residues generation amounts in target mills and consideration of biomass power plant capacity

PT.PN5 owns three palm oil mills, Sei Rokan Mill, Sei Tapung Mill, Sei Intan Mill in Rokan Hulu and biomass power plant utilizing residues generated in those mills was considered.

Annual residues generation amounts in each mill are shown below and annual EFB generation in the three mills (average of 2013-2017) are totally 144,829 ton.

Table 4.1 Annual FFB processing amounts and residues generation of the three study target mills (2017)

Item	Sei Rokan	Sei Tapung	Sei Intan	Total
FFB processing capacity (t/year)	60	60	30	120
Annual FFB processing amount (t/year)	258,307	160,836	215,662	634,804
PKS generation (t/year)	16,790	14,018	10,454	41,262
MF generation (t/year)	32,288	26,958	20,104	79,351
EFB generation (t/year)	56,828	47,446	35,384	139,657
POME generation (t/year)	180,815	150,963	112,585	444,363

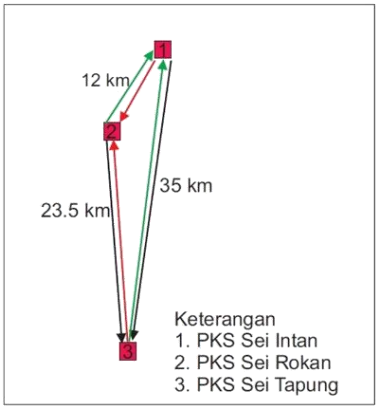
Source: Prepared by Nippon Koei based on data provided by PT.PN5

As a result of calculation based on the data above and moisture rate of EFB, annually 1,593,119TJ can be available in case that only EFB is used as biomass fuel. In accordance with the result, capacity of the biomass plant is assumed to be approximately 7.5 MW.

4.2.3 Consideration of construction site of biomass power plant

Selected construction site of biomass power plant is around Sei Rokan Mill. Selection reasons are as follows.

- Strategic location in terms of collection of residues generated in the three mills
- Easy access by construction vehicles
- Relatively near location to national grid (3 km)
- Relatively near location to water resources required for power generation (4.5 km from Rokan River)



Source: PT.Gistec Prima Energindo

Figure 4.4 Positional relation among the three mills

4.2.4 Confirmation of electricity supply in Riau Province and study for grid connection

While information of power plants in Riau Province and recent electricity supply and demand data were collected, Gistec implemented an interview to National Electricity Company, PLN about grid connection and selected grid connection point. At present, Gistec assumes to connect to the connection point which is the nearest from Sei Rokan Mill (Approximately 3km away) in accordance with advices by PLN. Image of grid connection is shown below.

Source: PT.Gistec Prima Energindo

Figure 4.5 Image of grid connection

4.2.5 Calculation of GHG emission reduction

GHG emission reduction of EFB biomass power plant project was calculated based on the formula below of methodology, ID_AM027 "Electricity generation by a biomass power plant" which was approved by Indonesia JCM secretariat on February 17, 2021.

$$\boldsymbol{RE_p} = \boldsymbol{NEG_p \times EF_{RE,elec}}$$

RE_p : Reference emissions during the period p [tCO_2/p]
NEG_p : Net quantity of electricity generated by a project biomass power plant during the period p [MWh/p]
$EF_{RE,elec}$: CO_2 emission factor of national/regional and isolated grids and/or captive electricity [tCO_2/MWh]

$$\boldsymbol{PE_p} = \boldsymbol{PE_{ONSITE,p} + PE_{TRANS,p}}$$

PE_p : Project emissions during the period p [tCO_2/p]
$PE_{ONSITE,p}$: Project emissions by on-site consumption of fossil fuel for operating a biomass power plant during the period p [tCO_2/p]
$PE_{TRANS,p}$: Project emissions by transportation activity of solid biomass fuels from collecting sites to a biomass power plant during the period p [tCO_2/p]

$$\boldsymbol{ER_p} = \boldsymbol{RE_p - PE_p}$$

ER_p : Emission reductions during the period p [tCO_2/p]

Table 4.2 Calculation of GHG emission reduction

#	Item	Figure	Unit	Remarks
a	Net capacity	5.65	MW	Result of the study
b	Operation hour	7920	h/year	Result of the study
c	Annual electricity generation	44,748	MWh/year	=a x b
d	Emission Factor (National Grid)	0.458	tCO2/MWh	ID_AM027 (Sumatera)
e	Reference emission (RE_p)	20,494	tCO2/year	=c x d
f	Fossil fuel consumption	150,000	L/year	Diesel
g	Density	0.844	kg/L	IEA

#	Item	Figure	Unit	Remarks
h	Net calorific value	41.4	GJ/t	IPCC2006
i	Emission Factor (Diesel)	0.0726	tCO2/GJ	IPCC2006
j	Project emission (Fossil fuel) ($PE_{ONSITE,p}$)	381	tCO2/year	=f x g x h x i / 1,000
k	Transported EFB amount	144,829	ton/year	Assumed amount
l	Transportation distance	47	km	Assumed distance
m	Emission Factor (Transportation)	0.000129	tCO2/ton-km	ID_AM027, Heavy vehicle
n	Project emission (Transportation) ($PE_{TRANS,p}$)	878	tCO2/year	=l x m x n
o	Annual GHG emission reduction	19,235	tCO2/year	=e – (j + n)

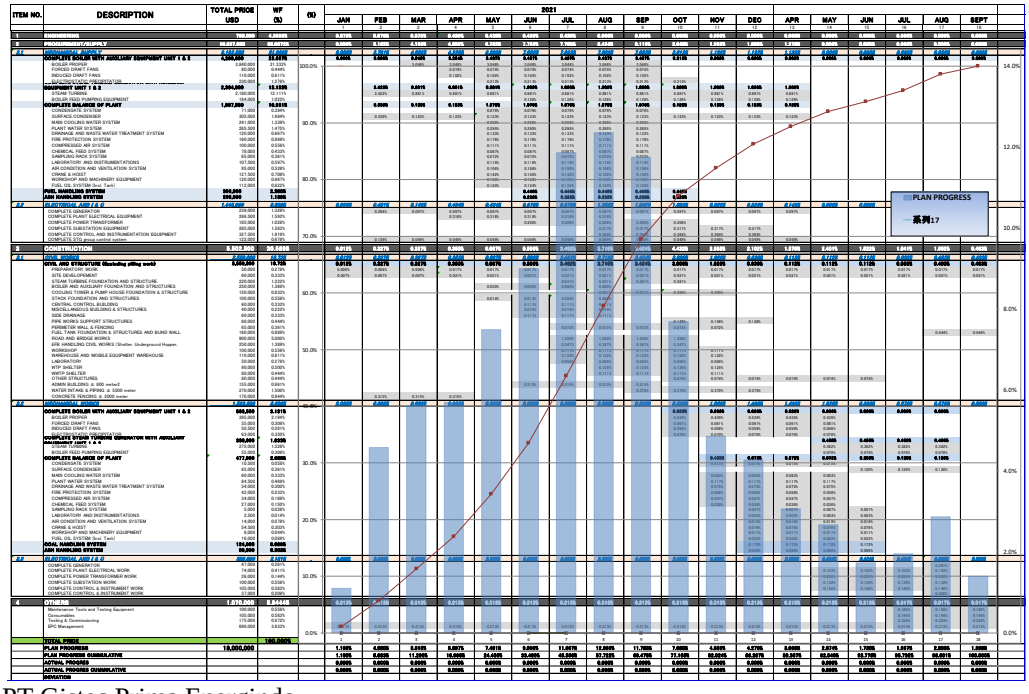
Source: Prepared by Nippon Koei

4.2.6 Consideration of International consortium

Aura is considering implementation structure and international consortium of the power plant project for application for JCM model project. At present, similar structure to the JCM project in Ache Province are assumed.

4.2.7 Consideration of plant construction schedule

Construction schedule of EFB biomass power plant was considered. It is assumed to take one year and nine months from purchase order to completion.



Source: PT.Gistec Prima Energindo

Figure 4.6 Schedule of plant construction

4.3 PROJECT FOR POME BIOGAS UTILIZATION

As Project for POME biogas utilization, installation of technologies to purify POME biogas and to produce highly purified methane gas, namely bio-CNG were studied. Separation membrane of Daicel-Evonik can produce biogas with more than 90% methane and the purified gas can be used same as normal CNG. Thus, bio-CNG can be used for not only power generation by gas engine, but vehicle fuel, household use. Furthermore, it will be available to discharge bio-CNG to pipeline which will be installed in the target area in near future.

In FY2020, selection of target palm oil mills, consideration of potential of biogas generation from POME, initial design of biogas purification plant was caried out. Also, a potential of fuel swich in case to utilize bio-CNG for fuel of buses owned by Trans Metro Pekanbaru, who operates city bus services in Pekanbaru, was calculated.

Source: Prepared by Nippon Koei

Figure 4.7 Overall image of project for POME biogas utilization

In East Kalimantan Province, similar biogas purification plant was constructed and started operation in 2020 and biogas separation membrane of Daicel-Evonik, SEPURAN® Green was installed to the plant. Overview of the plant project is as follows.

Table 4.3 Overview of biogas purification plant project in East Kalimantan

1	Owner	PT Dhama Satya Nusantara
2	Project cost (CAPEX)	US$ 6.45million
3	construction start / operation start	December 2018 / September 2020
4	FFB processing capacity	60ton/h
5	Annual FFB processing amount	280,000 ton/year
5	Generation of POME	238,000m3
6	Production capacity of bio-CNG	650-700m3/h
7	Operation hour	5,500h/year
8	Annual bio-CNG production	3,575,000-3,850,000 m3/year
9	Use of bio-CNG	Fuel of trucks for oil palm carriage

Source: Prepared by Nippon Koei based on information collected by PT. Gikoko Kogyo Indonesia

Source: Daicel-Evonik

Figure 4.8 SEPURAN® Green

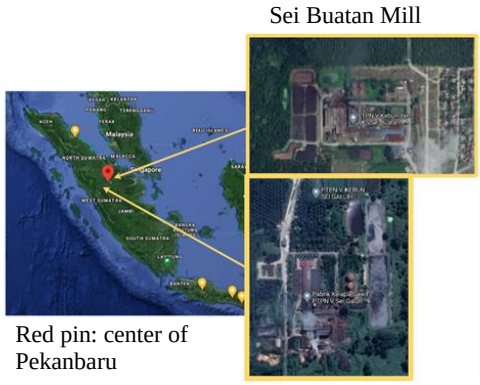
Source: PT.Gikoko Kogyo Indonesia

Figure 4.9 SEPURAN® Green installed in East Kalimantan Project

4.3.1 Selection of study target palm oil mills

Information collection of palm oil mills owned by PT.PN5 and selection of study target were implemented. Considering FFB processing amount and transport of bio-CNG, Sei Galuh Mill (Capacity: 60 ton/h), the nearest mill from Pekanbaru (30 km) and Sei Buatan Mill (capacity: 60 ton/h) 80km away from Pekanbaru were selected as target mills. Location of the two mills are illustrated in Figure 4.10 and annual FFB processing amounts in previous 5 years are shown below.

Sei Galuh Mill and Sei Buatan Mill will be applied for certificate of Roundtable on Sustainable Palm Oil (RSPO) in 2021 and in 2022 respectively.



Source: Prepared by Nippon Koei

Figure 4.10 Location of target palm oil mills

Table 4.4 Annual FFB processing amount in Sei Buatan Mill and Sei Galuh Mill (2016-2020)

Mill	2016	2017	2018	2019	2020
Sei Buatan	209,516	259,240	253,223	232,082	218,820
Sei Galuh	162,481	164,355	193,227	138,478	144,975

Source: Prepared by Nippon Koei based on data provided by PT.PN5

4.3.2 Consideration of potential of biogas generation

Potential of biogas generation was calculated based on annual FFB processing amount, POME generation amount and Chemical Oxygen Demand (COD) of POME. The result of the calculation is as follows.

Table 4.5 Potential of biogas generation

Item	Sei Galuh	Sei Buatan	Unit	Remarks
Annual FFB processing amount	144,975	218,820	ton/year	in 2020 PT.PN5 data
POME generation	86,985	131,292	m3	PT.PN5 data
COD	55,120	56,177	mg/L	PT.PN5 data
Methane emission factor	0.25	0.25	kgCH4/kgCOD	IPCC2006
Efficiency of biodigester	0.85	0.85		Assumed figure
Density	0.67	0.67	Nm3CH4/year	
Potential of methane gas generation	1,525,236	2,346,278	Nm3 /year	
Potential of biogas generation	2,773,157	4,265,959	Nm3 /year	55% methane gas

Source: Prepared by Nippon Koei based on data provided by PT.PN5

Source: PT.PN5

Figure 4.11 Anaerobic pond of Sei Buatan

Source: PT.PN5

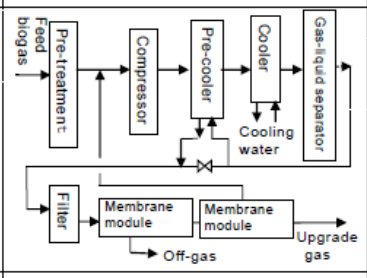
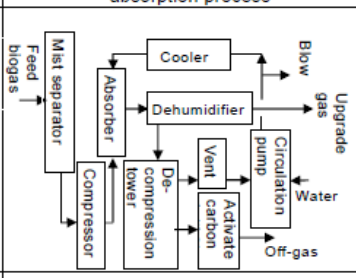
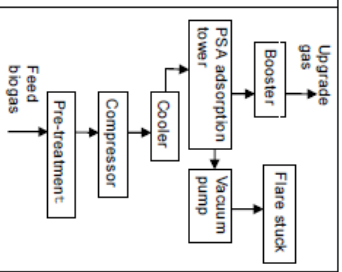
Figure 4.12 Anaerobic pond of Sei Galuh

4.3.3 Consideration of biogas purification method

There are three biogas purification methods, membrane separation process, high pressure-induced water absorption process and Pressure Swing Adsorption (PSA) process. To consider a method for initial design of biogas purification plant, the three methods were compared.

Table 4.6 below shows the comparison in terms of CH4 concentration, CH4 recovery rate, size, cost and track records. As a result, membrane separation process was adopted for initial design since the method is than the others from the perspectives of location condition, operation and maintenance, and design and operational flexibility.

Table 4.6 Comparison of biogas refining processes

	Membrane	High pressure-induced water absorption process	PSA
Typical flow diagram			
CH_4 concentration	High at multiple stage Design flexibility is available.	High Design flexibility is not expected.	High at multiple adsorption towers
CH_4 Recovery rate	High at multiple stage Design flexibility is available.	High Design flexibility is not expected.	High at multiple adsorption towers
Size	Small area is available for this system.	Each equipment is large. Absorption tower and Vent tower are high.	Adsorption tower is high.
Cost	Low	High	Low
Track record in Japan	A few	Many	Many
Others	Many track records in Europe	Huge amount of water and large-scale water treatment facility is required.	Vacuum pumps are required. Flare stuck is required due to high CH_4 concentration of off-gas.

Source: Company A

The membrane separation process selectively separates methane by applying the difference in the permeability of methane and carbon dioxide to the membrane. The membrane module is a bundle of many hollow fiber membranes. When biogas passes through the hollow fiber membrane, carbon dioxide is discharged outside the hollow fiber through the membrane wall.

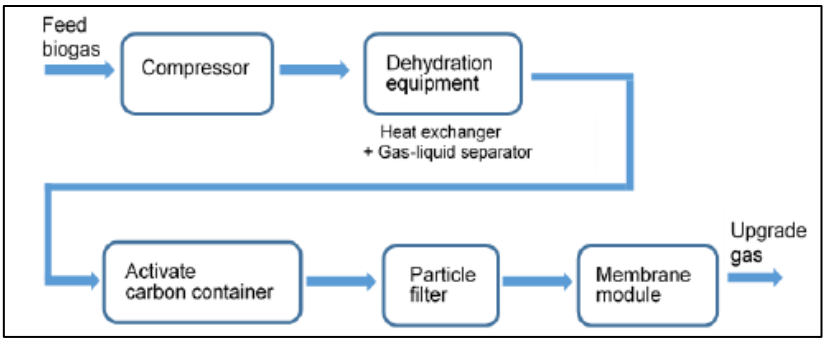
With this method, oxygen and nitrogen outside the membrane do not enter the membrane. Since the membrane is permeable to oxygen, it is able to partially remove oxygen. When oxygen reduction equipment is installed in the downstream of the refining system, oxygen removal load on the membrane will be reduced. This process is also capable of removing moisture.

In principle, it is said that the refining membrane does not need to be replaced, but the presence of impurities, compressor lubricating oil, etc. in the biogas deteriorates the separation performance of the membrane. For this reason, hydrogen sulfide, siloxane, etc. are usually removed before refining (pre-treatment).

The membrane separation process is adopted in air separation facilities (nitrogen production) and petrochemical plants (by-product hydrogen refining). It has an excellent track-record of applications in the area of biogas refining in Europe and the United States. In Japan, the process is adopted by the Shikaoi Environment Conservation Center in Hokkaido and Fukuoka City Chubu Water Treatment Center as one of the advanced next generation facilities such as hydrogen production equipment, although its history of applications to biogas refining is still short. Research is also underway in Yokohama City, and the Kagoshima City New Southern Incineration Plant has introduced the membrane separation system aiming at the effective use of biogas. In this way, its use is expected to spread in the future.

4.3.4 Initial design of biogas purification plant

Japanese engineering company A (hereinafter Company A) implemented initial design of biogas purification plant with membrane separation process by assuming utilization of biogas from POME in Sei Buatan Mill with higher biogas generation potential shown in the section 4.3.2. Scope of the initial design and prerequisites of raw biogas are as follows.



Source: Company A

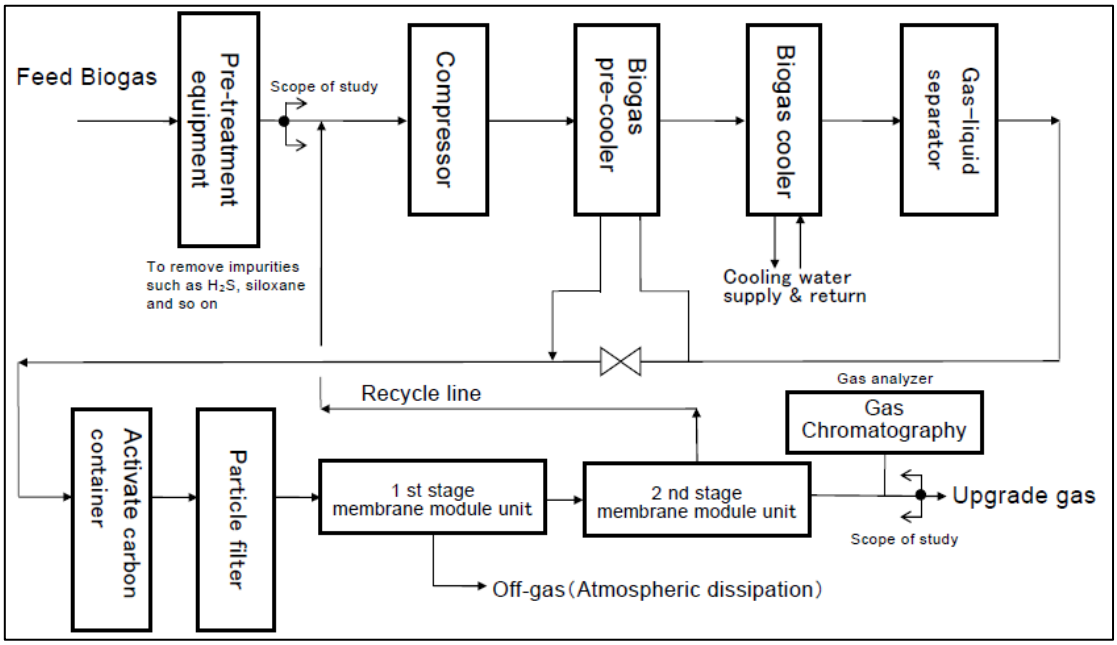
Figure 4.13 Scope of initial design

Table 4.7 Prerequisites of raw biogas

Item	Conditions
Flow rate (Nm3/h)	520
Pressure (MPa)	0.1
Temperature (C degree)	32.3 (It is assumed that steam is saturated at the temperature.)
Components of raw biogas	Methane (CH4): 55% Carbon dioxide (CO2): 44% Nitrogen (N2): 1% (Impurities such as hydrogen sulfide (H2S), siloxane, and ammonia are treated in the upstream of the refining facility.)

Source: Company A

Block flow considered under the conditions above is illustrated in Figure4.14 and each flow is described in Table 4.8. Process flow diagram and layout plan is Figure 4.15 and 4.16.



Source: Company A

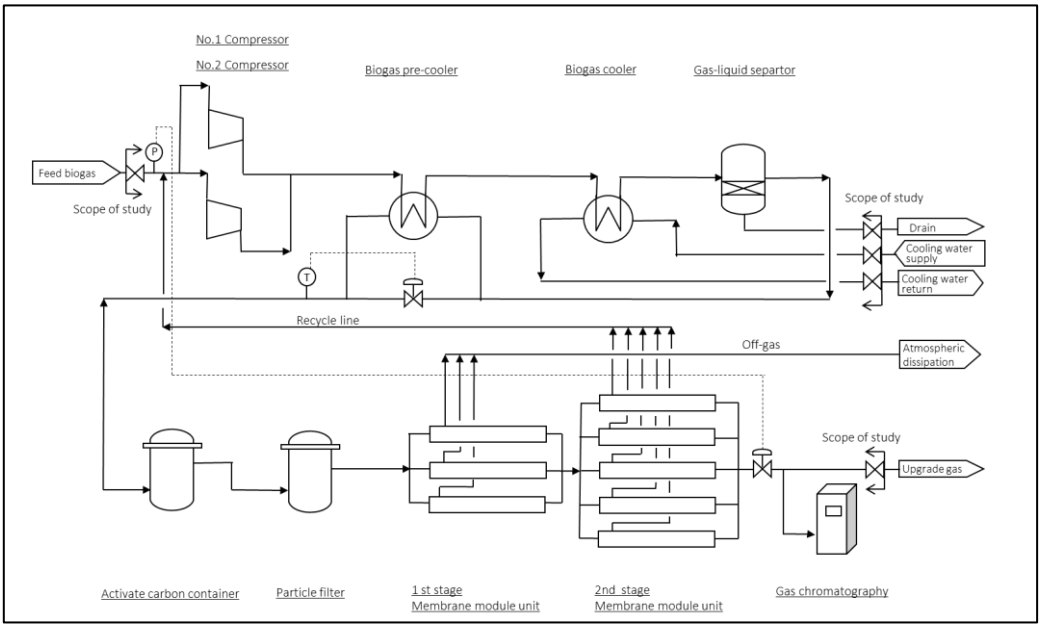
Figure 4.14 Block flow diagram of biogas membrane separator

Table 4.8 Description of each flow of initial design

Flow	Descriptions
1. Pre-treatment facility	Raw biogas contains impurities such as H2S, siloxane, and ammonia. In this study, it is assumed that raw biogas from which such impurities have been removed is fed to the refining equipment. Therefore, the pretreatment facility is not included in its scope.
2. Compressor	The pressure of raw biogas is raised to about 0.9 MPa. Since the raised pressure is the driving force for gas refining, the higher the pressure is, the more ideal the setting is. In this study, the pressure should be increased to 0.9 MPa, which is a level not regulated by the High-Pressure Gas Safety Act in Japan. There is a need to check with the laws and regulations in Indonesia during detailed investigations.
3. Biogas precooler	It is assumed that the raw biogas is sent to the refining plant in a saturated steam state. Water flows to the permeation side in the membrane module and is discharged. The gas is cooled in advance for efficient gas separation. The biogas precooler serves as a heat exchanger to precool the gas before feeding to the biogas cooler.
4. Biogas cooler	The biogas cooler is a heat exchanger that further lowers the temperature of raw biogas using cooling water.
5. Gas-liquid separation drum	Gas-liquid separation drums are installed for removing water from raw biogas cooled to temperatures below the condensation point by the biogas precooler and biogas cooler.
6. Activated charcoal container	Raw biogas is pre-treated before being supplied to the refining plant, but it cannot be denied that some impurities remain. Activated charcoal containers are therefore preinstalled in preparation to treat the impurities.
7. Particle filter	When passing through the activated carbon vessel, activated carbon particles accompanying the biogas may damage the separation membrane. For this reason, particle filters are used to remove the activated carbon particles.
8. Stage 1 membrane module	As a prerequisite of the study, the CH4 concentration of the refined gas was set to 90% and the CH4 recovery rate to 95% as targets in the investigations

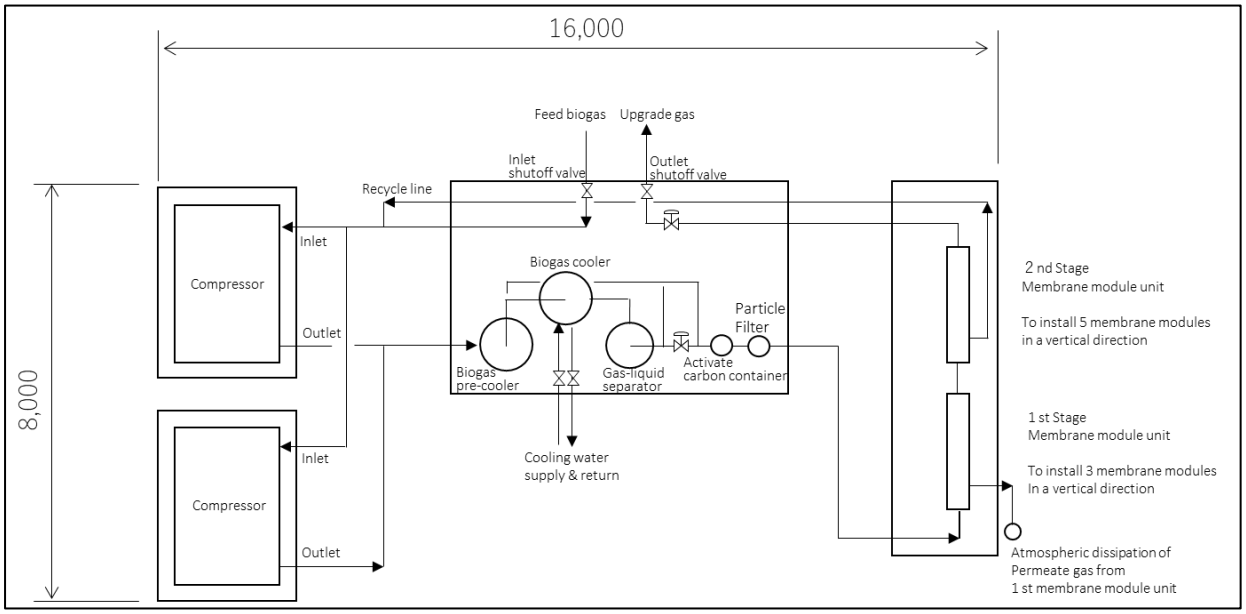
Flow	Descriptions
unit	and calculations. The system consists of two stages of units. Three membrane modules were used in the first stage. The stage 1 membrane module is designed for "coarse" refining. Simulation results show that CO2 in raw biogas penetrates the membrane wall and exit outside of the system. The discharged gas components are CH4 (about 6%) and CO2 (94%).
9. Stage 2 membrane module unit	CO2 also permeates the membrane wall in the second stage. Since the CH4 concentration in the permeated gas is as high at 65%, the aim of the stage 2 membrane module unit is to re-use the raw biogas effectively by returning it to the front of the compressor inlet through pipes (recycling line). There are five membrane modules in the second stage. The gas obtained at the outlet of the second stage is refined gas. Calculation results indicate that the gas volume was about 300 m3/h, CH4 concentration was 90%, CO2 concentration was 8%, N2 concentration was 2%, and CH4 recovery rate was about 95%. The number of membrane modules and the concentration of gas components described here are based on trial calculations. In the actual planning and design, simulation tests will be requested to the membrane module manufacturer, and these values will be decided based on the simulation results.
10. Chromatograph	Chromatographs are installed for analyzing refined gas components. Besides CH4 and CO2, other gas components measured will be those that may pose risks in the applications of refined gas depending on their concentration. If the concentration reaches a concentration range that affects the applications of refined gas, possible measures include dissipation of the refined gas to the atmosphere before it is fed from the refining facility. But given that this is related to the operation concept or principle of the facility, discussions with and consent from the facility owner, operator, and other stakeholders are necessary. Consequently, details such as the mechanism and control method will be considered in the future.

Source: Company A



Source: Company A

Figure 4.15 Process Flow Diagram



Source: Company A

Figure 4.16 Layout plan

4.3.5 Consideration of fuel switch potential of buses in Pekanbaru

Fuel switch potential of buses in Pekanbaru from diesel to bio-CNG was considered by using the result of consideration of biogas generation potential and initial design. As a result, it was found that 50.5% (1,736,234L) of total annual diesel consumption (3,438,088L) consumed by 25 medium buses and 50 large buses, can be replaced with bio-CNG.

Table 4.9 Annual fuel consumption by buses in Pekanbaru

#	Type	Item	Figure	Unit	Remarks
a	Medium	Annual driving distance	1,803,360	km/year	Data from Dept. Transportation of Pekanbaru City
b		Efficiency	3.26	km/L	Data from Dept. Transportation of Pekanbaru City
c		Annual consumption	553,178	L/year	= a/b
d	Large	Annual driving distance	4,587,008	km/year	Data from Dept. Transportation of Pekanbaru City
e		Efficiency	1.59	km/L	Data from Dept. Transportation of Pekanbaru City
f		Annual consumption	2,884,910	L/year	= d/f
g	Total	Annual consumption	3,438,088	L/year	= c+f
h		Density	835	kg/L	
i		Net calorific value	41.4	TJ/Gg	IPCC2006
j		Annual consumption	118,851	TJ	

Source: Prepared by Nippon Koei based on data from Dept. Transportation of Pekanbaru City

Table 4.10 Fuel switch potential and GHG reduction potential

#	Item	Figure	Unit	Remarks
a	Production Capacity of bio CNG	300	Nm3/h	Simulation by Company A
b	Operation hour	6,000	h/year	Assumption
c	Annual production of bio CNG	1,800,000	Nm3/year	=a x b
d	Annual production of bio CNG	1202.4	ton	
e	Net calorific value	50	TJ/ton	
f	Annual production of bio CNG	60,120	TJ	=d x e
g	Annual consumption by buses	118,851	TJ	Table 4.9
h	Fuel switch potential	50.5	%	
i	Annual reduction of diesel	1,736,234	L/year	
j	Density	0.835	kg/L	
k	Net calorific value	41.4	GT/t	
l	Emission Factor	0.0726	tCO2/TJ	IPCC 2006
m	GHG reduction potential	4,326	tCO2/year	= i x j x k x m /1,000

Source: Prepared by Nippon Koei

CHAPTER 5 IMPLEMENTATION OF ACTIVITIES DURING THE COVID-19 PANDEMIC

5.1 IMPACT OF COVID-19

The project was affected in various ways by the global pandemic of COVID-19. The major impacts are listed below.

(1) Restriction of travel: face-to-face meetings were expected very much because 1) efficient implementation was expected in the short and limited period due to the second round of adoption, and 2) the staff in charge was newly appointed in Kawasaki City, and there was no direct acquaintance between the staff of both city governments. However, no face-to-face meetings were held throughout the year due to the restriction of travels.

(2) Restrictions on field visits: Pekanbaru City and the Jakarta metropolitan area, where the local staff and subcontractors reside, were locked down several times, and field visits by local staff and subcontractors could not be carried out as expected.

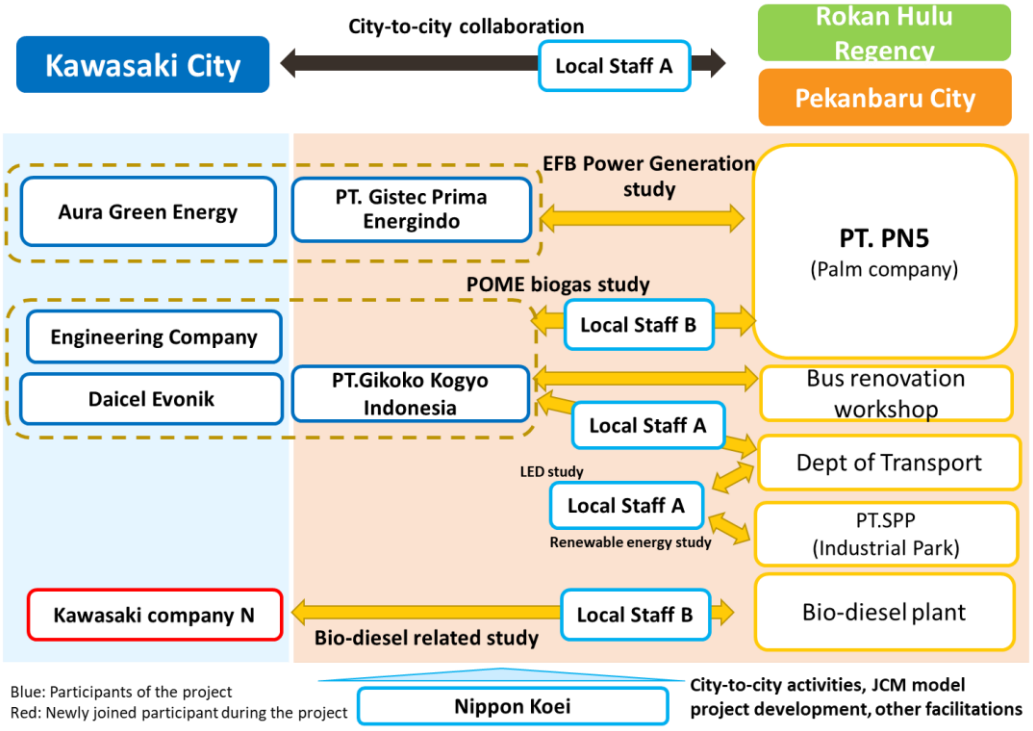
5.2 COUNTERMEASURES AGAINST THE IMPACT OF COVID-19

The following measures were taken to mitigate the impact of COVID-19 on this project.

(1) Restriction of travel: this year, activities were carried out remotely by utilizing two local companies and two local staff.

As for the city-to-city cooperation activities, a local staff A facilitated the activities, who has been participating in this project since the first year and has a good network with the local government.

For the study of JCM model project development, in addition to the two local subcontract companies, we conducted a field survey through mobilization of a local staff B, who has a good and comprehensive knowledge and experiences in palm oil related technologies and businesses and who can easily gather information from private companies as one of the experts in a central government agency for innovative technology development. In this way, by using the right person in the right place, we were able to carry out the activities smoothly. Figure 5.1 shows the roles of the subcontractors and local staff in this fiscal year.



Source: Nippon Koei

Figure 5.1 Roles of subcontractors and local hired workers

(2) Restrictions on field visits: In the beginning, it was assumed that there would be few problems with travel from the Jakarta metropolitan area, but in the reality, the infection situation remained unsettled, so it was decided to give priority to safety of the staff instead of travel to the area. In Indonesia, as “new normal”, remote meetings have become the norm with the use of various apps, etc., so although field visits and face-to-face discussions were limited, we were able to carry out our activities.

CHAPTER 6 FUTURE PLANS

6.1 JCM MODEL PROJECTS FOR FY2021

In this year's feasibility study (F/S), the parties concerned indicated that they would like to propose the EFB power generation project as a JCM model project for FY2022 as soon as the plant in Aceh province, which is currently under construction, is completed. For the next fiscal year, they plan to proceed with discussions on financing and other issues as final steps before the preparation of the proposal.

As for the POME biogas utilization project, the Pre-F/S was completed this fiscal year, and with this information, we will start explaining the project to the production side (each business that emits POME) and the utilization side (Pekanbaru City Bus Company, Trans Metro Pekanbaru and palm oil related companies that are interested in utilizing bio-CNG) in the next fiscal year, and formulate projects with interested companies.

At this point, these projects will be applied for JCM model projects after FY2022, while the other potential projects such as solar power projects will be examined in FY2021 to consider whether it will be possible to apply them in the middle of the fiscal year.

6.2 STRATEGY FOR CITY-TO-CITY COLLABORTAION PROJECT IN FY2021

The strategy of the City-to-City Collaboration Project in FY2021 is as follows.

As for Pekanbaru City, priorities for cooperation were agreed in this fiscal year and activities were started through discussions with Kawasaki City, including participation in the Kawasaki International Environmental Technology Exhibition. In the next fiscal year, the LoI between Kawasaki City and Pekanbaru City and the MoU between Nippon Koei and Pekanbaru City will be concluded.

In the next fiscal year, we plan to proceed with the conclusion of the LoI between Kawasaki City and Pekanbaru City and the MoU between Nippon Koei and Pekanbaru City.

6.2.1 City-to-City Collaboration activities in FY2021

<u>Pekanbaru City</u>

Kawasaki City and Nippon Koei continued to have good cooperative relations with Pekanbaru City Government. For example, in the area of river management, Pekanbaru City has taken the lead in coordinating cooperation not only within the City Government but also with Central Government agencies and surrounding city and regencies, and has started sharing information with Kawasaki City. Companies in Kawasaki City are also taking positive actions, such as providing samples of materials necessary for water purification, and the support for concrete implementation under this City-to-City Collaboration needs to be elaborated.

On the other hand, since the project was adopted as a second round of applications, the activity period was very short, and discussions were not sufficiently promoted in this COVID-19

pandemic. Therefore, in order to be adopted in the first round of application next fiscal year, it is necessary to proceed with discussions with the other parties, continuously after this contract period for FY2020.

Pekanbaru City has a strong desire to conclude a LoI with Kawasaki City for the City-to-City Collaboration. Since Kawasaki City has started to consider this matter positively, the consultant will provide side support in finalizing the agreement.

Rokan Hulu Regency

Although the regent was not changed in the 2020 regent election, there were some changes in the structure, including the appointment of a new deputy regent, which had been vacant. Due to the impact of this change and COVID-19, we were not able to hold policy discussions while we focused on BtoB project development.

We are currently in the process of consulting with the new person in charge, and based on the progress of these consultations, the approach for the next fiscal year will be decided. As for BtoB project formation, discussions with companies in the Rokan Hulu Regency was continued.

Other local governments

In the initial three-year plan, further discussions with cooperating local governments in the second year were planned to expand the number of cooperating parties in the third year. As for the biodiesel-related activities to be considered for the next fiscal year, another regency in Riau Province that faces the sea and has a port is promising.

On the other hand, due to the current COVID-19 travel restrictions, we were not able to start discussions with any local governments other than Pekanbaru City and Rokan Hulu Regency this fiscal year. Kawasaki City is also in the process of focusing on cooperation with Pekanbaru City, and any expansion that may lead to hasty action will be reconsidered. We would like to consider approaching other local governments, including starting remote meetings, while carefully monitoring the improvement in the travel restriction during the next fiscal year.

6.2.2 JCM project formulation

(1) EFB biomass power generation project

After this year's F/S, it was confirmed that the project will proceed positively, and preparatory activities will be carried out in FY2021 in order to apply for the JCM model project in FY2022. In order to apply for the JCM model project in FY2022, preparatory activities needs to be carried out in FY2021, including finalization of the cooperating palm oil mills, finalization of the implementation scheme and establishment of an agreement, preparation for licensing procedures, and further study on the adoption of Kawasaki City related technologies.

(2) POME biogas utilization project

The results of this year's survey indicate that the project has a great potential for emission reduction, and the results will be compiled into a project package and explained to related companies in FY2021.

(3) Consideration of further contribution to the circular economy

As mentioned above, the palm oil industry is an important industry not only in Riau Province but also in Indonesia. On the other hand, since its production activities have various impacts on the environment, various approaches are essential to achieve the circular economy for palm industry and other approaches may be appropriate for the industrial city like Pekanbaru. Specifically, we will examine the following.

1) Study of biodiesel-related business

A company in Kawasaki City is currently planning a project to utilize the byproducts generated during the production of biodiesel fuel. This project will be examined for the support of JCM model project or co-innovation project.

2) Carbonization Project

A company participating in GIC has carbonization technology and various other technologies related to the use of biomass energy, and it is possible to propose carbonization to companies in locations that are not necessarily suitable for EFB power generation, and we will conduct a survey on the applicability of these technologies next year.

3) Use of LED streetlights

As for the plan to replace the streetlights with LED lights, the study did not proceed this year due to the impact of COVID-19. The study will be continued in FY2021.

4) Promotion of the introduction of renewable energy

Since last fiscal year, we have been explaining to Tenayan Industrial Park that decarbonization of electricity procurement is important for attracting international companies. For the next fiscal year, in addition to the information from Kawasaki City on the implementation of its zero-carbon challenge plan, information will be shared on the Paris Agreement, the EU's Green Deal, the establishment of Biden administration in US, and other international discussions that have progressed rapidly throughout FY2020. At first, the implementation of solar power and other renewable energy projects in Riau Province Region, especially in Pekanbaru City will be promoted. Kawasaki City companies have also shown interest in these projects.

End of document