FY2022 Project for Ministry of the Environment Japan

FY2022
City-to-City Collaboration Programme for Zero-Carbon Society

Project to Promote 2050 Zero Carbon City in Riau Province Region through Cooperation with Pekanbaru City

Report

March 2023

Nippon Koei Co., Ltd.
Kawasaki City

FY2022
City-to-City Collaboration Programme for Zero-Carbon Society

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Report

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Abbreviations

BAPPENAS	Badan Perencanaan Pembangunan Nasional
BAU	Business-as-Usual
BWSSⅢ	Balai Wilayah Sungai Sumatera Ⅲ
CAPEX	Capital Expenditure
CNG	Compressed Natural Gas
COVID-19	Coronavirus Disease 2019
CRIC project	Climate Resilient and Inclusive Cities project
DISHUB	Dinas Perhubungan
DPRD	Regional People's Representative Council (Dewan Perwakilan Rakyat Daerah)
EFB	Empty Fruit Bunch
EMS	Energy Management System
FAME	Fatty Acid Methyl Ester
FFB	Fresh Fruit Bunch
F/S	Feasibility Study
GHG	Green House Gas
GIC	Kawasaki Green Innovation Cluster
IPB	Institut Pertanian Bogor
ITB	Institut Teknologi Bandun
JCM	Joint Crediting Mechanism
KSDLL	Regional Cooperation with Overseas Organizations (Kerja Sama Daerah Dengan Lembaga Di Luar Negeri)
KSDPL	Regional Cooperation with Overseas Local Governments (Kerja Sama Daerah Dengan Pemerintah Daerah Di Luar Negeri)
KLHK	Kementerian Lingkungan Hidup dan Kehutanan
LED	Light Emitting Diode
LOI	Letter of Intent
MF	Mesocarp Fiber
MOU	Memorandum of Understanding
NDC	Nationally Determined Contribution
OPEX	Operating Expenditure
PAO	Palm Acid Oil
PKS	Palm Kernel Shell
PLN	PT Perusahaan Listrik Negara /Persero (National Electricity Company)
POME	Palm Oil Mill Effluent
PSA	Pressure Swing Adsorption
PT.PN	PT. Perkebunan Nusantara
PT.PN5	PT. Perkebunan Nusantara V (PERSERO)
PT.SPP	PT. Sarana Pembangunan Pekanbaru
PUPR	Dinas Pekerjaan Umum dan Perumahan Rakyat
PV	Photovoltaic
RAD-GRK	Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca (Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca)
RAN-GRK	Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca (Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca)

RSPO	Roundtable on Sustainable Palm Oil
RUEN	Grand National Energy Plan 2015-2050 (Rencana Umum Energi Nasional)
SDGs	Sustainable Development Goals
UNRI	Universitas Riau
ZEB	Net Zero Energy Building
ZEH	Net Zero Energy House
ZEV	Zero Emission Vehicle

CHAPTER 1 BACKGROUND AND OBJECTIVE

1.1. Background of the project

Paris Agreement which entered into force in November 2016 and began to implementation stage from 2020, mentions that not only central governments but non-governmental actors including local governments and cities need to accelerate their countermeasures to climate change. Also, in “Ministerial meeting of the "Online Platform" on a Sustainable and Resilient Recovery from COVID-19” held in September 2020, necessity of zero-carbon policies of local governments leading communities directly and importance of development approach by initiatives of local communities were confirmed. In Japan, the Government declared that Japan is aiming to become a zero-carbon society by achieving zero emission of overall greenhouse gas (GHG) by 2050, and more than 300 local governments will declare net zero emissions.

Roles of cities and local governments are becoming more important to consider and implement climate change countermeasures and projects in each region. Toward realization of zero-carbon society in the entire globe, it is necessary to accelerate movements to sustainable and zero-carbon society especially in Asia where economic growth is remarkable. Thus, international supports for city’s activities have been enforced for realization of zero/low-carbon society with supporting activities for development of society and economy.

Also, cities are required to re-coordinate and consider new policies to achieve sustainable development while tackling issues induced by the COVID-19 pandemic. From this perspective, it is important to develop new measures and by collaboration between cities.

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. Also, Indonesian Government has promised to reduce 29% of GHG emission compared to Business-as-Usual (BaU), and in case international assistance such as JCM is introduced, their target is 41% in Nationally Determined Contribution (NDC) submitted in 2016, then the NDC was updated with the provision aiming to achieve carbon neutrality by 2060. Following that, DKI-Jakarta developed Governor’s regulation 2021/No.90 with the target of achievement of carbon neutrality by 2050. The movement for zero-carbon society in Indonesia is currently quite active.

This project is being implemented between Kawasaki City and Pekanbaru City. municipalities in Riau Province (Pekanbaru City and Rokan Hulu Regency). Pekanbaru City is the capital of Riau Province, which is located in the center of Sumatra Island of Indonesia and core industry there is oil palm. Palm oil is one of 10 key products 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 83% of palm oil in the world is produced in Indonesia and Malaysia (Palm Oil Explorer, USDA,

2022). Riau Province produces the biggest amount of palm oil in Indonesia, which composes 27% of total (same).

While oil palm sector is the 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 support foreign cities on activities, the introduction of equipment, and the realization of decarbonization domino for the development of zero-carbon society in cooperation with Japanese cities with the experiences and knowhow.

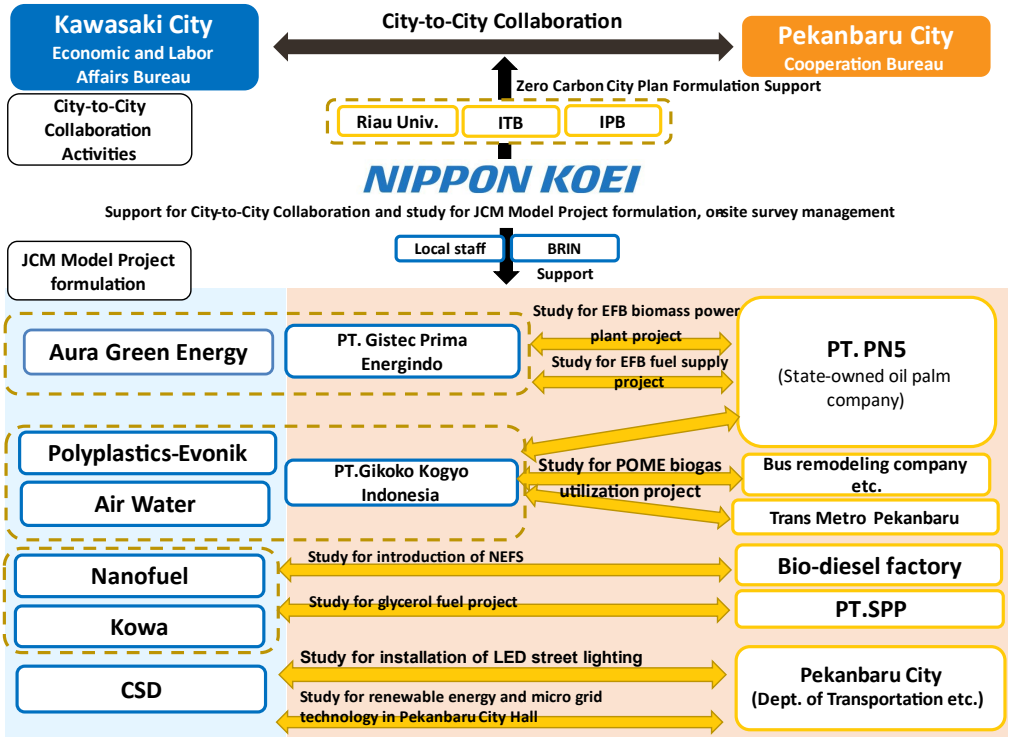
1.3. Implementation structure

Implementation structure of FY2022 is illustrated in Figure 1.1. Kawasaki City and Pekanbaru City carried out discussion of development of Zero Carbon City and of circular socio-economy.

Also, under the City-to-City Collaboration, 1-1) Empty Fruit Bunch (EFB) biomass fuel project as well as EFB biomass power plant project, 1-2) Project for Palm Oil Mill Effluent (POME) biogas utilization and 1-3) palm acid oil (PAO) utilization project were implemented as projects contributing to formulation of circular socio-economy. Regarding the EFB biomass power plant project of 1-1), Aura Green Energy Co., Ltd. implemented feasibility study on target palm oil mills owned by National Oil Palm Company, PT. Perkebunan Nusantara V (PT.PN5), cooperating with its local partner, PT. Gistec Prima Energindo. On the other hand, for the EFB biomass fuel project, we approached and gathered information from manufacturers of EFB fuel conversion equipment, feedstock and fuel (pellet) suppliers, and potential off-takers, with the aim of establishing a framework to commercialize it. Meanwhile, Polyplastics-Evonik Ltd., Air Water Inc., and a local company, PT. Gikoko Kogyo Indonesia implemented study with palm oil mills owned by PT.PN5 to considerate the design of bio-CNG plant and discussed with the Department of Transportation of Pekanbaru City (Dinas Perhubungan: DISHUB) for 1-2). Moreover, for 1-3), we surveyed of BDF factories and investigated where NanoFuel's nanoemulsion technology could be used, with the cooperation of NanoFuel Co., Ltd. and Kowa Company.

In addition, as JCM projects contributing to development of zero carbon city, 1-4) the introduction of renewable energy and energy management in public buildings, and 1-5) Project for installation of LED street lightings were studied. Based on information provided by Department of Public Works and Public Housing (Dinas Pekerjaan Umum dan Perumahan Rakyat: PUPR) and DISHUB of Pekanbaru City, CSD Co., Ltd. considered specification of technologies and impact on GHG emission reduction.

Nippon Koei Co., Ltd. entirely supported the city-to-city collaboration and JCM Model project as the representative operator. This project was implemented with three trips to Riau Province. Information collection, studies, and discussions were implemented in 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 June 20th, 2022 to March 10, 2023. Schedule of this project is shown below.

#	Study contents	Sep	Oct	Nov	Dec	Jan	Feb	Mar
City to City Collaboration Activities								
1	Discussion on circular economy	→	→	→	→	→	→	
2	Discussion on 2050 Zero-Carbon City	→	→	→	→	→	→	
3	Information collection regarding oil palm sector		→	→	→	→	→	
4	Procedure for LoI conclusion	→	→	→	→	→	→	→
Workshop, Seminar etc.								
1	Workshop and business matching seminar				▼		▼	
2	Kawasaki Eco-Tech Fair			▼				
Field study, preparation of report etc.								
1	Field study and information sharing	→	→	→	→	→	→	
2	Monthly report		▼	▼	▼	▼	▼	▼
3	Reporting meeting with MOE	▼				▼	▼	
4	Meetings (Kawasaki City, partner companies)	▼	▼	▼	▼	▼	▼	
5	Preparation of final report					→	→	
JCM project formulation study EFB biomass plant project（1-1）								
1	Study on biomass fuel		→	→	→	→	→	
JCM project formulation study: POME biogas utilization project（1-2）								
1	Design of bio-CNG plant	→	→	→	→	→	→	
2	Estimation of CAPEX and OPEX of bio-CNG plant	→	→	→	→	→	→	
3	Selection of company for retrofit of buses	→	→	→	→	→	→	
4	Project plan development and economic evaluation			→	→	→	→	
JCM project formulation study: BDF glycerol fuel project（1-3）								
1	Contact to BDF factories and collection of bi-glycerol sample	→	→	→	→	→	→	
2	Study on glycerol market			→	→	→	→	
3	Consideration of project plan			→	→	→	→	
JCM project formulation study: Project contributing to zero-carbon city（2-1, 2-2）								
1	Information collection from local stakeholders	→	→	→	→	→		
2	Technical proposal and discussion			→	→	→	→	
3	Consideration of specification of installed technologies			→	→	→	→	
4	Project plan development and economic evaluation			→	→	→	→	
5	Consideration of project structure			→	→	→	→	

Source: Prepared by Nippon Koei

Figure 1-2 Project schedule

CHAPTER 2 OVERVIEW AND ENVIRONMENTAL ACTIONS OF PARTICIPATING CITIES

2.1. 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 the 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 pollution 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.

Source: Kawasaki City

Figure 2-1 Location of Kawasaki City

Table 2-1 Statistical data of Kawasaki City

#	Item	Statistical data
1	Area	144.35km2
2	Population	1,540,516 (as of January 1, 2023)
3	Number of households	762,705 (as of January 1, 2023)
4	Gross city product (nominal)	6,381.6 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 such 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

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)

"SDGs Future City [2]". Through such activities and awards, Kawasaki City has been actively promoting climate change countermeasures and SDGs.

2.1.2. KAWASAKI CITY BASIC PLAN TO PROMOTE GLOBAL WARMING COUNTERMEASURES

Kawasaki City has been implementing global warming countermeasures based on the Kawasaki City Basic Plan to Promote Global Warming Countermeasures formulated in 2010 (revised in 2018), and in November 2020, the city formulated the Kawasaki Carbon Zero Challenge 2050 (see below), a strategy to realize a decarbonized society by 2050, and has been promoting decarbonization efforts. In November 2020, the company formulated the Kawasaki Carbon Zero Challenge 2050 (see below), a strategy to realize a decarbonized society by 2050. The following table summarizes the outline of the 2022 Plan.

Source: Kawasaki City

Figure 2-2 The Kawasaki City Basic Plan to Promote Global Warming Countermeasures

Table 2-2 Kawasaki City Basic Plan for the Promotion of Global Warming Countermeasures (Plan 2022)

Item	Proposed Plan for 2022
Duration	FY2022 - FY2030 period
Future Vision	Aim for Net-Zero GHG emissions in the city area by 2050
Basic Concept	"Creating a Zero-Carbon city where future generations can live peacefully" and "Creating a sustainable and powerful industry through a virtuous cycle between the environment and the economy"
Basic direction	A city where citizens, businesses, and other entities work toward decarbonization A city that contributes to decarbonization of the world through green innovation A city that optimizes energy by maximizing the use of renewable energy A city with earth-friendly transportation environment A city where the municipal office takes the initiative to achieve decarbonization A city that works on resource recycling aiming at decarbonization A city where people can adapt to climate change and lead safe and healthy lives A city where citizens are connected through diverse forms of greenery
GHG reduction targets	Target for city area: Net-Zero GHG emissions in the city area in 2050

[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).

Item	Proposed Plan for 2022
	50% reduction by FY 2030 (11.8 million tCO2 reduction compared to FY 2013) Consumer targets (consumer households and consumer businesses): 45% or more reduction by FY 2030 (1.7 million tCO2 reduction compared to FY 2013) Industrial targets (industries, energy conversion, industrial processes): 50% or more reduction by FY 2030 (9.52 million tCO2 reduction compared to FY 2013) Municipal office targets (all public facilities in the city): 50% or more reduction by FY 2030 (210,000 tCO2 reduction compared to FY 2013)
Renewable energy introduction target for FY 2030	Introduction of 330,000 kW or more by FY 2030 (200,000 kW of renewable energy was introduced in the entire city area in FY 2020)

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

2.1.3. ZERO CARBON STRATEGY "KAWASAKI CARBON ZERO CHALLENGE 2050"

On February 17, 2020, the Mayor 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 of images of achievements of zero carbon society in Kawasaki as shown below.

Table 2-3 Images of zero carbon society in Kawasaki in 2050

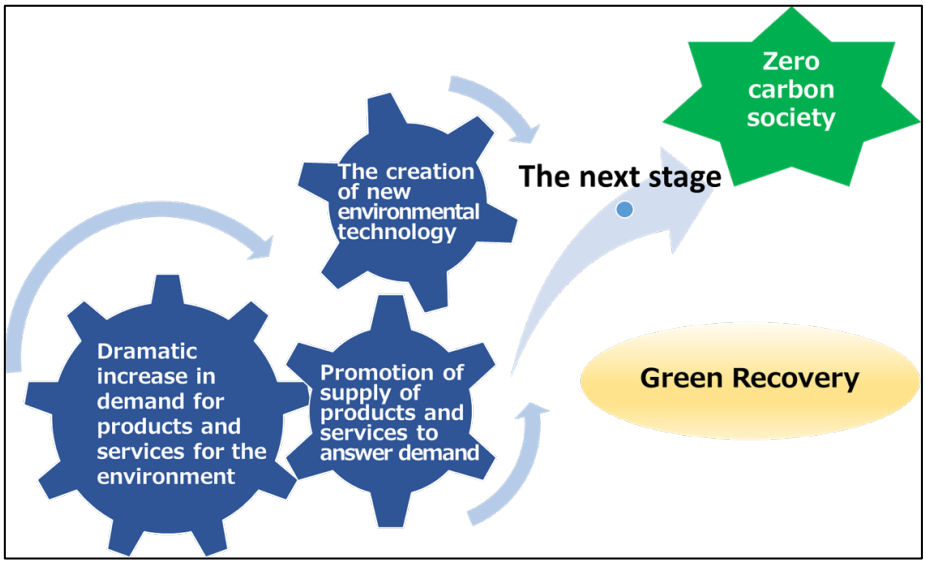
Sector	Images
Private sector (households and business operations)	(1) Zero-energy buildings (shifting to Net Zero Energy Building (ZEB) and Net Zero Energy House (ZEH)) become general. (2) Power sources based on renewables are widespread, as well as local power supply and consumption by utilizing the potential of the region. (3) Realization of compact city, decarbonization of buildings and realization of urban

Sector	Images
	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 having 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 sight 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.



Source: Kawasaki Carbon Zero Challenge 2050

Figure 2-4 Image of the approach to zero-carbon society

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

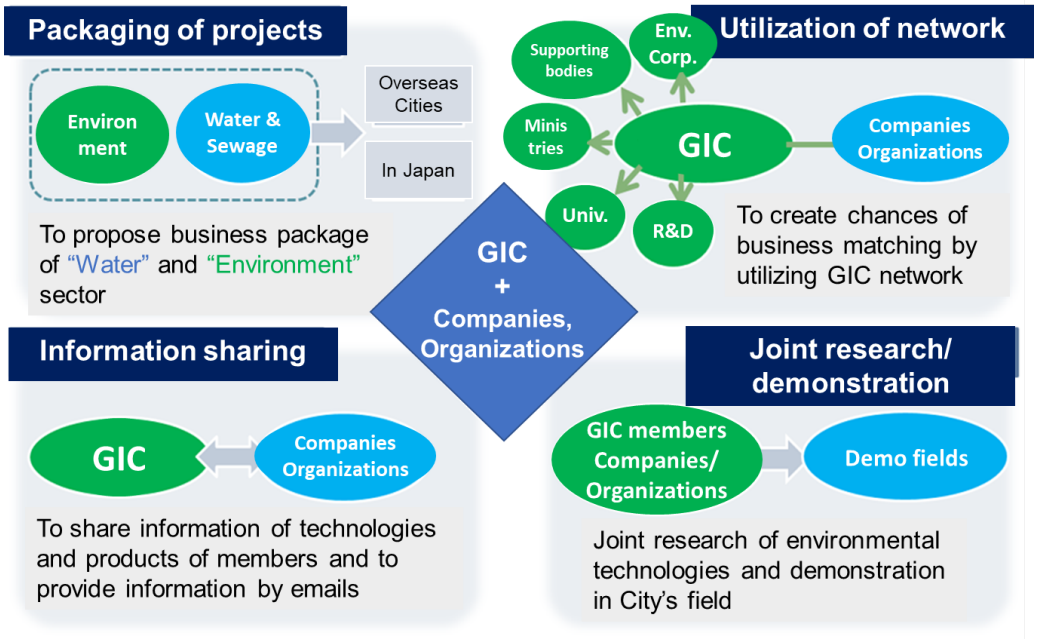
2.1.4. KAWASAKI GREEN INNOVATION CLUSTER (GIC)

In 2014, Kawasaki City released its Promotion Policy on Kawasaki Green Innovation (to be integrated into the Kawasaki Basic Plan for the Promotion of Global Warming Countermeasures in 2022). It describes basic policies and practices on how to create sustainable cities by taking 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

The Kawasaki Green Innovation Cluster (GIC) was established in 2015 as a network to promote Pillars I and IV of the four pillars, aiming to create a new society by working on environmental improvement through collaboration among industry, academia, government, and the private sector, and by promoting industrial development and international contributions. GIC has been positioned as a "consultation service for utilizing the policies of Kawasaki City and supporting organizations," "promotion, publicity, and provision of information," and "business creation utilizing environmental technologies, administrative expertise, and know-how," among the measures in the Kawasaki Basic Plan for the Promotion of Climate Change Countermeasures. GIC is working to create innovations in the environmental field through functions such as "consultation services to take advantage of the policies of Kawasaki City and support organizations," "promotion, publicity, and information provision," and "support for business creation utilizing environmental technologies, administrative knowledge, and know-how.



Source: Kawasaki City

Figure 2-5 Image of activities utilizing GIC

2.1.5. LEADING DECARBONIZATION REGIONS

The "Leading Decarbonization Regions" are regions that achieve virtually zero CO2 emissions from electricity consumption in the consumer sector (households, businesses, and other sectors) toward carbon neutrality in 2050. They are expected to achieve reductions in other greenhouse gas emissions, including transportation and heat use, consistent with Japan's 2030 target for the entire country. The region will be a model for the "Decarbonization Domino in Action".

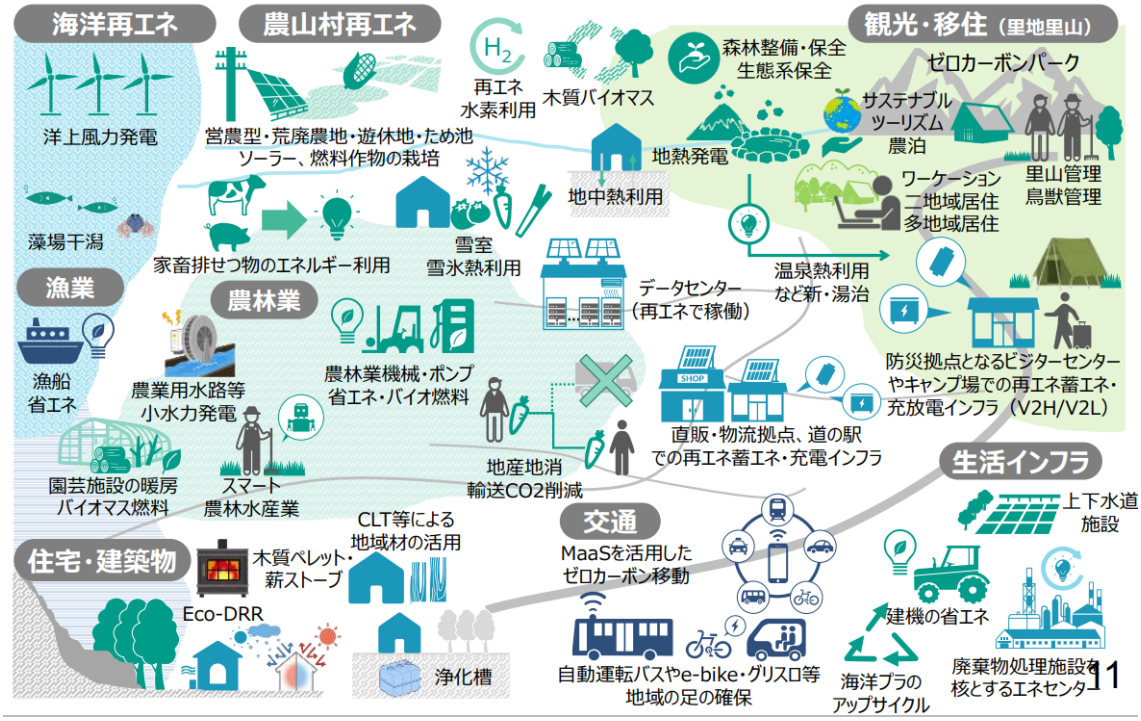
Leading decarbonization regions are established in the "Regional Decarbonization Roadmap" compiled by the National and Regional Decarbonization Conferences in 2021. Led by local governments, local businesses, and financial institutions with active support from the national government, especially from the Ministry of the Environment, Japan, at least 100 regions will establish a path toward decarbonization by FY2025, with implementation by FY2030. This will show a direction toward decarbonization in a variety of regions, including rural areas, remote islands, and urban areas while solving regional issues and improving the quality of residents' life.

Examples of initiatives that take advantage of regional characteristics are summarized in the table below.

Table 2-5 Examples of initiatives in Leading Decarbonization Regions categorized by geographical characters

Geographical Characteristics	Examples
Rural and fishing villages	Farm-based renewable energy, woody/livestock waste biomass, geothermal power generation, smart agriculture, forestry
Remote islands	Renewable energy such as offshore wind and solar power, use of hydrogen, electrification of ships
Urban areas	Roof-mounted solar power for housing, public facilities, and parking lots, use of renewable energy heat
Regional cooperation	cooperation among neighboring municipalities, for instance, between a rural region with abundant renewable energy potential and large urban consumption area

Source：Prepared by Nippon Koei based on meeting documents of the National and Regional Decarbonization Conferences



Source: The National and Regional Decarbonization Conferences

Figure 2-6 An Image of Livelihoods in the Leading Decarbonization Regions (Agricultural land and Fishing Area)

Source: The National and Regional Decarbonization Conferences

Figure 2-7 An Image of Livelihoods in the Leading Decarbonization Regions (Urban Area)

Mizonokuchi area, home to "Decarbonization Action Mizonokuchi," was nominated as a leading decarbonization region from Kawasaki City. This is because of its efforts since 2020 to achieve its 2030 CO2 emissions reduction target through the concerted efforts of citizens and businesses.
Examples for actions of Decarbonization Action Mizonokuchi are shown below.

Table 2-6 Examples for "Decarbonization Actions" of Decarbonization Action Mizonokuchi

Areas of actions	Examples
Renewable energy	Joint purchase of electricity for households, introduction of the energy to public and commercial facilities
Resource recycling	My bottle, reusable tableware and reusable bottles, recycling systems
Sharing economy	Shared bicycles, car sharing, umbrella sharing
Electric and fuel cell vehicles	Hydrogen stations, introduction into official and company vehicles
Reduction of food loss	Development and dissemination of eco-friendly recipes, food sharing

Source: prepared by Nippon Koei based on Decarbonization Action Mizonokuchi, Kawasaki City

The "Decarbonization Action Mizonokuchi" Promotion Council brings together various businesses and organizations active in the Mizonokuchi area, including energy-related companies, local businesses, and community groups, to collaborate on the development of decarbonization initiatives and publicity.

Table 2-7 The activity contents of Decarbonization Action Mizonokuchi Promotion Council

Promotion of "Decarbonization Action Mizonokuchi"	Dissemination of information on the initiatives of each member organization	Creating connections among members
● Information sharing on initiatives of each member organization ● Discussion on the future direction of the council	● Organize events and seminars for citizens ● Create videos, leaflets, etc. to introduce the initiatives of businesses ● Publicity using public relations tools	● Business matching ● Organizing seminars and other events for businesses

Source: prepared by Nippon Koei based on Decarbonization Action Mizonokuchi HP, Kawasaki City

2.2. Pekanbaru City

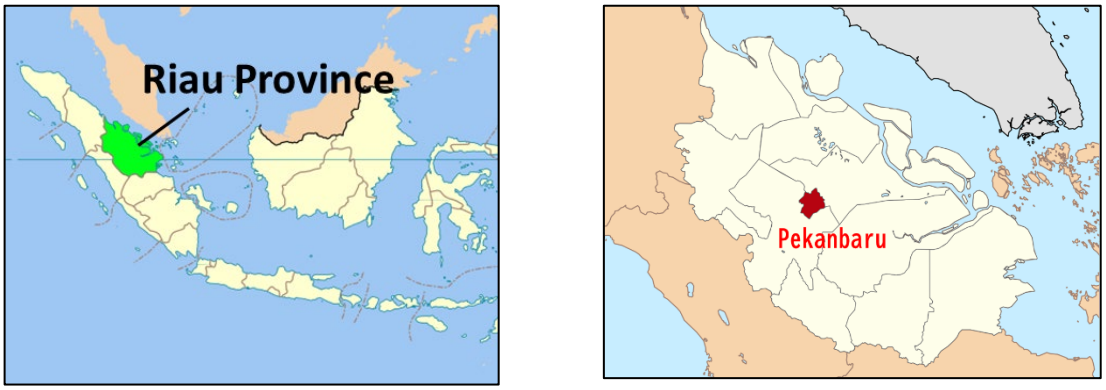
2.2.1. OVERVIEW OF PEKANBARU CITY

Pekanbaru City, the capital city of Riau Province which is in the center of Sumatra Island of Indonesia, has been developing its economy and industry rapidly over the years. With a population of more than one million, they have been promoting various policies and projects such as the development of an industrial park, the development of a new city center, and the

introduction of a new transportation system, etc. Forming a smart city is one of the city's priority policies.

The core industry in the province is palm oil. P which is one of 10 key products decided by the Ministry of Trade of Indonesia. Production amount of palm oil in Indonesia is the largest in the world, and 83% of palm oil in the world is produced in Indonesia and Malaysia (Palm Oil Explorer, USDA, 2022). Riau Province produces the biggest amount of palm oil in Indonesia, which composes 27% of total (same).

The location of Pekanbaru City and the overview are shown below.



Source: Prepared by Nippon Koei

Figure 2-8 Location of Pekanbaru City

Table 2-8 Overview of Pekanbaru City

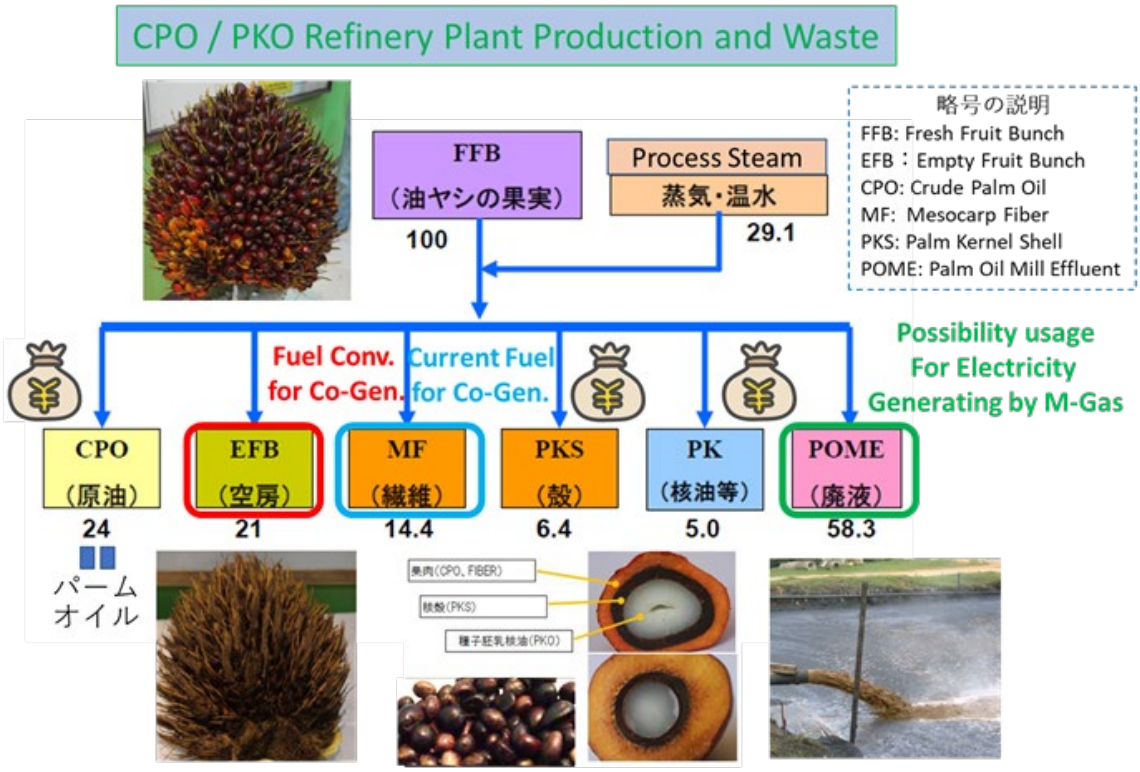
Content	Data
Population（2022）	1,085,000
Area（km2）	632
Density （person/km2）（2022）	1,717
Gross Regional Product (USD million) (2021)	8,845

Source: Prepared by Nippon Koei based on reports of Statistics of Pekanbaru City

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 fires. 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 2-9 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 Pekanbaru 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 both Letter of Intent between Pekanbaru City and Kawasaki City, between Pekanbaru City and Nippon Koei.

2.2.4. CRIC PROJECT

The CRIC (Climate Resilient and Inclusive Cities) project is a five-year EU-funded tripartite partnership between Southeast Asia (Indonesia, Malaysia, Philippines, Thailand), South Asia (India, Nepal, Bangladesh), and Europe. Under this project, 10 pilot cities in Indonesia are working on climate change initiatives under the management of the United Cities and Local Governments Asia Pacific (UCLG ASPAC). Pekanbaru has been selected as a pilot city and its focus sector is the waste sector. The pilot cities and their sectors of focus are summarized in the table below.

Table 2-9 The locations of CRIC project in Indonesia and the focus sectors

Location	Focus sector
● Pangkal Pinang ● Bandar Lampung	Early flood warning system
● Ternate	Early coastal warning system
● Pekanbaru ● Cirebon ● Samarinda ● Mataram	Waste management
● Banjarmasin ● Kupang	Water management
● Gorontalo	Water and sanitation

Source: Prepared by Nippon Koei based on "Climate Resilient and Inclusive Cities" (originally in Indonesian)

The project proposes a long-term and unique collaboration among European (EU) and Indonesian (and surrounding) cities and research centers. Through tools such as sustainable regional action plans, early warning tools, and expert panels, they aim to contribute significantly to sustainable integrated urban development, good governance, and climate adaptation/mitigation. The three targeted outcomes of the CRIC project are summarized in the table below.

Table 2-10 Targeted outcomes of the CRIC project

Outcomes	Description
1. Knowledge production and exchange	・ Production of knowledge and urban analysis ・ Urban reports ・ Strengthened tools and exchange between European, Indonesian and other Asian cities
2. Local action plans for climate resilient and inclusive cities	・ Strengthened cities and LA's capacities in the design and implementation of inclusive public policies ・ Improvement of the quality, delivery and equitable access to basic services and infrastructure ・ Enhanced capacities of cities and LAs in managing urban waste and air pollution, Promoted green low carbon and climate resilient urban development and urban circular economy ・ Enhanced capacities of cities, villages and LAs in managing (multi-hazard) disaster risks, and promoting shock responsive and resilience infrastructure and services
3. Communication and Capacity Building	・ Improved institutional, financial and administrative capacities of cities and LAs ・ Strengthened mechanisms for consultation, coordination and cooperation among public, private, civil society sectors and other relevant stakeholders in the decision making and production of urban development policies ・ Strengthened capacities of cities and LAs in using smart technologies ・ Improved public-private partnerships and schemes for local economy

Source: Prepared by Nippon Koei based on CRIC HP

According to the results of the analysis in the CRIC project published in 2020, Pekanbaru City faces disaster risks from floods, forest fires, and smog. Priority issues included waste management, sustainable urbanization, and disaster prevention as well as air pollution. Based on the results, Pekanbaru City is currently focusing on waste management in the CRIC project.

Pekanbaru City has established a Climate Change Working Group (WG; POKJA) and plans to issue a mayoral decree promoting climate change mitigation and adaptation measures and waste management initiatives.

2.2.5. DEVELOPMENT OF TENAYAN INDUSTRIAL PARK

Pekanbaru City is currently developing Tenayan Industrial Park (total developed land area: 2.66 km2), which has been designated by the Indonesian government as a priority industrial park (one of four nationwide) under a national strategic project. The project is supported by the Ministry of National Development Planning (Badan Perencanaan Pembangunan Nasional: BAPPENAS) and plans to start the operation of the park in 2024. 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 the experiences of Kawasaki City that 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 2-10 Tenayan Industrial Park

2.2.6. SIAK RIVER REHABILITATION

Siak river flows from the center of Sumatra 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: Pekanbaru City

Figure 2-11 Siak River

While Siak River supports the economy of Riau Province, pollution of the river by industrialization of urban areas is one of the largest issues. Considering this situation, Pekanbaru 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.

The main stem and tributaries of the Siak River are managed by the Sumatra Region III (Riau District) River Office (Balai Wilayah Sungai Sumatera III: BWSS III), and the artificial drainage system is managed by PUPR, Pekanbaru City. BWSS III is in charge of water utilization, flood control, pollution prevention, and remediation of the Siak River. However, the sources of pollution are the palm plantations upstream, which are under the Ministry of Environment and Forestry (Kementerian Lingkungan Hidup dan Kehutanan: KLHK) and the Ministry of Agriculture, making the solution to river pollution difficult.

On the other hand, Pekanbaru City is also facing the problem of flooding in many areas due to inadequate drainage systems where drainage channels are often blocked by waste materials dumped illegally. Therefore, Pekanbaru City officers are also looking forward to Kawasaki City's knowledge, experience, and technology of the companies there in urban drainage systems, including waste management, to help solve the problem.

CHAPTER 3 CITY-TO-CITY COLLBAOLATION ACTIVITIES FOR ZERO CARBON SOCIETY

3.1. City-to-city collaboration activities in FY2019 and FY2020

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 2019. Discussion between municipalities and JCM model project formulation for development of circular economy and 2050 zero-carbon city in Riau Province region has been carried out.

The main activities in FY2019 and FY2020 are as follows.

Table 3-1 City-to-City Collaboration activities in FY2019 and 2020

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 and city-to-city

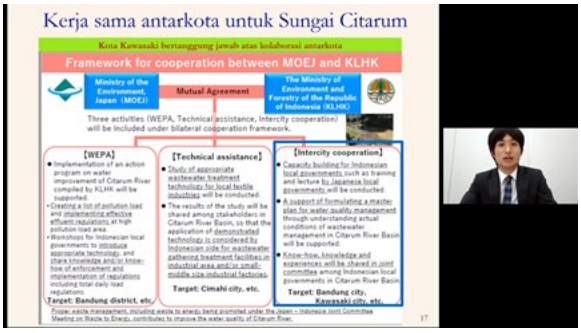
Year/Month	Activity (Location)	Overview
		collaboration of Kawasaki City (with DKI-Jakarta and Yangon City), and zero-emission industrial park were presented. During the conference, Pekanbaru City chows their interest in 2050 Zero Carbon City and it was agreed to make it theme of City-to-City Collaboration after the event
August 2020	Conclusion of LOI between Pekanbaru City and Nippon Koei	Pekanbaru City and Nippon Koei concluded LOI about 2050 Zero Carbon City on August 24, 2020.
September 2020	Selection as FY2020 City-to-City Collaboration Program for Zero-Carbon Society (2nd call)	"Project to Promote Development of Circular Economy for Oil Palm Industry and 2050 Zero Carbon City in Riau Province Region" was selected and started in December 2020.
January 2021	Online business seminar between GIC members and Pekanbaru City (Online)	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 Pekanbaru City.
January-February 2021	Kawasaki International Eco-Tech Fair (Online)	"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.
February, 2021	City-to-City Collaboration Seminar held by MOE (Online)	"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 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.
March, 2021	City-to-City Collaboration Webinar between Peanbaru City and Kawasaki City (Online)	City-to-City Collaboration Webinar between Pekanbaru City and Kawasaki City was implemented. In the webinar, reporting of activities' result in FY2020 and discussion for plan in FY2021 was carried out.

Source: Prepared by Nippon Koei

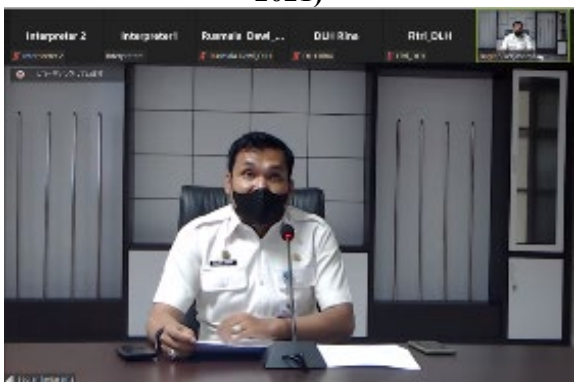
Courtesy visit to Pekanbaru City Mayor (August 2019)

Japan Visit (January 2020)

Online business seminar between GIC members and Pekanbaru City (January 2021)



City-to-City Collaboration Webinar (March 2021)



Opening remarks of City-to-City Collaboration Webinar (February 2022)

3.2. City-to-city collaboration in FY2021

Themes of FY2021 City-to-City Collaboration project were 1) Support for development of circular economy and green recovery and 2) Support for development of 2050 Zero Carbon City. City-to-city collaboration activities considering know-how and experiences of Kawasaki City and environmental needs found in Riau Province Region were carried out.

Overview of the activities are shown in the table below.

Table 3-2 Themes and overview of city-to-city collaboration activities

#	Theme	Overview
1	Support for development of circular economy and green recovery	Through Kawasaki International Eco-Tech Fair (Section 3.3.3), and Online business seminar of GIC members with Pekanbaru City and DKI-JKT (Section 3.3.4), information transmission of environmental needs of Pekanbaru City, and technology introduction from GIC members and network formulation for circular economy and green recovery was carried out.
2	Support for development of 2050 Zero Carbon City	Discussion for conclusion of LOI between Kawasaki City and Pekanbaru City about 2050 Zero-Carbon City was implemented (Section 3.3.2). In the City-to-City Collaboration Workshop, progress of zero-carbon strategy "Kawasaki Carbon Zero Challenge 2050" developed in November 2020 by Kawasaki City and activities for zero-carbon city by DKI-JKT, who published zero-carbon plan "RPRKD" in October 2021, were shared with Pekanbaru City. (Section 3.3.5)

Source: Prepared by Nippon Koei

3.3. Results of city-to-city collaboration activities

3.3.1. ACTIVITIES IN FY2021

Activities in FY2021 are summarized in the table below.

Table 3-3 City-to-city collaboration activities in FY2021

Activities	Date	Overview
Presentation in GIC member meeting	September 13, 2021	Nippon Koei participated in GIC member meeting and introduced this project to member companies whereas implementing individual meetings with some member companies.
Kick-off meeting with MOE	September 21, 2021	Kick-off meeting among MOE, Kawasaki City and Nippon Koei was carried out. Project overview and schedule in FY2021 was confirmed.
Meeting with the Indonesian Embassy in Japan	October 4, October 13, 2021	Kawasaki City and Nippon Koei visited Indonesian Embassy in Japan and explained about this project to Head of Forestry Department. It was agreed to implement information sharing of progress including LOI conclusion and to cooperate each other when necessary.
Meeting with Cooperation Division of Pekanbaru City	November 5, 2021	Meeting with Cooperation Division of Pekanbaru City was carried out. It was confirmed that Pekanbaru City requires to explain about LOI with Kawasaki City and MOU with Nippon Koei to Ministry of Home Affairs thus, signing on the documents will be later than January 2021.
Kawasaki International Eco-Tech Fair	November 16-26, 2021	Online booth of this project was prepared in Kawasaki International Eco-Tech Fair. In addition to overview of this project, “Development of Tenayan Industrial Park”, “Siak River Rehabilitation”, “Fuel-Switching of Buses in Pekanbaru” and “Installation of LED street lightings”, provided by Pekanbaru City were exhibited.
Online business seminar between GIC members and Pekanbaru City/ DKI-JKT	December 23, 2021	Online business seminar between GIC members and Pekanbaru City/ DKI-JKT was organized together with GIC Secretariat and four member companies presented their business and products.
Interim reporting meeting with MOE	January 5, 2022	Interim reporting meeting with MOE was implemented. Progress and schedule of this project were confirmed.
Meeting with Cooperation Division of Pekanbaru City	January 25, 2022	Meeting with Cooperation Division of Pekanbaru City was carried out. It was confirmed that officials of Pekanbaru City visit to Ministry of Home Affairs in February for explanation about LOI with Kawasaki City and MOU with Nippon Koei. Also, coordination and cooperation for City-to-City Collaboration Workshop in February was requested.
City-to-City Collaboration Workshop between Pekanbaru City and Kawasaki City	February 16, 2022	City-to-City Collaboration Workshop between Pekanbaru City and Kawasaki City with theme of 2050 Zero -Carbon City was held. Pekanbaru City mentioned that they positively proceed for LOI conclusion with Kawasaki City and zero-carbon declaration in their opening and closing remarks.
Final reporting meeting with MOE	February 24, 2022	This fiscal year’s activities and plans for the next fiscal year’s activities were reported to MOE

Source: Prepared by Nippon Koei

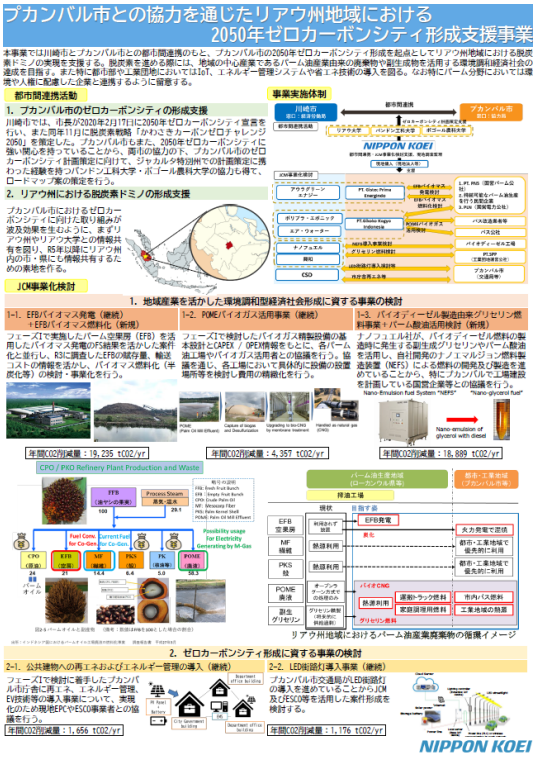
3.3.2. KAWASAKI INTERNATIONAL ECO-TECH FAIR

The 15th Kawasaki International Environmental Technology Exhibition was held on November 17 and 18, 2022. The aim was to provide a place for business matching between exhibitors and organizations and domestic and overseas companies, exhibiting from Kawasaki City to the world a wide range of environmental technologies, which are the environmental technologies that respond quickly to domestic and international environmental problems, and the technologies that solve global environmental problems. As part of this exhibition, a booth was set up in the category of contributing to a sustainable society. A poster was made and placed there about the outline explanation of this project and the present state and problems in Pekanbaru City. The project team also conducted business matching and exchanged opinions with GBS and Okamura Kenko. About 100 people, mainly from businesses in Kawasaki, government officials and related organizations, visited this booth to exchange opinions directly.

Exhibition

The booth

The poster 1



The poster 2

3.3.3. LOI BETWEEN KAWASAKI CITY AND PEKANBARU CITY

Kawasaki City and Pekanbaru City are preparing for conclusion of LOI about 2050 Zero-Carbon City under agreement of both cities,

In Indonesia, the "Government Regulation on Regional Cooperation (PP No. 28/2018)" was enacted in 2018, and more detailed procedures are stipulated in the "Ministry of Home Affairs Regulation on Procedures for Regional Cooperation with Overseas Local Governments and Overseas Organizations (Permendagri No. 25/2020)". The outline of each regulation and main points related to the signing of the LOI are summarized below.

Table 3-4 Summary of Provisions on Regional Cooperation

Item	Contents
Outline (Government Regulation Clause 1; Ministry of Home Affairs Regulation Clause 1)	Regional cooperation refers to the cooperation between local governments in Indonesia, between local governments in Indonesia and overseas local governments, or between local governments in Indonesia and overseas organizations for the effective and efficient provision of public services and mutual benefits. Regional cooperation with overseas local governments is referred to as KSDPL, while regional cooperation with overseas organizations is referred to as KSDLL.
Areas covered by KSDPL (Government Regulation Clause 23, Ministry of Home Affairs Regulation Clause 4)	・ Development of science and technology ・ Cultural exchange ・ Improvement of technical capabilities and management capabilities of the government ・ Promotion of regional potential ・ Others that do not violate legal provisions
Requirements for KSDPL (Clause 27, Ministry of Home Affairs Regulation Clause 5)	・ There must be a diplomatic relationship. ・ The cooperation activities must be carried out by local governments. ・ The local governments must not open representative offices overseas. ・ The overseas local governments must not interfere with the government of the country. ・ The activities must be in line with national and local policies and plans. ・ Administrative status/territorial equality must be maintained. ・ The two cities must complement each other. ・ The cooperation must strengthen the relationship between communities.
Stages of KSDPL implementation (Government Regulation Clauses 24, 26 and 28, Ministry of Home Affairs Regulation Clause 9)	1. Assessment of regional cooperation **2. Declaration of the intent to cooperate (Signing of LOI)** 3. Preparing cooperation plan 4. Approval by DPRD (Regional People's Representative Council) 5. Verification 6. Preparing draft MOU 7. Discussion on MOU 8. Approval by Minister 9. Signing of MOU 10. Implementation
Required Items and Procedures for LOI (Ministry of Home Affairs Regulation Clauses 13 and 14)	Required items: a) Title, b) Areas covered under cooperation, c) Objectives and goals, d) Scope of cooperation e) Period of validity (within one year after signature) f) Place and date of signature Procedure for signing the LOI: 1. The Mayor must coordinate and consult with the Ministers of Home and

	External Affairs prior to signing the LOI. Coordination and consultation shall be conducted by submitting a written request for response to the Ministers. 2. After receiving the request, the Ministers shall submit a written response. 3. The Mayor shall sign the LOI. The same LOI as submitted to the Home Minister shall be signed.

Source: Prepared by Nippon Koei based on the "Government Regulation on Regional Cooperation (PP No. 28/2018)" and the "Ministry of Home Affairs Regulation on Procedures for Regional Cooperation with Overseas Local Governments and Overseas Organizations (Permendagri No. 25/2020)"

The contents of the LOI were agreed between the two cities at this year's meeting, and the LOI signing ceremony was held as part of the City-to-City collaboration workshop held on February 9, 2023, as described in 3.3.4. Through the signing of the MOU to be signed within one year from the date of the final sign of LOI, the two cities will cooperate in four areas: "Zero Carbon City 2050", "Development of sustainable and environmentally friendly means of transportation", "Development of renewable energy sources", and "Energy optimization".

LOI sign ceremony

Source: Pekanbaru City

Group photo

LETTER OF INTENT
BETWEEN
THE GOVERNMENT OF PEKANBARU CITY,
OF THE REPUBLIC OF INDONESIA
AND
THE GOVERNMENT OF KAWASAKI CITY,
JAPAN
ON
THE ESTABLISHMENT OF CITY-TO-CITY COLLABORATION

The Government of Pekanbaru City of the Republic of Indonesia and the Government of Kawasaki of Japan, hereinafter referred to as the "The Parties";

Desiring to establish friendly relations and to promote mutually beneficial cooperation for both regions;

Recognizing the importance of the principles of equality and mutual benefit;

Pursuant to the prevailing laws, regulations, and administrative procedures of their respective countries;

Do hereby declare their intention to establish a city-to-city collaboration to improve welfare and promote better public services in both regions, in the following areas:

1. Zero Carbon City 2050
2. Development Sustainable and Environmentally Friendly Transportation;
3. Development of Renewable Energy Sources;
4. Optimal use of energy.

The implementation of cooperation on agreed areas will be carried out through the conclusion of Memorandum of Understanding to be agreed and signed by The Parties no later than 1 (one) year after the date of the last signing of this Letter of Intent.

Signed in duplicate in ..... on ..... 2023 and in ..... on ..... 2023, each in Indonesian, Japanese and English languages, all texts being equally authentic. In case of any divergences on the interpretation of this Letter of Intent, the English text shall prevail.

FOR THE GOVERNMENT OF PEKANBARU CITY OF THE REPUBLIC OF INDONESIA

MUFLIHUN
ACTING MAYOR

FOR THE GOVERNMENT OF KAWASAKI CITY OF JAPAN

NORIHIKO FUKUDA
MAYOR

LOI between Kawasaki City and Pekanbaru City

3.3.4. CITY-TO-CITY COLLABORATION WORKSHOP BETWEEN PEKANBARU CITY AND KAWASAKI CITY

The City-to-City cooperation workshop by Pukambaru City and Kawasaki City was held on February 9, 2023. In this workshop, a LOI signing ceremony was held. The theme of this workshop was 2050 Zero Carbon City, and Nippon Koei proposed the project progress in this fiscal year and activities for Zero Carbon City in Pukambaru City. In the meantime, "Kawasaki City global warming countermeasure promotion master plan" was introduced from the Kawasaki City Environment Bureau as a challenge for the realization of decarbonized society in Kawasaki City. IPB presented the progress roadmap of Zero Carbon City in Pukambaru City.

See Appendix 3 for the data of this workshop.

[Summary]

Date: Thursday, February 9, 2023 13: 00 -16: 15 (JST)

Location: Grand Jatra Hotel Pekanbaru (Hybrid with Zoom)

Participants: Pukambaru City (Cooperation Bureau, Environment Bureau, etc.)

Kawasaki City (Office of International Economic Promotion, Bureau of Economic and Labor Affairs, Department of Environment)

IPB

Riau University

PT.PN5

Nippon Koei

Interpreter 1 (Japanese to Indonesian)

Total of 49

Table 3-5 Agenda of City-to-City Collaboration Workshop between Pukambaru City and Kawasaki City

#	Time (WIB)	Program	presenter
1	11:00 -11:05	Attendee Entrance	Pukambaru Protocol
2	11:05 -11:15	Singing of the National Anthem of Indonesia and Japan	Pukambaru Protocol
3	11:15 -11:20	Introduction of the workshop outline	Nippon Koei
4	11:20 -11:25	Opening remarks	Pukambaru City
5	11:25 -11:35	Opening remarks	Kawasaki City
6	11:35 -11:40	LOI signing ceremony	Pukambaru City Kawasaki City
7	11:40 -11:45	Photography	Participants
8	11:45 -12:00	short break	-
9	12:00 -12:20	Progress of City-to-City Cooperation projects Toward 2050 Zero Carbon City	Nippon Koei
10	12:20 -13:10	Lunch	-

11	13:10 -13:30	Efforts to realize a decarbonized society in Kawasaki City Kawasaki City Global Warming Countermeasures Basic Plan	Kawasaki City
12	13:30 -13:45	Progress in developing a road map for Zero Carbon City formation in Pukambaru City	IPB
13	13:45 -14:05	question and answer	-
14	14:05 -14:10	Closing remarks	Kawasaki City
15	14:10 -14:15	Closing remarks	Pukambaru City

Source: Nippon Koei

Source: Website of Pukambaru City

Opening remarks from the acting mayor of Pukambaru City

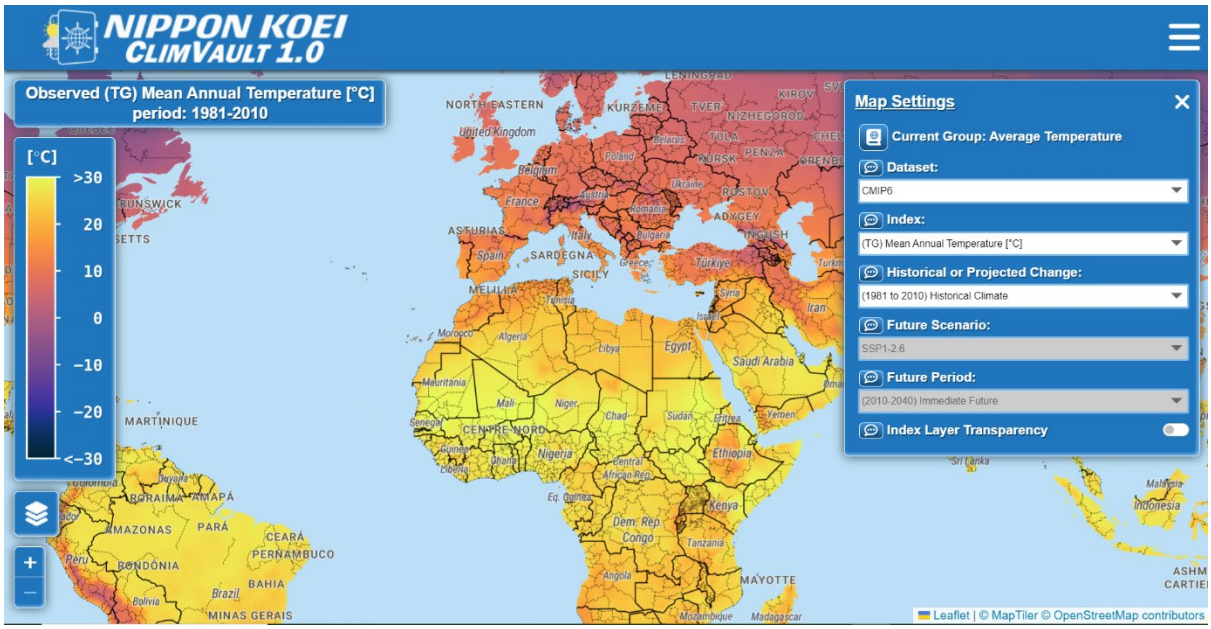
Opening remarks from Mr. Yonemura, Kawasaki City

Discussion in the workshop

Group photo

3.3.5. PROVISION OF CLIMATE CHANGE PREDICTION DATA

Since the fiscal year ending June 30, 2016, Nippon Koei has set "development of technologies to cope with climate change" as one of the key themes of its company-wide technology policy, and is working to develop cutting-edge technologies and new businesses. As a specific activity, the company has developed a correction technology for climate change prediction and released NK-ClimVault, a portal site that allows users to obtain future climate forecast information on rainfall and temperature for major cities free of charge from 2020. This is a tool that anyone can use to obtain highly accurate basic information, which can be used in the climate change adaptation business and in research in various fields.



Source: Prepared by Nippon Koei

Figure 3-1 Example of NK-ClimVault display screen

In developing the 2050 Zero Carbon Roadmap for Pekanbaru City, which is being considered in this project, Nippon Koei provided data to ITB and IPB to enable more effective future projections by utilizing the data collected and organized by JCI and the bias correction method (TR3S) it has developed. (See Attachment 4 in details)
We plan to hold discussions with ITB and IPB based on the data provided and establish appropriate indicators for Pukanbaru City.

CHAPTER 4 JCM PROJECT FORMULATION STUDY

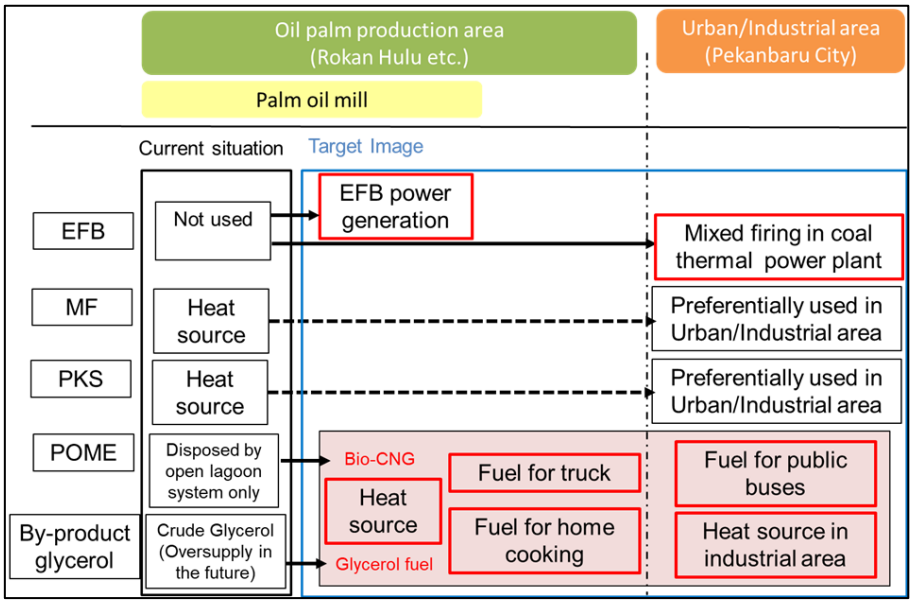
JCM project formulation studies for 1) development of circular economy, and 2) development of 2050 Zero-Carbon City were carried out.

4.1. Studies of JCM projects for development of circular economy

As JCM model projects for development of circular economy in oil palm sector, EFB biomass power plant project (Section 4.1.1) continued from last fiscal year, which utilize EFB as biomass fuel, and POME biogas utilization project (Section 4.1.2), which purifies biogas emitted from POME and produces bio compressed natural gas (bio-CNG), were studied with targeting palm oil mills owned by PT.PN5 continuously from last fiscal year. In addition, a glycerol fuel project (Section 4.1.3) using byproduct glycerol derived from BDF production was conducted targeting companies in Riau Province. Moreover, a new project (4.1.1 (2)) to convert EFB into biomass fuel by pelletizing or half-carbonizing EFB, and a project to utilize palm acid oil utilizing nano-emulsion technology, have also launched.

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. In addition, the pelleting and semi-carbonization of EFB, which was difficult to use in urban areas, solves the problems of transportation and utilization, and the use of EFB together with PKS, MF, POME, and bio-CNG, which are easy to handle, is expected to lead to resource recycling in the entire Riau Province Region.

In addition, to utilize the by-product glycerol, which is predicted to be much more emitted in the future corresponding to the drastic increase of BDF production in Indonesia, as nano-glycerol fuel, which can contribute to circular economy and decarbonization of the region.



Source: Prepared by Nippon Koei

Figure 4-1 Circular economy in oil palm sector in Riau Province Region

4.1.1. EFB UTILIZATION PROJECT

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

As a rollout 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,

had been planned, but due to the impending deadline for the Aceh project to start operation, the company has temporarily put the consideration of this EFB biomass power project in Riau Province on hold in order to focus on the Aceh project.

On the other hand, due to its size and weight, and the fact that it is generated far from urban areas, EFB has not been used as a heat source in urban areas. In this fiscal year, we started to study the EFB biomass fuel conversion project, because pelleting or half-carbonizing EFB can reduce transportation costs and make it possible to use EFB for co-firing at thermal power plants and other facilities located in urban areas. Utilizing the results of the research on the amount of biomass fuel generated and its transportation cost in the Phase 1 project, we actively studied the EFB biomass fuel conversion project, which is expected to be commercialized relatively quickly.

(1) EFB biomass power plant project

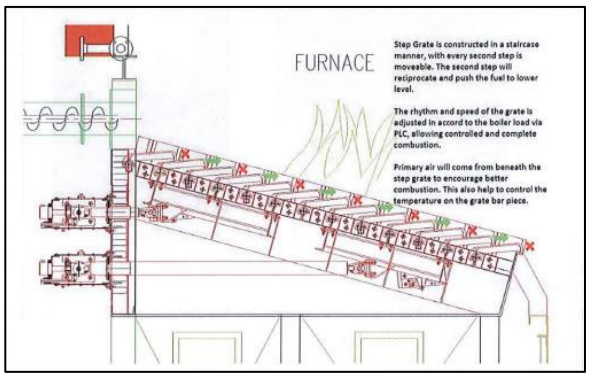
1) Overview of "12MW Biomass Power Plant Project in Aceh Province, Sumatra"

Aura and Gistec have been implementing JCM model project "12MW Biomass Power Plant Project in Aceh Province, Sumatra" adopted in FY2018, and the installation of equipment will be finished by March 2023, then its operation will be started during FY2023. 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 the 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

2) Study progress until FY2021

Study progress until FY2021 is summarized in Table 4-1. Also, GHG emission reduction by the EFB biomass power plant project is shown in Table 4-2. 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.

Table 4-1 Study progress until FY2021 (EFB biomass power plant project)

#	Contents	Overview/results
1	Study on generation amount of biomass fuel	The amount of biomass fuels generated from three palm oil mills in Rokan Hulu Regency (Sei Rokan, Sei Intan, Sei Tapung) was studied. Total amount of EFB from the three mills was 144,829 ton. As a result of consideration of such data and transport cost, project site was decided to be near Sei Intan and power generation capacity was to be 7.5MW.
2	Confirmation of status of electricity access and study on grid connection	By collecting information of power plant in Riau Province and data of recent electricity supply and demand and by interviewing to PLN, grid connection point was selected. It is assumed to connect to the nearest grid from Sei Intan (Approx. 3 km).
3	Consideration of installed technologies and project cost	Potential to install Japanese technologies and technologies of companies based in Kawasaki City was considered. Also, project cost and economic evaluation was carried out.
4	Confirmation of permits	Confirmation of required permits and schedule for obtaining them were implemented.

5	Survey of Biomass Fuel Emissions and Physical Properties	The amount of EFB, EF and PKS discharged from palm oil mill in Riau Province and their physical properties (Water content, calorific value, chemical components, etc.) were investigated. (Table 4-3)
6	Transportation cost survey	The cost of transporting biomass fuel within Riau Province, and from palm oil plants in Riau Province to major ports in Riau was investigated. (Table 4-4)
7	Survey on Biomass Fuel Processing Technology	The problems in the utilization of EFB were summarized, and processing methods and technologies corresponding to them were organized.
8	Supply Chain Validation	The state of RSPO certification acquisition of palm oil mill in Riau Province was confirmed.
9	Consideration of policies for dealing with the environmental impact of biomass power generation	The standard on exhaust gas and fly ash by the biomass power generation were confirmed and the correspondence measures were examined.
10	Review of reporting system for palm oil industrial waste utilization	A review was carried out on the report system on palm oil industrial waste utilization established in Aceh Province.

Source: Prepared by Nippon Koei

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 (Sumatra)
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
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

Table 4-3 Result of biomass fuel analysis of palm oil residues

Parameter	Unit	EFB	Fibre	Shell 1	Shell 2	Methods
Total Moisture	%, ar	48.80	31.30	14.10	15.60	ASTM D.3302-10
Proximate Analysis						
Moisture in Analysis	%, adb	7.20	9.50	9.80	14.30	ASTM D.3173-08
Ash Content	%, adb	5.60	5.10	2.50	2.60	ASTM D.3174-04
Volatile Matter	%, adb	71.90	68.20	69.80	66.70	ISO 562-2010
Fixed Carbon	%, adb	15.30	17.20	17.90	16.40	ASTM D.3172-07
Total Sulphure	%, adb	0.27	0.22	0.08	0.02	ASTM D.4239-10
Gross Calorific Value	kcal/kg, adb	4,822.00	4,485.00	4,728.00	4,322.00	ASTM D.5865-10
Gross Calorific Value	**kcal/kg, ar**	**2,660.00**	**3,405.00**	**4,503.00**	**4,256.00**	ASTM D.5865-10
Ultimate Analysis						
Carbon (C)	%	53.75	52.36	53.15	50.13	ASTM D.3178-02
Nitrogen (N)	%	0.63	0.40	0.35	0.32	ASTM D.3179-02
Hydrogen (H)	%	7.95	6.34	6.71	6.43	ASTM D.3178-02
Oxygen (O)	%	31.80	35.58	37.21	40.50	ASTM D.3176-02
Chemical Analysis of Ash						
Silicone Dioxide (SiO2)	%	40.28	60.89	74.69	74.60	ASTM D.6349-09
Aluminium Trioxide (Al2O3)	%	2.14	1.11	1.12	6.34	ASTM D.6349-09
Iron Trioxide (Fe2O3)	%	3.59	2.02	0.93	2.32	ASTM D.6349-09
Titanium Dioxide (TiO2)	%	0.10	0.07	0.06	0.32	ASTM D.6349-09
Calcium Oxide (CaO)	%	6.01	6.72	2.24	1.20	ASTM D.6349-09
Magnesium Oxide (MgO)	%	6.93	5.37	4.13	1.81	ASTM D.6349-09
Pottasium Oxide (K2O)	%	29.33	10.39	9.68	5.06	ASTM D.6349-09
Sodium Oxide (Na2O)	%	2.11	0.92	0.30	0.22	ASTM D.6349-09
Phosphorus Pentaoxide (P2O5)	%	3.30	4.56	4.98	2.24	ASTM D.6349-09
Sulphur Trioxide (SO3)	%	5.55	7.55	1.58	5.30	ASTM D.1757-03
Manganese Dioxide (MnO2)	%	0.21	0.12	0.12	0.13	ASTM D.6349-09
Chlorine (Cl)	%	0.27	0.18	0.10	0.02	ASTM D.3682-01

ar = sample as received

adb = sample as determined base

Source: PT.Gistec Prima Energindo

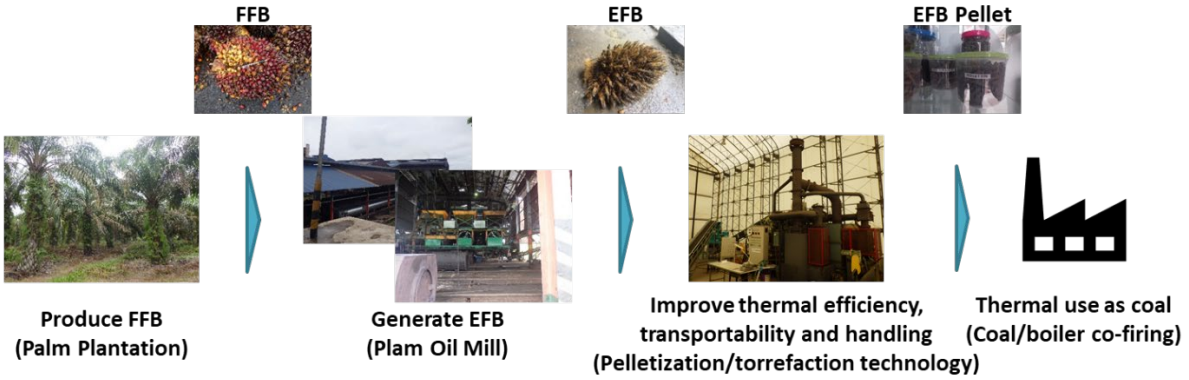
Table 4-4 Transport costs of biomass fuels from mills to main ports in Riau Province

No.	Name of POM	Dumai	Tanjung Buton Siak	Teluk Bayur
		Distance/Cost	Distance/Cost	Distance/Cost
1	PT. Rohul Sawit Industri			
2	PT. Padasa Utama 6 (1)			
3	PT. Padasa Utama 6 (2)			
4	PT. Padasa Utama 6 (3)			
5	PTPN V Sei Garo			
6	PTPN V Sei Galuh			
7	PTPN V Sei Rokan			
8	PTPN V Lubuk Dalam			
9	PTPN V Sei Pagar			
10	PTPN V Sei Tapung			
11	PTPN V Air Molek			
12	PTPN V Sei Buatan			
13	PT. Permata Berlian Indah			
14	PT. Guna Setia Pratama Pasir Putih			
15	PT. Bina Sawit Nusantara			
16	PT. Sawit Mas Nusantara Langga			
17	PT. INECDA			
18	PT. Nikmat Halona Reksa			
19	PT. Jalur Pusaka Sakti Kumala			
20	PT. Peputra Supra Jaya			

Source: PT.Gistec Prima Energindo

(2) EFB biomass fuel conversion project

As part of the EFB fuel conversion project, we have studied technologies to convert EFB into fuel that can be used in urban areas by improving the calorific value, transportation efficiency, and ease of handling of EFB through the EFB pelletizing and half-carbonization technologies possessed by Japanese companies. This technology will enable energy use over a wide area and contribute to GHG reduction.



Source: Prepared by Nippon Koei

Figure 4-4 Overall Process of EFB Fuel Conversion Project

This year, we selected a palm oil mill, conducted a comparative study of pelletizing and half-carbonization technologies, collected information on biomass materials and fuel (pellets) selling prices, and estimated GHG reductions.

Table 4-5 Summary of this year's survey (EFB biomass fuel conversion project)

#	Contents	Overview/Results
1	Selection of target palm oil mills	The research was conducted at two oil mills, Sei Galuh and KOTA GARO, located in Riau Province, to collect information on FFB generation, sales price, and status of RSPO acquisition. (Table 4 6)
2	Information gathering and comparative study of EFB fuel conversion equipment manufacturers	Through meetings with four Japanese companies that have EFB fuel conversion technology and plant inspection (one company), collected information on fuel conversion technology and estimated production costs. (Table 4 7)
3	Collection of information on biomass fuels in Indonesia	Information on biomass fuels in Indonesia was shared through meetings with EFB fuel suppliers and a company responsible for the EPC of an EFB fuel plant.
4	Estimate GHG reduction	Estimated GHG emission reductions based on the assumption that EFB fuel is co-fired with coal.

Source: Prepared by Nippon Koei

1) Selection of target palm oil mills

As candidates for the target palm oil mills, two mills were researched Sei Galuh, a palm oil mill owned by PT. PN5, and KOTA GARO, a palm oil mill used to be owned by PT. Kampar Tunggal Agrindo, a private company that deals with palm oil. Since KOTA GARO generates less amount of EFB and have not obtained an RSPO, it was decided that Sei Galuh would be the subject of future surveys.

Table 4-6 Results of information collection for palm oil mills

Items	Sei Galuh	KOTA GARO
Amount of FFB processing capacity	243,000 (ton/year) (planned value) 45 (ton/h) (planned value) 174,862(ton/year) (FY2022) ※Currently, processing volume is about 2/3 due to equipment repair	164,000 (ton/year) 22.7 (ton/h) ※Estimated from the amount of CPO
Amount of generated EFB	48,600 (ton/year) (5400h: FY2022) 9 (ton/h)	32,775 (ton/year) 4.55 (ton/h) ※Estimated from the amount of CPO
EFB shape	As it is →Incinerated and sold as fertilizer	1.As it is 2.Cut & compressed(like fiber) (1 inch=2.54 cm) (moisture rate≒40%)
EFB cost	10 IDR/kg →No demand and almost no price	1. 12 IDR/kg 2. 80 IDR/kg
Implementation	1.BOT (Building Operation Transfer) →transfer the facility in 10 years 2.JO (Joint Operation) →investment ×financial, ○land, ○human resources, ○material support	Supplier Business owner
RSPO	Acquired	In progress (may take time)

Source: Prepared by Nippon Koei

As for PT. PN5's involvement in this project, two methods are proposed. One is the Building Operation Transer (BOT) method and the other is the Joint Operation (JO) method. Under the

BOT method, it was proposed that the factory and facilities be transferred to PT.PN5 after 10 years of operation. Under the JO method, they can't invest financially, but will provide land, human resources and raw materials.
The EFB sales price is 10 IDR/kg, and at this point in time there is virtually no demand and no value attached. Currently, a portion of the EFB is burned at Sei Galuh and the ashes are shipped as fertilizer in order to make better use of the surplus resources. It has been confirmed that it is feasible to use the entire EFB as EFB fuel.
PN5 is in the transition phase of its group structure, so it is necessary to pay attention to future trends and maintain close contact with the company. In addition, it is necessary to hold discussions on land lease and to gather information on the construction of the EFB fuel plant.

Sei Galuh office(PT.PN5)

FFB collection area（Sei Galuh）

FFB Fuel Conversion Plant Candidate Site（Sei Galuh）

Palm Oil Mill（KOTA GARO）

2) Information gathering and comparative study of EFB fuel conversion equipment manufacturers

Through meetings with four Japanese companies that have EFB fuel conversion technologies, information on EFB fuel conversion technologies was collected and a comparison of each technology was conducted. Two EFB fuel conversion technologies were identified. One is a pelletizing technology that makes it easier to handle EFB as biomass fuel. The other is a half-carbonization technology that improves crushability and calorific value by carbonizing the pelletized EFB.

Table 4-7 EFB fuel conversion technologies gathered from four Japanese companies

company	A	B	C	D
Technology	Black pellet Half-carbonization	Black pellet Half-carbonization	White pellet pelletization	White pellet pelletization
Co-firing rate				
Calorific value(kcal/kg)				
Na, K, Cl Reduction technology	×	◎ Patented tech	○	○
Business achievement	△	△	○	○
Cost	△	◎	○	○
Crushability	-	◎	△	-
Water resistant	-	◎	△	△

Source: Prepared by Nippon Koei

Pelletizing technology is relatively inexpensive to produce because the process is less than half-carbonization, and demand is already anticipated in Indonesia as an alternative to fossil fuels. On the other hand, low crushability is an issue because EFB fibers remain during mixing and firing.
Half-carbonization technology increases the carbon content by thermal decomposition in an oxygen-deprived environment, resulting in a higher calorific value compared to wood pellets. Half-carbonization improves crushability, water resistance, spontaneous combustion resistance, and biodegradability, enabling high co-firing rates, improved stability for outdoor storage, improved storage safety, and long-term storage. On the other hand, the issue is that the process is more complicated and the production cost is higher than with pelletizing technology.
A common issue is to reduce the concentration of chlorine, potassium, etc. in order to use EFB as a fuel. Hydrochloric acid gas (Cl2) and hydrogen chloride gas (HCl) are known to cause severe corrosion of steel. The higher potassium (K) content also increases the potential for fouling and slagging ash adhesion and deposition disturbances in coal-fired pulverized coal boiler co-firing. Therefore, these reduction techniques are needed.
In selecting EFB fuel conversion technologies, it is necessary to take into account the quality standards of fuel acceptable to off-takers and the unit price.

3) Collection of information on biomass fuels in Indonesia

Information on biomass fuels in Indonesia is shared through meetings with suppliers of produced EFB fuels and EPC companies of EFB fuel conversion plants. The following table shows the collected information.

Table 4-8 Collected information about biomass fuels in Indonesia

#	Contents	Overview
1	Carbonization equipment operation in Indonesia	[redacted]
2	Land area required for facilities to convert to EFB fuel	
3	Possibility of supplying EFB fuel to PLN	
4	Biomass fuel prices	
5	Ideal production volume	

Source: Prepared by Nippon Koei

4) Estimate GHG reduction

Based on the information available at this time, the GHG reductions that would result from the co-firing of EFB fuels with coal are estimated.

Table 4-9 Estimated GHG reductions from EFB fuel conversion

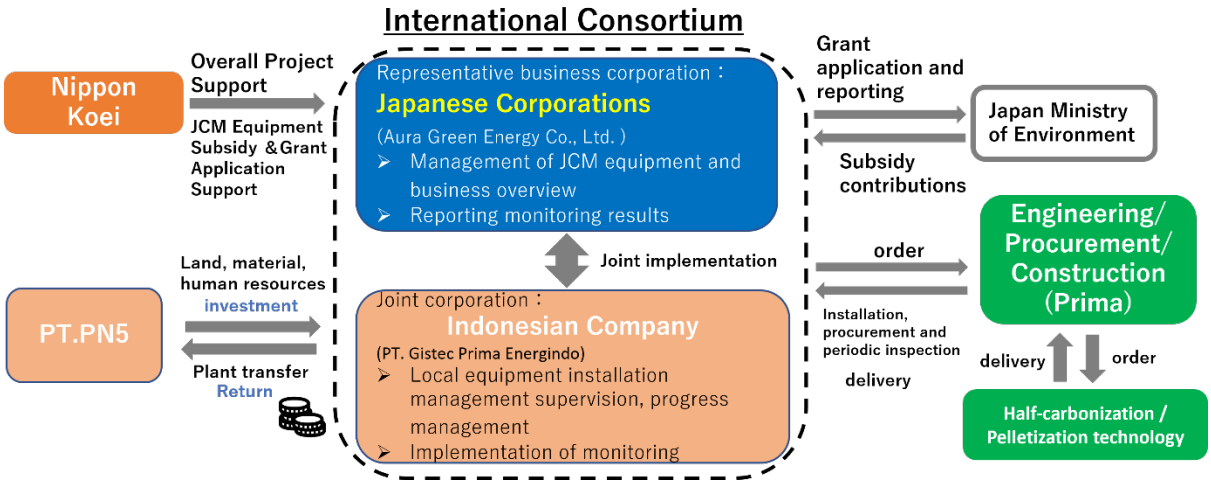
#	Item	Figure	Unit	Remarks
a	FFB amount	45	ton/h	Design throughput (some machines are currently out of order but will be repaired in the future)
b	The amount of generated EFB	9	ton/h	Approximately 21% of the FFB volume is EFB
c	EFB fuel production	1.4	ton/h	Mass loss due to drying of water content in EFB
d	Annual operating time	5,400	h/year	Actual results
e	Annual EFB fuel production	7,560	ton/year	=c x d
f	EFB Fuel Unit Calorific Value	4,000	kcal/kg	Assumed amount
g	EFB Fuel Unit Calorific Value	16.7	GJ/ton	1 kcal=4.184kJ
h	General coal unit calorific value	26.08	GJ/ton	Source: Agency for Natural Resources and Energy List of Standard Calorific Value and Carbon Emission Coefficient by Energy Source
i	CO2 emissions per unit of general coal	2.409	kg-CO2/kg	
j	Fuel switch potential	64.2	%	=g / h x 100
k	GHG reduction potential	11,687	t-CO2eq/year	=e x i x j

Source: Prepared by Nippon Koei

5) Consideration of implementation system

The business scheme currently contemplated is shown below. Aura is assumed as the Japanese company, Gistec as the Indonesian company, PT. PN5 as the EFB supplier and land lessee, and Prima as the EPC for the EFB fuel. Based on the results of the comparative study of EFB fuel

conversion technologies conducted this year, an approach to EFB fuel off-takers should be implemented and a project implementation system should be established in the future.



Source: Prepared by Nippon Koei

Figure 4-5 Proposed Implementation Structure for EFB Fuel Conversion Project

4.1.2. POME BIOGAS UTILIZATION PROJECT

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

In FY2022, selection of target palm oil mills, information gathering of target palm oil mill, initial design of biogas purification plant, fuel conversion potential when bio-CNG gas is used as fuel for buses owned by Trans Metro Pekanbaru, which operates the city buses in Pekanbaru, information sharing with DISHUB was caried out.

Source: Prepared by Nippon Koei

Figure 4-6 Overall image of project for POME biogas utilization

In East Kalimantan Province, similar bio-CNG purification plant was constructed and started operation in 2020 and biogas separation membrane of Polyplastics-Evonik, SEPURAN® Green was installed to the plant.

Source: Polyplastics-Evonik

Figure 4-7 SEPURAN® Green

Source: PT.Gikoko Kogyo Indonesia

Figure 4-8 SEPURAN® Green installed in East Kalimantan Project

Study progress until FY2021 is summarised in Table 4-10.

Table 4-10 Study progress until FY2021 (POME biogas utilization project)

#	Study contents	Overview
1	Selection of study target palm oil mills	Considering information of palm oil mills owned by PT.PN5 collected by local consultant, target mills were decided. In consideration of FFB processing amount and transport of bio-CNG, two mills the nearest from Pekanbaru City, Sei Galuh Mill (Approx. 30 km away, FFB processing capacity 60ton/h), and Sei Buatan (Approx. 80 km away, FFB processing capacity 60 ton/h) were decided to be study target.
2	Consideration on Biogas generation potential and fuel switch potential	Considering components of POME emitted from Sei Buatan Mill and Sei Galuh Mill, potentials of biogas generation were estimated. Also, from the estimation of the potentials and data of public buses in Pekanabru City, preliminary calculation of fuel switch potential of the buses (diesel to bio-CNG) was carried out. In case of Sei Buatan mill, 58.8 % of annual diesel consumption of public buses can be switched to bio-CNG and in case of Sei Galuh, 38.2%.
3	Consideration on Preliminary design of bio-CNG purification plant	Based on the data and calculation results from #1, #2, preliminary design of bio-CNG plant was implemented.
4	Information collection of companies capable of retrofitting buses for fuel switch	Information collection of companies capable of retrofitting from diesel to CNG buses for fuel switch was carried out by cooperation with PT. Gikoko Kogyo Indonesia.
5	Information collection of POME biogas utilization project in East Kalimantan Province	Information collection of POME biogas utilization project operated in East Kalimantan Province and installing biogas separation membrane of Polyplastics-Evonik was carried out by cooperation with PT. Gikoko Kogyo Indonesia.
	Bio-CNG plant design	Bio-CNG plant design for a palm oil mill (Sei Buatan mill) owned by PT. PN5.
	Rough CAPEX, OPEX estimate	Roughly calculated CAPEX and OPEX for the bio-CNG plant using the information obtained in #6.
	Examination of fuel conversion potential and GHG reductions	Fuel conversion potential and GHG reductions for buses in Pekanbaru were studied.

Source: Prepared by Nippon Koei

Based on the study until FY2021, the studies below were carried out in FY2022.

Table 4-11 Summary of this year's survey (POME Biogas Utilization Project)

#	項目	概要
1	Selection of target palm oil mills	Conducted site visits to two oil mills in Riau Province, Sei Galuh and KOTA GARO, to collect information on POME generation, sales price, and status of RSPO acquisition. Sei Galuh was chosen as a future study target due to its distance from Pekanbaru city, the amount of generated POME, and status of RSPO acquisition.
2	Information gathering of target palm oil mill	Various information necessary for the construction of a bio-CNG plant was collected at the Sei Galuh (PT.PN5).
3	Initial design of biogas purification plant	Bio-CNG plant design for a palm oil mill (Sei Galuh mill) owned by PT. PN5.
4	Rough CAPEX, OPEX estimate	Roughly calculated CAPEX and OPEX for the bio-CNG plant using #3 information.
5	Examination of fuel conversion potential and GHG reductions	Calculated fuel conversion potential and GHG reductions for buses in Pekanbaru.
6	Information sharing with DISHUB	Shared information with DISHUB, which is considering bio-CNG user, on the status and future policies.

Source: Prepared by Nippon Koei

(3) Selection of target palm oil mills

As candidates for the target palm oil mills, two mills were researched Sei Galuh, a palm oil mill owned by PT. PN5, and KOTA GARO, a palm oil mill used to be owned by PT. Kampar Tunggal Agrindo, a private company that deals with palm oil.
KOTA GARO has already been selling and using POME effluent with high oil content and wished to participate in this project as a PAO supplier.
Considering the distance from Pekanbaru city, the amount of POME generated, and the status of RSPO acquisition, it was decided that Sei Galuh would be the target of future surveys.

Source: Prepared by Nippon Koei using Google maps image

Figure 4-9 Location of palm oil mills

Table 4-12 Results of information collection for palm oil mills

Contents	Sei Galuh	KOTA GARO
Distance form Pekanbaru city	Approximately 30 ㎞	Approximately 80 ㎞
FFB processing capacity	243,000 ton/year (design value) 174,862 ton/year (Actual results for 2022)	142,500 ton/year
Biogas generation potential	8,952,007（Nm^3/year） (Calculated based on design value) 6,441,835（Nm^3/year）(Calculated based on actual results for 2022)	unknown： POME effluent is sold as PAO due to its high oil content.
Implementation	Desire BOT.	Desire PAO supplier
RSPO	Acquired	In progress(may take time)

Source: Prepared by Nippon Koei

(4) Information gathering of target palm oil mill (Sei Galuh)

Various information necessary for the construction of a bio-CNG plant was collected at the target palm oil mill, Sei Galuh. The collected information is summarized below.

Table 4-13 Information about Sei Galuh

Contents		Sei Galuh
Materials	FFB processing capacity	243,000 ton/year (design value) 174,862 ton/year (Actual results for 2022)
	Biogas generation potential	8,952,007（Nm^3/year）(Calculated based on design value) 6,441,835（Nm^3/year）(Calculated based on actual results for 2022)
Water	Water source location	There is a Dam with a capacity of about 6,500 m3 near the mill. The mill uses 15,000 ton/month. There is no drought experience, even in the dry season.
	Water treatment	Water treatment using aluminum-based coagulant (aluminum sulfate) and anhydrous sodium carbonate for industrial use
	Discharge standards for POME treatment solutions	BOD: 5,000 ppm or less
Electricity	Power supply position	Sub-station to be built near the oil mill
	Electric power	1,700kW（plan）
	Voltage	220V（plan）
Ground	Ground date	No information available PT.PN5 permit required to conduct drilling survey

Source: Prepared by Nippon Koei

Source: Prepared by Nippon Koei

Figure 4-10 Location of palm oil mill Sei Galuh (PT.PN5)

(5) Initial design of biogas purification plant

Design of bio-CNG plant targeting a palm oil mill owned by PT.PN5 (Sei Galuh Mill) was carried out. By using two-stage membrane separation, it was confirmed that methane gas with a CH4 concentration of 95% could be obtained at a rate of 103 Nm3/h.

1) Preconditions

Conditions of raw material gas and purified gas are shown in Table 4-14 and Table 4-15 respectively. Conditions of raw material gas was set based on the chemical composition data of POME biogas from Terantam Mill while purified gas was decided in accordance with standard of CNG in Indonesia. For the feedstock biogas, it was assumed to have the same composition as the Sei Galuh plant. Biogas generation was assumed to be 174 Nm3/h based on the results of surveys conducted up to last year. Regarding the treatment of CO and H2 in refined biogas, we confirmed that there is no description in the CNG standard for the transportation sector in Indonesia, so it was decided not to remove them.

This consideration was carried out under the concept to unitize the plant in Japan and to install it outside Sei Galuh Mill.

Table 4-14 Condition of raw material gas

Contents	Conditions
Flow rate (Nm3/h)	174
Pressure (MPaG)	0.001
Temperature (degree C)	32
Composition	Methane (CH4) :60.00% Carbon dioxide (CO2) :34.72% Nitrogen (N2) :1.10% Hydrogen (H2) :1.00% Carbon monoxide (CO) :0.62% Hydrogen sulfide (H2S) :0.16% Water (H2O) :2.40%

Source: Prepared by Air Water

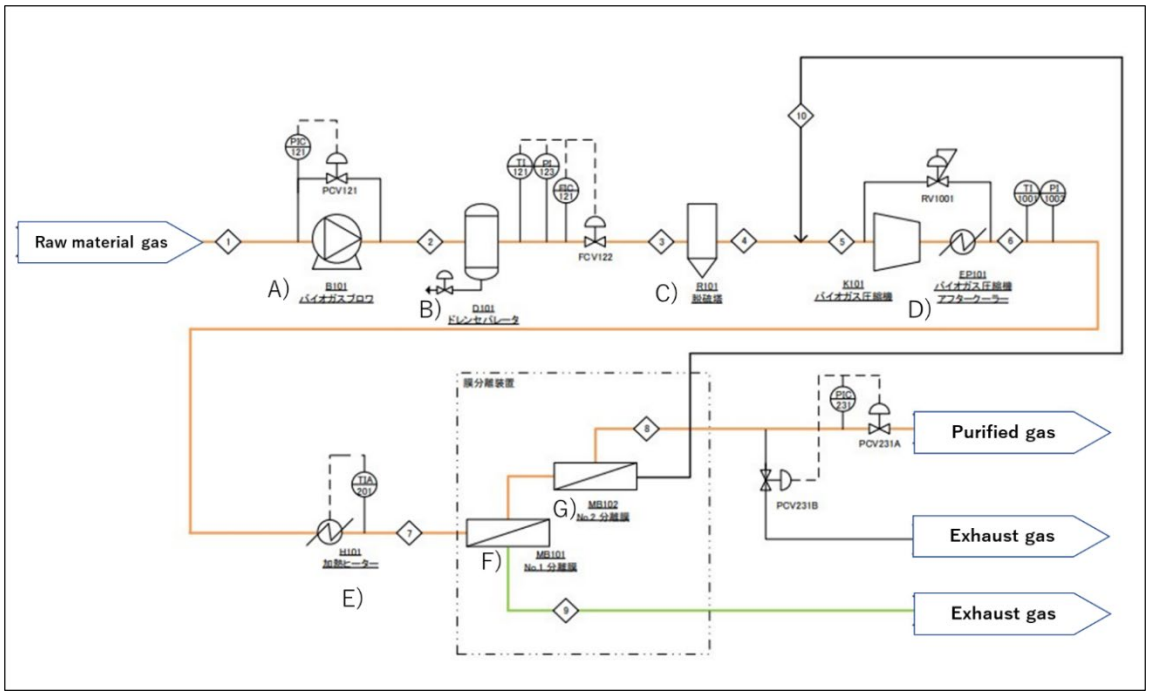
Table 4-15 Condition of purified gas

Contents	Conditions
Composition	Methane (CH4) : over 89.00% Carbon dioxide (CO2) : less than 5.00% Nitrogen (N2) : less than 3.00% Hydrogen sulfide (H2S) : less than 0.63% Water (H2O) : less than 3.00%

Source: Prepared by Air Water

2) Process flow

The results of consideration on process flow under the preconditions above are described in Figure 4-11 and Table 4-16. Also, each process flow is explained in Table 4-17.The flow is the same as in the previous year's study, but the material balance values were updated due to changes in flow rates.



Source: Prepared by Air Water

Figure 4-11 Process flow diagram

Table 4-16 Material balance

Number*		1	2	3	4	5	6	7	8	9	10
Flow	Nm3/h	174	174	174	173.7	209.8	205.9	205.9	102.6	67.2	36.1
Pressure	MPaG	0.001	0.03	0.027	0.026	0.026	0.792	0.784	0.73	0.028	0.03
Temp.	℃	32.3	32.3	31.9	31.9	29.8	10	30	25.7	28.6	25.7
Composition (%)	CH4	60.00	60.00	60.00	60.10	57.91	57.91	59.01	95.42	9.64	47.37
	CO2	34.72	34.72	34.72	34.78	37.26	37.26	37.96	1.93	86.95	49.2
	N2	1.1	1.1	1.1	1.1	1.13	1.13	1.15	1.66	0.32	1.25
	H2S	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CO	0.62	0.62	0.62	0.62	0.64	0.64	0.65	0.93	0.18	0.7
	H2O	2.40	2.40	2.40	2.40	2.00	2.00	0.14	0.00	0.41	0.05
	H2	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.05	1.40	2.50

*Liquid numbers correspond to process flow numbers
Source: Prepared by Air Water

Table 4-17 Explanation of each flow

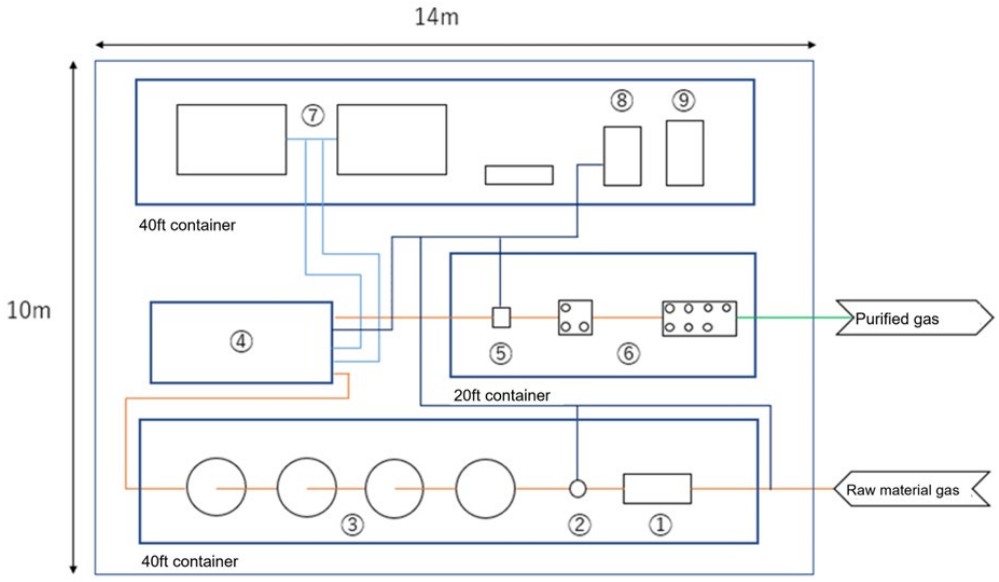
Flow	**Overview**
Blower	The pressure of raw material biogas is raised from 0.001 MPaG to 0.03 MpaG. By raising the pressure, the gas is transported to next stage.
Drain separator	Droplet in the biogas is removed.
Desulfurization equipment	H2S in raw material biogas is removed by iron-based catalyst. The desulfurization equipment was designed so that H2S becomes less than 1 ppm at the outlet. If raw material gas includes H2S, compressor and membrane are easily damaged. Thus, Desulfurization tower was set before them.
Compressor	The pressure of raw material biogas is raised to about 0.8 MPa. Although high-

	pressure gas safety law in Japan was taken into account and the pressure was set to be 0.8 MPa in this designing, it is necessary to confirm Indonesian law. After chilling the compressed biogas to 10 degree C by chilling water, condensed water is removed because if water is condensed in membranes, function of membrane deteriorates.
Heater	Biogas chilled on the previous stage is heated from 10 degree C to 30 degree C to improve function of membrane.
Stage 1 membrane module	To aim at 95% of CH4 concentration in purified gas, membrane process has two stages. Stage 1 has three membranes. CH4 does not permeate while CO2 permeates the membrane wall to outside the system. Stage 1 is rough purification and as a result of simulation, approx. 87 % of permeated gas is CO2 and Approx. 9.6% is CH4.
Stage 2 membrane module	Second stage has 7 membranes. Since CH4 concentration of permeated gas is approx. 60%, it is recycled to before compressor. By doing this, collection rate of CH4 can improve. Purified gas is collected in non-permeated side and as a result of simulation, gas flow is 103 Nm3/h, concentration of CH4 is 95.4%, CO2 is 1.9% and N2 is 1.7%.

Source: Prepared by Air Water

3) Layout

Layout of the bio-CNG plant is illustrated in Figure 4-12. Size of each equipment is shown in Table 4-18. Since it is assumed that the plant is installed outside, the design is basically done to be stored in 40 ft containers. As a result of consideration, main equipment other than compressor are placed in two 40 ft containers and one 20 ft high cube container while compressor is set outside individually. Required area is 14m x 10m. Container of chiller, N2 PSA and power control panel is non-explosion-proof while containers of others are explosion-proof.



Source: Prepared by Air Water

Figure 4-12 Layout

Table 4-18 List of equipment

#	Name	Size [mm]	Spec	Capacity [kW]	Num
(1)	Blower	(W) 574 ×(L) 1,332×(H) 756	Explosion-proof	7.5 (per equipment)	2
(2)	Drain separate	(Diameter) 268/ (Length) 1,440	-	-	1
(3)	Desulfurization tower	(Diameter) 1,100 / (Length) 1,639	-	-	4
(4)	Compressor (Wing type)	(W) 1,600 × (L) 3,800 × (H) 2,330	Explosion-proof	37	1
(5)	Heater	(W) 395 × (L) 345 × (H) 1,430	Non-explosion-proof	1.9	1
(6)	Membrane	(Diameter) 184 / (Length) 1,450	-	-	10
(7)	Chiller	(W) 2,190 × (L) 1,340 × (H) 2,150	Non-explosion-proof	74.4 (per equipment)	2
(8)	N2 PSA	(W) 1,200×(L) 750 × (H) 1,800	Non-explosion-proof	-	1
(9)	Compressor	(W) 1,320 × (L) 700 × (H) 1,200	Non-explosion-proof	11	1

Source: Prepared by Air Water

(6) Rough calculation of CAPEX and OPEX

1) Rough calculation of CAPEX

The result of CAPEX calculation of the bio-CNG plant is shown in Table 4-19. Main equipment includes blower, compressor, heater, chillers, membranes and N2 PSA (for instrumentation /purge) and catalyst for desulfurization towers. Foundation work excludes piling cost because data of soil is insufficient.

Table 4-19 Rough calculation of CAPEX

#	Contents	Price [1,000 JPY]
1	Main equipment	XXXXX
2	Valves and meters	XXXXX
3	Production cost	XXXXX
4	Power control panel	XXXXX
5	Design cost	XXXXX
6	Transport cost	XXXXX
7	Installation cost	XXXXX
8	Foundation work	XXXXX
9	Contingency	XXXXX
Total		279,100

Source: Prepared by Air Water

2) Rough calculation of OPEX

The result of CAPEX calculation of the bio-CNG plant is shown in Table 4-20. Required amount of utility was calculated based on the data in Indonesia in 2017. Regarding chilling water, it was found that rainwater-derived dam water used in oil mills could be used. But may

bear some of the costs related to water treatment, which will need to be coordinated with the mills (Sei Galuh PT.PN5) in the future. Since the amount of water that can be supplied from the dam is limited, it is necessary to circulate and cool the water within the plant, and it will be necessary to consider installing a cooling tower on site in the future.

It is necessary to develop local maintenance structure. Maintenance cost of main equipment is reference value calculated by assuming implementation in Japan although maintenance of equipment other than compressor and heater can be carried out in Indonesia.

Table 4-20 Rough calculation of OPEX

Contents		Consumption	Price [1,000 JPY/year]
Utility	Chilling water	30 m3/h	XXXXX
	Electricity	150 kW	XXXXX
Maintenance	Main equipment	---	XXXXX
	Filler of desulfurization tower	---	XXXXX
	Others	---	XXXXX
Total			XXXXXX

Source: Prepared by Air Water

(7) Fuel switch potential and GHG emission reduction

Fuel switch potential of buses in Pekanbaru City by utilization of bio-CNG was re-calculated based on the consideration result above. Annual diesel consumption of buses was estimated based on actual amount in January 2020, before COVD-19 pandemic.

Table 4-21 Fuel switch potential and GHG emission reduction

#	Item	Figure	Unit	Remarks
a	Production Capacity of bio CNG	102.6	Nm3/h	Simulation result
b	Operation hour	8,700	h/year	Assumption
c	Annual production of bio CNG	892,620	Nm3/year	=a x b
d	Annual production of bio CNG	596.3	ton	
e	Net calorific value of bio-CNG	45	TJ/ton	Assumption
f	Annual production of bio CNG	26,832	TJ/year	=d x e
g	Annual diesel consumption by buses	1,942,594	L/year	Dept. Transport of Pekanbaru City
h	Density	835	kg/L	
i	Net calorific value of diesel	41.4	TJ/Gg	IPCC2006
j	Annual diesel consumption by buses	67,154	TJ/year	=g x h x i /10^6
k	Fuel switch potential	40	%	= f / j x 100
l	Annual reduction of diesel	776,181	L/year	= g x k/100
m	Emission Factor	2.58	tCO2/TJ	IPCC2006
n	GHG reduction potential	2,003	tCO2/year	= l x m

Source: Prepared by Nippon Koei

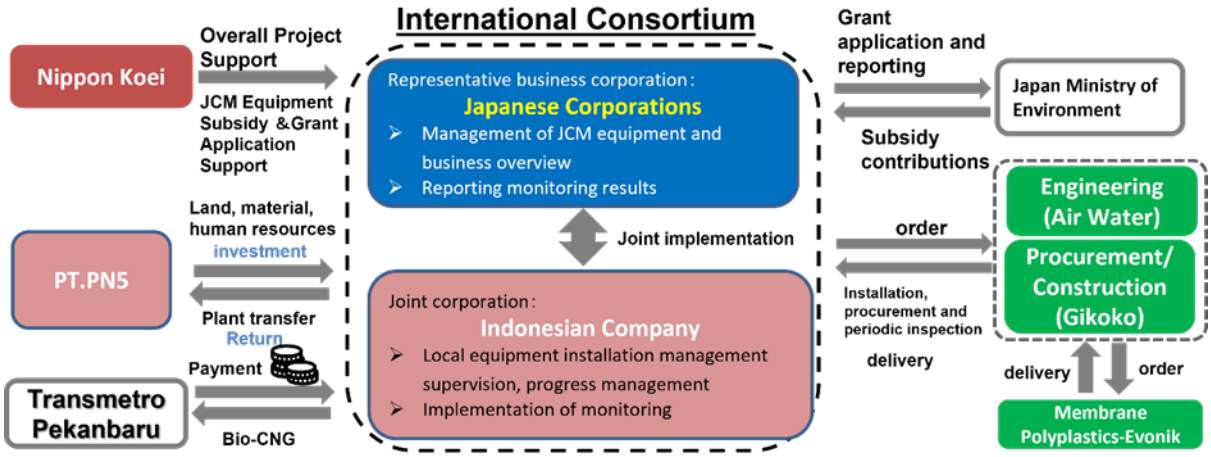
(8) Examination of fuel conversion potential and GHG reductions

DISHUB has set a goal of zero emissions in the near future, and both EV and CNG gas buses are under consideration for the bus project. On the other hand, OPEX costs amount to more

than 300 million yen per year, with fuel costs accounting for the largest portion at more than 100 million yen. DISHUB confirmed that it is open to introducing Bio-CNG buses because Bio-CNG is less expensive and environmentally friendly.
There are currently 15 bus routes in Pukanbaru with 90 buses in operation (owned: 115). Future discussions should be held on the policy of converting buses to CNG gas and the location of gas stations.

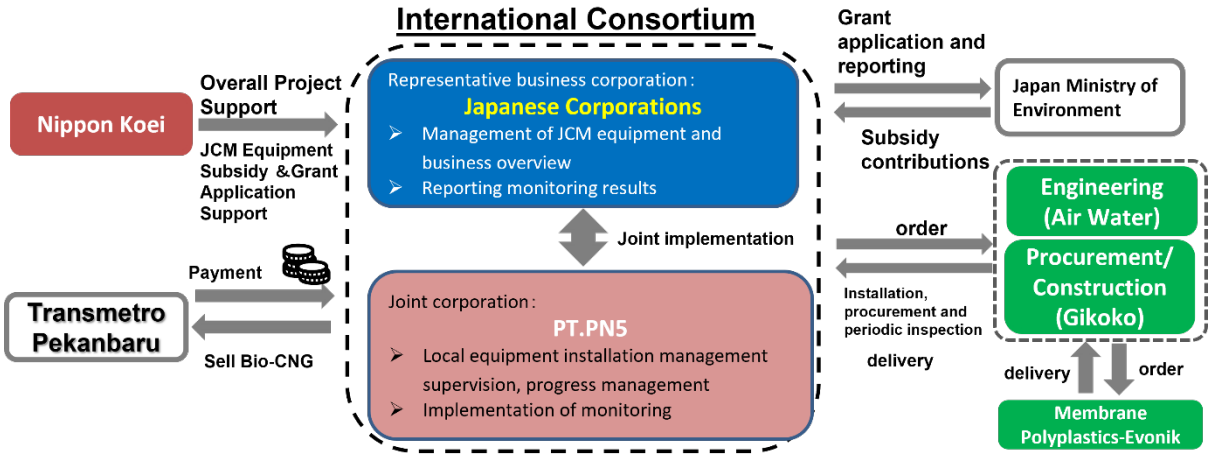
(9) Information sharing with DISHUB

The business scheme currently contemplated is shown below. PT. PN5 is assumed to be the POME supplier and land lessee, Air Water to design the bio-CNG refinery plant, Gikoko to procure and construct the plant, and Polyplastic-Evonik to provide membrane technology. A rough estimate of the project cost was conducted based on research conducted this year. From the next fiscal year onward, it will be necessary to calculate detailed costs and study the details of the project for supplying bio-CNG to Pekanbaru City after refining bio-gas, as well as to approach potential representative companies and establish a project implementation system in the future.



Source: Prepared by Nippon Koei

Figure 4-13 Proposed Implementation Structure for POME biogas utilization Project (1)



Source: Prepared by Nippon Koei

Figure 4-14 Proposed Implementation Structure for POME biogas utilization Project (2)

4.1.3. BDF GLYCEROL FUEL PROJECT AND PAO UTILIZATION PROJECT

In addition to the development of nano-glycerol fuel produced by mixing by-product glycerol with diesel with nano-emulsion technology of Nanofuel (based in Kawasaki City and GIC member) and formulation of BDF nano-glycerol fuel project with Kowa, this year we also studied the development of a new biomass liquid fuel that utilizes PAO generated during the palm oil refining process and makes use of proprietary nano technology.

(1) Nano-Emulsion Fuel System "NEFS"

Nano-Emulsion Fuel System "NFES" of Nanofuel is a system to produce nano-emulsion fuel by adding water to liquid fuel by original nano technology. By making diesel and heavy oil nano-emulsion, combustibility and fuel efficiency can be improved, which leads to CO2 emission reduction.
This equipment awarded grand prize of "Low CO2 Kawasaki Brand" which Kawasaki City certifies products and technologies to reduce CO2 in whole lifecycle from material procurement to disposal/recycling in comparison with ordinary ones.

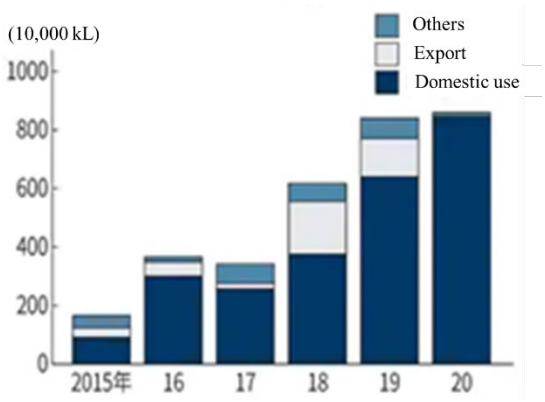
Source: Nanofuel

Figure 4-15 Nano-emulsion fuel system "NEFS"

(2) BDF GLYCEROL FUEL PROJECT

1) Background

In Indonesia, since National Energy Policy was published as President Law No.5 in 2006, conversion from fossil fuel to bio-fuel generated from palm oil has been proceeding. BDF is mainly produced by mixing fatty acid methyl ester (FAME) with diesel. Corresponding to the increase of BDF production and mixture rate of FAME, production of FAME has also been increasing drastically. In addition, as national oil company, Pertamina has a plan to increase BDF production by 15%, production of FAME is predicted to increase further.

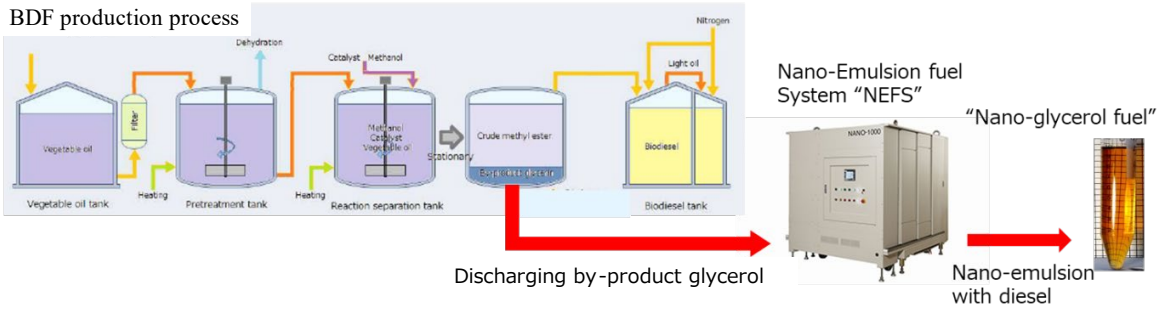


Source: Indonesia Biofuel Producer Association

Figure 4-16 FAME production in Indonesia

On the other hand, when producing FAME, by-product glycerol with low concentration is generated. Most BDF factory purify by-product glycerol and sell purified glycerol at present. However, it cannot be predicted that while BDF production is rising rapidly, demand of

glycerol is increasing at the same rate. Therefore, glycerol will be over-supplied and be difficult to be sold in the future, which means that measures for utilization of by-product glycerol would be necessary.



Source: Prepared by Nippon Koei based on document of Nanofuel

Figure 4-17 Production process of nano-glycerol fuel

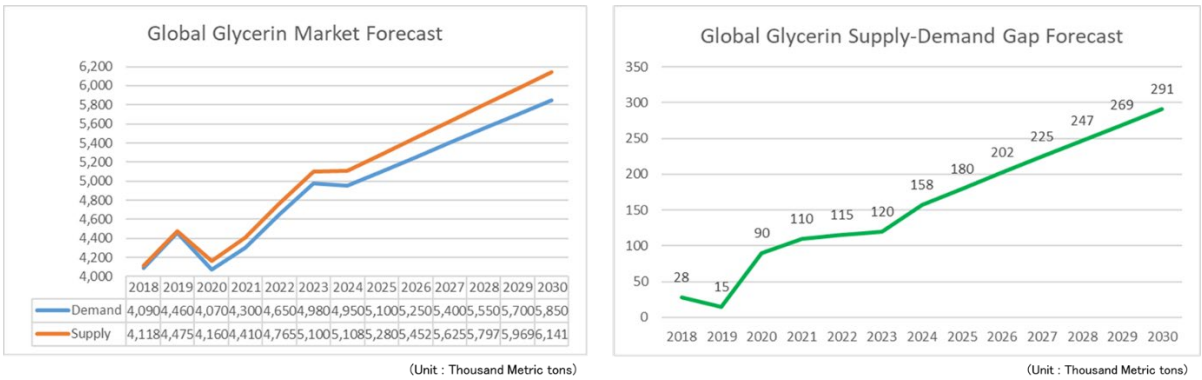
2) Overview of glycerol market

Glycerol is utilized as food additives such as sweeteners, preservatives, moisturizers, thickening stabilizers and used as moisturizers and lubricants of pharmaceuticals, cosmetics, etc.

Glycerol can be divided into natural glycerol produced by purifying vegetable oil such as palm oil and soy, and synthetic glycerol produced by hydrolysis of epichlorohydrin. Production rate of them is 93:7 and the rate of natural glycerol is much larger than that of synthetic glycerol. Also, two-thirds of all glycerol production consists of glycerol from BDF production, which means BDF production amount has a large impact on production of glycerol.

Figure 4-18 shows the prediction of supply and demand in the world. It is anticipated that the glycerol production will be increasing corresponding to drastic increase of BDF globally. Because of the increase of world population, demand of glycerol can also increase. However, the gap of supply and demand will be larger and will reach 290,000 tons in 2030.

Therefore, it is important to consider new uses of glycerol and it is valuable to explain and propose nano-glycerol fuel as one of the uses, to BDF suppliers.



Source: Prepared by Kowa based on "Status and prospect of biochemical / de-petrochemical market 2020" (Fuji Chimera Research Institute)

Figure 4-18 Prediction of glycerol supply and demand in the world

3) Collection of by-product glycerol from BDF factories

As the first step of the implementation of BDF nano-glycerol fuel project, it is necessary to confirm production technology of the nano-glycerol fuel using by-product glycerol generated in Indonesia. For this purpose, request for collection of by-product glycerol sample was carried out.

There are 22 BDF factories in Indonesia and 8 of them are located in Riau Province. Location of each factory in the Province are as shown below.

Table 4-22 BDF factories in Riau Province

#	Name of supplier	Factory location
1	PT Wilmar Bioenergi Indonesia	Dumai
2	PT Bayas Biofuels	Indragiri Hilir
3	PT Cemerlang Energi Perkasa	Dumai
4	PT Intibenua Perkasatama	Dumai,
5	PT Dabi Biofuels	Dumai
6	PT Ciliandra Perkasa	Dumai
7	PT Pelita Agung Agrindustri	Bengkalis

Source: Prepared by Nippon Koei based on Ministry of Energy and Mineral Resources Law No. 252.K/10/MEM/2020

Requests for by-product glycerol were sent mainly to factories in Riau Province. It was found that all contacted factories sell glycerol purified from by-product glycerol generated by BDF production.

Although we were unable to obtain a sample FY2021, we were able to obtain a sample from one of the above companies during the second round of travel in FY2022. We are currently analyzing the composition of the samples in Japan and will consider our policy for the next fiscal year based on the results.

Source：Nippon Koei

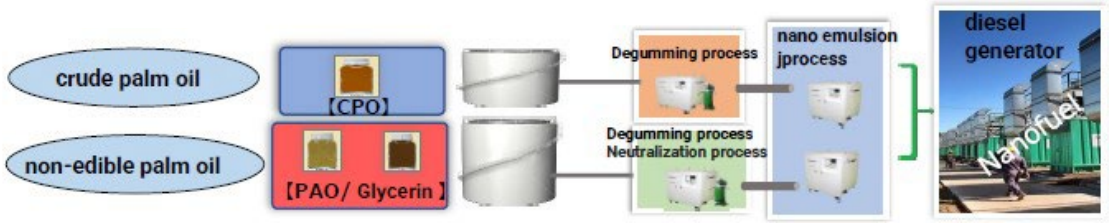
Figure 4-19 Sample of by-glycerol

(3) PAO utilization project

1) Overview of the project

POME (broad sense) is usually composed of about 3-5% PAO and about 95-97% water, while POME (narrow sense) considered in 4.1.2 is the effluent after minimizing PAO. PAO is a by-product of the palm oil refining process and is known as a biofuel feedstock. It is mainly used mixed with biofuels for vehicles.

In this project, we provided research support to NanoFuel, which aims to develop a new liquid BDF fuel utilizing PAO by improving combustion efficiency with its proprietary nanotechnology.



出典：JETRO Jakarta office, "Business Catalog by Japanese Companies for Decarbonization Realization in Indonesia (Ver.2)", November 2022

Figure 4-20 Overview of PAO utilization project

2) Result of study

Of the two companies listed in 4.1.1 (PT. PN5 and PT. Kampar Tunggal Agrindo), we interviewed PT. Kampar Tunggal Agrindo and confirmed the following;

- PAO has a lot of oil content and high value, and is sold at a high price.

On the other hand, in order to proceed with a project aiming to obtain Ministry of Environment funds, especially in the palm sector, it is necessary to give sufficient consideration to environmental and human rights impacts, and it is therefore necessary to consider placing companies in the value chain that have at least RSPO or equivalent certifications.

(4) Estimation of GHG emission reduction

1) BDF GLYCEROL FUEL PROJECT

GHG emission reduction by BDF nano-glycerol fuel project was calculated with assumption of production capacity 3,000L/h. The result of the calculation is shown below.

Table 4-23 Estimation of GHG emission reduction (BDF nano-glycerol fuel project)

#	Item	Figure	Unit	Remarks
a	Production capacity of nano-glycerol fuel	3,000	L/h	Assumption
b	Annual production of nano-glycerol fuel	21,024,000	L/yr	Assumption
c	NCV of nano-glycerol fuel	31.40	MJ/L	Assumption
d	Annual production of nano-glycerol fuel	660,056,364	MJ/year	= b x c
e	NCV of diesel	38.04	MJ/L	Petroleum Association of Japan
f	Potential of switch from diesel	17,351,639	L/year	= d / e
g	Emission Factor (Diesel)	0.0726	tCO2/GJ	IPCC2006
h	Annual reference CO2 emission	47,920	tCO2/year	= d x g /1,000

i	Rate of glycerol mixture	50%		Assumption
j	Annual diesel mixture amount	10,512,000	L/year	= b x i
k	Annual project CO2 emission	29031	tCO2/year	=e x g x i / 1,000
i	Annual CO2 emission reduction	18,889	tCO2/year	= h - k
m	Project period	7	year	Legal lifetime
n	Total CO2 emission reduction	132,223	tCO2	= i x m

Source: Prepared by Nippon Koei

2) PAO utilization project

GHG reduction effects of PAO utilizing project were estimated based on the assumption that 2,000 tons of PAO will be used per year. The results of the trial calculation are as follows.

Table 4-24 Estimation of GHG emission reduction (PAO utilizing project)

#	項目	数値	単位	備考
a	Annual fuel consumption of PAO	2,000	t/year	Assumption
b	Calorific value of PAO	17,000	MJ/t	Assumption based on "Energy database of the oil palm", Palm Oil Engineering Bulletin No.70 (Jan - Mar 2004) p15-16, 21-22
c	Annual Calorific value of PAO	34,000,000	MJ/year	= a x b
d	NCV of diesel	38.04	MJ/L	Petroleum Association of Japan
e	Potential of switch from diesel	893,796	L/year	= c / d
f	Emission Factor (Diesel)	0.0726	tCO2/GJ	IPCC2006
g	Annual reference CO2 emission	2,468	tCO2/year	= c x f /1,000
h	Rate of PAO mixture	10%		Assumption
i	Annual project CO2 emission	2,222	tCO2/year	=c (1-h) x f / 1,000
j	Annual CO2 emission reduction	246	tCO2/year	= g - i
k	Project period	7	year	Legal lifetime
i	Total CO2 emission reduction	1,722	tCO2	= i x m

Source: Prepared by Nippon Koei

4.2. Studies of JCM projects for zero carbon city

In this project, introduction of renewable energy and energy management in public buildings and the project to introduce LED street lightings were considered as projects that contribute to the formation of zero-carbon city.

The effects of the implementation of these projects combining renewable energy and energy-saving technologies with IoT technology are the followings.

- Reduction of CO2 emissions through the use of renewable energy (reduction of environmental impact)
- Local production for local consumption of energy and utilization of local resources
- Lower energy costs
- Vitalization of local industry and virtuous circulation of local funds
- Improvement of energy supply reliability
- Strengthening resilience (enhancing energy security during disasters)
- Attracting companies which are member of RE100

In addition, it is possible not only to induce private companies and others in the region to take zero carbon initiatives but also to expand similar projects to other regions, promoting these projects as model projects to promote the formation of zero-carbon city in Pekanbaru City in collaboration with Kawasaki City.

4.2.1. INTRODUCTION OF RENEWABLE ENERGY AND ENERGY MANAGEMENT IN PUBLIC BUILDINGS

(10) Study on introduction of EMS technology in the new city hall of Pekanbaru City

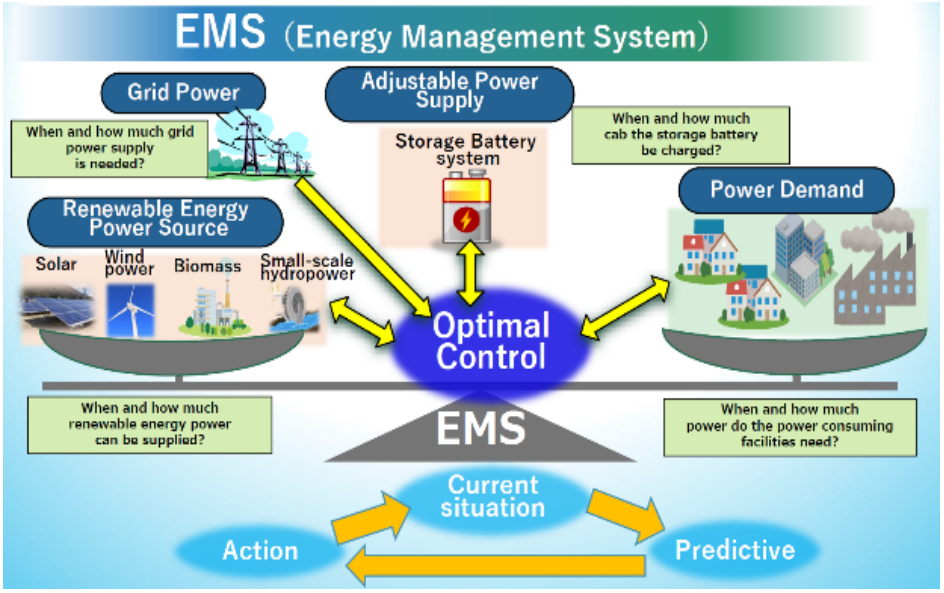
Continuing from last year, the possibility of introducing CSD's EMS technology in the new city hall of Pekanbaru City was studied.

EMS is a system that optimally controls the entire energy system by assessing the current status of when and to what extent grid power is needed, renewable energy sources can be supplied, storage batteries can be charged and discharged, and how much power is needed by power-consuming facilities.

CSD is mainly engaged in the development of environmentally and safety-conscious systems using EMS technology.

Source: Pekanbaru City

Figure 4-21 New City Hall area of Pekanbaru City



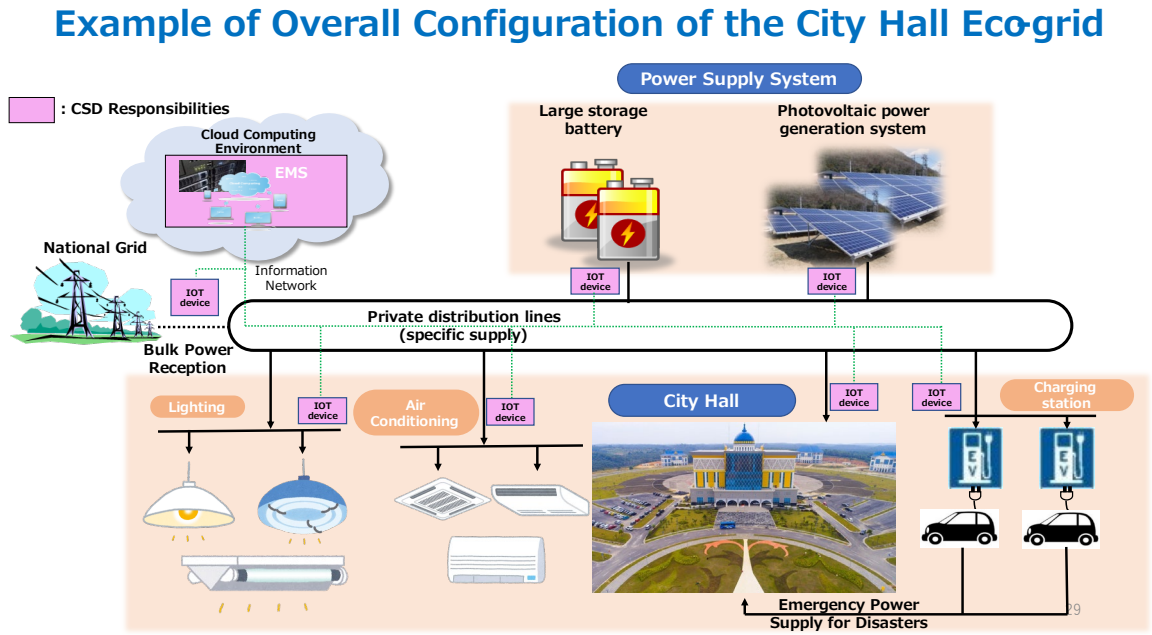
Source: Presentation material provided by CSD

Figure 4-22 Image of EMS technology

The measures and results of this fiscal year's study are as follows.

<Main measures>

1. Energy savings and CO2 reduction effects when solar power generation is used as electricity.
2. Furthermore, the energy saving and CO2 reduction effects of incorporating EMS-based lighting control and air conditioning control in the new city hall.
3. Emergency power supply by EVs in the event of a disaster



Source: CSD

Figure 4-23 Overview of the project

In addition, the following were confirmed through this fiscal year's interview survey;

1. When installing PV, confirmation with the PLN (National electric power company) is required, and the PV capacity that can be installed is less than (or equal to) 15% of the electricity consumed.
2. Ground-mounted PV is considered an IPP (Independent Power Producer), which makes it difficult to obtain approval from PLN.
3. The roof of the City Hall is a traditional design with a steep slope, making it difficult to install PV.

(11) Results

In order to study the possibility of applying EMS technology to the new city hall in Pekanbaru City, we calculated the GHG reduction. Each value was calculated by referring to local information from Pekanbaru City through on-site investigation, and using hypothetical data for information that was not available.

The results of the calculations are shown in the table below and the figure below. When discussing the effect of EMS, it is common to include the effect of adopting solar power generation in the evaluation, and the effect of only EMS in this case is;

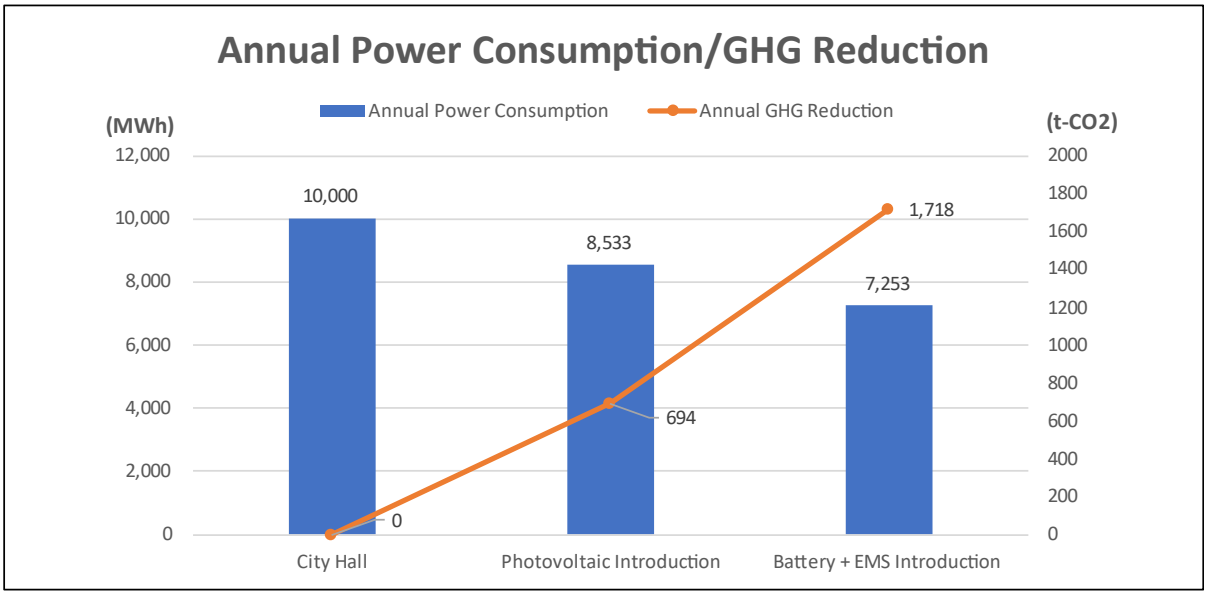
- Reduction of purchased electricity by storage batteries: 3-6% (depending on the size of the storage batteries)
- Reduction in electricity consumption by control: approx. 10% (varies depending on control target and content)
- The overall effect was assumed to be 15% in this study

The annual GHG emissions reductions when a 1.1 MW solar power system is installed for an EV bus system are 694 t-CO2 shown in . In addition, the annual GHG emission reductions when EMS and storage batteries besides on the above solar power system are installed is 224 t-CO2, assuming a 15% reduction effect, indicating the reduction effect of EMS.

Table 4-25 Results of the study of EMS technology introduction in the new city hall in Pekanbaru City

#	Items	Figure	Unit	Remarks
a	Annual power consumption on the city hall	10,000	MWh/Year	Solar power capacity: 1.1 MW
b	Annual power generation	1,467	MWh/Year	Source: Global Solar Atlas
c	(PV system)	0.473	t-CO2/MWh	JCM model project (Renewable Energy, Sumatra)
d	Emission Factor	694	t-CO2/Year	= b×c
e	Annual GHG reduction	15	%	Storage batteries capacity: 2 MWh
f	(PV system)	0.8	t-CO2/MWh	Hypothesis data
g	Reduction effects	2,747	MWh/Year	EMS= PV optimum control + lighting control + air conditioning control
h	(Storage batteries + EMS)	1,718	t-CO2/Year	JCM model project (Energy saving, Sumatra)

Source: Prepared by Nippon Koei from materials provided by CSD



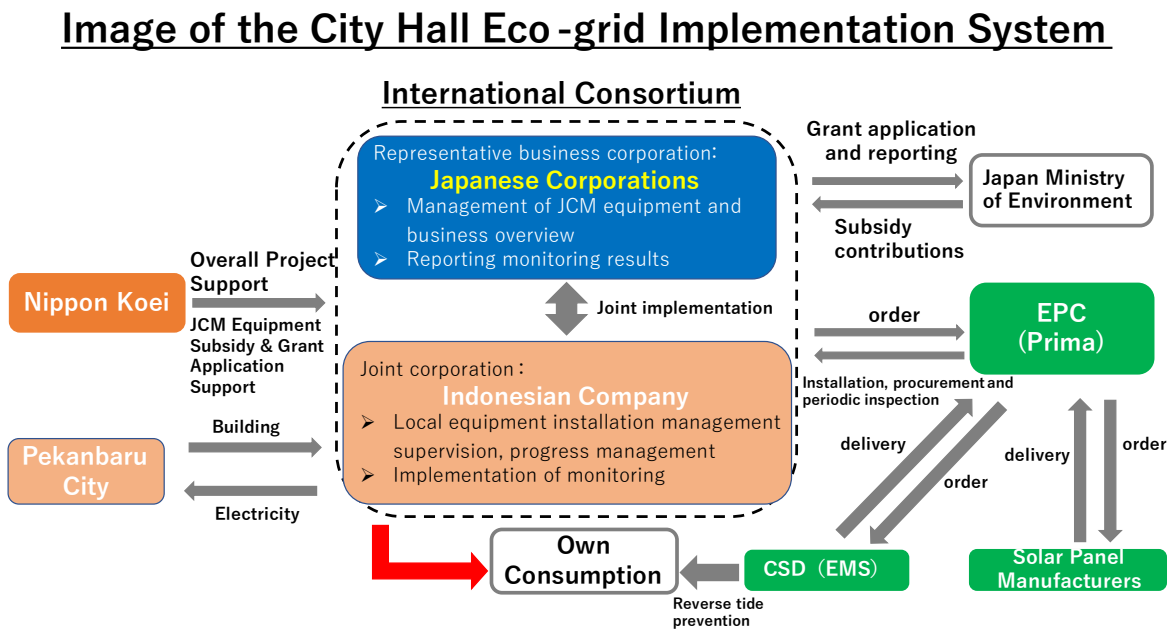
Source: provided by CSD

Figure 4-24 Results of the study of EMS technology introduction in the new city hall in Pekanbaru City

(12) Next steps

We are considering the implementation structure shown in the figure below for application to the JCM model project. One of the current issues is the limitation of the amount of electricity that can be installed due to the PLN regulation mentioned above, which is currently under discussion, and further information gathering is desirable. In addition, detailed power consumption data should be obtained from the City of Pekanbaru, as the PLN restrictions will

affect the power consumption of buildings used. In this regard, the LOI mentioned in 3.3.3 has been signed, and it is expected to be available without problems in the next fiscal year.



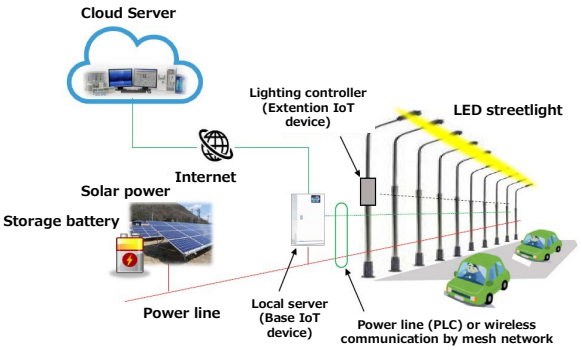
Source: Prepared by Nippon Koei from materials provided by CSD

Figure 4-25 Draft implementation structure for JCM model project

4.2.2. LED STREET LIGHTING PROJECT

(13) Project overview

DISHUB of Pekanbaru City is currently promoting the installation of LED streetlights in the city. As of 2017, there were approximately 40,000 street lights installed in Pekanbaru City, but 30,000 of them were not metered, resulting in higher-than-usual electricity rates. To solve this issue, we considered installing a combination of LED streetlights and CSD's EMS technology, which will enable smart management of power consumption and reduce electricity costs and GHG emissions through optimal operation. Not only will the conversion to high-efficiency LEDs and the combination of IoT technology and optimal operation provide significant energy savings, but the EMS technology will also enable various settings, fault monitoring, schedule control, and so on at the center, which is expected to significantly reduce OM costs.



Source: Prepared by Nippon Koei from materials provided by CSD

Figure 4-26 Image of combination of LED streetlights and EMS technology

The measures and results of this fiscal year's study are as follows.

<Main measures>

I. Energy savings and reduction of CO2 emissions through remote monitoring and control

II. Energy saving by dimming control based on time of day, ambient brightness, and traffic volume

III. Integrated street light management application

(14) Results

In order to study the possibility of introduction of LED streetlight and applying EMS technology, we calculated the GHG reduction. Each value was calculated by referring to local information from Pekanbaru City through on-site investigation, and using hypothetical data for information that was not available.

The results of the calculations are shown in the table below and the figure below. When discussing the effect of EMS, it is common to include the effect of adopting solar power generation in the evaluation, and the effect of only integrated management system in this case is;

- Reduction in electricity consumption due to simplified systems and more efficient operations = approx. 5%
- Reduction in electricity consumption by control: approx. 5% (varies depending on control target and content)

The overall effect was assumed to be 10% in this study

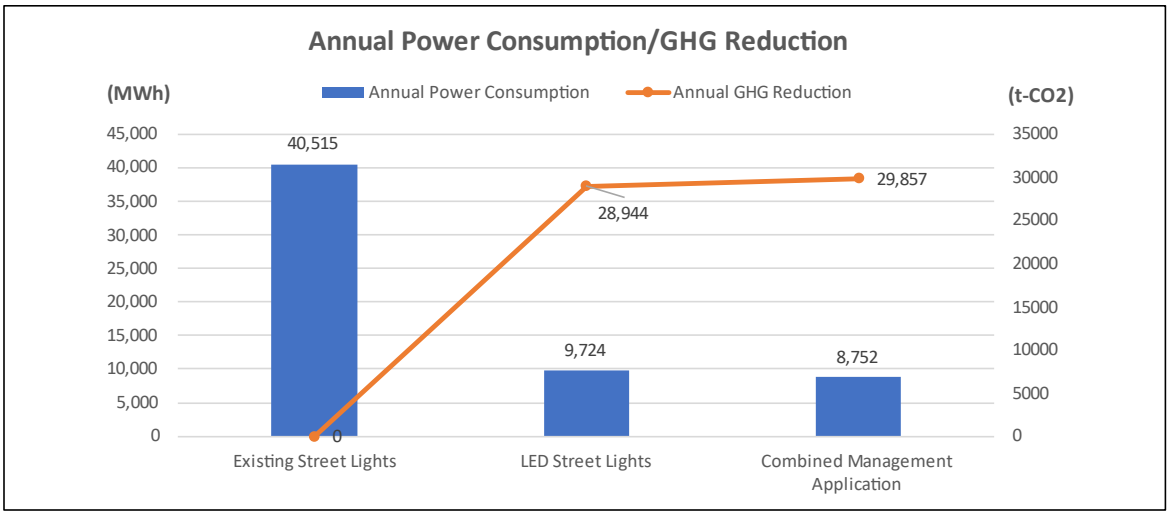
The results show that switching existing streetlights to LED streetlights leads to a GHG emissions reduction of 28,944 t-CO2/year, and furthermore, the introduction of an integrated management application leads to a GHG emissions reduction of 29,857 t-CO2/year.

Table 4-26 Results of study on introduction of LED streetlight and EMS technology

#	Items	Figure	Unit	Remarks
a	Preconditions	-	-	Number of streetlights: 37,000 Lighting time: 12 hours/day Power consumption of conventional streetlights: 250W/point
b	Annual electricity consumption (Conventional)	40,515	MWh/Year	= a ($37,000\times12\times250\times365\times10^{-6}$)
c	Annual electricity consumption (LED light)	9,724	MWh/Year	Power consumption of LED lights: 60W =$37,000\times12\times60\times365\times10^{-6}$
d	Annual electricity reduction (LED light)	30,791	MWh/Year	= b – c
e	Emission Factor	0.94	t-CO2/MWh	JCM model project (Case 1, Energy saving, Sumatra)
f	Annual GHG reduction (LED light)	28,944	t-CO2/Year	= d × e

#	Items	Figure	Unit	Remarks
g	Annual electricity reduction (Integrated management application)	10	%	Storage batteries capacity: 5 MWh
h	Annual electricity reduction (Integrated management application)	972	MWh/Year	= c × g
i	Annual GHG reduction (Integrated management application)	914	t-CO2/Year	= h × e
j	Annual electricity reduction (LED light + Integrated management application)	31,763	MWh/Year	= d + h
k	Annual GHG reduction (LED light + Integrated management application)	29,857	t-CO2/Year	= j × e

Source: Prepared by Nippon Koei from materials provided by CSD

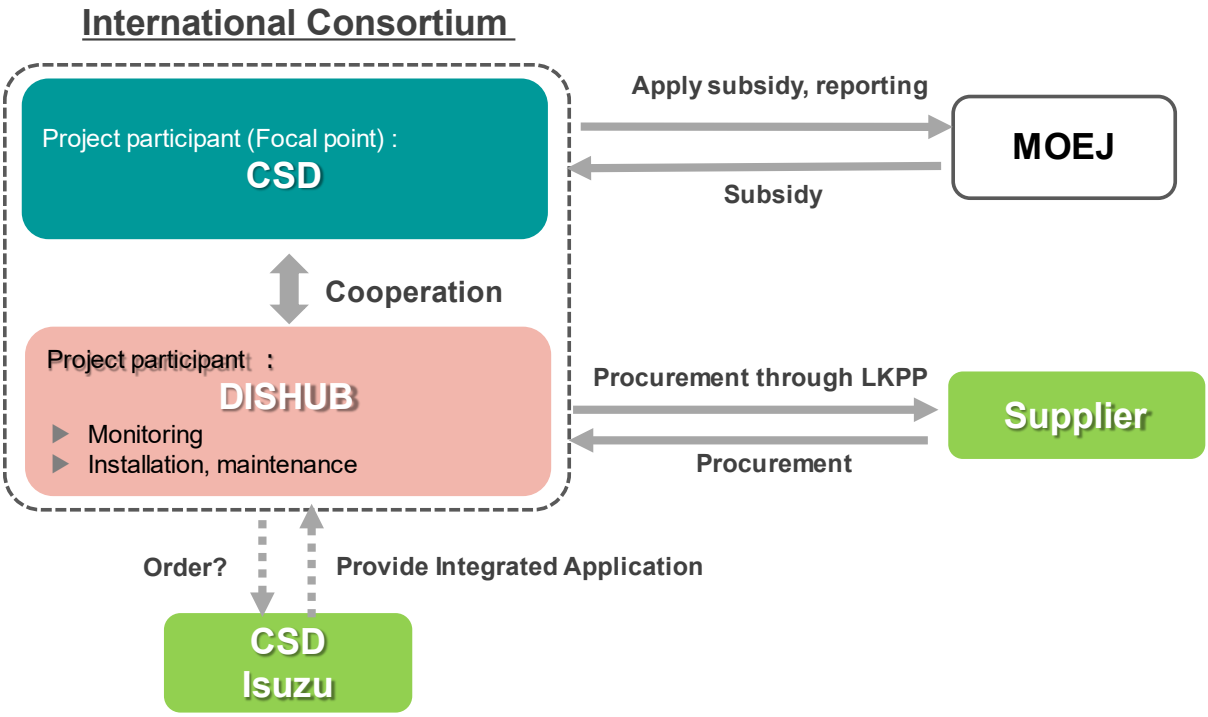


Source: Provided by CSD

Figure 4-27 Results of the study of installation LED lights and integrated management application

(15) Next steps

The following implementation structure is being considered for application to the JCM model project. The procurement scheme is not based on public bidding, but on the e-catalog of LKPP (Government Procurement Agency). Currently, we are confirming the specific number of LEDs, specifications, installation locations, and other information based on the current year's budget of DISHUB, Pekanbaru, and are working on a concrete proposal to DISHUB.



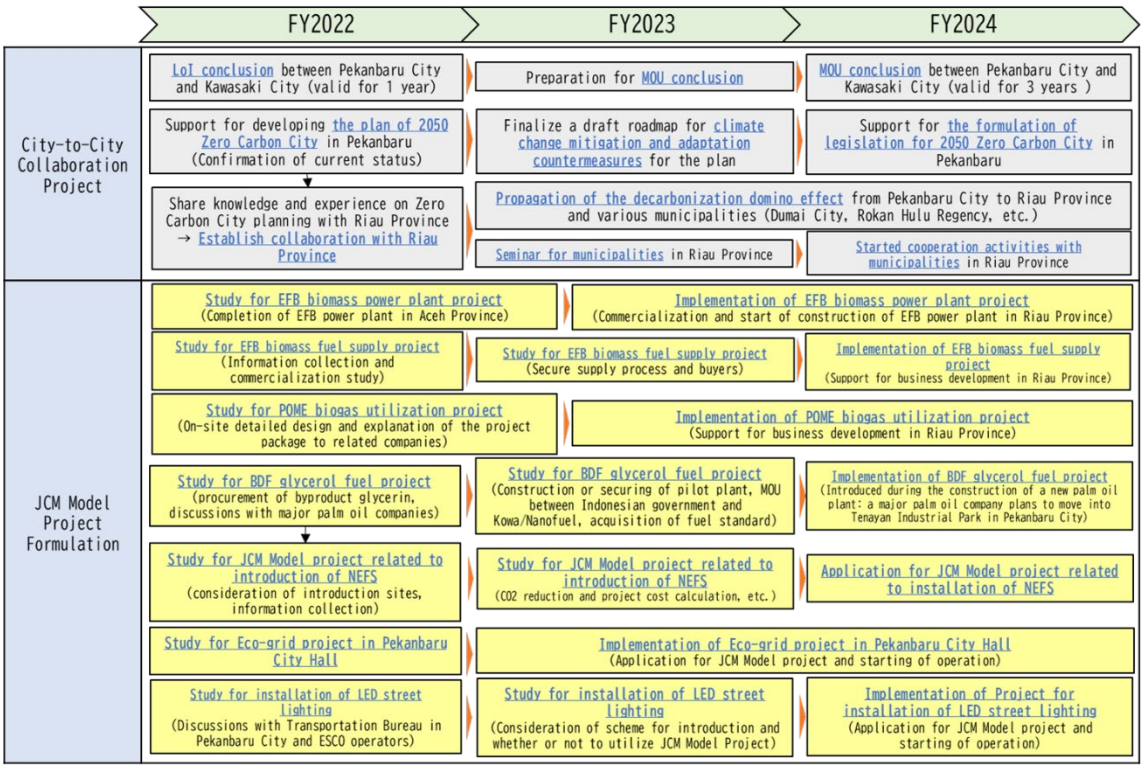
Source: Prepared by Nippon Koei

Figure 4-28 Draft implementation structure for JCM model project

CHAPTER 5 PROGRESS AND OUTCOMES OF FY 2022

City-to-City Collaboration Project in Riau Province Region launched in 2019. Kawasaki City's inter-city collaboration project in the Riau region began in 2019, and this fiscal year was the first year of project Phase 2.

The figure below shows the three-year plan as of the time of the current year's proposal.



Source: Prepared by Nippon Koei

Figure 5-1 3-year plan (at the beginning of FY 2022 project, partly edited)

Progress and outcomes of the plan are summarized in Table 5-1.

Table 5-1 Progress and outcomes of FY 2022

Sector	Progress and outcomes
(1) City-to-city collaboration activities	
Kawasaki City - Pekanbaru City LOI Conclusion	As mentioned in 3.3.3, the LOI signing ceremony between Kawasaki City and Pekanbaru City was held on 9 Feb 2023. Thanks to this, we can expect more successful results in both City-to-City collaboration activities and JCM model project formation in the next fiscal year and beyond. The MOUs that are being considered for the next year onward will be based on the intentions of Kawasaki City and Pekanbaru City.

Sector	Progress and outcomes
Support for Pekanbaru City 2050 Zero Carbon City Plan Formulation	We established a structure for Pekanbaru City, Riau University, and IPB/ITB to support the development of the 2050 Zero Carbon City Roadmap. Specific roadmap proposals will be developed in the next fiscal year in FY2022. In addition, at a workshop held on 9 Feb 2023, a presentation was made on Kawasaki City's revised master plan for global warming countermeasures, which was the subject of many questions and active discussions.
Propagation of the Decarbonization Domino in the Riau Region	It was found that the establishment of a partnership with Riau Province requires the conclusion of an LOI between Kawasaki City and Pekanbaru City. The partnership was initiated with the LOI signing ceremony mentioned above.
(2) JCM project formulation studies	
Studies of projects for development of circular economy	<u>EFB biomass power plant project</u> No specific activities were conducted in Riau Province this year because the project in Aceh, which is being conducted by the representative company, is scheduled to start operation this year. <u>EFB Fuel Conversion Project</u> A survey was started this fiscal year including interviews with EFB suppliers and companies with fuel conversion technologies. A system to commercialize the project was studied. <u>POME Biogas Utilization Project</u> The following items were also studied: the selection of palm oil mills to be surveyed and information gathering there, the initial design of the biogas refining plant, the fuel conversion potential of bio-CNG gas for Trans Metro Pekanbaru buses, which operate city buses in Pekanbaru City. Interviews were held as well with DISHUB to establish a system to commercialize the project. <u>Glycerol fuel business derived from biodiesel production and liquid biomass fuel business utilizing PAO</u> We conducted an on-site survey at a BDF plant to obtain by-product glycerole samples and collected information for the commercialization of liquid biomass fuel utilizing PAO. Also, a study was conducted on where to introduce a nanoemulsion fuel production system (NEFS) in Indonesia.
Studies of projects for development of zero-carbon city	<u>Project for introducing renewable energy and energy management to public buildings</u> Through a number of discussions with local EPC candidate companies and the city of Pekanbaru, we examined Indonesian laws and regulations and the implementation system. <u>Project for the introduction of LED streetlights</u> Through a number of discussions with Pekanbaru City and LED manufacturers, we examined the possibility of introducing LED streetlights in the next fiscal year.

Source: Prepared by Nippon Koei

CHAPTER 6 FUTURE PLANS

6.1. JCM Model Projects development in FY2023

An overview of JCM-related project initiatives for the next fiscal year is described below as a summary of the status of future plans. In the feasibility study (F/S) for this fiscal year, the parties concerned indicated that they would like to begin full-fledged consideration of the EFB power generation project as a model project from FY2023 as soon as the plant in Aceh, which is expected to be completed by the end of this fiscal year, is completed. Regarding EFB fuel project, it was found that a promising technology is currently in the final stage of demonstration for commercialization, and the manufacturers would like to wait until the demonstration is completed before making a firm proposal for the model project scheme. The proposal for the model project will be prepared in the next fiscal year or later.
The basic design for the POME biogas project was completed this year, and costs have been updated to a certain extent. Using this information, we will present it to potential business operators in the next fiscal year to formulate the project with interested companies. In addition, a similar project that uses livestock manure instead of POME as the source of biogas, for which information was obtained last fiscal year, was studied by the companies concerned. The project proposal was not submitted for application due to the lower economic feasibility of the project because of the overall budget increase and the need for additional budget for treatment of digested wastewater.
Regarding the biodiesel production-derived glycerol fuel business, the samples of by-product glycerol from a biodiesel company were obtained through this project in the latter half of this fiscal year, and they are currently being analyzed by the project member company. The results of this analysis will be shared soon with the biodiesel company. The nano-technology used in this project can increase the combustion efficiency of ordinary liquid fuels (such as heavy oil and diesel oil) and reduce emissions per unit calorie by mixing them with water through emulsification.
At present, one of these projects that may be applied for as a JCM-related project as early as FY2023 is to propose a liquid fuel efficiency project (assuming it is proposed under the future Co-Innovation Scheme in 2023) in another province in Indonesia.
As for projects contributing to the formation of zero-carbon cities, among solar power and LED streetlights, the latter in particular has made progress. Currently, coordinating with a local Japanese manufacturer to conduct on-site studies in progress and formulation of JCM model project is aimed at within FY2023. As for solar power, the info was collected that that PLN has requested only a maximum of 30% of the electricity consumed be installed, and that the right to credits be waived, which needs clarification before the submission of the proposal.

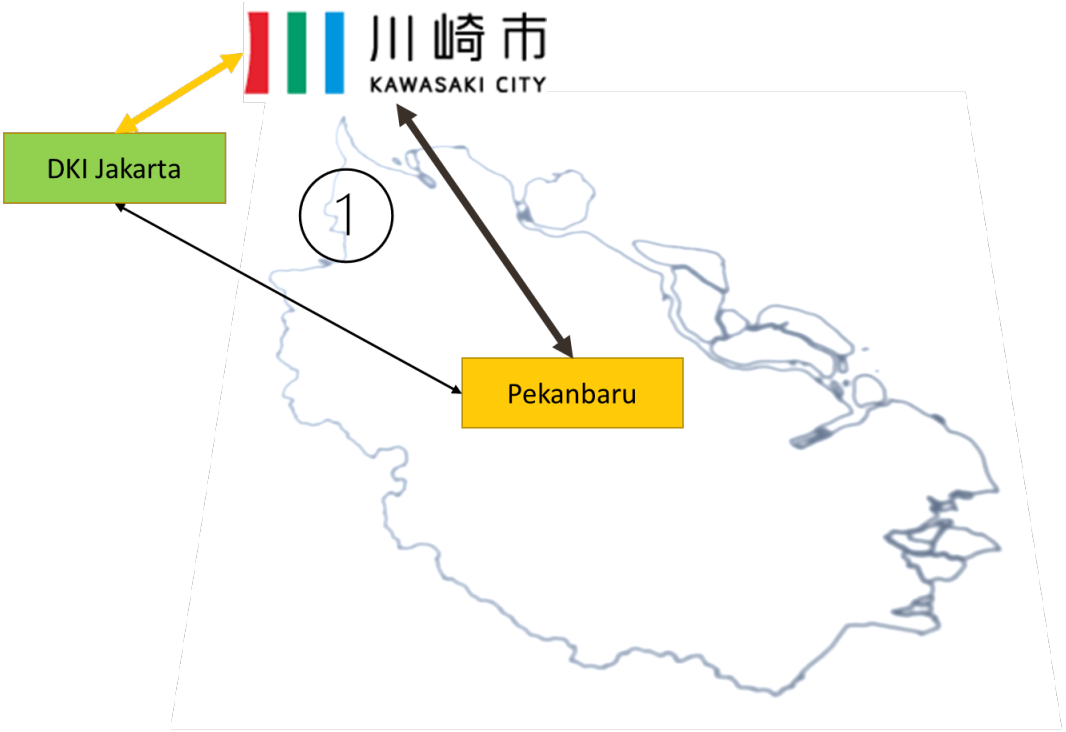
6.2. Strategy for FY2023

In FY2022, the first year of Phase 2, the resume of travels to Pekanbaru city enabled to achieve various results. In particular, the LoI between the two cities in February 2023 were concluded, which had been one of the most important targets since Phase 1. Since the LoI was inevitable to involve other local government and departments such as Riau Province and various organizations in the city for the development of the zero-carbon city roadmap. Taking advantage of the existence of the LoI, it is expected to further ramp up activities in FY2023.
In FY2023, first, it is important to identify stakeholders to create a Zero Carbon City Roadmap.

Until this year, the Climate Change Working Group, organized under the CRIC project to study the Climate Change Action Plan, has been the main partner for discussions.
The development of the roadmap is an initiative of Pekanbaru City with the support of the project team. Therefore, it is important to clarify the stakeholders of the Pekanbaru City side, and the city side needs to establish a system to work on the roadmap development as soon as possible.

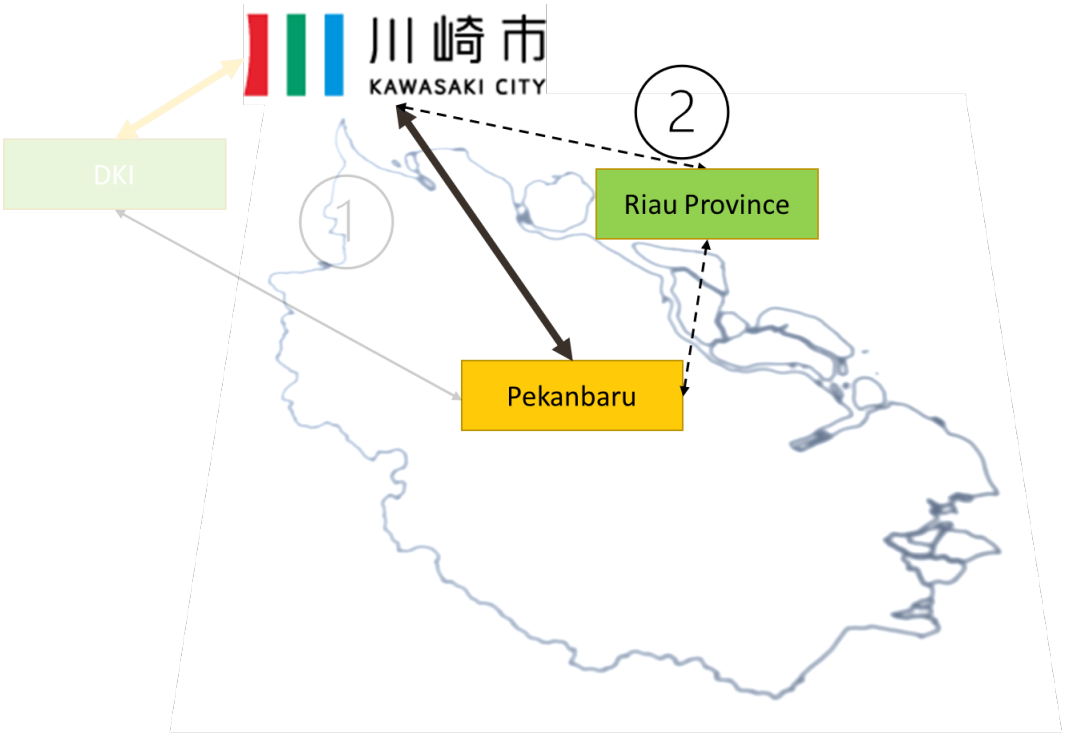
6.2.1. CITY-TO-CITY COLLABORATION ACTIVITIES

Realization of a decarbonization domino from Pekanbaru City
In the last fiscal year, DKI Jakarta, Kawasaki's city-to-city collaboration partner, participated in a seminar in Pekanbaru and introduced their efforts and laws and regulations for decarbonization. Questions were actively raised among the Indonesian local governments, and it was confirmed that the coordination of city-to-city collaboration project by Kawasaki was effective.
In Phase 2, the approach will be to first support Pekanbaru City in developing a decarbonization roadmap by introducing the knowledge and experience of Kawasaki City and DKI Jakarta, and then to spread that knowledge within Riau Province. In doing so, the approach is to establish a partnership with Riau Province as Step 2, and in Step 3, Pekanbaru City will take the lead in spreading decarbonization to Riau Province and each local government (city and regency). Rather than Kawasaki working directly with many local governments, the approach is to support key organizations that will serve as the starting point of spreading decarbonization. As support for Pekanbaru City, Kawasaki will provide planning support in FY2022 and FY2023, while promoting the implementation of JCM projects in FY2023 and FY2024 that will lead to actual GHG reductions.
In particular, as for the possibility of utilizing the technology under consideration in this project, in addition to Pekanbaru City, there is high potential in other central palm oil production areas in Riau Province, such as Dumai City, where many palm oil-related industries are located in the coastal area, and Rokan Hulu Regency and other regencies which have large palm plantation areas.
The following is an image of the decarbonization workflow in Riau Province Region with the city of Pukanbaru at its core.



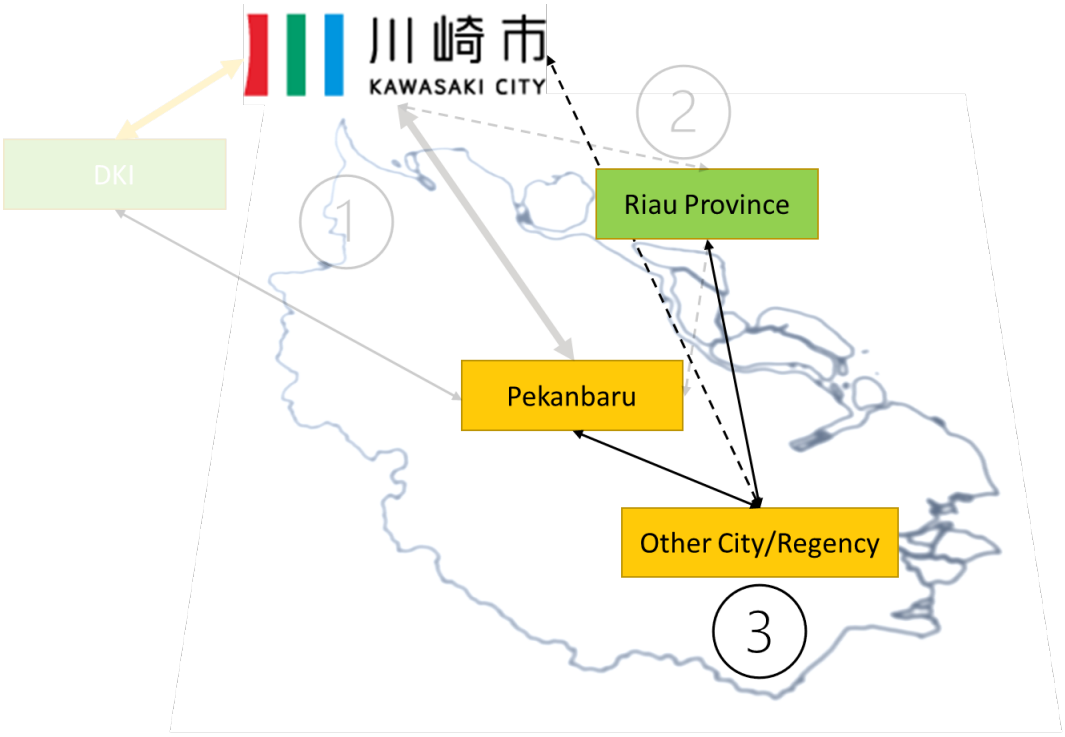
Source: Nippon Koei

Figure 6-1 Step 1: Develop a zero-carbon city roadmap for Pekanbaru in collaboration with Kawasaki City and the DKI Jakarta



Source: Nippon Koei

Figure 6-2 Step 2: Collaboration with Riau Province for development of zero-carbon city roadmap of Pekanbaru City supported by Kawasaki City



Source: Nippon Koei

Figure 6-3 Step 3 Decarbonization spread to cities and regencies in Riau, with Pekanbaru City as the core

In order to ensure the implementation of the project, the experts from ITB and IPB, who had assisted DKI Jakarta in planning, joined the project implementation structure this year and started supporting Pekanbaru City. In addition, Riau University has joined the project as a core organization to store experience and knowledge in the province of Riau. We believe that an implementation support system has been established with these universities as the core, and we will continue to share the knowledge of ITB and IPB with Riau University, Pekanbaru City, and Riau Province in the next fiscal year as we support the creation of a concrete roadmap for the project. Since the LoI was indispensable for Riau's participation, we were not able to proceed with specific discussions this fiscal year.

6.2.2. JCM FEASIBILITY STUDY

Based on the results of this year's study, the following candidate decarbonization projects will be considered in the Pekanbaru zero-carbon city roadmap as potential JCM model projects and other support programs.

(1) EFB utilization project

The construction of the EFB power plant in Aceh by Aura Green Energy is expected to be implemented also in Riau, after the completion of the first project in Aceh. Besides, given the growing demand for biomass fuels from PLN, a shift to the EFB-derived biomass fuel supply business is also considered promising, and the two approaches will be pursued together to solve the problem of utilizing EFB in Riau, a palm-producing region.

(2) POME biogas utilization project

Based on the results of this year's basic design, the estimated project cost and plant design have been finalized, and the results are now ready to be compiled into a project package to be presented to the companies to be involved. The results of last year's study have shown that significant GHG reductions can be expected.

(3) BDF glycerol fuel project

As for the glycerol fuel projects, this year's survey revealed that under the current situation in Riau, it would be more desirable to introduce it at the same time as the construction of a new palm oil plant than to apply it to an existing palm oil plant, and that a more feasible proposal can be made. As a major palm oil company is planning to set up a palm oil plant in Tenayan Industrial Park in Pekanbaru City, we will proceed with discussions with the company as a top priority.

(4) Introduction of EMS Technology in the New Government Complex in Pekanbaru

Since last year, it has been explained to Tenayan Industrial Park that decarbonization of electricity procurement is important to attract promising companies. However, due in part to the impact of COVID-19, the status of companies operating in Tenayan Industrial Park has been slower than planned. Based on the research conducted up to last year, it was concluded that it would be desirable to introduce renewable energy + EMS + electricity storage technology to the new government complex in Pekanbaru (adjacent to Tenayan Industrial Park) and demonstrate its GHG reduction more quickly. Based on the results of the demonstration, it will be effective to proceed to further large-scale introduction targeting the industrial park, and therefore, the project targeting the new government complex will first be undertaken as a JCM model project. Although the project will be affected by the policy of PLN, a state-owned electric power corporation, this year we met with a representative participant who has experience in the field of solar power generation adopted in Indonesia in recent years, and were able to obtain advice on the actual issues, how to proceed, and how to install solar panels. In the next fiscal year, it is planned to proceed with the project after confirming whether there will be any relaxation of the restrictions on the capacity of solar power installed, particularly with respect to the amount of electricity consumed, and whether the Japanese government will be able to obtain credits for the project to generate solar power.

(5) LED Street Lighting Project

Through this year's activities, three direct discussions were held with the Transportation Department of Pekanbaru City, which confirmed the plan to replace streetlights with LEDs and the significant benefits expected. Transportation Department expressed strong interest in the possibility of accelerating the introduction of LED streetlights by obtaining subsidy. In addition, several discussions were held in Jakarta with a Japanese company active in Indonesia in the field of LED street lighting and confirmed the procedures for proposing future model projects. Together with a potential representative company, it was agreed to work toward applying for the subsidy during the next fiscal year. At this stage, Transportation Department has shared the target area and approximate number of streetlights in the area when the model project is implemented. With the support of LED streetlight manufacturer, a feasibility study will be conducted to decide the actual number and specification of lights to be installed.

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