FY2020 Project for Ministry of the Environment Japan

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

（Urban Development project through decarbonized transportation using bio-fuel and Zero Carbon City development project through dissemination of renewable energy）

Report

March 2021

Japan NUS Co., Ltd

Toyama City

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List of units and abbreviations

ADB	Asian Development Bank
BOG	Boil off gas
BRT	Bus Rapid Transit
CNG	Compressed natural gas
EPC	Engineering, Procurement and Construction
FIT	Feed in Tariff
GHG	Green house gas
DDF	Dual Diesel Fuel
IRDA	Iskandar Region Development Association
IRR	Internal Rate of Return
JANUS	Japan NUS Co., Ltd.
JCM	Joint Crediting Mechanism
KK	Kota Kinabalu City
LNG	Liquefied Natural Gas
LPG	Liquefied petroleum gas
LRT	Light Rail Transit
MRV	Measurement, Reporting and Verification
NDC	Nationally Determined Contributions
POME	Palm Oil Mill Effluent
SDGs	Sustainable Development Goals

Chapter 1　Background and purpose of the tasks

1.1 Background of the tasks

In November 2016, the Paris Agreement took effect, and in 2020, it was finally at the stage of implementation of actual measures. The Malaysian government set the goal of reducing greenhouse gas emissions by 35% between 2005 and 2030 or by 45% if international cooperation can be enlisted, as a nationally determined contribution (NDC). In 2019, the government announced the plan “Malaysia: Energy Supply 2.0 (MESI 2.0),” which is targeted at raising the ratio of renewable energy to the total amount of fuels for power generation to 20% by 2025, and energized activities for reducing greenhouse gas emissions.

Under these circumstances, Toyama City, which is a “futuristic environmental city” and a “futuristic city that would attain SDGs,” is highly evaluated for the development of a compact city based on public transportation and the utilization of renewable energy, such as micro-hydroelectric power, taking advantage of regional characteristics, and is recognized by the United Nations as the only “city that has improved energy efficiency” in Japan. In order to fulfill the roles as an advanced environmental city, Toyama City has concluded agreements for cooperation in utilization of renewable energy and vitalization of public transportation with Iskandar located in Malaysia’s state of Johor and Kota Kinabalu, which is the state capital of Sabah in the northern portion of Borneo, and is disseminating technologies and know-how for conserving the environment of the city and enterprises in the city, in order to realize a low-carbon society.

	
Scene of conclusion of an agreement with Iskandar	Scene of conclusion of an agreement with Kota Kinabalu

1.2 Purpose of the tasks

It is mentioned, in the Paris Agreement, that the activities of not only central governments, but also non-governmental bodies, such as municipalities and cities, accelerate climate change. Accordingly, cities and municipalities become key players, when concrete local measures and projects against climate change are discussed and executed. In order to achieve low-carbon societies around the globe, it is necessary to accelerate the activities for decarbonizing societies sustainably and then realizing low-carbon societies in Asia, whose economy is growing by leaps and bounds,

and international support for municipal activities is being enhanced, for decarbonizing cities and realizing low-carbon urban societies, which underpin the advance of societies and economies.

In this inter-city collaborative project, we researched the feasibility of urban development based on low-carbon public transportation utilizing biofuel and the distribution of renewable energy based on micro-hydroelectric power generation, selected candidate JCM projects, including the proposal for a JCM equipment support project, and proposed and produced policies and systems for conducting projects smoothly.

1.3 System for carrying out the tasks

The system for conducting the tasks this fiscal year is shown in the Fig.1-1. Under the framework of intercity collaboration, Toyama City, Iskandar, and Kota Kinabalu concluded an agreement for cooperation, and the development agency of Iskandar and Kota Kinabalu served as liaisons. Then, they had discussions about the sharing of know-how and the support for policymaking regarding the development of compact cities for proceeding with the urban development based on decarbonized transportation utilizing biofuel and the distribution of renewable energy based on micro-hydroelectric power generation.

When discussing commercialization, we cooperated with Hokusan Co., Ltd., which possesses the experience of creating the JCM equipment support project (change of fuels for buses for public transportation), after seeing the inter-city collaborative project in Indonesia, JGC Corporation, which has the knowledge of biogas liquefaction technologies, and so on. In addition, Japan NUS Co., Ltd. managed the entire project, including the gathering of information on inter-city cooperation, the support for surveys, and coordination of communication among related institutions and enterprises.

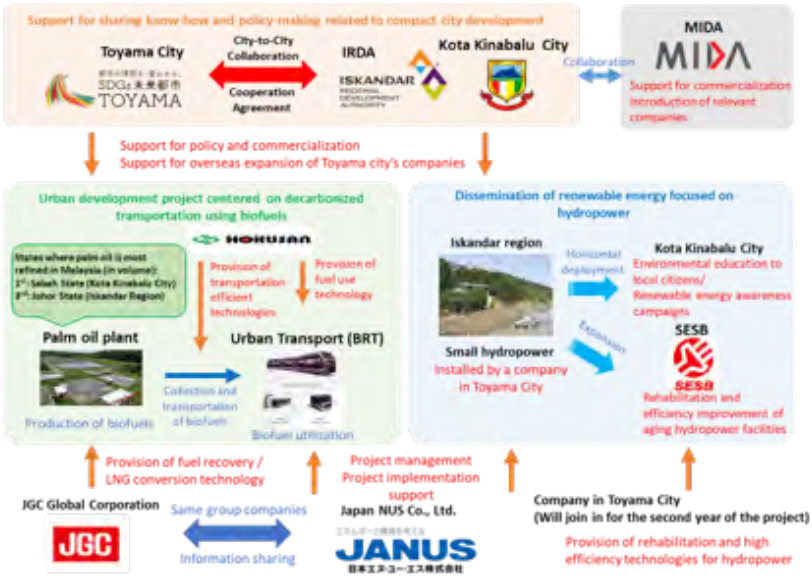


Figure 1-1 Outline of the tasks and systems for conducting the tasks

Chapter 2　Outlines of Iskandar and Kota Kinabalu

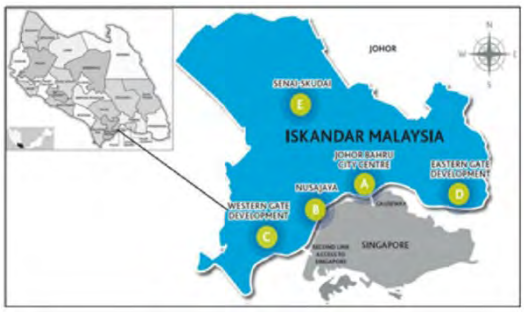
2.1 Outline of Iskandar

2.1.1 Basic information

Iskandar is an economic zone located in Johor, Malaysia. Since the establishment in 2006, large-scale urban development has progressed, as part of the intensive regional development project promoted by the Malaysian government. Since it adjoins Singapore geographically, the investment by foreign enterprises is increasing, as foreign-affiliated companies are constructing their production sites in the industrial complex of Iskandar. The total area of the designated development region is about 3 times the area of Singapore, being nearly equal to the area of Tokyo, and its population is estimated to grow from 1.7 million to 3 million people in 2025.

The development region of Iskandar is being developed as a smart city, which is composed of 6 pillars (smart economy, smart business administration, smart environment, smart people, and smart lifestyle), and various pilot businesses are in operation there. The development of Iskandar is led by Iskandar Regional Development Authority, which was established by the federal government of Malaysia, for the purpose of developing the region as a sustainable city.

As measures for mitigating global warming and climate change, they announced the public plan for reducing greenhouse gas emissions “Blueprint for realizing a low-carbon society in the development region of Iskandar, Malaysia by 2025” while receiving support from Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA) in November 2012. As for transportation infrastructure, which is the target of this survey, they produced “Blueprint regarding transportation infrastructure in the development region of Iskandar, Malaysia” (For details of this plan, see Chapter 3). In these plans, 12 measures were specified under the theme of the development of low-carbon society scenarios, and one of them is to develop an environmentally friendly network for public transportation. Under these circumstances, IRDA requested Toyama City, which has a track record of development of a compact city based on public transportation, to cooperate in actualizing a “futuristic city” by vitalizing public transportation and distributing renewable energy, and signed an agreement for cooperation in February 2015.

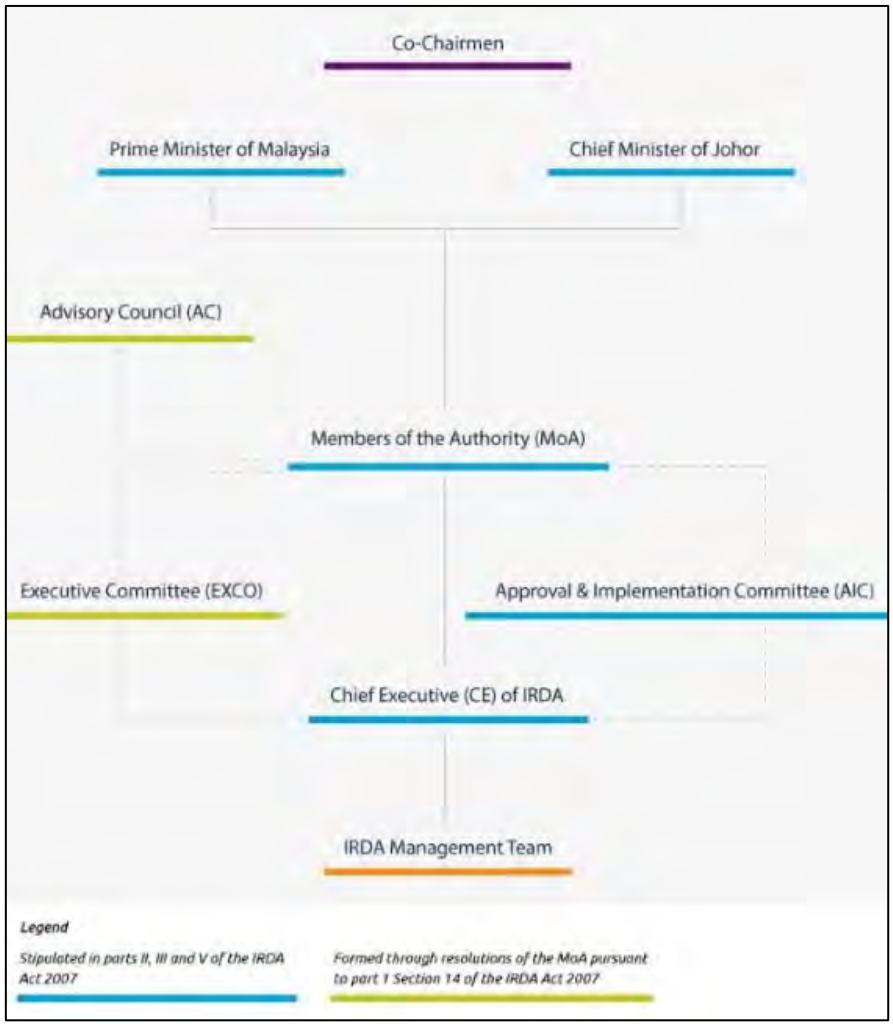


Source: Taken from the website of IRDA

Figure 2-1　Location of Iskandar

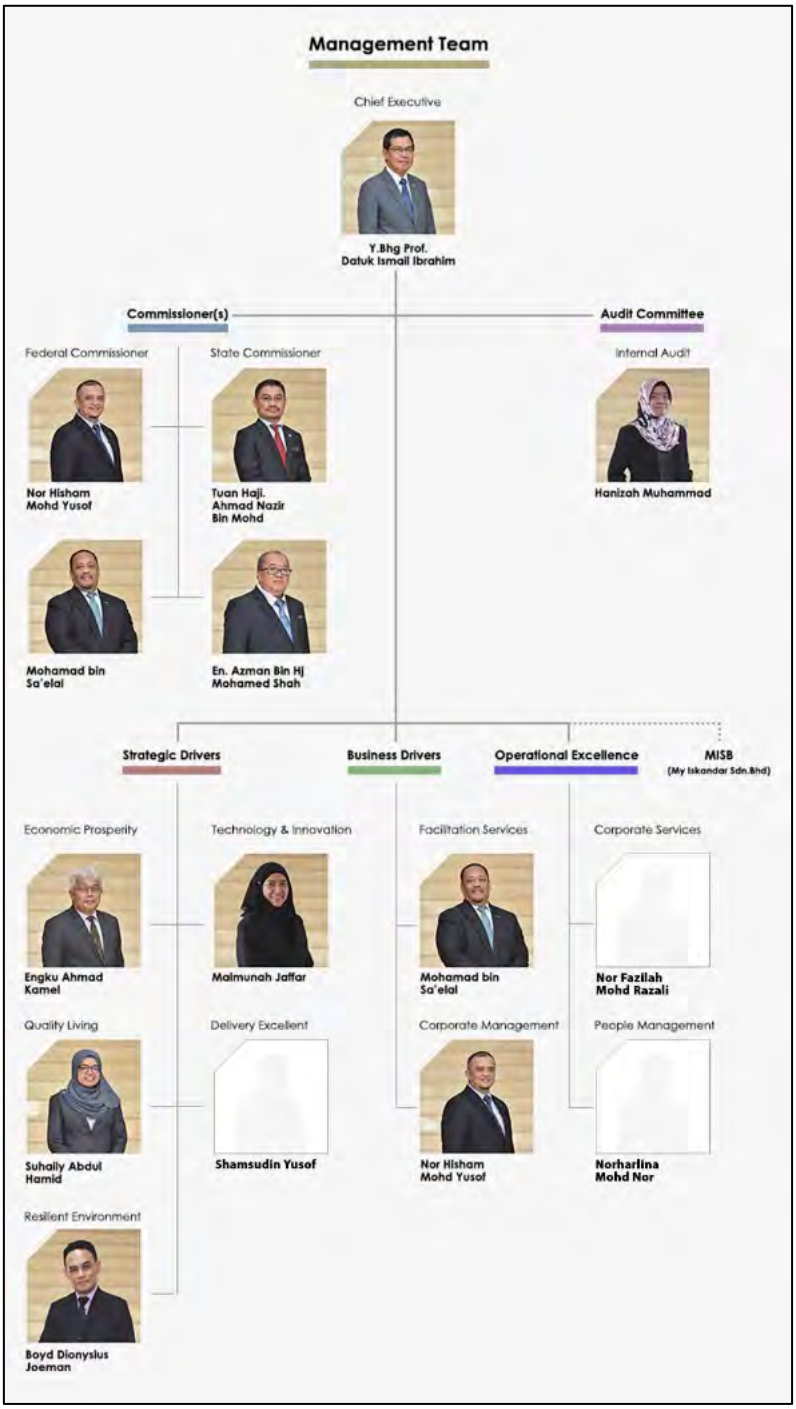
２．１．２ Iskandar Regional Development Authority

As mentioned above, Iskandar Regional Development Authority (IRDA) was established as an organization in charge of development of Iskandar by the federal government of Malaysia, for the purpose of developing the region as a sustainable city. The positioning of IRDA is as shown in Fig. 2-2. Namely, the Prime Minister of Malaysia and the governor of Johor became co-chairmen, and are managing the entire project. The organizational chart of IRDA is shown in Fig. 2-3. In this survey, the Resilient Environment Division of the Strategic Drivers Team served as a liaison desk.



Source: Taken from the website of IRDA

Figure ２-2 Positioning of IRDA



Source: Taken from the website of IRDA

Figure 2-3 Organizational chart of IRDA

2.2 Outline of Kota Kinabalu

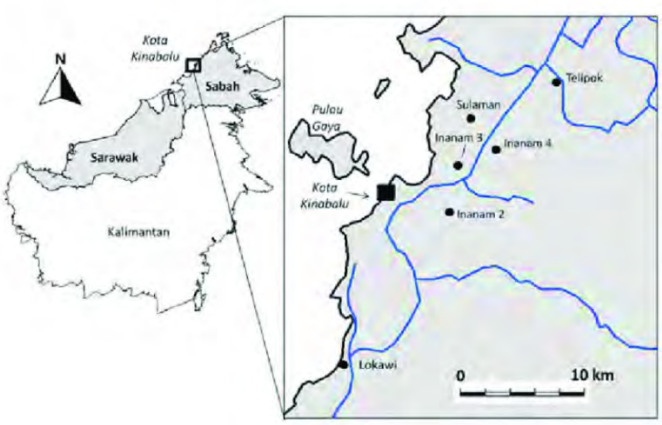
2.2.1 Basic information

Kota Kinabalu is the capital of Sabah, and serves as the hub of commerce and industries in Sabah as the largest city in eastern Malaysia. Its area is 394 km^2, and its population is about 470,000.

Its climate is tropical, so rainfall fluctuates considerably throughout the year, reaching a peak during the monsoon season around October. In 2019, they produced “Green City Action Plan Kota Kinabalu: KK GCAP” in order to make the city a clean, greenery-rich, comfortable place, by enlisting cooperation of ADB.

In addition, Sabah, which includes Kota Kinabalu, is located in northern Borneo, and its most part is covered with forests. It boasts Mt. Kinabalu, the highest mountain in Southeast Asia, and Kinabalu National Park, which was registered as a world heritage. Sabah is replete with energy resources, such as petroleum and natural gas, but its economic power is inferior to the Malay Peninsula. In order to raise the economic level, the government announced “Sabah Development Corridor Blue Print 2008-2025” in January 2008. In the third phase (2016-2025) of the plan, they will develop infrastructure and improve manpower in Sabah, to transform Kota Kinabalu into a the most livable city in Asia and reel in direct investment from foreign countries, with the aim of growing the region as a major economic zone in eastern Malaysia. The development plan is composed of 4 sections: “sightseeing,” “distribution of goods,” “agriculture,” and “industry.” In the sightseeing section, they plan to organize tours under the theme of the environment (eco-tourism), conduct educational activities for raising citizens’ awareness of environmental conservation, and so on. In the agricultural section, they plan to research the development of biofuel.

According to this background, Kota Kinabalu requested Toyama City, which is a “futuristic environmental city” and a “futuristic city that would attain SDGs,” to cooperate in the micro-hydroelectric power generation utilizing the rich natural environment and the utilization of renewable energy through IRDA, and concluded an agreement for cooperation in February 2018.



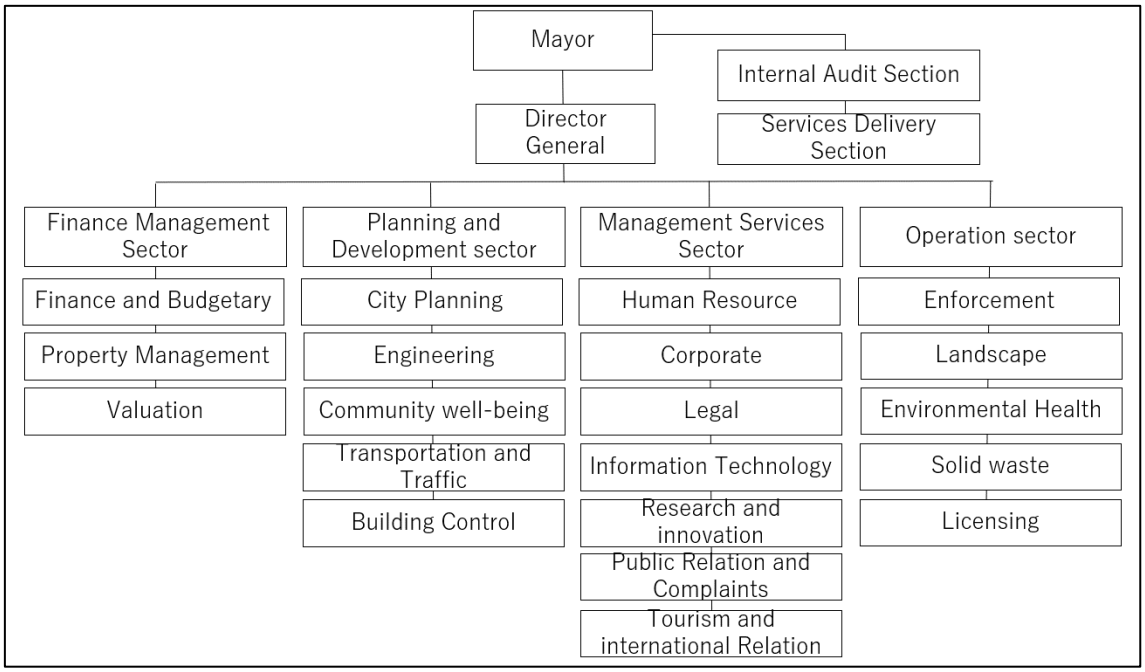
Source: https://www.researchgate.net/figure/Map-of-the-study-area-around-the-city-of-Kota-Kinabalu-West-Sabah-Malaysia-in-northern_fig2_341821831

Figure 2-4 Location of Kota Kinabalu

2.2.2 Structure of the Kota Kinabalu government

The organizational chart of Kota Kinabalu is shown in Fig. 2-5. There is the director general under

the mayor, and under them, there are 4 sectors led by 4 directors. In this survey, the Environmental Health and Solid Waste divisions of the Operation Sector served as main liaison desks.



Source: Produced by our company with reference to the material received from Kota Kinabalu.

Figure 2-5 Structure of the Kota Kinabalu government

Chapter 3　Urban development project centered around decarbonizing public transportation utilizing biofuel

3.1　Analysis of trends in related policies and systems

3.1.1　Policies and systems for biofuel utilization

Although Malaysia is an oil producer, its oil consumption has been increasing year after year with recent economic growth. In response to this, the government has enacted various policies and systems for biofuel as a measure to reduce reliance on fossil fuel resources in order to ensure future energy supply. The related policies and systems are summarized below.

1)Biofuel-specific policies and systems

①National Biofuel Policy (NBP) 2006

The National Biofuel Policy was announced in March 2006 as a major policy to support Malaysia's biodiesel industry. It aims to decrease the country's dependence on foreign oil, stabilize palm oil prices, and export biofuel.

The policy provides strategies for each of the following five sectors: ① Biofuel for Transportation, ② Biofuel for Industry, ③ Biofuel Technologies, ④ Export of Biofuel, and ⑤ Biofuel for Cleaner Environment (Table 3-1), and in order to realize them, the short-, medium- and long-term implementation plans were also set out.

Table 3-1　Five strategies in the National Biofuel Policy

(1) Biofuel for Transportation	Diesel for land and sea transportation will be produced by blending biodiesel fuel derived from palm oil (5%), and called B-5 fuel. This B5 fuel will be made available throughout the country. The main user of diesel which is highly subsidised will be given priority in this policy.
(2) Biofuel for Industry	B5 fuel will also be supplied to the industrial sector for boilers for manufacturing, construction, and generators.
(3) Biofuel Technologies	Research, development and commercialisation of biofuel technologies (including technologies for extraction of minor components) will be conducted and adequately funded by both the government and private sectors including venture capitalists to enable increased use of biofuel.
(4) Export of Biofuel	In order to meet the global demand for biofuel, which will grow from now on, Malaysia will encourage and facilitate the establishment of plants for producing biofuel for

	export.
(5) Biofuel for Cleaner Environment	The use of biofuel will reduce the use of fossil fuels, minimize the emissions of greenhouse gases (carbon dioxide), carbon monoxide, sulphur dioxide and particulates.

Among the implementation plans, the short-term plan includes the establishment of the Malaysian standard specifications of B-5 diesel fuel and the installation of the stations suitable for the B-5 diesel specifications. The medium-term plan clearly states that a law requiring the specifications of biodiesel will be passed, and in preparation the Malaysian government made it mandatory to use domestic biodiesel fuel of palm-oil origin (B-5 fuel produced by blending biodiesel derived from palm oil (5%) with light oil) on the vehicles owned by government agencies from February 2009. In addition, the long-term plan mentions that more biofuel technologies from Malaysian and overseas companies will be adopted. This indicates Malaysia's willingness to secure more technologies related to the utilization of biofuel.

The plan also introduces the methods of investment promotion as an example of the incentive of biofuel use. More specifically, biodiesel is included in the list of products/activities encouraged under the Promotion of Investment Act 1986, and the biodiesel-related projects are considered priority businesses and eligible for investment tax deductions. If these projects meet certain criteria, incentives for strategic or high-tech projects and those for the commercialization of the findings of R&D by the public sector in resource-based industries may also be considered.

②The Malaysian Biofuel Industry Act 2007

The Malaysian Biofuel Industry Act 2007 was formulated in response to the National Biofuel Policy and came into effect in November 2008. The act stipulates the mandatory mixing of biofuel and petroleum diesel, as well as the authorization of downstream activities such as production, mixing, storage, transportation, and export. Previously, the companies wanting to produce biofuel had to obtain two types of licenses, but after its enforcement, they were unified into one license and the management of license holders was streamlined. With the law's enforcement, the government approved licenses for 56 operators by March 2010, increasing the total production capacity of biofuel to 6.8 million tons.[1]

[1] Chin, M. 2011 Biofuels in Malaysia: an analysis of the legal and institutional framework. Working Paper 64. CIFOR, Bogor, Indonesia

2)Biofuel-related policies and systems

①National Development Plan

The highest decision-making body for the economic and socio-economic affairs in Malaysia is the National Planning Committee (NPC), an economic affairs department of the Cabinet chaired by the Prime Minister. The NPC is tasked with formulating the country's long-term economic plans according to the long-term prospect, and the five-year plans for their operation are devised based on these plans.

In 1991, the then-Prime Minister Mahathir launched Vision 2020, the blueprint for Malaysia to join the developed countries in all aspects, including economic and cultural aspects, by 2020, and presented the guidelines for the national policies of the following 30 years. It has been the basis of the country's economic and industrial implementation policies ever since. Despite the adversities such as the Asian currency crisis of 1997 and the global financial crisis that spanned from 2008 into the following year, Malaysia would forge ahead to achieve its goal to join the developed countries by 2020.

The Mahathir administration also carried out a medium-term review of the Eleventh Malaysia Plan, the five-year national plan, and an interim report and the revised plan were announced on October 18, 2018. In the revised five-year plan, six new pillars were defined, and 19 priority areas and 66 strategies were formulated around these pillars with the aim of fiscal stabilization and comprehensive growth. The six pillars are: (i) reforming governance toward greater transparency and enhancing efficiency of public services, (ii) enhancing comprehensive development and wellbeing, (iii) pursuing balanced regional development, (iv) developing the abilities of human capital, (v) enhancing environmental sustainability through green growth, and (vi) strengthening economic growth. Incidentally, the Twelfth Malaysia Plan – the five-year plan from 2021 to 2025 – was originally scheduled to be submitted to the parliament in August 2020, but has been postponed until early 2021 due to the impact of COVID-19.

In October 2019, as a successor to Vision 2020 launched in 1991, the then-Prime Minister Mahathir also unveiled the "Shared Prosperity Vision 2030 (SPV2030)" that incorporated the 10-year national development plan for the 2021-2030 period. This plan is aimed at achieving "sustainable growth through fair and equitable distribution among income groups, ethnic groups, religions, and supply chains" by 2030. SPV2030 employs the Seven Strategic Thrusts (Table 3-2) and aspires to support the new areas, including renewable energy, as part of its priority economic growth activities.

Table ３-2 Strategic Thrusts of SPV2030

	戦略的推進力	主な具体目標
1	ビジネスおよび産業エコシステム	・中小企業によるGDP貢献比率を50％に ・中小企業における高度技術導入企業を30％に
2	重点経済成長活動(KEGAs)	・機械設備分野の投資額を全投資額の4割に ・イスラム金融や再生可能エネルギーなど新分野を育成
3	人的資本	・労働力の35％を高度人材に ・人的資源開発基金(HRDF)の40％をインダストリー4.0関連研修に
4	労働市場および従業員補償	・年齢、性別、民族、宗教などによる差別のない労働市場の実現 ・外国人労働者数の削減
5	社会福祉	・社会保障制度の拡大 ・各地域へのデイケアセンター設置
6	地域包括	・都市－農村間の公共交通機関の統合 ・地域間の所得格差を半減
7	社会関係資本	・汚職、宗教、環境、犯罪、健康など各種指標の改善

②Environmental Laws

In Malaysia, each government agency for specific types of projects and activities formulates, enforces, and has jurisdiction over laws and regulations, in order to address a wide range of environmental issues. Table 3-3 below shows the key laws and regulations concerning biofuel utilization.

Table ３-3 Key legislation of Malaysia concerning biofuel utilization

No.	Name of legislation	Source
1	Environmental Quality Act 1974	www.doe.gov.my
2	Sabah Environment Protection Enactment 2002	ww2.sabah.gov.my
3	Renewable Energy Act 2011	www.seda.gov.my

Since its enforcement in 1974, numerous amendments and new rules have been added to the Environmental Quality Act, which is the foundation of Malaysia's environmental management alongside the country’s environmental policies and climate-change policies, and the latest amendments came into effect on February 15, 2017. More than 30 regulations and orders have been issued according to this act, of which the order and regulations related to biofuel utilization are as follows.

- Environmental Quality (Prescribed Premises) (Crude Palm Oil) Order 1977 [P.U. (A) 199/77]
- Environmental Quality (Prescribed Premises) (Crude Palm Oil) Regulations 1977 [P.U. (A) 324/77]

③The Roundtable on Sustainable Palm Oil (RSPO)

The Roundtable for Sustainable Palm Oil was established in 2004 in order to enhance the sustainability of palm oil. The RSPO's certification requires the palm oil producers to meet 8 principles and 39 criteria covering management practices, social responsibility, and environmental considerations for their palm oil to be labelled as "certified sustainable palm oil."

As of March 2011, there are 53 RSPO certified palm oil production plants in Malaysia, producing about 2 million tons of certified palm oil. In December 2015, the Amsterdam Declaration was adopted with the aim of achieving 100% RSPO certification throughout Europe, helped by the commitment by the governments and industry associations in the European countries. Similar efforts towards sustainable production at the government level are beginning to emerge not only in Europe but also in China, India, Malaysia, Africa, and Latin America. According to the RSPO, of the approximately 3,000 members who had joined by 2016, the number of Malaysian and Japanese members was 128 and 51 respectively.[2]

At the 73rd Session of the United Nations General Assembly in New York on September 28, 2018, the then-Prime Minister Mahathir announced in his general debate speech that he planned to make the management of palm oil production governed by the Malaysian Sustainable Palm Oil (MSPO) would become compliant with a number of existing national laws and regulations by the end of 2019.

④National Policy on the Environment

The National Policy on the Environment which integrates the three elements of sustainable development – economic, social, and cultural development, and environmental conservation – drafted by the Ministry of Energy and Natural Resources was approved in 2002. The policy clearly states the goal of "achieving a pollution-free, safe, healthy, and productive environment for the current and future generations" with the utilization of biofuel.

⑤Energy-related policies and systems

Table 3-4 below shows Malaysia's energy-related policies and systems. Since the key policies on the utilization of renewable energy are outlined in Chapter 4, their details are omitted in this chapter.

Table 3-4 Key energy-related legislation of Malaysia

No.	Name	Overview
1	National Petroleum Policy (1975)	Established as a means of regulating the oil and gas industry in order to fulfil Malaysia's

[2] World Wide Fund for Nature Japan (2017): Sustainable procurement of palm oil and RSPO

		economic development needs.
2	National Energy Policy (1979)	Developed to ensure an efficient, safe, and environmentally sustainable supply of energy, including electricity. Three main targets (energy supply, usage, and environmental considerations) were cited.
3	National Depletion Policy (1980)	Introduced to curb the depletion of natural petroleum reserves as crude oil production was increasing rapidly.
4	The Four-Fuel Diversification Policy (1981)	Aimed at easing the over-reliance on crude oil by diversifying the supply of coal, natural gas, hydroelectric power, etc., in order to ensure the reliability and safety of energy supply.
5	The Fifth-Fuel Policy (2001)	Promotes new renewable energy sources such as oil palm, rice husks and woodchips to supplement the conventional energy supply.

⑥Green Technology Master Plan

The Green Technology Master Plan was developed with the aim of promoting the growth of Malaysia's green technology sector, based on the assumption that the country will see a strong demand for renewable energy and energy conservation arising in the near future. The 2017-2030 Green Technology Master Plan indicates that the capacity of biogas power generation equipment will increase from 5% in 2014 to 12% by 2020. In addition, in certain areas within the palm oil industry, methane collection will be made mandatory for all palm oil plants by 2020 as a condition to apply for a new license. This was started as part of the National Key Economic Areas (NKEA).

⑦Low Carbon Society Blueprint for Iskandar Malaysia 2025

As part of the green-industry revival strategies, the Iskandar region was chosen to become a global hub for the industry. Biofuel, biomass, nanotechnology, smart communities (urban and rural areas) and energy services are listed as the contributors for the green industries in the Iskandar region. To promote R&D in the strategic sectors, the technological developments related to renewable energy such as biofuel are being encouraged. In addition, it mentions the needs to establish a quality standard for the biofuel, as biofuel such as biodiesel and bioethanol are selected as an alternative to fossil fuels to help achieve a low-carbon society.

３．１．２ Policies and systems for public transportation-based urban development

1)The Eleventh Malaysia Plan 2016-2020

The Malaysian government has set the goal to reduce GHG emissions by 40% between 2005 and 2020. As a guideline for attaining this goal, the Eleventh Malaysia Plan (2016-2020) was announced in May 2015, and an interim review was conducted in October 2018 as described above. In the transportation sector, described in “Chapter 7: Strengthening infrastructure to support economic expansion,” the focus is on “Building a translation system for meeting demand” and “Encouraging sustainable energy use.” Table 3-5 shows the goals set for 2020 and the progress as of 2017.

The 2016-2017 interim review found that the affordable prices had made public transportation more accessible while pointing out the challenges such as the lack of maintenance and the difficulty of building new infrastructure due to insufficient investment. In addition, it has become apparent that the service providers are hesitating to invest in public transportation since the return is deemed too low for the amount of investment. Despite significant investments in urban rail and bus services, the use of public transportation remains low. High reliance on private vehicles, a lack of control over demand, and poor connectivity are indicated as the reasons.

Table ３-5 Goals and progress toward them in the public transport sector in the Eleventh Malaysia Plan

Goals set for 2020	Progress in 2016-2017
“Building a transportation system for meeting demand” - 40% share of public transportation in the Greater Kuala Lumpur (GKL) and KV	- 21% achieved
“Encouraging sustainable energy use to support growth” - New electric power supply in Peninsular Malaysia: 7,626 MW - Increase in LNG import capacity in Pengerang, Johor: 3.5 MTPA	- Achieved 3,825MW - Achieved

2)Transportation Blueprint 2010-2030 for Iskandar Malaysia

The Iskandar region’s population has been increasing every year since the region was designated as a priority area for the country’s development in 2006, and it is projected to reach 3 million by 2030. With the larger population, the number of private vehicles is expected to rise as well, deepening the urban problems such as traffic congestion and environmental problems more than ever. For this reason, “Transportation Blueprint 2010-2030 for Iskandar Malaysia” was created by IRDA to develop a more rigorous transportation infrastructure system.

To carry out the blueprint’s action plans efficiently, the IRDA has launched such organizations as

the Iskandar Malaysia Transport Council (IMTC), PAIM, and PPIM, and plans to deploy the BRT system.

The blueprint also focuses on adopting state-of-the-art green technologies, including engines and alternative fuels, as the means to achieve sustainable transportation and the environment for the next generation. More specifically, the focus is on fuel switching – the blueprint elaborates on the merits of importing less petroleum such as, the energy guarantee, being able to avoid competing for resources, and the transport users less likely to be affected by fluctuations in fuel prices.

3)Low Carbon Society Blueprint for Iskandar Malaysia 2025

Low Carbon Society Blueprint for Iskandar Malaysia 2025 was drawn up in cooperation with JICA and Japanese universities, with the aim of developing the Iskandar region into a sustainable metropolis of international standing by 2025. The blueprint outlines 12 Actions and over 300 programs.

The Iskandar region is the first municipality in Malaysia to set the targets to combat climate change. In this blueprint, GHG emission reduction target is put in place for each of 12 Actions, as shown in Table 3-1, and if all targets are reached, it will cut down 41% of GHG emissions by 2025, compared to the BaU scenario.

Mitigation Options	Reduction ($ktCO_2eq$)	Percentage (%)
Green Economy	6,937	54%
Action 1 Integrated Green Transportation	1,916	15%
Action 2 Green Industry	1,094	9%
Action 3 Low Carbon Urban Governance**	-	-
Action 4 Green Building and Construction	1,203	9%
Action 5 Green Energy System and Renewable Energy	2,725	21%
Green Community	2,727	21%
Action 6 Low Carbon Lifestyle	2,727	21%
Action 7 Community Engagement and Consensus Building**	-	-
Green Environment	3,094	25%
Action 8 Walkable, Safe and Livable City Design	263	2%
Action 9 Smart Urban Growth	1,214	10%
Action 10 Green and Blue Infrastructure and Rural Resources	392	3%
Action 11 Sustainable Waste Management	1,224	10%
Action 12 Clean Air Environment**	-	-
Total	12,758**	100%

Figure 3-1 GHG emission reduction targets for each of the 12 Actions

The blueprint also specifically gives priority to the Actions 1, 5, and 6, as they are indicating

significant GHG emission reductions. Below is the summary of these Actions.

①Action 1: Integrated Green Transportation

As seen above, the Iskandar region's population has been increasing constantly since the region was designated as a priority area for the country's development in 2006. According to the blueprint, if left unchecked, the growth in the transportation sector is expected to add to Iskandar Malaysia's carbon emission by 8,584 ktCO2 (27% of total BaU emission) by 2025. The Iskandar area residents also favor private vehicles such as cars (approx. 60%) and motorcycles (approx. 21%) as their modes of transportation, and when it comes to public transportation, 10% uses buses and 0% trains.

Because of these factors, Action 1 has set 1,916 kt-CO2 by 2025 as the GHG emission reduction target through the integrated green transportation. In addition, the blueprint asserts that it is essential to increase the use of public transportation to 50% or higher by 2030. More specifically, it recommends the reduction of car use rate to 25% and motorcycles to 10%, while increasing the use of buses and trains to 28%. Furthermore, it also states that all diesel engine buses currently operating in the Iskandar region will be phased out and replaced with CNG as part of the fuel switching measures for buses. In the meantime, CNG buses are presently costly, and the subsidies to construct the appropriate facilities are being requested.

②Action 2: Green Industry

Action 2 has 1,094 kt-CO2 by 2025 as its GHG emission reduction target through green industry. Green industries include energy-saving equipment, renewable energy, zero- and low-carbon alternative fuels. Action 2 also identifies industries and companies with high GHG emission reduction potentials (Table 3-6): Sime Darby is mentioned for the biofuel industry and Felda for the biomass industry.

Table 3-6 Industries and companies with high GHG emission reduction potential

Potential Strategic GI Sectors	Malaysian Industrial Player	Foreign Investors
Nanotechnology	Nano Malaysia Bhd	To be identified
Bio-fuel	Sime Darby	
Biomass	Felda	
Smart Community	IBM Malaysia	
Electric Vehicles	Proton	

③Action 5: Green Energy System and Renewable Energy

Action 5's GHG emission reduction target is set at 2,725kt-CO2 by 2025 via the green energy

systems and renewable energy. In addition to the following three action specifics, the policy also advocates the active diversion of POME to energy.

1. Promoting renewable and alternative energy use.
2. Providing sustainable, clean and efficient systems for both supply and demand sides by establishing advanced energy system such as decentralized power generation via smart grids.
3. Provision of incentives and subsidies for publicizing renewable and alternative energy.

3.2 Basic survey for the formulation of commercialization plans

In this section, we aim to formulate an urban development project based on decarbonized public transportation using biofuel, mainly in the Iskandar region and Kota Kinabalu City, and collected basic information necessary for the formation of the project through field surveys (online), bibliographic surveys, and interviews with related companies.

The following section summarizes the results of the surveys from the perspectives of manufacturing, transportation, and utilization, as well as the results of the study of possible business model proposals based on the collected information.

3.2.1 Grasping the biofuel supply potential

1)Biofuel production technology

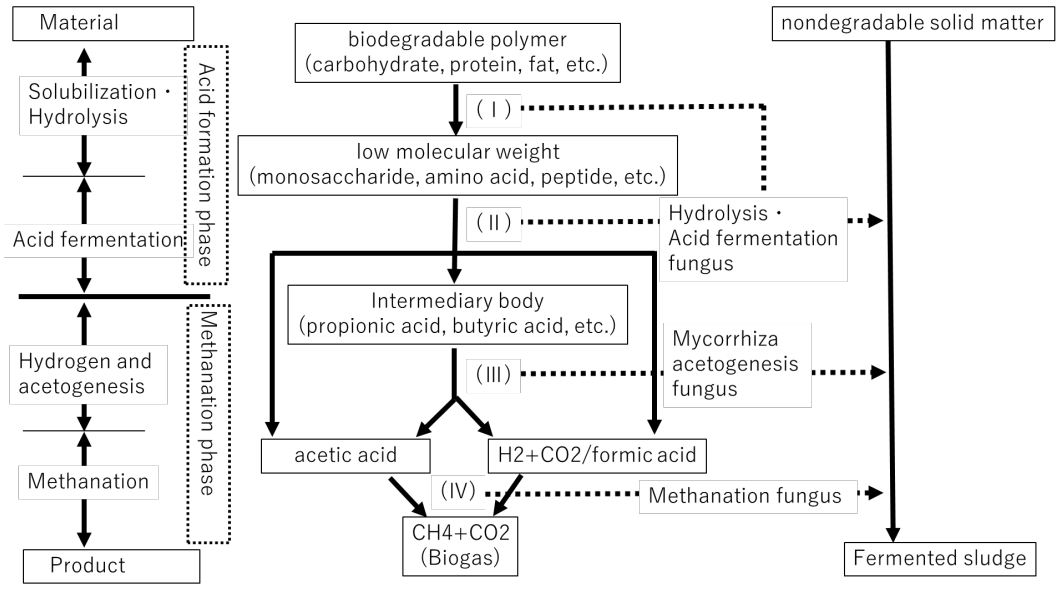
Methane fermentation is a technology to obtain biofuel from biomass. Methane fermentation is a reaction in which biomass (organic matter) is decomposed by anaerobic microorganisms under anaerobic conditions without oxygen, ultimately producing biogas consisting mainly of methane and carbon dioxide. Methane is combustible gas and can be used as a fuel. Therefore, methane fermentation is used as a technology that can recover biogas, or biofuel, from biomass,

If the carbon dioxide in the biogas is removed, it becomes methane gas, which can be used in the same way as city gas or propane gas commonly used in households. The difference is that the energy gained per the same volume is smaller. In order to meet the 13A thermal standard for gas in Japan, it is necessary to adjust the heat amount by mixing it with other gases such as ethane, propane, and butane.

The advantages of methane fermentation are, as mentioned above, the possibility of energy recovery and the ability to produce environmentally low-impact fuels from biomass wastes that used to be disposed of by incineration. The disadvantages include low removal rates of nitrogen compounds and phosphoric acid, long processing time, and the need for heating to maintain fermentation temperatures.

Methane fermentation can be divided into four main processes (Fig. 3-2), i.e., solubilization and hydrolysis, acid fermentation, production of hydrogen and acetic acid, and methane production. Biomass is decomposed and biogas is produced by the action of various anaerobic microorganisms.

In solubilization and hydrolysis, high-molecular-weight organic matter is broken down into low-molecular-weight organic matter, and in acid fermentation, intermediate organic acids, such as propionic acid and butyric acid, are produced. Then, after hydrogen and acetic acid, biogas consisting of methane and carbon dioxide is finally produced.



Source: http://www.env.go.jp/recycle/waste/biomass/foundation.html

Figure 3-2 Mechanism of methane fermentation

There are several types of methane fermentation depending on temperature, such as high or medium temperature, and moisture content, such as wet or dry.

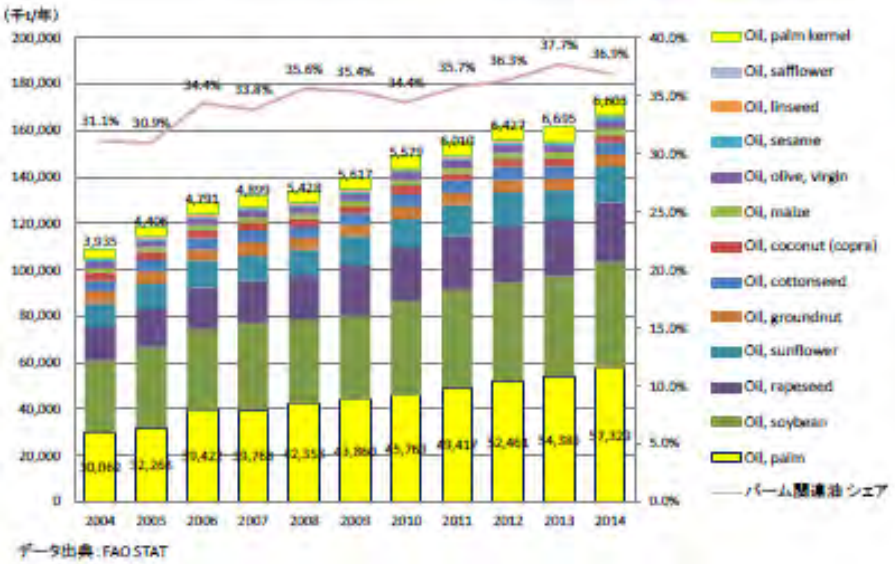
The amount of biogas generated depends on the type of biomass used for methane fermentation. As mentioned above, it depends on the ease of decomposition of the raw biomass, since the reaction is induced by a group of microorganisms. Also, many factors have to be considered, such as the moisture content of the raw material, the percentage of organic matter and nitrogen content, and so on.

Many studies have been conducted on biomass wastes such as food wastes, sewage sludge, and livestock manure as raw materials for methane fermentation. A lot of research is being conducted on mixing not only one raw material, but multiple biomasses. Organic materials can be methane-fermented to obtain biofuel, but energy can be obtained from biomass that would normally be incinerated by using biomass waste.

2)Status of POME processing in Malaysia

Malaysia is the world's second-largest palm oil producer (21.486 million tons, in 2014) (Fig. 3-3), Johor, where the Iskandar region is located, has the third-largest palm oil refining capacity in the

country (15.89 million tons FFB [Full Fruit Bunches], in 2015), and Sabah, where Kota Kinabalu is located, has the country's largest capacity (33.76 million tons FFB, in 2015; Table 3-7). Palm oil is a major export commodity in Malaysia and production is expected to increase in the future. However, the EU, which is a major export destination, has started to restrict imports of palm oil from the viewpoint of forest protection, etc. Under such severe scrutiny of the world, more sustainable development, such as RPSO certifications, is being demanded.



Source: Report on the Completion of the Project for Promotion and Demonstration of Advanced Wastewater Treatment and Resources Recycling at a Palm Oil Mill in Malaysia (JICA)

Figure 3-3 Global palm oil production

Table 3-7 Palm oil refining capacity in each state in Malaysia

州	国土面積	パーム農園の面積	農園面積比率	工場数	
				数量	精製能力
単位	ha	ha	%	-	tFFB/年
Malaysia全体	32,984,700	5,642,943	17.1%	445	108,396,400
Sabah	7,611,500	1,544,223	20.3%	129	33,763,200
Sarawak	12,445,000	1,439,359	11.6%	73	18,297,000
Johole	1,998,400	739,583	37.0%	61	15,885,400
Pahang	3,596,400	725,239	20.2%	71	15,692,200
Perak	2,100,600	398,314	19.0%	45	10,302,800
Terengganu	1,295,500	172,587	13.3%	13	3,317,600
Negeri Sembilan	664,500	177,741	26.7%	15	3,509,400
Selangor	795,600	137,336	17.3%	17	3,329,600
kelantan	1,492,200	151,973	10.2%	10	1,679,200
Kedah	942,600	87,244	9.3%	6	1,564,000
Malacca	165,000	54,603	33.1%	5	1,056,000
Penang	104,630	14,447	13.8%		
Perlis	81,000	294	0.4%		

データ出典：MPOB"Malaysian Oil Palm Statictics 2015"

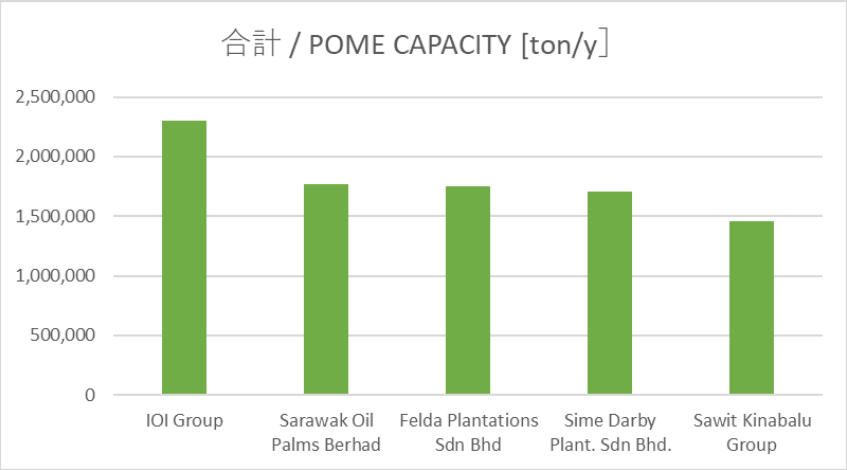
Source: Report on the Completion of the Project for Promotion and Demonstration of Advanced Wastewater Treatment and Resource Recycling at a Palm Oil Mill in Malaysia (JICA)

One of the environmental problems associated with the palm oil industry is the pollution of rivers by POME, the liquid waste discharged from palm oil mills, and the resulting greenhouse gas emissions. Pome contains high concentrations of organic pollutants, and its treatment has been an issue for many years. Many palm oil mills do not treat the waste liquid and discharge it into rivers with a large number of organic components. Particularly in Sabah, there are areas where people are forced to use water from rivers contaminated by POME for drinking, bathing, and other domestic purposes, and health problems have been reported. In response to these issues, the Malaysian government has set effluent standards through environmental regulations for the palm oil industry and requires POME to undergo appropriate treatment, but the degree of penetration of the regulations is currently low.

In addition, since the biomethane generated from POME is estimated to be equivalent to about 7% of Malaysia's total GHG emissions, the National Key Economic Areas (NKEA) has set 2020 as the target year to recover and reuse the methane gas emitted during the processing of POME. In the future, with the global trend toward a decarbonized society centered on the Paris Agreement, regulations to reduce greenhouse gas emissions in various industries are projected to advance, and this is expected to become an important issue for the palm oil industry as well.

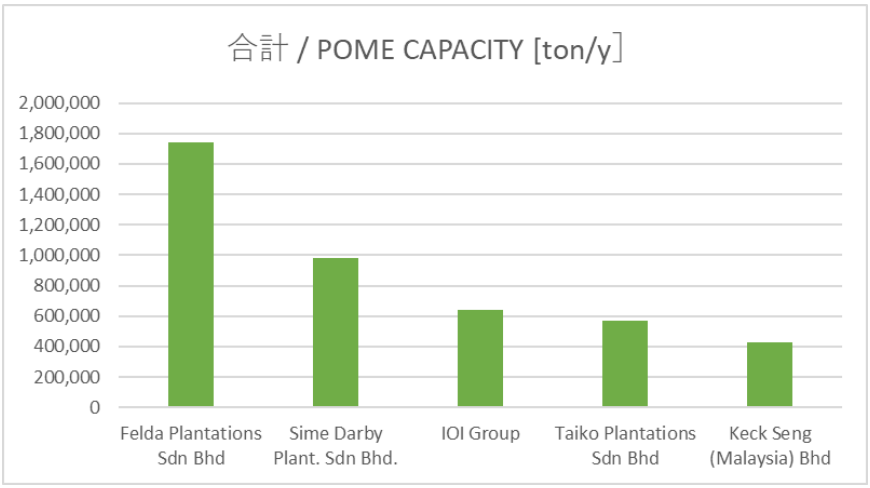
3)Understanding palm oil mills and biofuel supply potential

In this study, we have listed palm oil mills and their operators in the states of Johor, where the Iskandar region is located, and Sabah, where the city of Kota Kinabalu is located, based on bibliographic surveys and interviews with MIDA. Fig. 3-4 and Fig. 3-5 show the estimated POME generation based on the amount of palm oil refined by palm oil refineries and operators in each state. The annual amount of POME generated in Sabah was about 20.76 million tons (about 42% of Malaysia's total) and about 8.9 million tons (about 18% of Malaysia's total) in Johor as a whole, and IOI, Felda, and Sime Darby were among the top five companies in each state in terms of the amount of POME generated.



Source: Prepared by our company based on material, etc. received from MIDA.

Figure 3-4 Top five companies in terms of estimated POME generation (Sabah)



Source: Prepared by the company based on material, etc. received from MIDA.

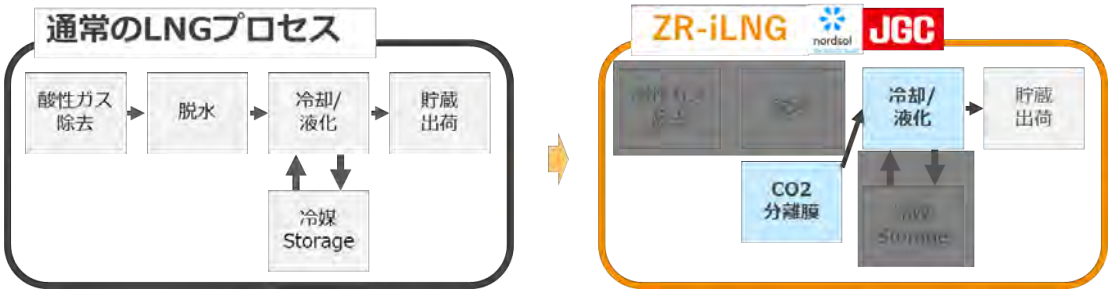
Figure 3-5 Top five companies in terms of estimated POME generation (Johor)

In the processes considered so far, the biogas recovered from POME is generally used in its gaseous state as an energy source, such as heat, in palm oil refineries where POME is generated. On the other hand, the amount of biogas that can be used in this process is greatly limited, compared to the amount of biogas generated, so there is little benefit for palm oil companies to invest in biogas recovery facilities. Furthermore, in terms of transportation, the amount that can be transported at one time is greatly limited when transporting in a gaseous state, unless pipelines and other infrastructure are in place. These are the reasons for the lack of progress in the utilization of biogas generated from POME.

Therefore, in the target project of this study, we examined the establishment of a supply chain for the use of biogas generated from POME by liquefying the biogas recovered from POME and turning it into LNG to solve the above problems. Specifically, we examined the use of ZR-iLNG technology,

which JGC Corporation is aiming to develop as a non-fossil fuel field, as a technology to convert the methane gas recovered from POME into LNG. The technology is an innovative process that eliminates the need for acid gas removal and refrigerant storage in the existing biogas LNG conversion processes, and can significantly reduce the number of equipment compared to the existing technology. Also, a 20-40% reduction in the initial investment can be expected through the reduction in the number of devices and the associated reduction in the required site area (Fig. 3-6).

Table 3-8 shows the method for calculating the supply potential of biofuels that can be produced if the above technology is adapted. Using the same calculation method, the bio-LNG potential that can be produced from palm oil refineries for each operator is shown in Fig. 3-7 and Fig. 3-8. In terms of bio-LNG production potential, the total of the top five companies with the highest production potential was about 117,000 tons per year in Sabah and about 58,000 tons per year in Johor.



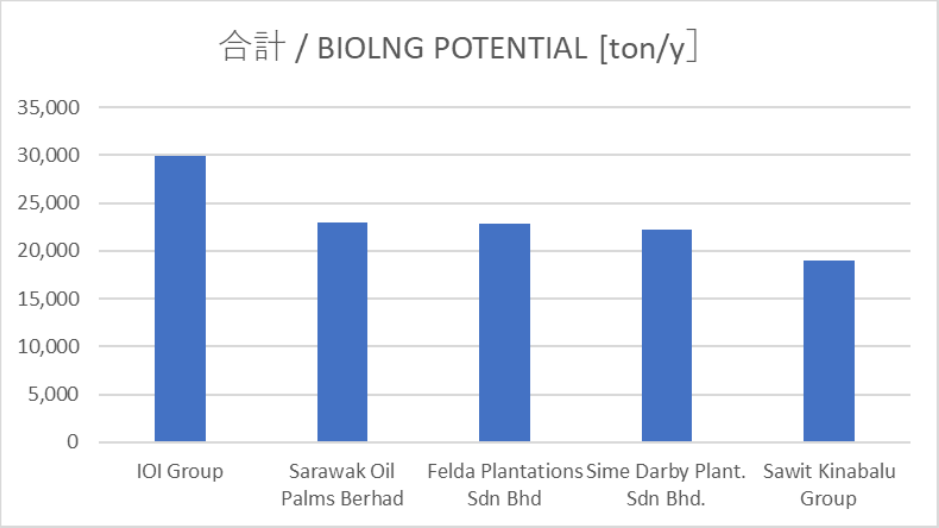
Source: received from JGC Corporation

Figure 3-6 Comparison between existing LNG conversion technologies and ZR-iLNG technology

Table 3-8 Calculation method of biofuel supply potential

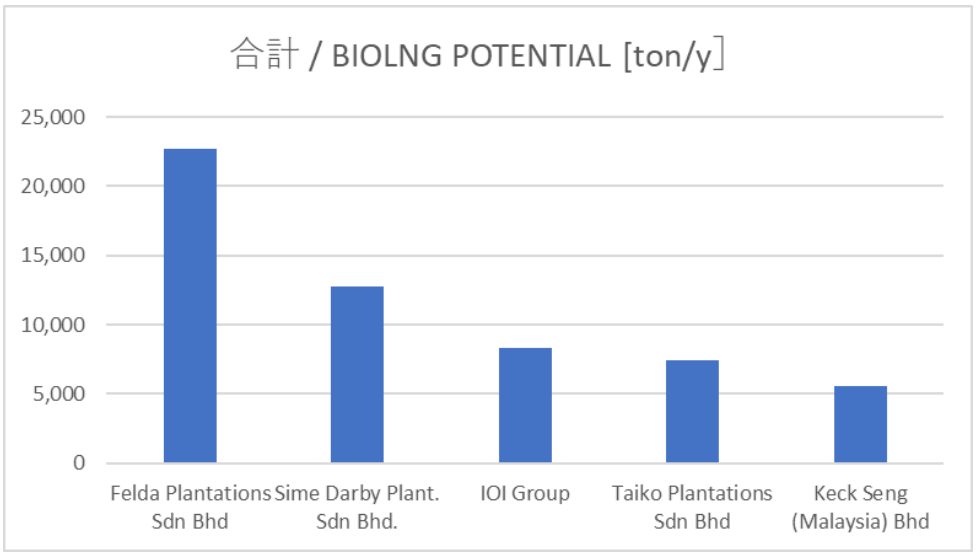
According to "Measurement of Methane Gas Emissions from a Lagoon System Treating Palm Oil Mill Effluent (Proceedings of JSCE (Environment), Vol.69, No.4, 157-165, 2013), the amount of biogas emitted from POME per ton is 28 m3, and it is reported that the biogas contains 65% methane gas. Therefore, by using the gas density of methane gas of 0.717 [kg/Nm3] for weight conversion, the amount of biofuel generated can be calculated by the following formula.

1 [t-POME] Weight of methane gas produced [kg]＝1 [t-POME] × 28 [Nm3/t-POME] ×0.65[%]×0.717[kg/Nm^3] ＝13.04[kg]＝0.013[t]



Source: Prepared by our company based on material, etc. received from MIDA.

Figure 3-7 Bio-LNG production potential of each business operator (Sabah)



Source: Prepared by the company based on material, etc. received from MIDA.

Figure 3-8 Bio-LNG production potential of each business operator (Johor)

Next, the top five companies with the largest supply potential of biofuel were selected, and their management policies were confirmed through their corporate websites, press releases, and interviews with MIDA. As a result, Sime Darby Plantation Berhad, which is listed as a company with high potential in the biofuel industry in the Iskandar region with a strong interest in decarbonization and low-carbonization, including biofuel supply businesses, and is a founding member of the Roundtable for Sustainable Palm Oil (hereinafter referred to as RSPO), an international certification system for the production and use of sustainable palm oil, was selected as

the candidate company to implement the biofuel supply project.

Sime Darby Plantation was established in 2007 to serve as the plantation and agribusiness division of the Sime Darby Group, one of its five core divisions, and is involved in the palm oil value chain from upstream to downstream. The company has the world's largest planted area and is the world's largest producer of certified sustainable palm oil (CSPO) at 2.496 billion tons. Also, in order to fulfill its production responsibilities, the company is actively engaged in the research and development of renewable energy and green technologies, such as the production of biogas and bio-based chemicals. Specifically, it has set a target of reducing carbon dioxide emissions by 40% by 2030 by utilizing the biogas recovered from POME. Currently, there are nine biogas power plants in operation in Malaysia (Table 3-9), with plans to add seven more plants between 2020 and 2025. As a result of these activities, the company was awarded the Sustainable Business Awards (SBA) by the Ministry of Energy, Science, Technology, Environment, and Climate Change of Malaysia in January 2019.

Table 3-9 Biogas power plants owned by Sime Darby Plantation

	
Flemington Biogas Plant	Flemington Biogas Plant
	
Chersonese Biogas Plant	View of the lagoon under construction

Source: https://www.simedarbyplantation.com/content/biogas

The list of palm oil refineries managed by the company in Sabah and Johor is shown in Table 3-10 and the maps are shown in Fig. 3-9 and Fig. 3-10. It was found that eight plants in Sabah have a total

supply potential of 22,500 tons/year, and five plants in Johor have a total supply of about 12,900 tons/year of bio-LNG. In terms of LNG power plants, this is equivalent to the amount needed to operate a power plant with an installed capacity of about 20 MW and 10 MW for one year, respectively, so they can be said to have great potential.

Table 3-10 Palm oil refineries owned by Sime Darby Plantation

No	PALM OIL MILL	STATES	ADDRESS	FFB CAPACITY [ton/hr]	FFB CAPACITY [ton/y]	POME CAPACITY [ton/y]	BIOLNG POTENTIAL [ton/y]
1	Merotai Oil Mill	SABAH	KKS Merotai, P.O. Box 135, 91007 Tawau	90	534,600	320,760	4,200
2	Lavang Oil Mill	SABAH	KKS Lavang, P.O. Box 1288, 97008 Bintulu	90	534,600	320,760	4,200
3	Sandakan Bay Oil Mill	SABAH	KKS Sandakan, Locked Bag 39, 90009 Sandakan	60	356,400	213,840	2,800
4	Pekaka Oil Mill	SABAH	KKS Pekaka, P.O. Box 1641, 97010 Bintulu	60	356,400	213,840	2,800
5	Rajawali Oil Mill	SABAH	KKS Rajawali, P.O. Box 2324, 97011 Bintulu	60	356,400	213,840	2,800
6	Binuang Oil Mill	SABAH	KKS Binuang, P.O. Box 130, 91207 Kunak	40	237,600	142,560	1,900
7	Glram Oil Mill	SABAH	KKS Giram, P.O. Box 19, 91207 Kunak	40	237,600	142,560	1,900
8	Derawan Oil Mill	SABAH	KKS Derawan, P.O.Box 2324, 97011 Bintulu	40	237,600	142,560	1,900
9	Gunung Mas Oil Mill	JOHORE	KKS Gunung Mas, K/B 524, 86009 Kluang	60	356,400	213,840	2,800
10	Hadapan Oil Mill	JOHORE	KKS Hadapan,09,Bt 6, Jln Bkt Permai, Bkt Permai, 81850 Layang Layang	60	356,400	213,840	2,800
11	Ulu Ramis Oil Mill	JOHORE	KKS Ulu Remis, P.O. Box 107, 81850 Layang Layang	60	356,400	213,840	2,800
12	Pagoh Oil Mill	JOHORE	KKS Pagoh, P.O. Box 101, 84300 Bukit Pasir, Muar	45	267,300	160,380	2,100
13	Chaah Palm Oil Mill	JOHORE	KKS Cha'ah, Peti Surat 104, 85400 Cha'ah	30	178,200	106,920	1,400
14	Bukit Benut Oil Mill	JOHORE	KKS Bukit Benut, P.O.Box 513, 86009 Kluang	20	118,800	71,280	1,000

*Blue ruled lines indicate plants that have already installed biogas power plants.
Source: Prepared by our company based on material, etc. received from JGC Corporation.

Source: Prepared by our company based on material, etc. received from JGC Corporation.

Figure 3-9 Palm oil refineries managed by Sime Darby Plantation (Sabah)

Source: Prepared by our company based on material, etc. received from JGC Corporation.

Figure 3-10 Palm oil refineries managed by Sime Darby Plantation (Johor)

Based on the above, online interviews were held with the company twice, in October 2020 and January 2021, to discuss the possibility of considering the commercialization of the biofuel supply business. The summary of the interviews is shown in Table 3-11 and Table 3-12. As can be seen from the results of the interviews, Sime Darby is very interested in the POME-derived biogas business and has a strong will to expand the biogas power generation business that is already in operation. They are also conducting their own research on how to produce biogas, and have found that they have the potential to produce more biogas than conventional methods. On the other hand, the awareness of decarbonization is still low in Malaysia and the focus is on cost, so exporting to other countries seems to be the basic concept. Therefore, it was suggested that if the project were to be implemented in Malaysia, it would be necessary to find off-takers in the Japanese side who are highly conscious of decarbonization and establish a biofuel supply chain from upstream to downstream.

Table 3-11 Outline of the interview with Sime Darby Plantation (October 9, 2020)

Participants	Sime Darby Plantation (3 participants), Japan NUS (3 participants), and JGC Global (6 participants)
Outline of the interview	・We understood that they are looking for a plant that they can extract biogas from POME to meet a request from the Japan's side. ・As for the treatment of POME, all factories have basically adopted an open aerobic digestion system in accordance with local laws. It is left to the initiative of each plant to cover the swamp. ・As a method of producing biogas, covering with sheets is inexpensive, but

	it takes time to gasify. On the other hand, tanks require additional costs, but can produce only the amount of gas needed, and the production time is shorter. ・Of the six factories in Johor, two are already in the biogas business and are benefiting from biogas power generation. ・As for the electricity generated, 100% is sold due to the high price of FIT. ・At present, 80% of the gas generated from POME is being used, and the remaining 20% is being released into atmosphere. ・In Sabah, there is no plant within about 3 hours away by land from the center of the state. ・Sime Darby is currently conducting research on a new biogas production method to replace the conventional biogas production method. ・There is a prospect of recovering a large amount of gas with a small amount of POME by using this method. Although there are precedents in Europe, there is none in Asia. ・If this technology is to be used, it could be considered as a target for FS because it could be done in small-scale factories. ・The use of bio-LNG and bio-CNG is an excellent plan, and we believe that demand will continue to rise, but the question is whether we can find companies willing to invest. If possible, it would be better for Japan to invest in the whole process from upstream to downstream to increase the possibility of commercialization.

Table 3-12 Outline of the interview with Sime Darby Plantation (January 21, 2021)

Participants	Sime Darby Plantation (1 participant), Biotek Dinamik (1 participant), IRDA (1 participant), and JGC Corporation (2 participants).
Outline of the interview	・Discussions were held on the effective use of POME-derived biofuels. ・Three options for using biofuels can be considered: CNG, LNG, and hydrogen. ・The current biogas power generation facility uses CNG to generate electricity. There was an option to use LNG, but CNG was chosen as the facility was too large for the scale. ・Hydrogen is expected to be generated by steam reforming of biomethane. ・There have been inquiries for hydrogen from several European vendors for hydrogen, and it is expected that it will be produced cheaply. ・As for hydrogen, exporting it to Japan is one of the options. The reason for

	this is that although low-cost hydrogen (green hydrogen/blue hydrogen/gray hydrogen) is transported from Australia to Japan now, Malaysia can compete with Australia because the transportation distance is half that of Australia and the transportation cost can be reduced. ・Unfortunately, decarbonization incentives are currently low in Malaysia, and off-takers are completely focused on cost. For this reason, attention is being paid to overseas. ・In the future, we will conclude an NDA and conduct specific exchanges.

4)Grasping other biofuel supply potential

In order to establish a supply chain for biofuels, it is very important to make the volume of biofuels handled as large as possible and ensure the economic viability of the business. Therefore, this study summarized the generation status of “food waste,” “sewage sludge,” and “livestock manure” in Malaysia as candidates for biofuel sources other than palm oil mills.

①Food waste

Food wastes include residues from food processing plants, waste from restaurants, and food waste from households. In general, the amount of biogas generated from food waste is high, depending on the type of food. In Japan, food waste is generally incinerated or disposed of in landfills, and the same is true in Malaysia.

In Malaysia, food accounted for 45% of the 19,000 tons/day of solid waste in 2005, and is estimated to account for 44.5% of the 33,000 tons/day of solid waste in 2012.[3] In other words, it is estimated that about 15,000 tons of food is wasted per day in Malaysia, or about 5.4 million tons per year.

Since it is said that 150 Nm3/t of biogas is produced from food waste[4], 2,700 tons/day or 980,000 tons/year of biogas can be generated assuming methane fermentation using food waste as a source of biomass, and 950 tons/day or 350,000 tons/year of methane gas can be generated assuming that 60% of the biogas is methane.

②Sewage sludge

When water is treated at a sewage treatment plant, sludge is always generated. Sewage sludge is generally incinerated, but it requires a lot of energy for incineration due to its high water content, and it is also separated into solid and liquid components before incineration, and the liquid component is further treated as wastewater, which requires a lot of energy for disposal. For this reason, research on methane fermentation using sewage sludge as a source of biomass has been actively conducted.

[3] https://www.env.go.jp/recycle/circul/venous_industry/pdf/malaysia.pdf
[4] https://www.env.go.jp/recycle/report/h28-10/manual2_syousai.pdf

Although the amount of biogas generated per ton of sewage sludge is smaller than that of food waste, sewage sludge is always generated as long as people live using water, so ways to utilize it are being explored and methane fermentation is one of them.

It is estimated that 4.3 million m3 of sewage sludge is produced annually in Malaysia.[5]

Sewage sludge can produce 12-14 Nm3/tons of biogas.[6] Assuming methane fermentation using sludge as the source of biomass, 68,000 tons/year of biogas will be produced in Malaysia as a whole, and assuming that 60% of the biogas is methane, 24,000 tons/year of methane gas will be produced in Malaysia as a whole.

③Livestock manure

Livestock manure is generally composted, but there are problems such as limited places to accept it after composting and bad odor. While the composting process is often used in Japan, some farmers have already installed methane fermentation facilities to produce biogas.

In Malaysia, 750,000 dairy cattle and 2.1 million pigs are being raised.[7]

The amount of biogas generated varies greatly depending on the type of livestock. Dairy cattle manure produces 15-30 Nm3/tons and pig manure produces 19-34 Nm3/tons of biogas.[8] Although the amount of biogas generated varies depending on the feed and other factors, assuming methane fermentation using manure from dairy cattle as the source of biomass, 300,000 tons/year of biogas will be produced and 100,000 tons/year of methane gas will be generated in Malaysia as a whole. Assuming methane fermentation using manure from swine as the source of biomass, 100,000 tons/year of biogas will be produced and 36,000 tons/year of methane gas will be generated in Malaysia as a whole.

Although only dairy cattle and pigs are mentioned above, other types of cattle such as beef cattle and egg-laying hens are raised in Malaysia, and it is thought that there is potential for livestock manure as a source of biomass.

３．２．２ Grasping of the actual situation of the business of transporting natural gas fuel (including biofuel)

1)Outline of the biofuel transportation system

The system for transporting biogas from palm oil factories to destinations is constituted by equipment for collecting biogas, a plant for processing the gas to produce LNG and CNG, transportation by truck, and transportation by ship or pipelines and satellite stations for receiving biogas and adjusting it so that users can use it.

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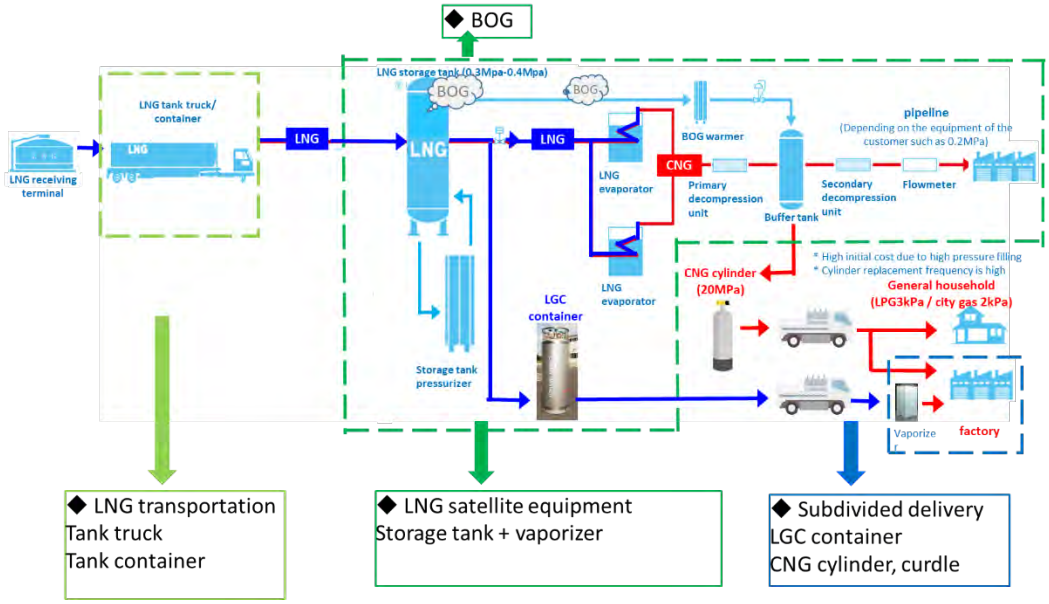
[5] https://openjicareport.jica.go.jp/pdf/11932357_01.pdf
[6] https://www.env.go.jp/recycle/report/h28-10/manual2_syousai.pdf
[7] https://lin.alic.go.jp/alic/month/fore/2005/dec/spe-02.htm
[8] https://www.env.go.jp/recycle/report/h28-10/manual2_syousai.pdf

In general, the imported LNG, which accounts for 97% of the natural gas used in Japan, is first received at the primary LNG acceptance station, is vaporized by a vaporizer, undergoes heat amount adjustment and odorization to be used as city gas, and is transported via pipelines to consumers. From the business viewpoint, a transportation method that does not require significant investment in facilities, such as tanker trucks, is generally adopted for regions where demand for gas is estimated to be small. LNG is transported by tanker truck or train, and vaporized and supplied by local stations (satellite stations) in the areas where it is consumed (Fig. 3-11).

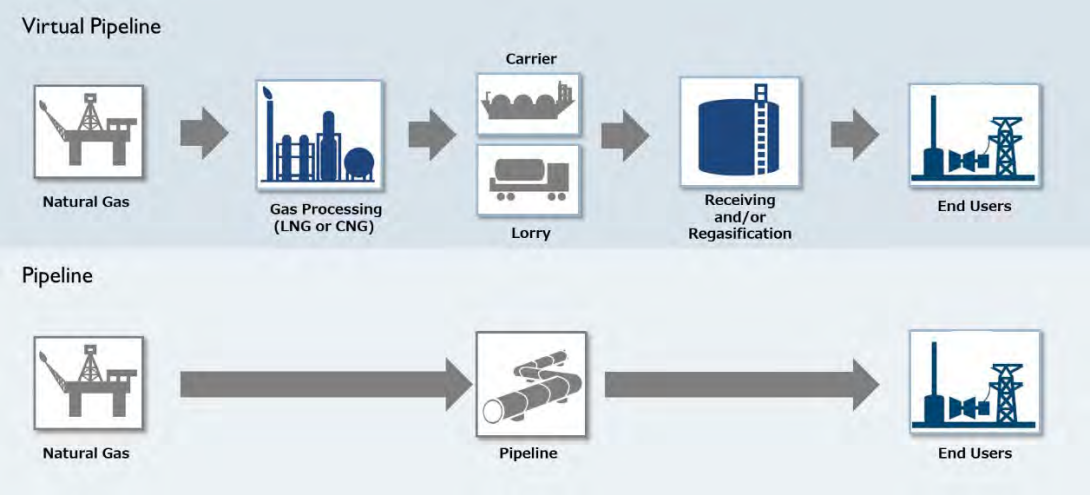
In the case of virtual pipelines for LNG, CNG, etc., raw gas is processed through liquefaction, compression, etc. as well as the pretreatment for removing impurities, and transported by truck, ship, or the like to places where they are consumed. Through virtual pipelines, it is possible to transport LNG, CNG, etc. to anywhere as long as it is profitable. Meanwhile, in the case of pipelines, it is necessary to construct new pipelines in order to extend existing routes, so pipelines with excessive capacities are first constructed in most cases. Accordingly, initial investment amounts tend to become large. Fig. 3-12 is the schematic diagram of gas flow.

The following section outlines necessary facilities for transporting fuel from supply areas to consumption areas and summarizes their characteristics, for discussing the biofuel use project.



Source: Provided by Hokusan Co., Ltd.

Figure 3-11 Chart of transportation and supply of natural gas in Japan



Source: Provided by JGC Corporation

Figure 3-12 Schematic diagram of gas flow (comparison between virtual and real pipelines)

①Biogas collection

The biogas generated from the pome left after palm oil production needs to be collected and made usable. There are the covered lagoon method (Fig. 3-13), in which the pome lagoon is covered and biogas is collected, and the tank method (Fig. 3-14), in which pome is fed to fixed tanks and biogas is generated inside the tanks. In general, the covered lagoon method is less expensive, but it requires a large area, so it is not adopted according to construction site.

Source: Handbook POME-to-Biogas Project Development in Indonesia Second Edition, WINROCK INTERNATIONAL, 2015

Figure 3-13 Covered lagoon method

Source: Handbook POME-to-Biogas Project Development in Indonesia
Second Edition, WINROCK INTERNATIONAL, 2015

Figure 3-14 Tank method

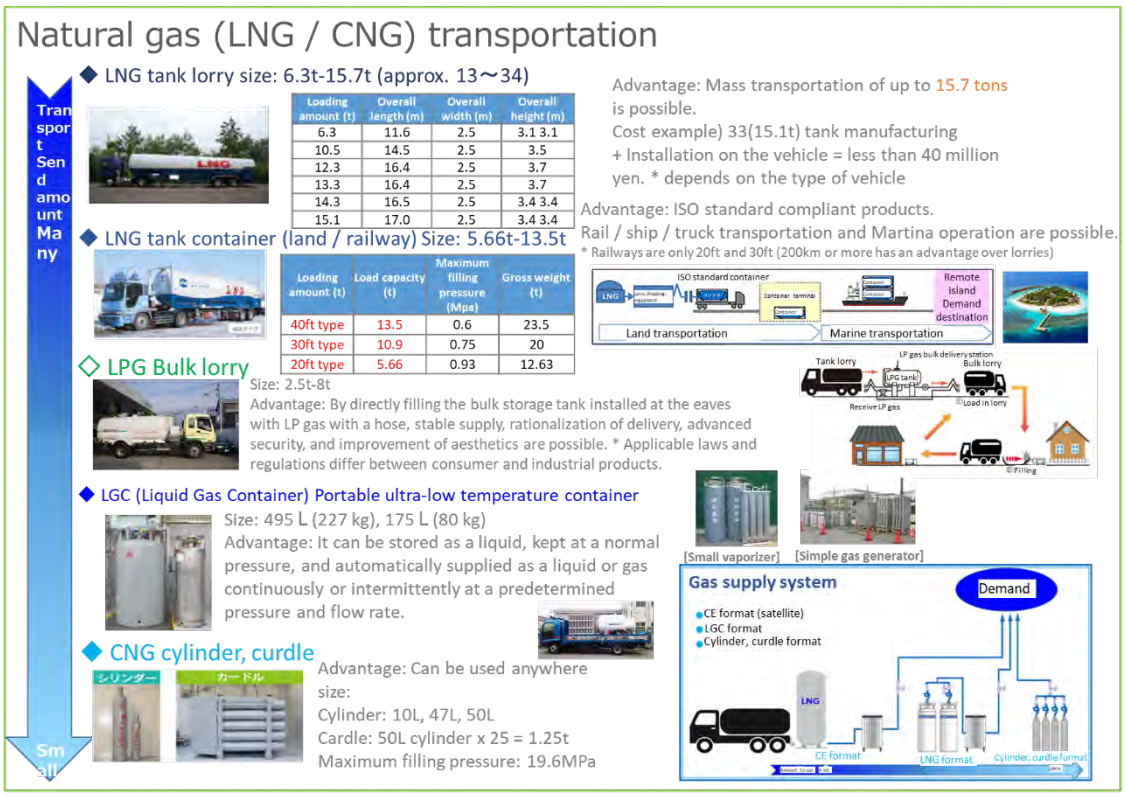
②Biogas transportation

Collected biogas is compressed or liquefied according to transportation distance and quantity, and transported to areas where it is consumed in the form of CNG or LNG. Table 3-13 shows the comparison between CNG and LNG in general characteristics. Transportation facilities vary according to transportation volume, but the outline is as shown in Fig. 3-15.

Table 3-13 Comparison between LNG and CNG

	LNG	CNG
Transportation distance	Long (over 100 km)	(10 km or less)
Transportation volume	Large (18 tons/truck)	Small (7.5 tons/truck)
Operation and management of production facilities	Because of the existence of deep-cooling units, facilities are complicated compared with those for CNG.	Because of simple pretreatment and compression processes, operation and management are easy compared with those for LNG.
Safety	Since gas pressure is relatively low, safety is high.	Since gas pressure is relatively high, it is necessary to be careful when handling LNG.

Initial investment	Plant: Relatively large Transportation: Energy density is high, so the number of tanker trucks is small.	Plant: Relatively large Transportation: Energy density is low, so the number of tanker trucks is large.

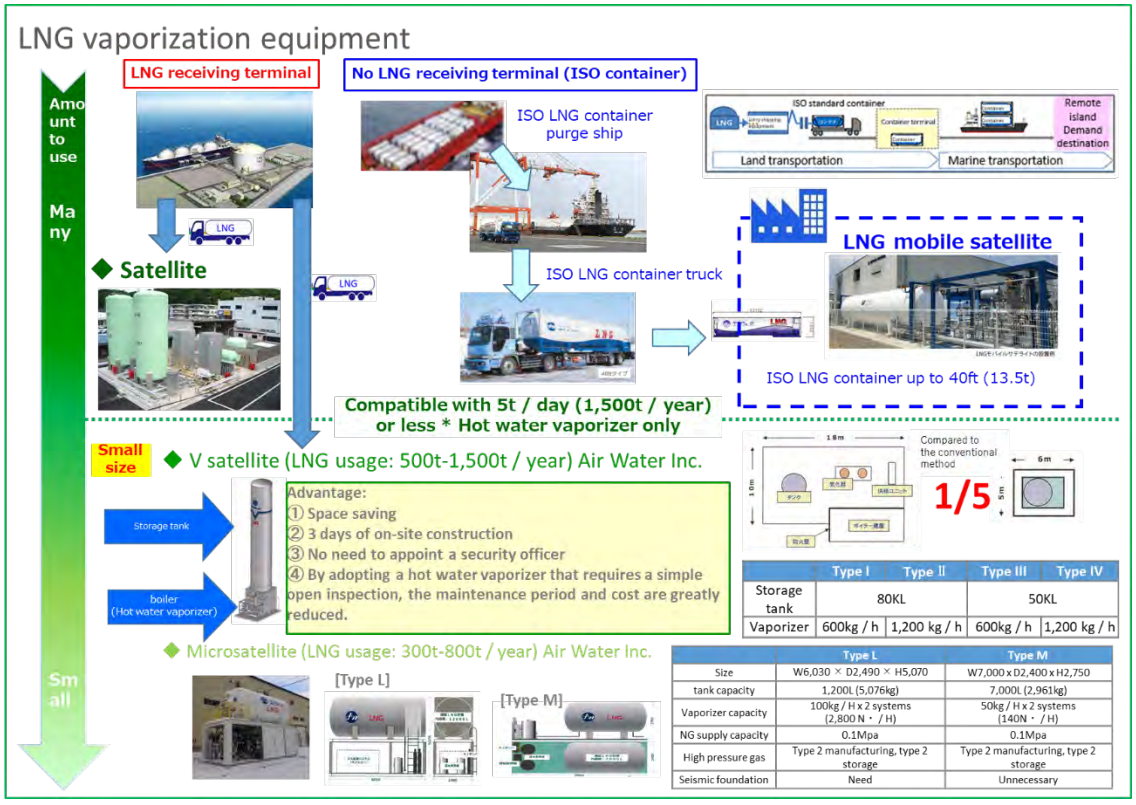


Source: Provided by Hokusan Co., Ltd.

Figure 3-15 Outline of the natural gas transportation method

③Satellite equipment for supplying biogas

When consumers use liquefied biogas, it is necessary to liquefy gas again with satellite equipment. The outline of satellite equipment is as shown in Fig. 3-16, and it is necessary to choose equipment according to the amount of consumption. When LNG is stored, part of it vaporizes spontaneously and the storage amount declines. Accordingly, when a large volume of LNG is stored, it is necessary to be careful because the evaporation volume is large.



Source: Provided by Hokusan Co., Ltd.

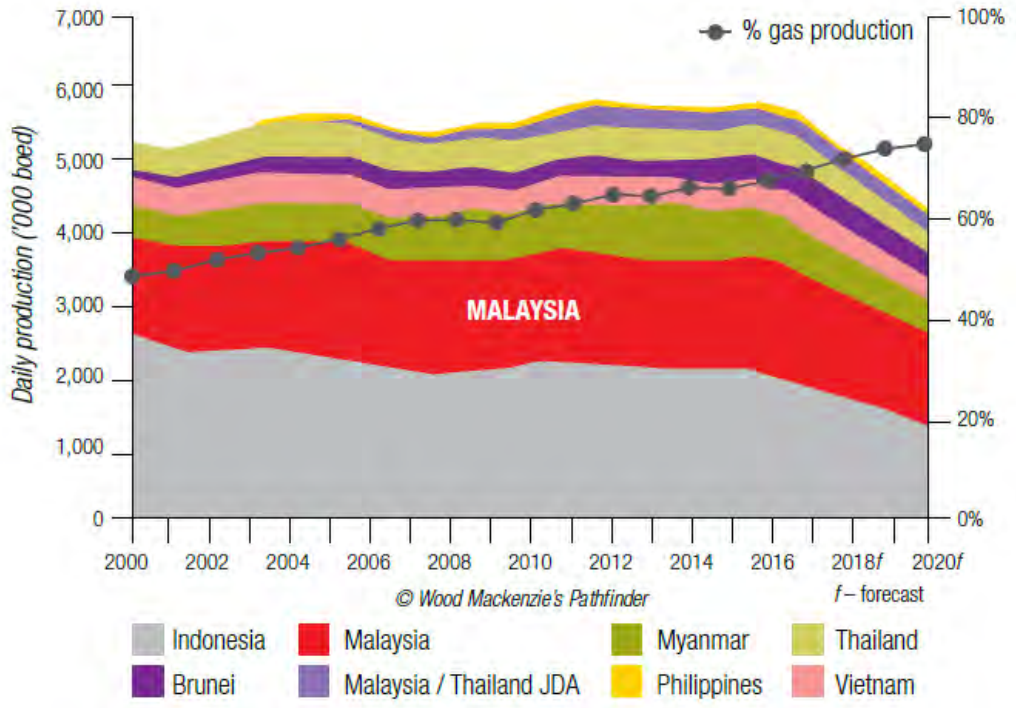
Figure 3-16 Outline of satellite equipment

2)Situation of the natural gas market and progress of gas infrastructure development in Malaysia

According to Meet Malaysia Investment Opportunities in Asia's Oil and Gas Hub (June 2020, MIDA), Malaysia has oil reserves of about 12,940 million barrels and natural gas reserves of 1.75 trillion m3, accounting for about 1.2% of global reserves. In Southeast Asia, the ratio of natural gas output is increasing year by year, and expected to reach 80% in 2020 (Fig. 3-17).

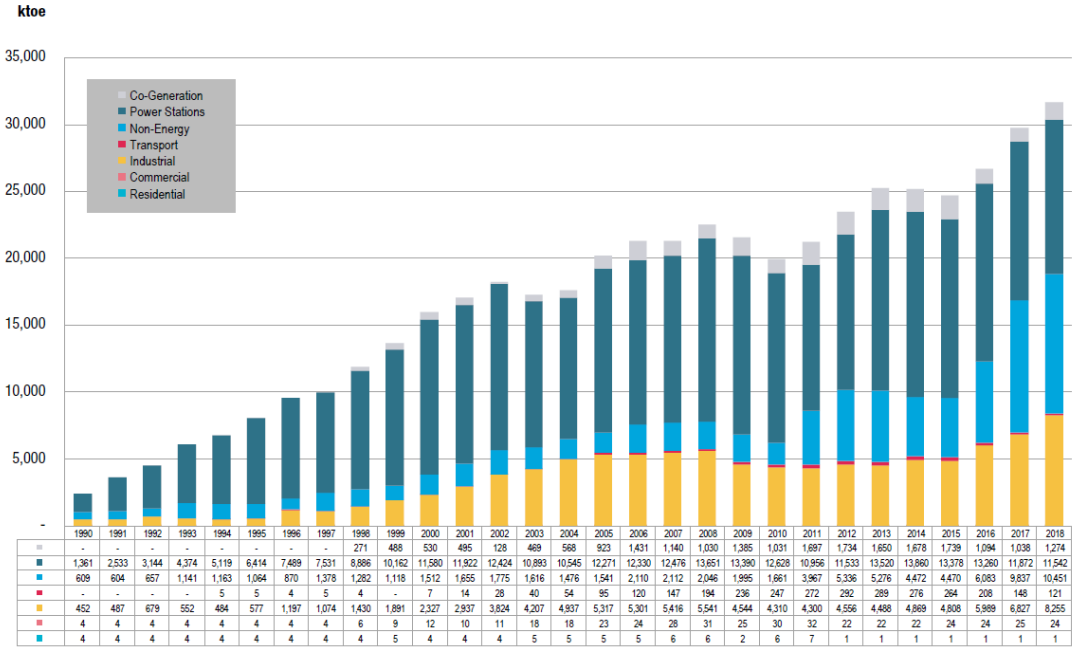
The Malaysian oil industry has been oligopolistic as it has been dominated by Shell and Esso for many years, but in 1974, the government-run oil company Petronas was founded, and in the 1980s, mining areas were opened based on a new production sharing system (PSC). The offshore mining area of Malaysia is large, and divided into "off the Malay Peninsula," "off Sarawak," and "off Sabah." It is difficult to directly transport natural gas collected off Sarawak to the Malay Peninsula, because the distance exceeds 1000 km and there exists an exclusive economic zone (EEZ) of Indonesia between Borneo and the Malay Peninsula (Fig. 3-19). Accordingly, the gas produced off Sarawak is mostly exported, because the demand inside the region is low. The gas produced off the Malay Peninsula is supplied to part of the Malay Peninsula by Peninsular Gas Utilization (PGU), but cannot satisfy demand, so LNG is imported. The natural gas produced off Sabah is partially consumed inside Sabah, but most of it is transported via Sabah-Sarawak Gas Pipeline (SSGP) to the LNG liquefaction plant in Sarawak, liquefied to produce LNG, and exported.

The gas price in Malaysia is determined based on the approval of the government, and it is said to be the lowest among ASEAN countries. When determining the price, neither the market concept nor costs are considered, so if the cost exceeds the selling price, the Malaysian government will pay a subsidy to Petronas.



Source: Meet Malaysia Investment Opportunities in Asia's Oil and Gas Hub

Figure 3-17 Variations in oil and gas production amounts in Southeast Asia



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Co-Generation	-	-	-	-	-	-	-	-	271	488	530	495	128	469	568	923	1,431	1,140	1,030	1,385	1,031	1,697	1,734	1,650	1,678	1,739	1,094	1,038	1,274
Power Stations	1,361	2,533	3,144	4,374	5,119	6,414	7,489	7,531	8,886	10,162	11,580	11,922	12,424	10,893	10,545	12,271	12,330	12,476	13,651	13,390	12,628	10,956	11,533	13,520	13,860	13,378	13,260	11,872	11,542
Non-Energy	609	604	657	1,141	1,163	1,064	870	1,378	1,282	1,118	1,512	1,655	1,775	1,616	1,476	1,541	2,110	2,112	2,046	1,995	1,661	3,967	5,336	5,276	4,472	4,470	6,083	9,837	10,451
Transport	-	-	-	-	5	5	4	5	4	-	7	14	28	40	54	95	120	147	194	236	247	272	292	289	276	264	208	148	121
Industrial	452	487	679	552	484	577	1,197	1,074	1,430	1,891	2,327	2,937	3,824	4,207	4,937	5,317	5,301	5,416	5,541	4,544	4,310	4,300	4,556	4,488	4,869	4,808	5,989	6,827	8,255
Commercial	4	4	4	4	4	4	4	4	6	9	12	10	11	18	18	23	24	28	31	25	30	32	22	22	22	24	24	25	24
Residential	4	4	4	4	4	4	4	4	4	5	4	4	4	5	5	5	5	6	6	2	6	7	1	1	1	1	1	1	1

Source: National Energy Balance 2018（Suruhanjaya Tenaga）

Figure 3-18 Variation in the ratio of natural gas consumption in Malaysia

Source: Discussion on Petronas (Part 2) (Japan Oil, Gas and Metals National Corporation in 2019)

Figure 3-19 Mining areas in Malaysia

Source: https://www.gasmalaysia.com/index.php/gas-fundamentals/peninsular-gas-utilisation-project

Figure 3-20 Peninsular Gas Utilization (PGU) Project

3)Existing natural gas transportation companies

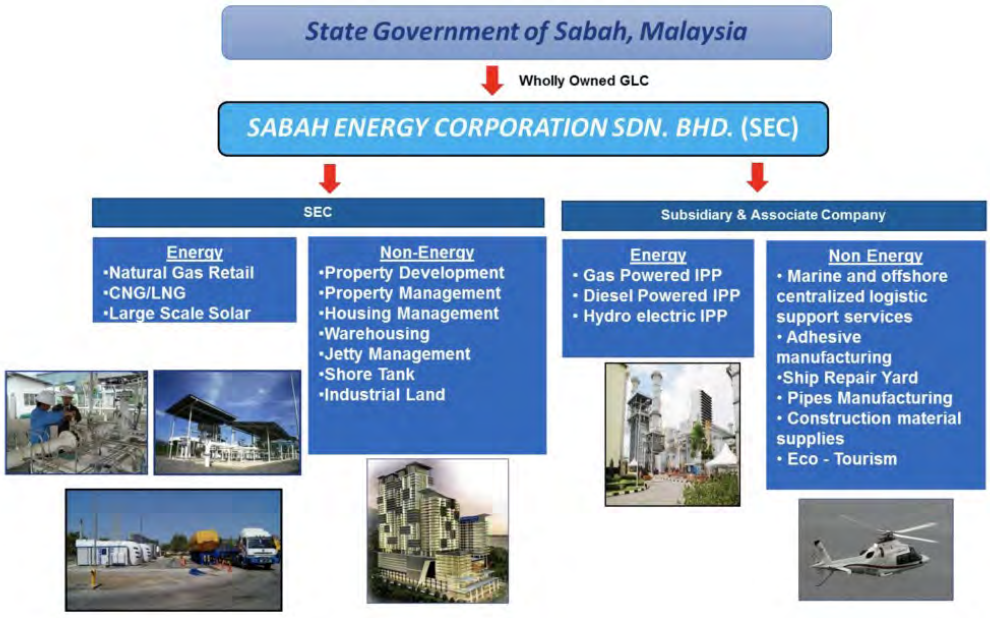
An existing natural gas transportation company in Kota Kitabalu is Sabah Energy Corporation Sendirian Berhad, which is supervised by the Sabah government. This company engages in a variety of activities, including energy-related businesses, such as the retail of natural gas and IPP, and non-energy businesses, such as logistics (Fig. 3-21).

As for transportation of natural gas, the company operates mainly three businesses: transportation via pipelines, CNG transportation, and LNG transportation.

As for transportation via pipelines, the company started services in November 1996, to supply natural gas to Kota Kinabalu Industrial Park (KKIP) in Kota Kinabalu and Lankalanka Industrial Park in Labuan.

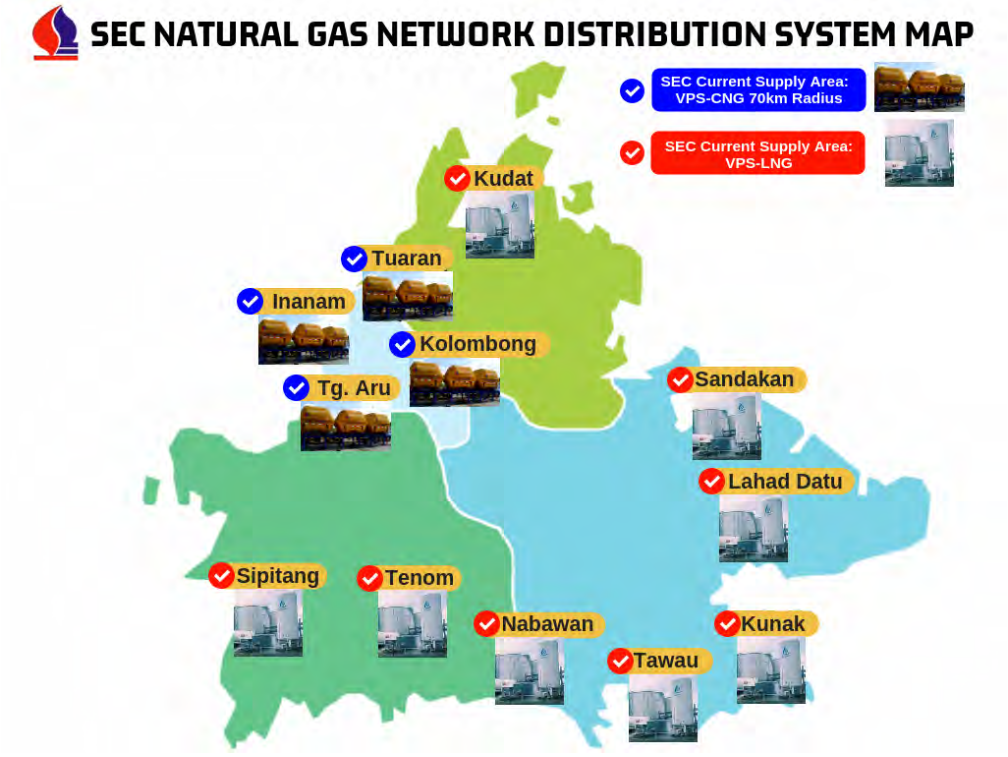
As for CNG transportation, the company supplies the gas to mainly KKIP (Fig. 3-22). The supply method is as shown in Fig. 3-23. Namely, CNG is supplied to the mother station of the industrial park at low pressures (4-17 bar), compressed to 250 bar, put into dedicated CNG tanks (Fig. 3-24), transported by dedicated truck or the like, and depressurized at sites where it is consumed.

As for LNG transportation, it is supplied more broadly than CNG, because it is more transportable (Fig. 3-22). The supply method is as shown in Fig. 3-25. LNG is produced with compact liquefaction equipment, and then it is gasified at sites where it is consumed.



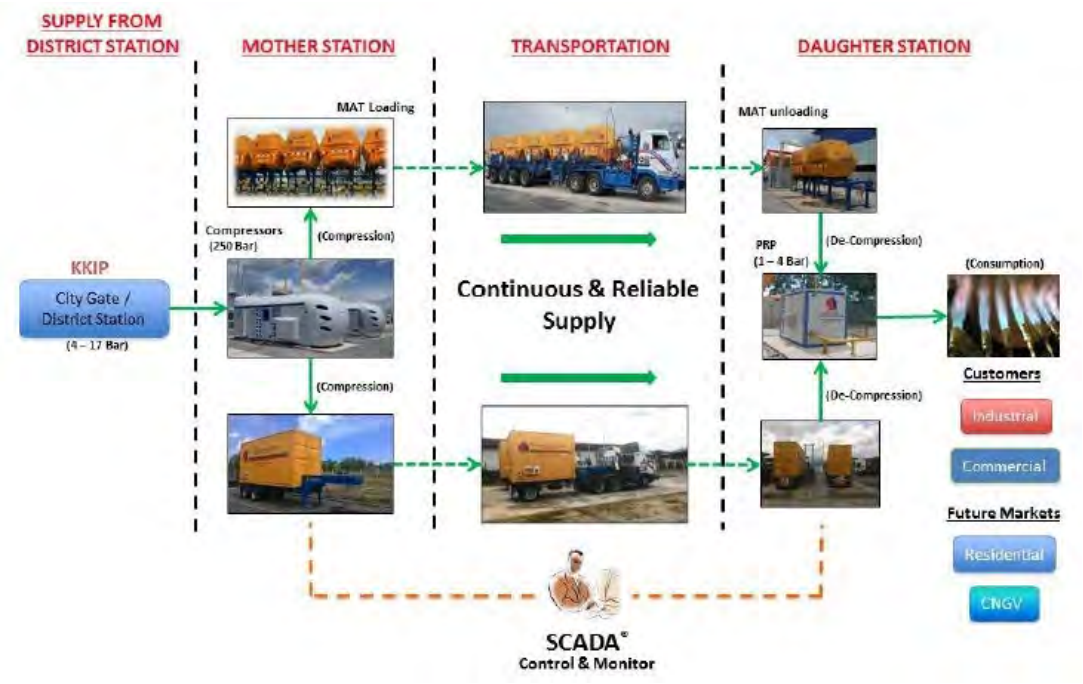
Source: https://www.sabahenergycorp.com

Figure 3-21 Outline of the business of Sabah Energy Corporation



Source: https://www.sabahenergycorp.com

Figure 3-22 Areas where CNG or LNG of Sabah Energy Corporation is supplied

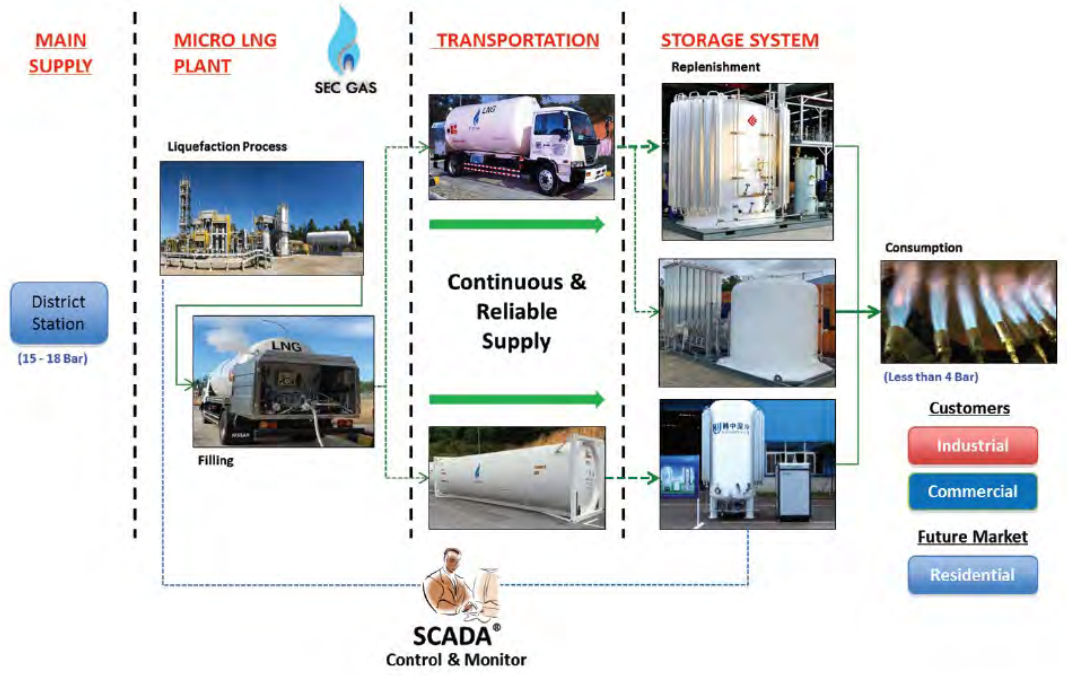


Source: https://www.sabahenergycorp.com

Figure 3-23 CNG supply chain of Sabah Energy Corporation

Source: This photo was taken by our company.

Figure 3-24 CNG tank



Source: https://www.sabahenergycorp.com

Figure 3-25 LNG supply chain of Sabah Energy Corporation

Since Sabah Energy Corporation operates the natural gas transportation business in Sabah, it will probably become a key player when we discuss transportation for realizing the biofuel use business. Accordingly, we held an online interview on Feb. 8, 2021, to ask about problems and interests when planning a biofuel transportation business. Table 3-14 shows the outline of the interview. They think that the utilization of biofuel is possible, but it is difficult to fully replace the gas with that from biofuel, considering costs. Therefore, they suggested that biogas produced from biofuel should be blended with the existing natural gas in the supply network with a ratio of several percent, considering the available biogas volume.

Table 3-14 Outline of the interview with Sabah Energy Corporation (Feb. 8, 2021)

Participants	Sabah Energy Corporation (2 participants), Japan NUS Co., Ltd. (3 participants), and JGC Corporation (2 participants)
Outline of the interview	・ There are many enterprises that are interested in utilization of biofuel, because of the trend of realizing a low-carbon society. ・ Considering the current Malaysian economy, the price needs to be at least 5-10% lower than that of diesel fuel, so that the gas will be selected for supply in Malaysia. ・ Some of enterprises that use existing natural gas derived from fossil fuels

	may blend biogas derived from biofuel with a ratio of several percent. ・ Currently, Sabah Energy Corporation handles about 35 tons/day (13,000 tons/year) of LNG, and supplies it from Kota Kinabalu to 8 areas. ・ If this is discussed on a full-scale basis, we can introduce an offtaker of Sabah Energy Corporation.

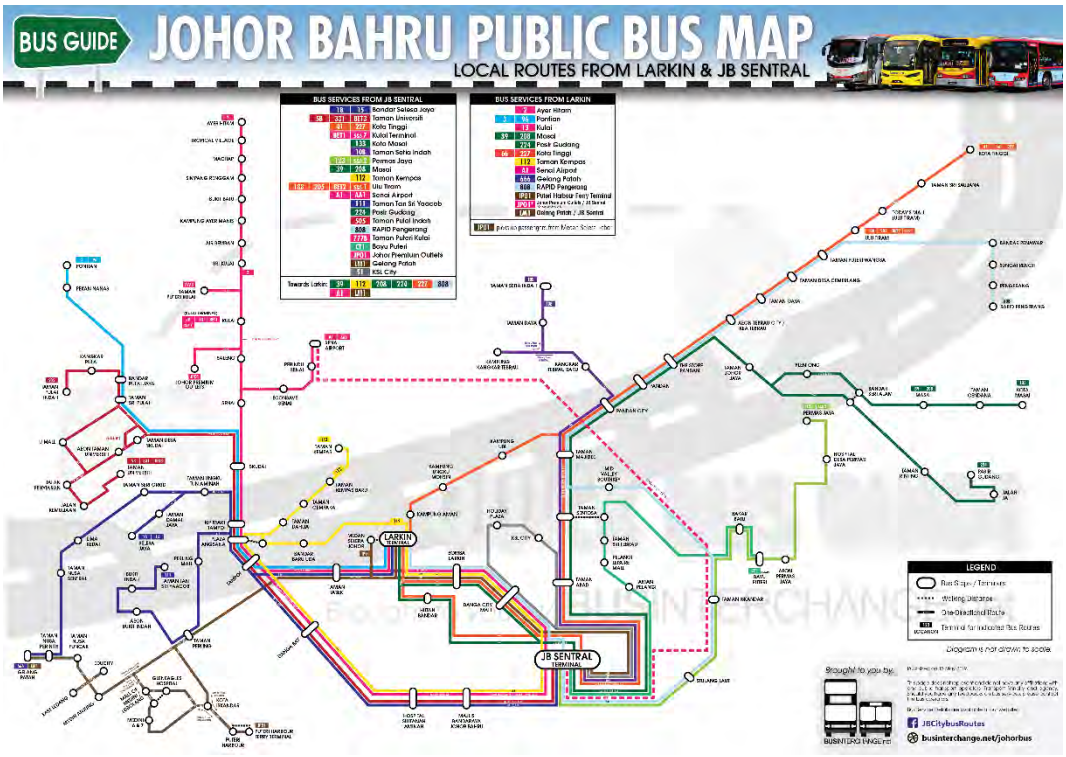
３．２．３ Grasping of the potential of demand for biofuel

1)Project for installing a bus rapid transit (BRT) system in Iskandar

As mentioned above, large-scale urban development has been progressing in Iskandar, as part of the intensive regional development project promoted by the Malaysian government. As for transportation, the percentage of people owning a private vehicle is expected to increase from 30% in 2010 to 80% in 2025, so there is concern over the possibility that traffic congestion, air pollution, and greenhouse gas emissions will increase steeply. According, the government formulated “Blueprint for transportation infrastructure in the Iskandar development region in Malaysia,” setting the goal of realizing environmentally friendly public transportation networks and planning to adopt public transportation systems centered around the bus rapid transit (BRT) system. In the plan, they discussed measures for reducing greenhouse gas emissions and preventing air pollution, including the use of biofuel. The following section summarizes the demand for biofuel estimated from the current fuel consumption and the latest plans.

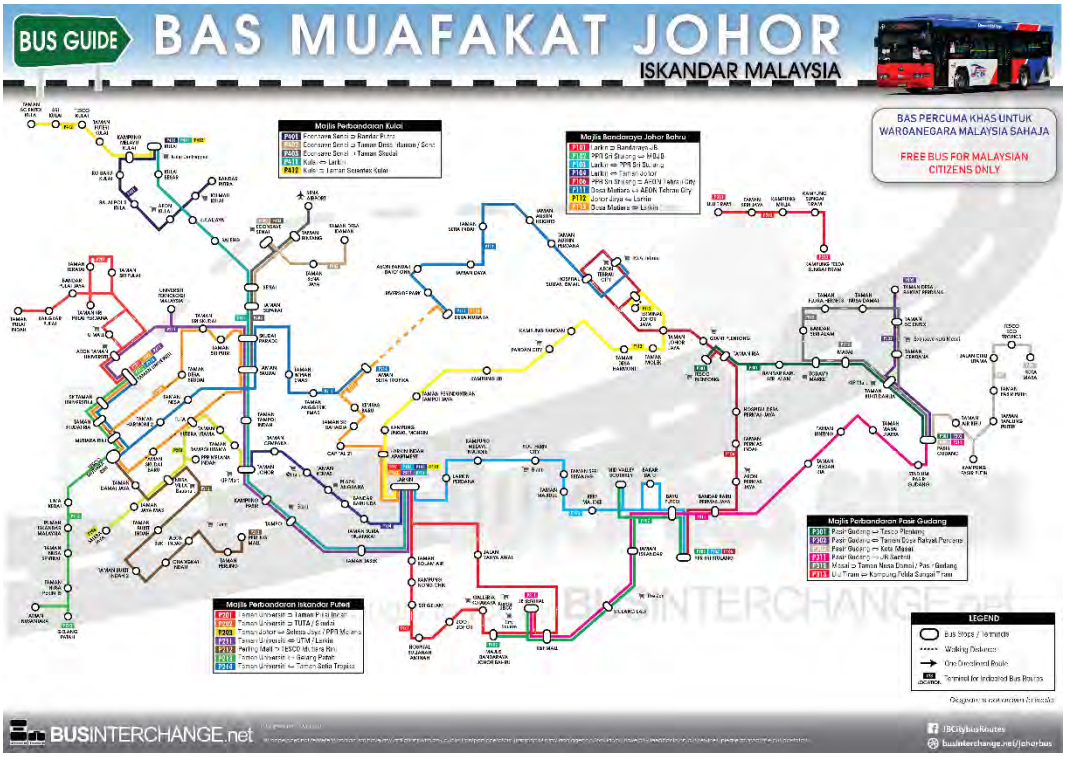
①Current fuel consumption and costs

In today’s Iskandar, 7 enterprises operate about 700 buses inside the city and between the city and the adjacent Singapore (Figs. 3-26, 3-27, 3-28, 3-29, and 3-30). They plan to have all of the enterprises install the BRT system, but they will first replace the buses of Causway Link, which has the largest number of buses among the 7 enterprises, examine its effects, problems, etc., and then replace the buses of the other enterprises.



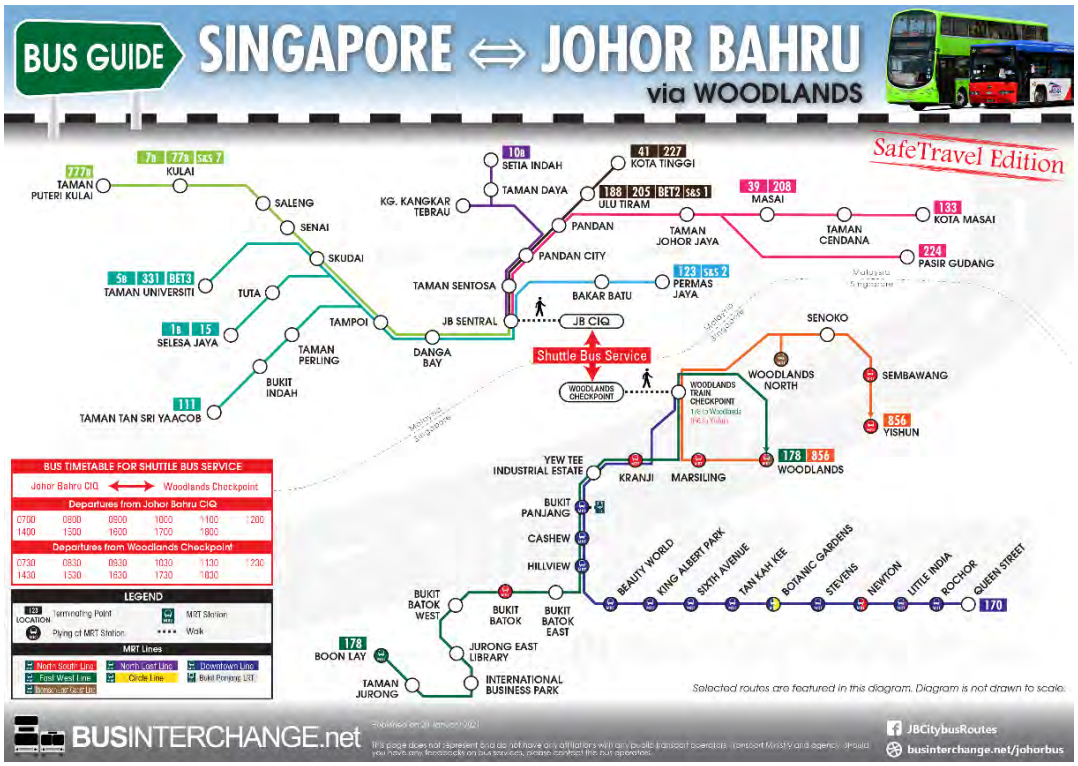
Source: https://businterchange.net/johorbus/routes.html

Figure 3-26 Existing bus routes 1



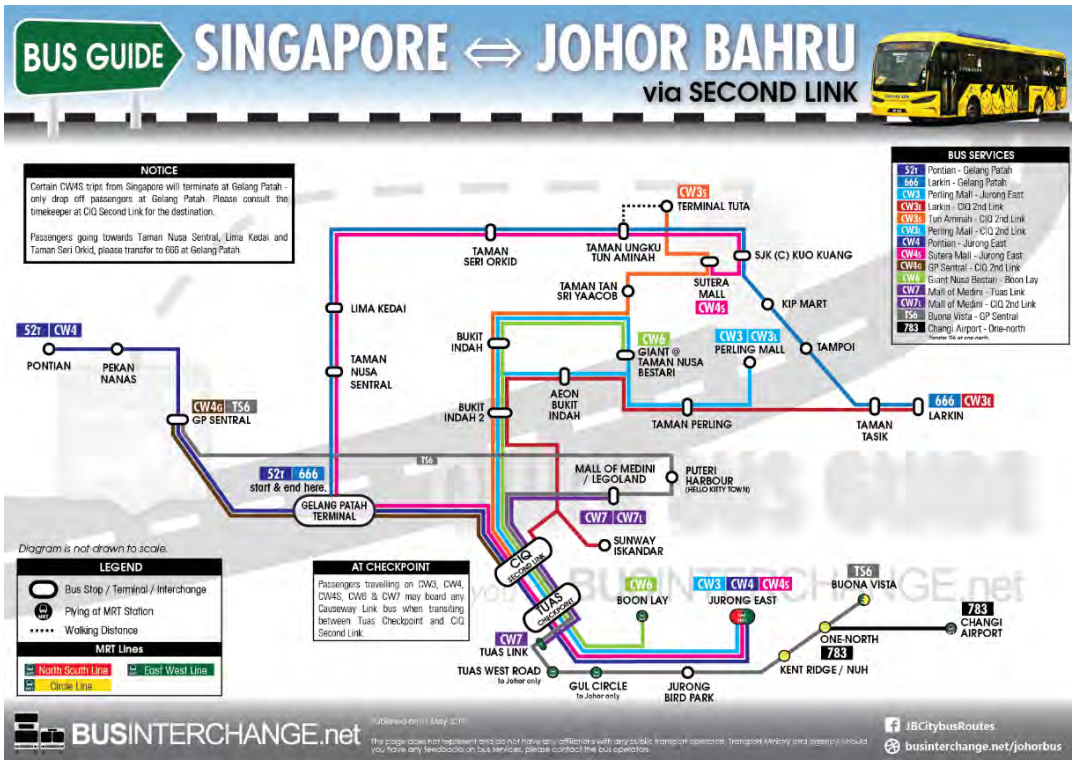
Source:https://businterchange.net/johorbus/routes.html

Figure 3-27 Existing bus routes 2



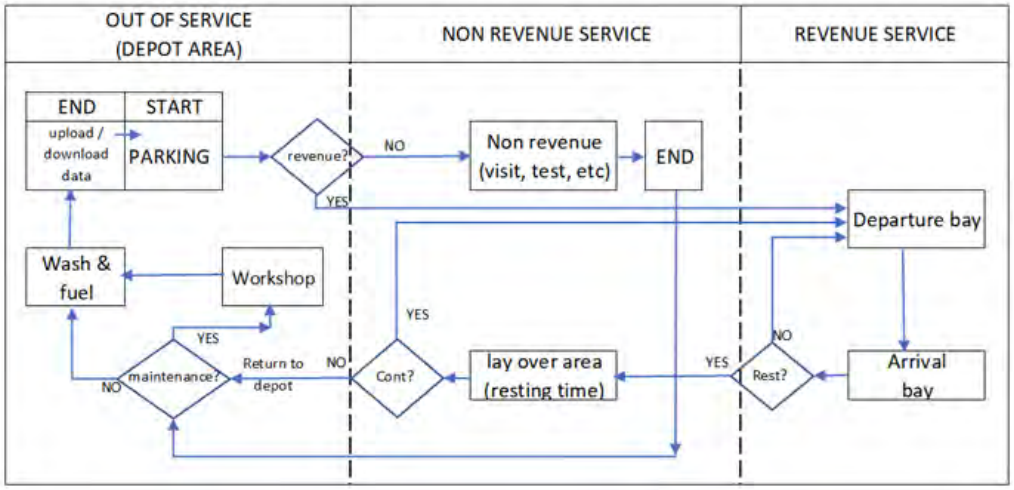
Source: https://businterchange.net/johorbus/routes.html

Figure 3-28 Existing bus routes 3



Source: https://businterchange.net/johorbus/routes.html

Figure 3-29 Existing bus routes 4



Source: Provided by IRDA

Figure 3-30 Bus operation system

Table 3-15 shows the monthly travel distance and diesel fuel consumption of Causeway Link. The average cost paid for diesel fuel was RM12,000 to 16,000/unit/month between January and March 2020 before the impact of the coronavirus. Since the diesel fuel price in January 2020 is RM2.18 / L, the diesel fuel consumption is 5,500-7,350L /unit/ month. Since Causeway Link owns 400 buses, Causeway Link as a whole consumes approximately 26,400-35,280 kL of diesel per year.

Table 3-15 Diesel fuel consumption of Causeway Link

	Item	unit	Value
①	Monthly fuel consumption per bus	L / unit / month	5,500-7,350
②	Causeway Link's annual fuel consumption	kL	26,400-35,280
③	Monthly fuel cost per bus	RM / unit / month	12,000 to 16,000
④	Causeway Link's annual fuel costs	RM	57,600,000-76,800,000

②Policy for developing a low-carbon public transportation system in Iskandar

After installing the BRT system in Iskandar, they aim to operate buses with the routes shown in Fig. 3-31. For realizing a low-carbon system, they are discussing the utilization of hydrogen fuel and the adoption of electrical buses in addition to biofuel. They have conducted demonstration tests, etc. for respective technologies, and plan to select technologies considering their environmental and economic aspects. The following section outlines the situation of discussions on hydrogen fuel and electrical buses.

As for hydrogen technologies, they are thinking about the NEUTO technology of NEUTORINOS

Engineering, which is a Singaporean enterprise. The NEUTO technology is used for storing hydrogen as solid metal and using it (Fig. 3-32). In IRDA, equipment was tentatively installed in June 2019, to examine its function to reduce CO2 emissions and economic performance (Fig. 3-33).

As for electrical buses, they are planning to install an automatic driving system, which was adopted by Yibin, China in December 2019. From now on, they plan to it tentatively for 3 months from February 2021, but for the automatic driving function, it is difficult to obtain an approval/permission in the legal system of Malaysia, so they plan to test the functions of electrical buses with a driver.

Source: https://paultan.org/2016/03/31/iskandar-malaysia-brt-system-gets-the-green-light/

Figure 3-31 Route map after the installation of the BRT system

Source: https://neutrinos.com.sg/neuto/

Figure 3-32 Images of the NEUTO technology

Source: Provided by IRDA

Figure 3-33 Scene of the demonstration test of the NEUTO technology

Source: https://paultan.org/2021/01/22/automated-rapid-transit-arrives-in-johor-for-testing-to-be-test-line-for-iskandar-malaysia-brt-system-project/

Figure 3-34 Photos of electrical buses with the automatic driving function adopted by Yibin, China

2)Other potential consumers of biofuel

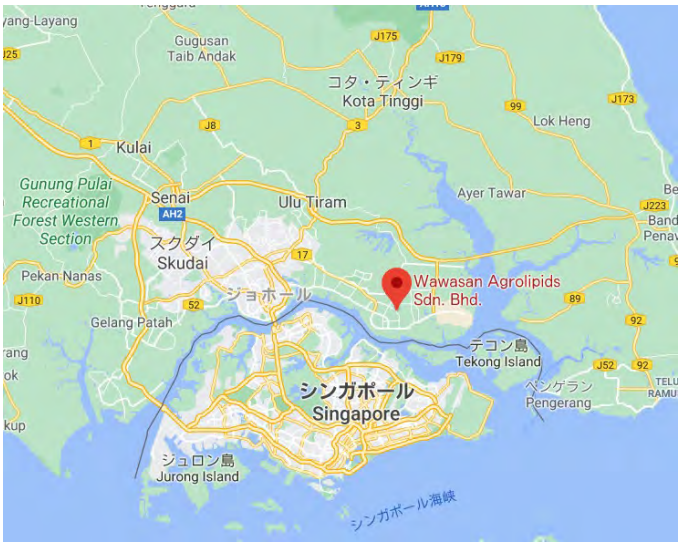
As mentioned above, it is essential to increase the consumption of biofuel as much as possible, in order to secure the profitability of business and develop the supply chain of biofuel. Potential consumers of biofuel include factories that use natural gas derived from fossil fuels, but the hurdle for switching to biofuel is high from the viewpoint of prices. On the other hand, considering the recent global trend of mitigating global warming, there is a possibility that global companies will show an interest in the switch to biofuel, as their management policies include the realization of decarbonized or low-carbon systems.

In this survey, we listed Japanese enterprises and global companies that have a factory in Johor or Sabah, and summarized the domains and locations of respective enterprises. We contacted them by using apps, such as Linked In, and asked about their interests in biofuel based on a questionnaire sheet. For the enterprises that showed an interest in the project for utilizing biofuel, Table 3-16 shows the results of the interview with Wawasan Agrolipids. Wawasan Agrolipids manufactures and sells diet

fat, while using the palm oil produced in house. As it exports 99% of its products to mainly Europe, the company joined RSPO in response to a request from clients. Accordingly, it is keenly interested in the use of biofuel derived from POME and its factory is located adjacent to Iskandar (Fig. 3-35), so it will probably become a key player when commercialization is planned.

Table 3-16 Outline of the interview with Wawasan Agrolipids (Jan. 20, 2021)

Participants	Wawasan Agrolipids (1 participant), Japan NUS Co., Ltd. (2 participants), and JGC Corporation (3 participants)
Outline of the interview	・ The electric power generated from sunlight is to be used in factories. ・ Since it is considered difficult to meet the total demand with solar power only, it is assumed that existing natural gas boilers will be used, too. ・ The current consumption of natural gas is 120,000 Nm^3/month. ・ There is interest in biofuel, but costs need to be taken into account.



Source: Google map

Figure 3-35 Location of Wawasan Agrolipids

3.2.4 Formulation of a business model

In this section, we designed a biogas value chain model in Malaysia, while considering the results of the survey mentioned in the previous section, and evaluated its economic performance in a simplified manner, and examined the effect of reducing greenhouse gas emissions. When designing the business model, we assumed the following conditions regarding the production, transportation, and supply of biofuel.

■ **Production of biofuel**

Under the assumption that Sime Darby, which has a keen interest in projects for realizing decarbonized or low-carbon systems and using biogas, including the biofuel supply project, is a candidate supplier of biofuel, its factories in Sabah and Johor were set as the sites that could supply biofuel.

■ **Transportation of biofuel**

The transportation between the eastern and western areas of the Malay Peninsula crosses the exclusive economic zone (EEZ) of Indonesia, so it is not realistic. The construction of new pipelines in uncultivated areas is not feasible, considering land procurement and costs. Accordingly, transportation areas were set in each of Johor and Sabah, LNG/CNG transportation costs were estimated for respective schemes, and then gas prices were compared.

■ **Supply of biofuel**

In Sabah, there are the existing distribution networks for CNG and LNG, so it was assumed that biofuel and biofuel-blended fuel would be sold to 8 existing clients of Sabah Energy Corporation. In Johor, we assumed the fuel for transportation of the BRT system in Iskandar, whose supply potential has been grasped.

1)Models for production and consumption of biofuel in Johor

①Envisioned commercialization and execution system

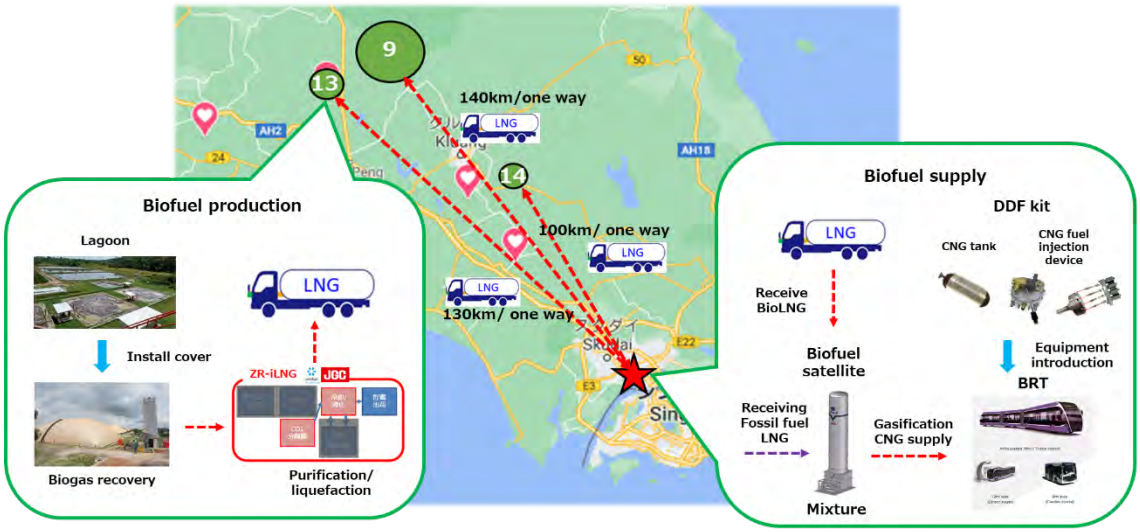
As for biofuel production, Sime Darby owns 6 palm oil factories in Johor, and 3 of them are already equipped with biogas collection and power generation facilities, so the remaining 3 factories, which are tabulated below, were selected as biogas collection sites. The potential amount of bio LNG collected from each of these factories is about 1,000 to 3,000 tons per year (5,200 tons/year in total), which is suited for the ZR-iLNG process discussed in this survey. Accordingly, we assumed a scheme of constructing bio CNG/LNG equipment attached to each palm oil factory and transporting biofuel to Iskandar.

Next, as the destination of biofuel, the BRT system to be installed in Iskanar is assumed. As a result of the above-mentioned basic research and interviews, it was found that the current bus fuel consumption is about 35,000 kL of diesel fuel per year in Causeway Link, which plans to adopt biofuel in the first phase. When it is converted into the LNG weight based on heat, it is about 25,100 tons per year, which is around 5 times the potential supply amount of bio LNG, so it is difficult to cover it with biofuel only. On the other hand, the bio CNG and LNG derived from pome basically have the same characteristics as the existing fuels derived from fossil fuels, except their raw materials being organic waste, so it is possible to blend them with existing fuels. Therefore, in this model, we assumed a

scheme of storing bio CNG and LNG at newly built satellite stations, which will be used also for existing fuels, blending them before transportation to BRT, and using them as hybrid fuels. From now on, it is necessary to have discussions while taking into account the procurement from palm oil factories other than those of Sime Darby and the blending of bio CNG and LNG derived from waste other than palm oil, with the aim of replacing all of currently used fuels with biofuel from the viewpoint of decarbonization.

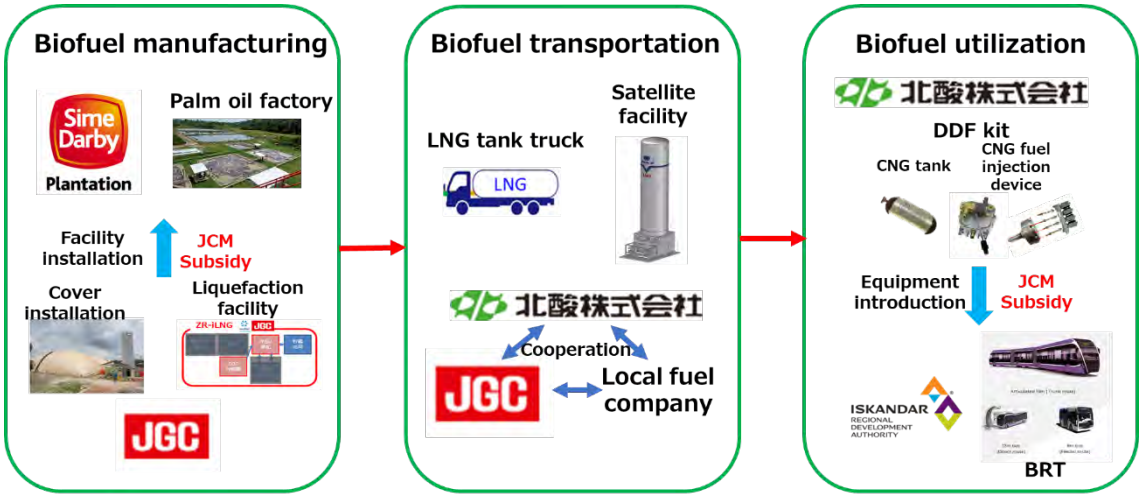
Lastly, we assumed the transportation of biofuel from respective factories using LNG tanker trucks that can transport 18 tons of bio LNG at a time. As for satellite stations, it was assumed that 6 LNG tanks of the 60-kL vessel type would be set, considering the transportation of fuel from 3 respective factories by using different tanker trucks.

When these are summarized, the business model becomes as shown in Fig. 3-36, and the current system for executing it is as shown in Fig. 3-37.



Source: Produced by our company

Figure 3-36 Schematic diagram of biofuel production and consumption models in Johor



Source: Produced by our company

Figure 3-37 Schematic diagram of the system for executing biofuel production and consumption models in Johor

②Economical evaluation

For economical evaluation in this survey, we decided to use the equipment installation cost (CAPEX) and operation cost (OPEX) estimated by JGC Corporation, which is an outsourcee, the actual results of "the project for installing equipment for co-combustion of CNG and diesel fuel in public transportation buses in Semarang, Indonesia," which was implemented by Hokusan Co., Ltd. in Indonesia, and so on.

In the case of the biofuel production project, necessary facilities include lagoon covers, biogas pressure increase equipment, pretreatment equipment, liquefaction equipment, and storage equipment.

In the case of the biofuel transportation project, it was assumed that all kinds of equipment would be established to secure maintainability, and costs for transportation and construction of satellite stations were estimated.

The price of biofuel per thermal unit in the case where the above-mentioned biofuel production, transportation, and satellite facilities are operated economically was estimated as shown in Table 3-17. Accordingly, the weighted average 19.6 US dollars/MMBTU is used for gauging the economic performance of the biofuel use project, which will be described later.

Table 3-17 Biofuel price per MMBTU*

	Unit	Price
Without subsidies	USD/MMBTU	19.6
Subsidies: 50%	USD/MMBTU	13.4

*The pome procurement price was calculated under the condition that the plant operation period is 25

years, the depreciation period is 10 years, and the IRR of the plant business is 10%.

In the case of the biofuel use project, equipment installation costs were estimated while assuming the DDF kit required for co-combustion of CNG and diesel fuel (Table 3-18), and operation costs were calculated while assuming that the price of diesel fuel is 13.1 US dollars/MMBTU, the price of LNG derived from fossil fuels is 10 US dollars/MMBTU, the price of bio LNG (without subsidies) is 19.6 US dollars/MMBTU, and 50% of bio LNG is subsidized.

When only the biofuel use project is considered, equipment installation costs can be recouped in 3 years, even without subsidies, but it is necessary to take into account the costs for the production, transportation, and satellite equipment of biofuel, so we need to consider the entire supply chain.

Table 3-18 Information on costs for the biofuel use project

	Unit	DDF kit
Equipment installation costs (without subsidies)	thousand yen/unit	1,000
Equipment installation costs (50% subsidized)	thousand yen/unit	500
No. of units installed	unit	400
Equipment installation costs (without subsidies)	thousand yen	400,000
Equipment installation costs	thousand yen	200,000

Table 3-19 Investment recovery calculation table

	Cost (project)						Cost (reference)			Benefit		Cumulative benefit	
year	Investment cost	Running cost	Diesel cost	BioLNG cost	Fossil LNG cost	Total cost	Diesel cost	Total cost	Subsidy Amount	Without Subsidy	With Subsidy	Without Subsidy	With Subsidy
1	400,000	0	0	0	0	400,000	0	0	200,000	-400,000	-200,000	-400,000	-200,000
2	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	-256,402	-56,402
3	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	-112,804	87,196
4	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	30,794	230,794
5	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	174,393	374,393
6	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	317,991	517,991
7	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	461,589	661,589
8	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	605,187	805,187
9	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	748,785	948,785
10	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	892,383	1,092,383
11	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	1,035,981	1,235,981
12	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	1,179,579	1,379,579
13	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	1,323,178	1,523,178
14	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	1,466,776	1,666,776
15	0	40,000	997,500	395,954	417,948	1,851,402	1,995,000	1,995,000		143,598	143,598	1,610,374	1,810,374
	400,000	**560,000**	**13,965,000**	**5,543,356**	**5,851,270**	**9,657,009**	**0**	**9,975,000**		**317,991**	**517,991**	**9,077,803**	**12,077,803**

③Effect of reducing greenhouse gas emissions

Table 3-20 shows the effect and costs of reducing greenhouse gas emissions in this project.

Table 3-20 Amount and costs of reduction of greenhouse gas emissions

	Unit	Fuel production project	Fuel use project	Total
Annual reduction amount of greenhouse gas emissions	t-CO_2/year	123,165	37,935	161,100
Project period	years	10	5	-
Total reduction amount of greenhouse gas emissions	t-CO_2	1,231,650	189,675	1,421,325
Subsidy	thousand yen	1,246,350	200,000	1,446,350
Costs for reducing greenhouse gas emissions	yen/t-CO_2	1,012	1,054	1,017

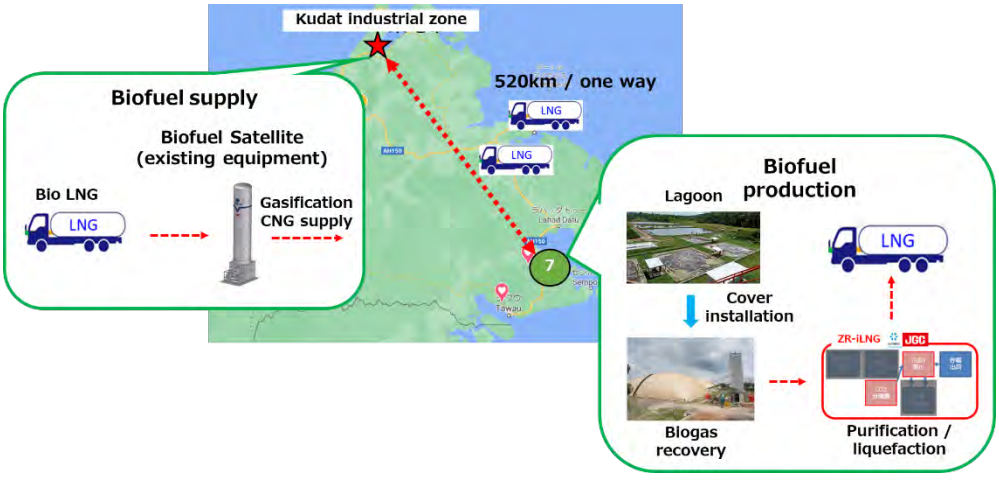
2)Biofuel production and consumption models in Sabah

①Envisioned commercialization and implementation system

As for the producers and consumers of biofuel, Sime Darby has 8 palm oil factories in Sabah, and according to the results of the interview with Sabah Energy Corporation, it supplies about 1,835 tons per year to clients in Kudat. The potential amount of bio LNG collected from this factory is about 1,900 tons per year.

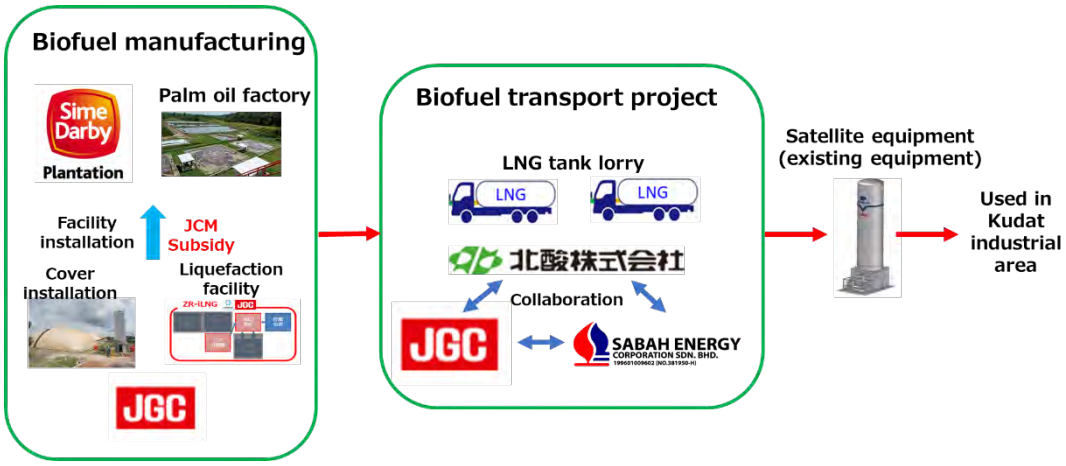
Basically, transportation will be conducted under the same condition as the project in Johor, but two tanker trucks will be used, because round-trip transportation distance is long. As for satellite stations, existing facilities at destinations will be used, so the costs for satellite stations were omitted.

When these are summarized, the business model becomes as shown in Fig. 3-38, and the current implementation system is as shown in Fig. 3-39.



Source: produced by our company

Figure 3-38 Schematic diagram of biofuel production and consumption models in Sabah



Source: produced by our company

Figure 3-39 Schematic diagram of the system for executing biofuel production and consumption models in Sabah

②Economical evaluation

Estimation was conducted like in the previous section. Table 3-21 shows the biofuel price per thermal unit calculated from the estimated costs. If there are no subsidies, the biofuel price becomes about 5.5 US dollars/MMBTU higher than that of LNG derived from fossil fuels, which is currently handled by Sabah Energy Corporation, but if the program for subsidizing the installation of JCM equipment is applied, the price difference becomes 0.2 US dollars/MMBTU, and more enterprises may choose bio LNG, considering the effect of reducing CO2 emissions.

Table 3-21 Biofuel price per thermal unit*

	Unit	No.7
Without subsidies	USD/MMBTU	19.5
50% subsidized	USD/MMBTU	14.2
Reference: Selling price of SEC	USD/MMBTU	14.0

*Calculated under the assumption that the procurement price of pome is zero, the plant operation period is 25 years, the depreciation period is 10 years, and the IRR of the plant business is 10%.

③Effect of reducing greenhouse gas emissions

Table 3-22 shows the amount and costs of reduction of greenhouse gas emissions

Table 3-22 Amount and costs of reduction of greenhouse gas emissions

	Unit	Fuel production project	Fuel use project	Total
Annual reduction amount of greenhouse gas emissions	t-CO_2/year	46,598	4,101	50,698
Project period	years	10	10	10
Total reduction amount of greenhouse gas emissions	t-CO_2	465,980	41,010	506,980
Subsidy	thousand yen	449,400	-	449,400
Costs for reducing greenhouse gas emissions	yen/t-CO_2	964	-	886

3.3 Discussions on problems and countermeasures

The results of the survey in this fiscal year indicate that by utilizing the JCM program for subsidizing the installation of equipment, it is possible to conduct a business with a certain level of economic performance secured, with either of the business models in Johor and Sabah.

On the other hand, there are some problems due to the impossibility of visiting sites due to the novel coronavirus in this survey, and Table 3-23 shows the results of discussions on such problems and countermeasures.

According to an article in the Feb. 19, 2021 issue of NNA ASIA (Asian economic news)[9], Alam Duta Mandili, which is an Indonesian company, signed a memorandum for exporting about 2,000 tons/month of pome, which is discharged from the company, Dendoro, which is a Malaysian company, for two years and utilizing it for biofuel. Like this, the demand for fuel derived from pome is actually growing also in Malaysia, and this news can be said to be favorable for future business expansion. Accordingly, we need to discuss more details, including on-site surveys, for commercialization, and establish systems for operating business.

Table 3-23 Problems and countermeasures

	Problem	Countermeasure
General	As of March 2021, there is no JCM agreement between Japan and Malaysia.	The results of the survey in this fiscal year indicate that the business models under consideration have significant merits from the viewpoints of economic performance, environmental

[9] https://www.nna.jp/news/show/2154115

		conservation, and SDGs. In the survey in the next fiscal year, we will discuss the possibility of concrete fund procurement, while considering the utilization of funding schemes other than the JCM program for subsidizing the installation of equipment as an option.
	For the business models discussed in the survey in this fiscal year, it is necessary to clarify the mandatory tasks, roles, merits, etc. of each business operator.	In the survey in the next fiscal year, we will discuss business execution systems, allocation of roles, etc. in detail while referring to the case of City of Semarang, Indonesia, the case of LRT installation in Toyama City, etc. and consulting with local staff.
Production	We grasped the location of palm oil factories and the potential of bio LNG production through online interview, etc., but we were not able to conduct on-site surveys. Accordingly, it is necessary to obtain detailed information on actual processes, the composition of pome, etc.	We will visit candidate sites in the survey in this fiscal year, and conduct on-site surveys, and conclude NDAs and MoUs with Sime Darby, Wawasan Agrolipids, etc. in preparation for the case where it becomes difficult to travel due to the lingering of the novel coronavirus pandemic, to exchange more detailed information.
	With the palm oil factories of Sime Darby only, it is difficult to fully replace the fuel for BRT, which is to be installed in Iskandar, with bio LNG.	At the workshop, which will be described later, we succeeded in stirring the interest of local governmental officials (IRDA, Kota Kinabalu, and Sabah) in the models discussed in this survey. Accordingly, we will ask them to introduce local leading palm oil producers and factories in addition to Sime Darby, and add them to the system, to increase the potential of bio LNG supply.
Transportation	In the biofuel transportation project, it	In the survey in this fiscal year, we

	is necessary to involve business operators who have already obtained approval/permission, such as a license in the target region. In Sabah, we fostered a cooperative relationship with SEC, but in Johor, too, it is necessary to select an enterprise.	contacted Petronas, a leading government-run company that supplies gas in Malaysia, and stirred their interest in the project for using bio LNG. Since it is a leading government-run company, it will probably be necessary to conclude an NDA or MoU in the survey next fiscal year, in order to proceed with the project. Accordingly, we will explain the business model at an early stage, and develop a system for enabling them to participate in discussions for the project.
	It is necessary to discuss necessary licenses for conducting the biofuel supply project and the possibility of participation by foreign-affiliated enterprises.	In the survey next fiscal year, we will summarize whether there are any necessary licenses or conditions for joining the project, schedules for obtaining licenses, etc.
Supply	It is necessary to discuss the sites for installing biofuel supply equipment in Iskandar, its capacity, etc.	In the survey next fiscal year, we will grasp the locations of existing diesel fuel supply facilities (gas stations), cooperate with IRDA, grasp the bus routes and locations of bus stops just after the installation of the BRT system, and discuss optimal locations, capacity, etc.
	It is necessary to discuss contractors for installing the DDF system and how to procure devices.	We will interview IRDA, MIDA, etc. and contact local contractors involved in the case of City of Semarang, Indonesia.

Chapter 4 Promotion of Renewable Energy Centering on Micro Hydropower Generation

4.1 Analysis of trends of relevant policies and programs

4.1.1 Energy policy by the Government of Malaysia

The following three goals are defined in the National Energy Policy formulated in 1979:

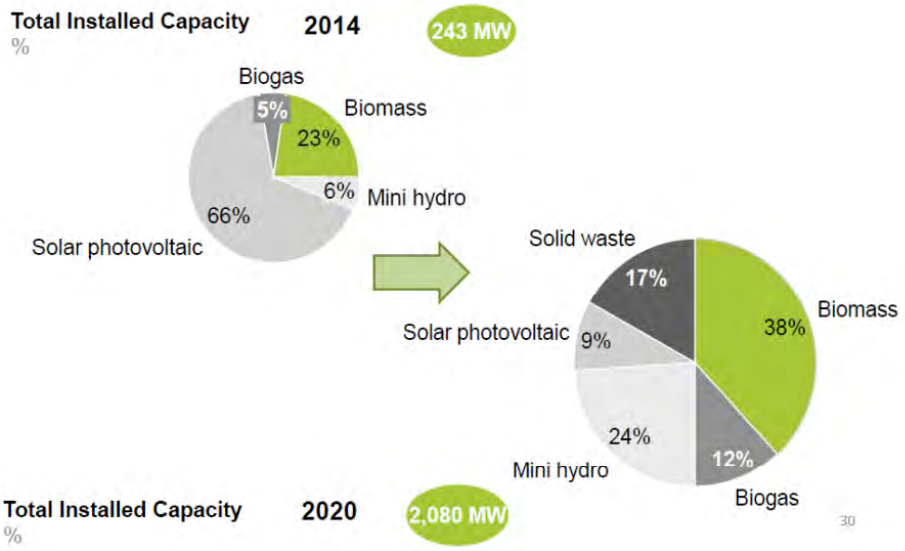
- Goal related to energy supply: To supply appropriate, safe, and highly cost-effective energy
- Goal related to energy use: To avoid dependence on petroleum through diversification of energy sources with the aim of lengthening the period during which crude oil and gas, which are domestic resources, are available
- Environment: To alleviate adverse impacts on the environment through encouraging use of highly efficient energy and preventing a waste of energy

4.1.2 Electricity policy

The electricity policy is based on the Electricity Supply Act 1990 enforced in 1990. The act transformed the National Electricity Board from a state-run public corporation for electricity into a private electricity company, and Tenaga Nasional Berhad (TNB) was established in Peninsula Malaysia. In Sabah in 1998, privatization of a public corporation for electricity, which was operated jointly by the Sabah State Government and the federal government up until then, resulted in Sabah Electricity Sdn. Bhd. (SESB). Furthermore, the act set forth a license to conduct the business of supplying electric power, which in principle opened the market and enabled the independent power producer (IPP) program.

Target values for the electricity sector are listed in the 11th Malaysia Plan 2016-2020, which is Malaysia's five-year development plan described in the previous section. As a measure to mitigate global warming, the plan has established a goal of reducing the carbon dioxide emissions intensity with respect to GDP by 40%, with a target renewable energy generation capacity set at 2,080 MW by 2020 (Figure 4-1).

As mentioned earlier, plans for 2021 and subsequent years are slated to be published in March 2021, but the release is expected to be postponed due to the novel coronavirus.



Source: https://eneken.ieej.or.jp/data/6447.pdf

Figure 4-1 Target increase in the share of renewable energy set in the 11th Malaysia Plan

4．1．3 Renewable energy policy

In regard to matters related to renewable energy, the National Renewable Energy Policy was formulated in 2010. The objectives of the policy are as tabulated in Table 4-1, with a vision of covering 20% of the country's energy mix with renewable energy by 2025. The policy also states that, in order to achieve the aforementioned goal, a program to facilitate development of renewable energy sources will be drawn up and focus will be given to solar power and other green energy sources.

Specifically, the country has been pursuing a goal of gradually increasing the renewable energy installed capacity, which is set at 985 MW (about 5.5% of the total amount of electricity generated) for 2015, 2,080 MW (11%) for 2020, and 4,000 MW (17%) for 2030. These numbers are consistent with the targets of the above-mentioned 11th Malaysia Plan.

Table 4-1 Objectives of the National Renewable Energy Policy

・Increase the share of renewable energy
・Facilitate development of the renewable energy sector
・Appropriately set and ensure the cost of generating renewable energy
・Maintain the environment for future generations
・Raise awareness of the roles and importance of renewable energy

Aiming at facilitating adoption of renewable energy, resolving the issue of power shortages, attracting related industries, and using diverse electricity sources through a mechanism called a Feed-In-Tariff (FIT) as our country does, Malaysia formulated the Renewable Energy Act that provides for

implementation of an FIT program and the Sustainable Development Authority Act which sets forth establishment of the Sustainable Energy Development Authority (SEDA) that is in charge of FITs, in 2011. The act consists of nine parts, specifying such matters as the FIT program and funds.

Specific regulations associated with FITs are stipulated in the Renewable Energy (Feed-In Approval and Feed-In Tariff Rate) Rules enforced in 2011.

The price at which energy is purchased through FITs depends on the type of renewable energy, the scale of the facility installed, whether or not the criteria for bonuses are satisfied, and when renewable electricity begins to be sold.

To be specific, the types of energy sources covered by the FIT program are biogas, biomass, micro hydropower, and solar power, and their respective purchase prices and guaranteed purchase periods are as tabulated in Table 4-2. In addition, as of January 2020, bonus rates are added as shown in Table 4-3 to electricity generated from biogas, biomass, and solar power. Purchase prices and bonus rates in the FIT scheme are reviewed every year in view of relevant information, such as the rate of spread.[10]

Table 4-2 Price, guaranteed purchase period, and degression rate by energy source (as of January 2020)

Energy source	Amount generated	Purchase price (RM/kWh)	Guaranteed purchase period	Degression rate (/year)
Biogas	≦4MW	0.3184	21 years	0.5
	＞4MW、≦10MW	0.2985	21 years	0.5
	＞10MW、≦30MW	0.2786	21 years	0.5
Biogas (landfill/agricultural waste)	≦5MW	0.2210～0.2814	21 years	0.5
Biomass (including use of non-industrial waste)	≦10MW	0.3085	21 years	0.5
	＞10MW、≦20MW	0.2886	21 years	0.5
	＞20MW、≦30MW	0.2687	21 years	0.5
Micro hydropower	≦2MW	0.2600	21 years	0.5
	>2MW、≦10MW	0.2500	21 years	0.5
	＞10MW、≦30MW	0.2400	21 years	0.5
Micro hydropower (high head)	≦30MW	0.2599	21 years	0.5
Micro hydropower (low head)	≦30MW	0.2900	21 years	0.5
Solar power*	≦4kW	0.5413	21 years	8.0
	＞4kW、≦24kW	0.5280	21 years	8.0
	>24kW、≦72kW	0.3205	21 years	8.0
	＞72kW、≦ 1 MW	0.8208	21 years	8.0

[10] https://www.env.go.jp/recycle/circul/venous_industry/pdf/fit_malaysia.pdf

	＞1MW、≦10MW	0.6840	21 years	8.0
	＞10MW、≦30MW	0.6120	21 years	8.0

*The amount of electricity generated from solar power for home use shall be up to 12 kW.
Source: http://www3.seda.gov.my/iframe/

Table 4-3 Bonus rate in the FIT scheme (as of January 2020)

	Bonus (RM/kWh)
Biogas	
When an engine technology with an electrical efficiency of 40% or over is used	+0.0199
When a locally manufactured or assembled gas engine is used	+0.0500
When gas produced at landfill sites or waste water treatment facilities, or from livestock is used	+0.0000
Biogas (landfill/agricultural waste)	
When an engine technology with an electrical efficiency of 40% or over is used	+0.0199
When a locally manufactured or assembled gas engine is used	+0.0500
When gas produced at landfill sites or waste water treatment facilities, or from livestock is used	+0.0786
Biomass (including use of non-industrial waste)	
When a gasification technology is used	+0.0199
When a steam electric generation system with a total efficiency of 20% or over is used	+0.0100
When a locally manufactured or assembled boiler or gasification facility is used	+0.0500
When non-industrial waste is used	+0.0000
Solar power	
When used as installation in buildings or building structures	+0.1017
When used as building materials	+0.0542
When a locally manufactured or assembled solar photovoltaic module is used	+0.0500
When a locally manufactured or assembled power inverter is used	+0.0500

Source: http://www3.seda.gov.my/iframe/

4．1．4 Energy-related organizations

1)Economic Planning Unit

The Economic Planning Unit is an organization operating under the immediate control of the

Prime Minister’s Office and is in charge of formulation and implementation of general energy policies, and laws, regulations, and plans for economic development in Malaysia.

2)Ministry of Energy, Green Technology and Water (KeTTHA)

The Ministry of Energy, Green Technology and Water, abbreviated as KeTTHA, is an agency established in 2009 with the aim of developing industries in the sectors of energy, green technology, and water supply services and is responsible for approval of electricity rates and licenses to run electricity-related businesses.

3)Energy Commission

Electricity-related businesses in Malaysia are regulated and managed, in principle, by the Energy Commission, which was set up in accordance with the Energy Commission Act enacted in 2001 and operates under the jurisdiction of KeTTHA. The Energy Commission engages in:

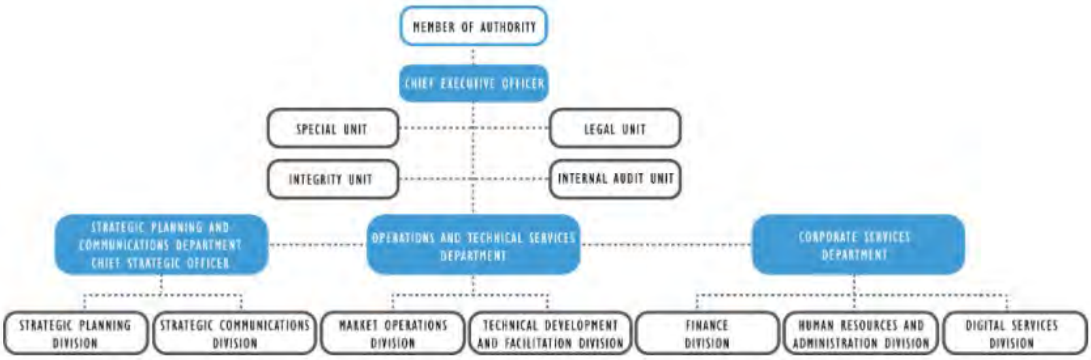
・Providing the Energy Minister with advice on matters of all kinds regarding electricity supply services

・Designing and enforcing regulations for electricity supply services (from the perspectives of economy, techniques, safety, and consumer protection)

・Implementing policies related to electricity supply services

4)SEDA

The Sustainable Energy Development Authority (SEDA) is an organization established under the jurisdiction of KeTTHA as a government agency for administering the FIT scheme. In addition to being in charge of FITs, the SEDA gives advice, carries out policies, and enforces laws and regulations in regard to the renewable energy sector. The SEDA also makes proposal for tax incentives aimed at encouraging private companies to invest in sustainable energy sources and make a specific move toward business development. Figure 4-2 illustrates the organizational structure of the SEDA.

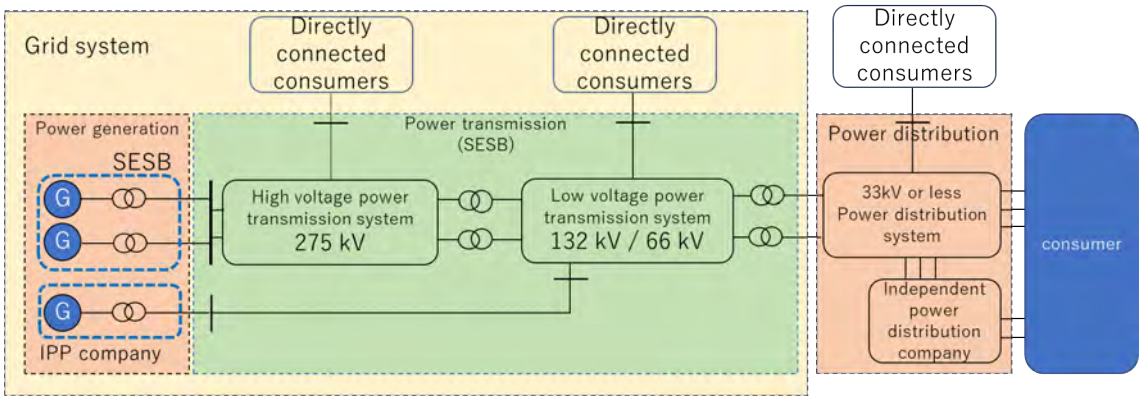


Source: http://www.seda.gov.my/about-seda/organizational-structure/

Figure 4-2 Organizational structure of the SEDA

5)Electric utility companies

The major electric utility companies in Malaysia are Tenaga Nasional Berhad (TNB) in Peninsular Malaysia, Syarikat SESCO Berhad (SESCO) in the Sarawak state, and Sabah Electricity Sdn. Berhad (SESB) in the Sabah state. Although these three formerly state-run companies are the only organizations that comprehensively manage businesses of generation, transmission and transformation, and distribution of electric power, a multitude of private companies have branched out into the businesses of electricity generation and supply since the 1990s when the markets were opened. On the other hand, the business of transmitting and transforming electric energy is run monopolistically by each region (Figure 4-3).



Source: https://www.tnb.com.my/commercial-industrial/malaysian-grid-code

Figure 4-3 Electrical power grid system in Malaysia (Sabah state)

４．１．５ Application for electricity business licenses

The markets of electricity generation and supply are opened for private companies so that they can run business in the electricity sector as mentioned above. Companies hoping to do business activities in the sector are required to obtain licenses from the Energy Commission. As tabulated in Table 4-4, in accordance with the Electricity Supply Act 1990, two types of licenses are issued for the electricity-related businesses: the public installation license and the private installation license. Criteria that companies must meet for gaining the licenses are not only those specified in the Energy Commission Act 2001 (i – iv below), but also the special requirements of the government (v – x below) as tabulated in Table 4-5.

Table ４-4 Description of cases of the license for public installation and the license for private installation

Public installation license	Private installation license
The license for public installation covers the business of distributing electricity to those who do not hold the license, and example cases are as follows:	The license for private installation covers generation of electricity for the purpose of consumption by the licensee, and example cases are as follows:
・ Electricity supply to general consumers (as TNB and SESB do)	・ Operation of overhead or underground power lines striding over hindrances (such as roads, rivers, and bridges)
・ Sale of electricity to electric utility companies (such as IPPs)	・ Electricity generation for home use in areas where electricity is not supplied
・ Sale of excess electricity, which was generated from renewable energy for home consumption, at a price per electrical grid	・ Temporary electricity generation at such places as construction sites and exhibition halls
・ Sale of excess electricity, which was generated with efficient power generation technology, such as cogeneration, for consumption in particular areas (such as airports)	・ Electricity generation using efficient technology, such as cogeneration and renewable energy
・ Supply of electricity for users of composite facilities and high-rise buildings together with other services of electricity purchased from outside organizations	

Table ４-5 Criteria for electricity business licenses

ID	Criteria
(i)	Contribute to the increase in the competitiveness in electricity generation and supply, and ensure supply of electric power at fair prices
(ii)	Facilitate electricity generation with the aim of developing Malaysia’s economy
(iii)	Ensure stable electricity prices, safety, and supply

(iv)	Ensure business continuity during the license period
(v)	Diversity energy sources for consumption, and enhance generation of electricity by coal-fired power and hydropower in particular
(vi)	Use biomass (such as palm oil and rice husks), industrial waste (gas), or non-industrial waste
(vii)	Use advanced or efficient technology, such as cogeneration and regional air conditioning
(viii)	Offer efficient, speedy, and economical solutions (such as power supply by other licensees)
(ix)	Avoid any electricity generation business causing environmental contamination
(x)	Encourage development through such means as demonstration of new technology

According to the material of the Energy Commission (Guidelines on Procedures for Licensing Electricity Supply 2015), although the procedure for applying for the licenses to distribute electricity depends on the scale and type of the facility installed, application can be submitted online for both licenses (Table 4-6).

Table 4-6 Overview of procedures for applying for electricity supply licenses

	Organization in charge of testing	Remarks
・ License for private installation with a capacity of 5 MW or over ・ License for public installation ・Provisional license	Tested by the Energy Commission and approved by the Energy Minister	It is recommended that any operator that hopes to run the electricity supply business applies for the license at least three months before it goes into business
・ License for private installation with a capacity of less than 5 MW	Tested by a regional office of the Energy Commission and approved by the director thereof	-

According to “Performance & Statistical Information on the Malaysian Electricity Supply Industry 2018” published by the Energy Commission, Independent Power Producers (IPPs) that are approved for running electricity-related businesses in the Sabah state are as tabulated in Table 4-7.

Table 4-7 Operators holding a license to run business as an IPP in Sabah

BIL. NO.	PEMEGANG LESEN LICENSEE	ALAMAT SURAT MENYURAT MAILING ADDRESS	KAPASITI (MW) CAPACITY (MW)	JENIS LOJI PLANT TYPE	SUMBER TENAGA ENERGY SOURCE
1.	Kimanis Power Sdn. Bhd.	Kimanis Power Plant, Office Building, KM 48, Kg. Batu Pungit, Papar, 89607 Kimanis, Sabah	285	CCGT	Gas asli *Natural gas*
2.	Ranhill Powertron II Sdn. Bhd.	Lot 35 (IZ4) IZ4 Kota Kinabalu Industrial Park (KKIP) 88460 Kota Kinabalu, Sabah	190	CCGT	Gas asli *Natural gas*
3.	Ranhill Powertron Sdn. Bhd.	Lot 3, KKIP Selatan IZ3 Kota Kinabalu Industrial Park (KKIP) 88460 Kota Kinabalu, Sabah	190	CCGT	Gas asli *Natural gas*
4.	Sepangar Bay Power Corporation Sdn. Bhd.	Suite 2A-12-1, Blok 2A, Level 12, Plaza Sentral, Jalan Stesen Sentral 5, 50470 Wilayah Persekutuan Kuala Lumpur	100	CCGT	Gas asli *Natural gas*
5.	SPR Energy (M) Sdn. Bhd.	No. 1.01, 1st Floor Wisma E&C, No. 2, Lorong Dungun Kiri, Damansara Heights, 50490 Wilayah Persekutuan Kuala Lumpur	100	CCGT	Gas asli *Natural gas*
6.	Stratavest Sdn. Bhd.	Tingkat 15, Amcorp Tower, Amcorp Trade Centre, No. 18, Jalan Persiaran Barat, 46050 Selangor	64.4	Enjin diesel *Diesel engine*	Diesel

Source: Performance & Statistical Information on the Malaysian Electricity Supply Industry 2018（Energy Commission）

4．1．6 Application procedures for FITs

As mentioned earlier, the FIT scheme was designed in accordance with the Renewable Energy Act 2011 and launched in January 2012. The scheme requires Distribution Licensees to purchase electricity generated by Feed-In Approval Holders (FIAHs) from renewable energy at a specified price for a certain period of time. Operators that meet the following criteria are eligible to apply for FITs:

・The operator shall be a Malaysian company, or a company at least 51% of whose shares are held by a Malaysian company; provided, however, that a Malaysian company can serve as a business entity with a foreign company receiving orders for engineering, procurement, construction (EPC).

・The operator shall be permitted to run business in Malaysia.

・The percentage of the operator’s shares held by a power supply company, if any, shall not exceed 49%.

・The operator shall generate, or intend to generate, electricity of 30 MW or less from renewable energy.

Requirements that operators must fulfill when applying for the licenses are as follows. The most important requirement among them is: the operator has obtained necessary permission from relevant authorities, such as local governments. The Department of Environment conducts a one-year

assessment before each application is submitted to the SEDA, which means that the SEDA receives only applications that have satisfied the application requirements:

・The operator has obtained necessary permission from relevant authorities, such as local governments.

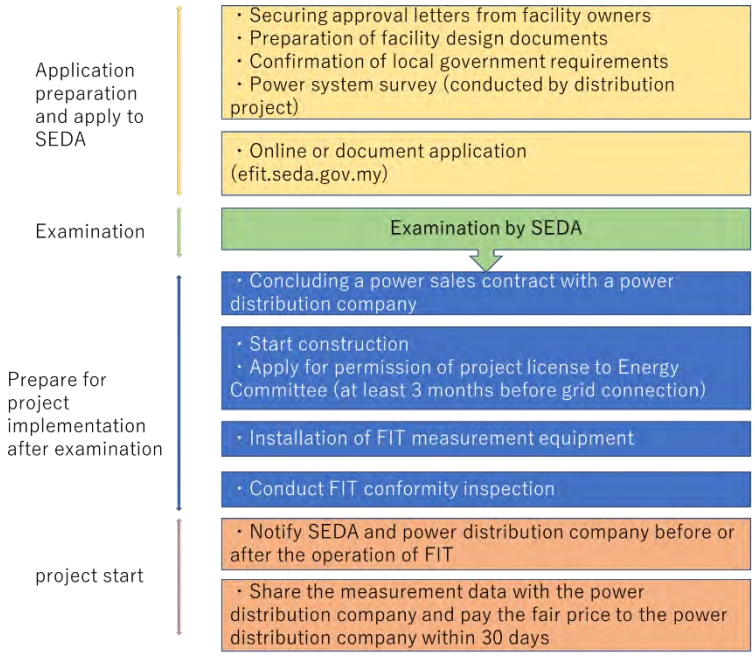
・The place of use has been determined.

・Technical feasibility has been confirmed with TNB, an electricity utility company operating in Malaysia.

・The operator has no financial issue.

Operators directly negotiate with TNB about an extension of their guaranteed purchase period. The requirements that operators must satisfy during the period include renewing the energy condition license every year, holding a license for the waste disposal business, and undergoing monitoring by the SEDA each year (in relation to the FIT bonus rate). For facilities with a capacity of 10 MW or greater, operators are required to generate electricity of 70% or more of their power generation capacity every year.

Application for FITs can be submitted via the website of the SEDA or in paper form. The flow from application for an FIT to implementation of a project is as described in a leaflet published by the SEDA (Feed-in Tariff in Malaysia), and the procedure is as shown in Figure 4-4.



Source: Produced by our company with reference to the SEDA's leaflet, Feed-in Tariff in Malaysia

Figure 4-4 Flow from application for an FIT to project implementation

Regarding FIT eligibility testing for the micro hydropower business, the Guideline for Testing and Commissioning Small Hydro Power Plant for Feed-in-Tariff (FiT) Projects for Malaysia, 2015, a material prepared by the SEDA in cooperation with power producers, local parties concerned, the Energy Commission, and other related parties, can be used as reference. The guidelines offer a detailed description of the testing methods for checking whether the facilities applied for an FIT is as stated in the application form submitted, and contain checklists used for the testing. Specific test methods are divided into two phases, before and during trial operation, and as tabulated in Table 4-8.

Table 4-8 Tests conducted upon application for an FIT

Before trial operation	・Check matters related to civil engineering and pipelines ・Check mechanical and electrical systems ・ Comprehensively check mechanical and electrical systems ・Check control units
During trial operation	・Measure the head loss in pipelines ・Measure fluctuations of the speed in pipelines ・Take measurements at the exit ・Check the setting of when to open and close valves

4.2 Basic surveys for drawing up commercialization plans

4.2.1 Selection of candidate places for micro hydropower plant installation

1)Electricity situation in Malaysia

As mentioned earlier, in Malaysia, the business of transmission and transformation of electricity is monopolized by Tenaga Nasional Berhad (TNB) in Peninsular Malaysia, Syankat SESCO Berhad (SESCO) in the Sarawak state, and Sabah Electricity Sdn. Berhad (SESB) in the Sabah state following the enforcement of the Electricity Supply Act 1990 in 1990, and these three companies are also the major operators of power generation and supply businesses. Table 4-9 and Figure 4-5 show the energy mix and Figure 4-5 illustrates the ratio of electricity generated at the existing power plants in each of the regions. The amount of electricity generated at micro hydropower plants (including large-scale plants) is about 5,100 GWh that accounts for 3.7% of the total electricity generated in Peninsular Malaysia in which the Johor state is located, and about 370 GWh, making up 5.4% of the total electricity, in the Sabah state in which Kota Kinabalu city is located.

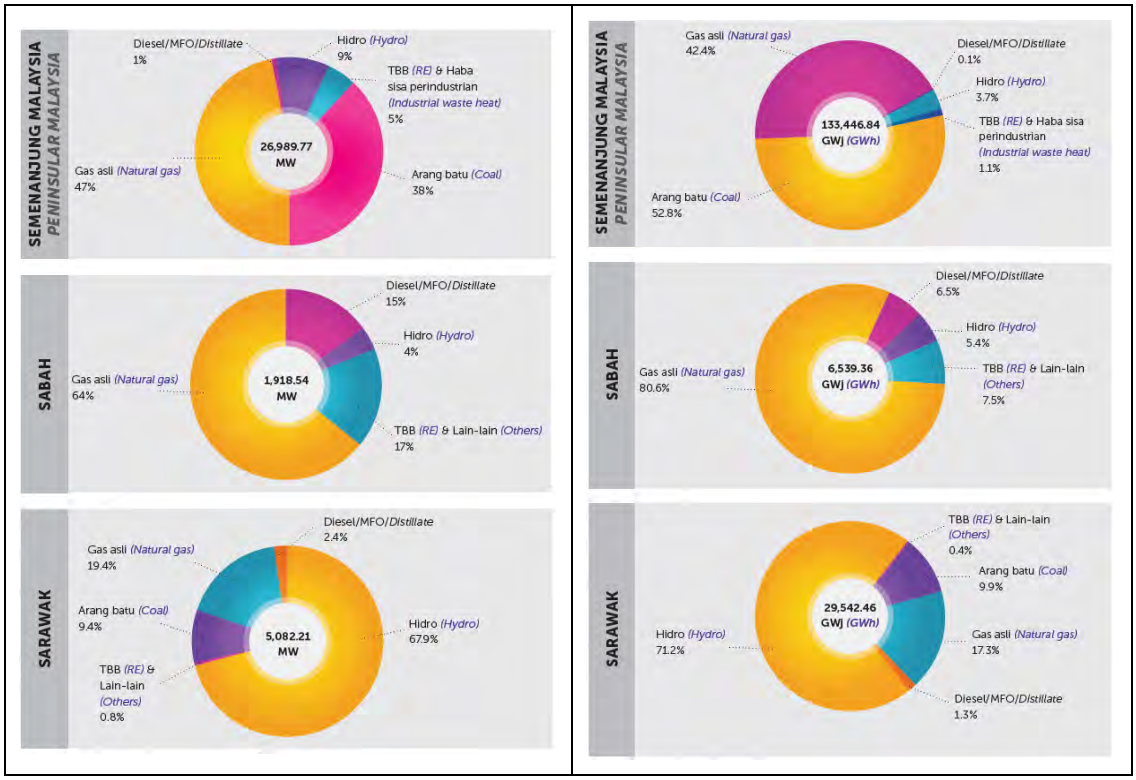
Table 4-10 tabulates the share of electricity use in each region, and Figure 4-6 illustrates the changes in the amount of electricity demanded by use. How electricity is used differs from region to

region, with the amount of electricity used for industrial purposes being the greatest in Peninsular Malaysia while electricity is consumed the most for commercial purposes in Sabah. The amount of electricity demanded is rising each year, with the rate of increase jumping particularly after 2015. The trend is expected to continue for the time being, and therefore, it will be required to develop power sources according to the energy policies.

Table 4-9 Energy mix at existing power plants in Malaysia in each region (2018)

		Hydro	Natural Gas	Coal	Diesel / MFO	Biomass	Solar	Biogas	Others	Total
Peninsular Malaysia	TNB	2,557.7	2,530.0	0.0	0.0	0.0	0.0	0.0	0.0	5,087.7
	IPPs	20.0	9,276.4	10,180.0	0.0	0.0	0.0	0.0	0.0	19,476.4
	Co-Generation	0.0	821.1	0.0	0.0	12.4	0.0	0.0	54.0	887.6
	Self-Generation	0.0	7.4	0.0	399.0	296.6	71.8	0.0	0.0	774.8
	FIT	43.8	0.0	0.0	0.0	44.9	344.0	60.3	0.0	493.0
	LSS	0.0	0.0	0.0	0.0	0.0	260.5	0.0	0.0	260.5
	NEM	0.0	0.0	0.0	0.0	0.0	9.8	0.0	0.0	9.8
	Subtotal	2,621.5	12,635.0	10,180.0	399.0	353.8	686.1	60.3	54.0	26,989.8
Sabah	SESB	81.8	112.0	0.0	178.9	0.0	21.5	0.0	0.0	394.2
	IPPs	0.0	1,012.6	0.0	0.0	0.0	0.0	0.0	0.0	1,012.6
	Co-Generation	0.0	106.8	0.0	0.0	36.7	0.0	0.0	0.0	143.5
	Self-Generation	0.0	2.8	0.0	111.0	79.9	0.0	10.1	8.7	212.5
	FIT	6.5	0.0	0.0	0.0	50.7	38.9	9.6	0.0	105.7
	LSS	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	50.0
	NEM**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Subtotal	88.3	1,234.3	0.0	289.9	167.3	110.4	19.7	8.7	1,918.5
Sarawak	SEB	3,458.1	594.6	480.0	113.8	0.0	0.6	0.0	0.0	4,647.1
	Co-Generation	0.0	389.0	0.0	0.0	0.0	0.0	0.0	0.0	389.0
	Self-Generation	0.0	0.0	0.0	9.7	31.3	0.0	0.0	5.1	46.1
	Subtotal	3,458.1	983.6	480.0	123.5	31.3	0.6	0.0	5.1	5,082.2
Total		6,167.9	14,852.9	10,660.0	812.5	552.4	797.1	80.1	67.7	33,990.5
Share (%)		18.15%	43.7%	31.4%	2.4%	1.6%	2.35%	0.2%	0.2%	100.0%

Source: National Energy Balance 2018 (the Energy Commission)



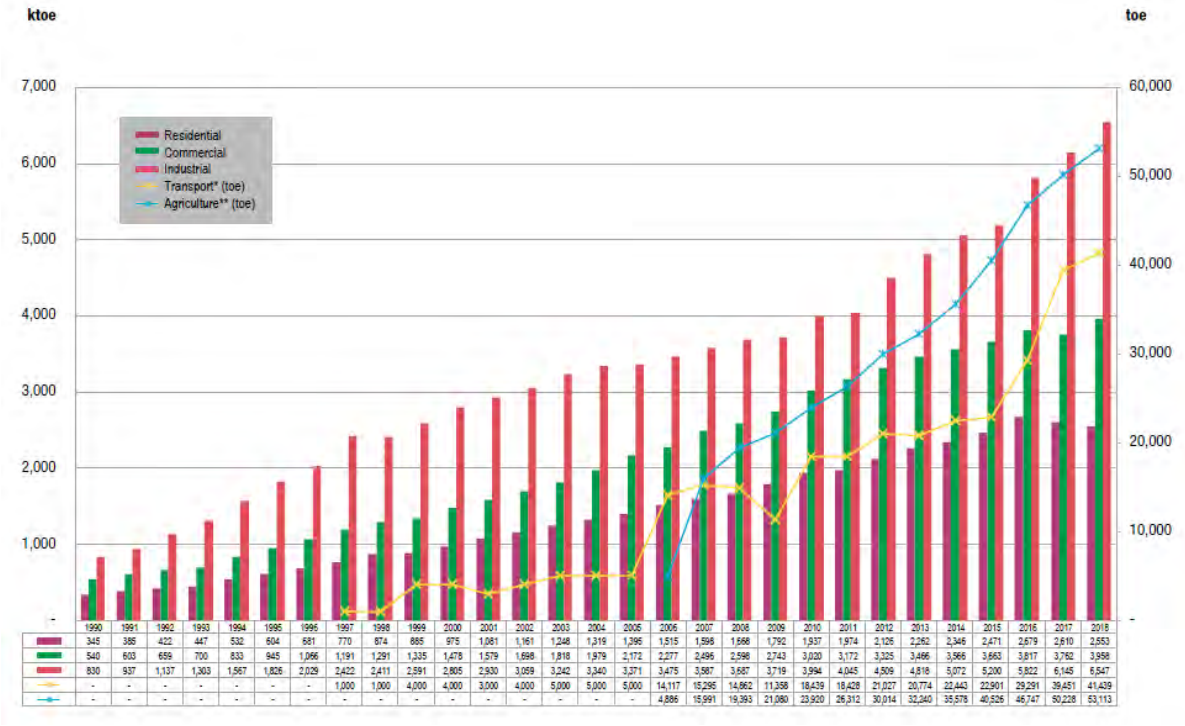
Source: Performance & Statistical Information on the Malaysian Electricity Supply Industry 2018 (the Energy Commission)

Figure 4-5 Share of energy mix and electricity generated in Malaysia by region

Table 4-10 Share of electricity use in Malaysia by region

Region	Industry		Commercial		Residential		Transport		Agriculture		Total
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	
Peninsular Malaysia	53,388	70.2	39,124	88.2	27,006	86.2	482	100.0	617.3	100.0	120,617
Sarawak	21,297	28.0	2,844	6.4	2,478	7.9	-	-	-	-	26,618
Sabah	1,404	1.8	2,377	5.4	1,850	5.9	-	-	-	-	5,630
Total	**76,088**	**100.0**	**44,345**	**100.0**	**31,334**	**100.0**	**482**	**100.0**	**617**	**100.0**	**152,866**

Source: National Energy Balance 2018 (the Energy Commission)



Source: National Energy Balance 2018 (the Energy Commission)

Figure 4-6 Changes in the amount of electricity demanded in Malaysia by use

2)Existing micro hydropower plants in Johor and Sabah states

According to National Energy Balance 2018 (the Energy Commission) and Performance & Statistical Information on the Malaysian Electricity Supply Industry 2018 (the Energy Commission), hydropower stations built in the Johor state and the Sabah state as of 2018 are as tabulated in Tables 4-11 and 4-12, respectively. The location of each facility is as illustrated in Figures 4-7 and 4-8.

Table 4-11 Hydropower plants in Johor

No.	Power plant	Operator	Installed capacity [MW]
1	Temengor	TNB	348.0
2	Bersia	TNB	72.0
3	Kenering	TNB	120.0
4	Chenderoh	TNB	40.0
5	Sg Piah	TNB	68.6
6	Pergau	TNB	600.0
7	Kenyir	TNB	400.0
8	Sultan Yussuf	TNB	100.0

9	Sultan Idris	TNB	150.0
10	Hulu Terengganu	TNB	250.0
11	Tembat	TNB	15.0
12	Ulu Jelai	TNB	372.0
13	Hidro mini	TNB	21.6
14	Musteg Hydro	Musteg Hydro Sdn. Bhd	20.0
15	Hidro mini	FIT※	43.8

*The value for the FIT is as is stated in the aforementioned materials because a total at multiple facilities is presented.

Table 4-12 Hydropower plants in Sabah

No.	Power plant	Operator	Installed capacity [MW]
1	Tenom Pangi	SESB	75.0
2	Hidro mini Merotai	SESB	1.0
3	Hidro mini Bombalai	SESB	1.0
4	Hidro mini Melangkap	SESB	0.0
5	Hidro mini Sayap	SESB	1.0
6	Hidro mini Kiau	SESB	0.0
7	Hidro mini Carabau	SESB	2.0
8	Hidro mini Naradau	SESB	1.8
9	Hidro mini	FIT※	6.5

*The value for the FIT is as is stated in the aforementioned materials because a total at multiple facilities is presented.

Source: National Energy Balance 2018 (the Energy Commission)

Figure 4-7 Location of power plants in Johor (with hydropower plants indicated in light blue)

Source: National Energy Balance 2018 (the Energy Commission)

Figure 4-8 Location of power plants in Sabah

3)Micro hydropower plants owned by SESB

Sabah Electricity Sdn. Berhad (SESB) runs seven micro hydropower plants which started to be in operation in the early 1990s. Figure 4-9 and Table 4-13 show the locations of the micro hydropower plants owned by SESB and overview of the facilities thereof. Each of these facilities was installed more than 20 years ago and suffers from various troubles, and we have confirmed through an interview that they hope to repair them.

Source: Material given by SESB

Figure 4-9 Locations of the micro hydropower plants operated by SESB

Table 4-13 Overview of the micro hydropower plants operated by SESB

No.	Power plant	Turbine and country of manufacture	Installed capacity	Year of start of operation
1	Naradau, Ranau	WKV Turgo Turbine/ England	2*880kW	1999
2	Carabau, Ranau	Pelton Hidro Biwater/England	2*1,000kW	1991
3	Sayap, Kota Belud	Xian China – CJ-W-90/1 x 11/ China	2*500kW	1991
4	Melangkap, Kota Belud	Jyoti 600T-500 / India & Xian China – CJ-W-90/1 x 11/ China	2*500kW	1990 & 1992
5	Kiau, Kota Belud	Wassercraft TD50H 330-1	1*350kW	1994
6	Bombalai, Tawau	WKV-Turgo Implus TT-285-180-1	1*1,000kW	1996
7	Merotai, Tawau	Gilkes Hidro G-150 (Francis Turbine)	1*1,000kW	1992

Based on our interview with SESB, a large earthquake with a magnitude of 5.9 that hit the Ranau region on June 5, 2015 affected five of the power plants, excluding Bombalai Plant (No. 6) and Merotai Plant (No. 7), in some way, causing the amount of electricity generation to drop. Specific changes in the amount of electricity generated are as shown in Table 4-14, and the capacity factor decreased by 20% or more at each plant. Even the capacity factor of Merotai Plant, which was not affected by the earthquake, declined by about 10% for some reason. There seem to be several reasons behind the decreased capacity factor, such as malfunctioned waterways and power facilities; however, each of the plants has been operated for more than 20 years, and their respective capacity factors did not reach 70%[11], which is the publicized general capacity factor of Japanese micro hydropower plants, even before the earthquake. This means that it is desirable to not only carry out infrastructure development work, such as repair of the waterways, but also upgrade such equipment as water wheels and power generators to state-of-the-art ones that are suited for the environment of Malaysia.

[11] https://www.env.go.jp/earth/ondanka/shg/page02.html

Table 4-14 Changes in the amount of electricity generation and capacity factor for 5 years before and after 2015

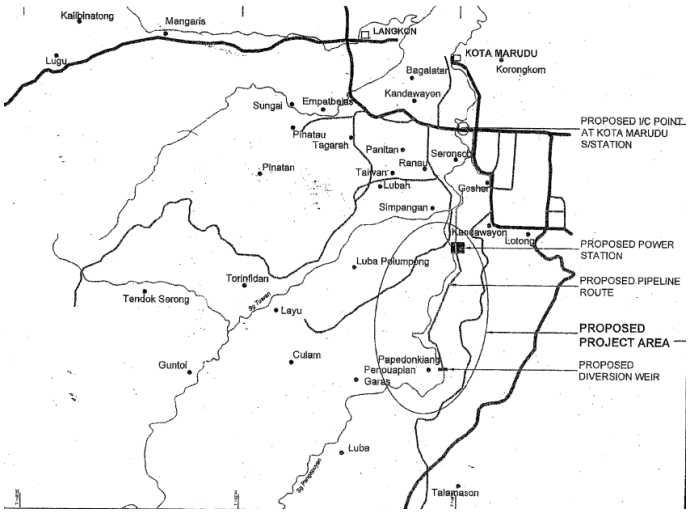
No.	Power plant	Amount of electricity generated 2010-2014 [MWh]	Capacity factor 2010-2014 [%]	Amount of electricity generated 2015-2019 [MWh]	Capacity factor 2015-2019 [%]
1	Naradau, Ranau	48,914	64	26,047	40
2	Carabau, Ranau	22,698	65	5,584	19
3	Sayap, Kota Belud	20,330	58	10,669	36
4	Melangkap, Kota Belud	17,363	50	1,690	6
5	Kiau, Kota Belud	2,979	19	0	0
6	Bombalai, Tawau	434	1	2,111	7
7	Merotai, Tawau	6,751	19	2,540	9

4)Other micro hydropower plants

In addition to the micro hydropower plants operated by SESB, we were introduced, during an online meeting with Kota Kinabalu city, to two of the micro hydropower plants that are in operation under long-term FIT contracts for guaranteed electricity purchase, as facilities at which the amount of electricity generated is on the decline. The overview of each plant is presented below:

①Sg.Pangapuyan Kota Marudu (4.5MW)

Sg. Pangapuyan Kota Marudu (hereinafter referred to as Pangapuyan Plant) is located in a village about 122 km northeast of Kota Kinabalu city (Figure 4-10). The facility of Pangapuyan Plant are as summarized in Table 4-15, and the appearance of the facility and rivers are as shown in Figure 4-11.

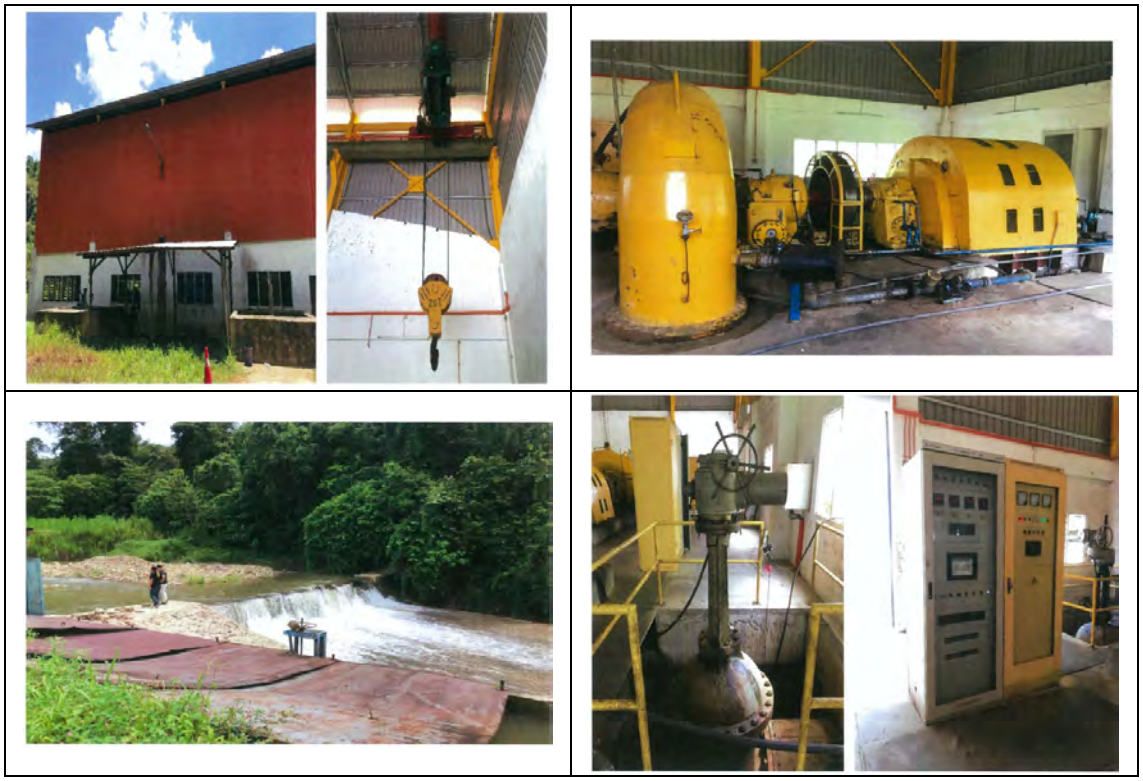


Source: Excerpts from the material given by Kota Kinabalu city

Figure 4-10 Location of Pangapuyan Plant

Table 4-15 Overview of Pangapuyan Plant facility

Item	Specifications
Water wheel	・ Model: HLA 550-WJ-71 manufactured by Zhejiang Jinlun Electromechanical (China) x2 ・ Output: 2,475kW (4,950kW in total for two wheels) ・ Rotational speed: 1,000 rpm ・ Head: 134 m ・ Flow velocity: 2.25 m3/second ・ Manufactured in: September 2007
Power generator	No information available
Other/special remarks	・ Automatic speed regulator (YWT-1000) ・ Power generator control unit



Source: Taken from the material given by Kota Kinabalu city

Figure 4-11 Photograph of Pangapuyan Plant

The changes of the annual amount of electricity generated, capacity factor, and proceeds from electricity sales since the plant started to be in operation in January 2011 are as tabulated in Table 4-

16, with the capacity factor having been very low at around 20% since the plant was opened. The reasons behind the low capacity factor need to be explored through an on-site investigation or other methods.

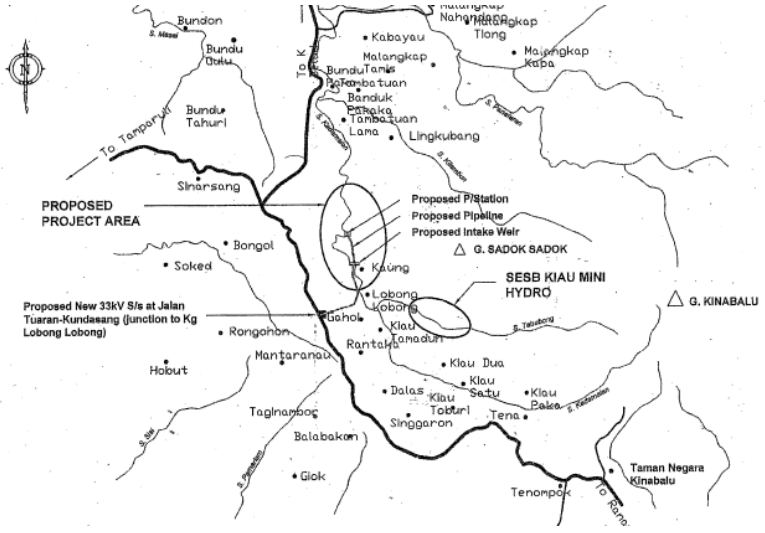
Table 4-16 Changes in the amount of electricity generated at Pangapuyan Plant

Year	Amount of electricity generated [MWh]	Capacity factor [%]
2011	8,191	20,8
2012	13,066	33.1
2013	9,789	24.8
2014	7,056	17.9
2015	4,633	11.8
2016	1,772	4.5
2017	9,768	24.8
2018	5,872	14.9
2019	2,539	6.4
2020	5,006	12.7

Source: Produced with reference to the material given by Kota Kinabalu city

②Sg.Kadamaian Kota Belud (2.0MW)

Sg. Kadamaian Kota Belud (hereinafter referred to as Kadamaian Plant) is located near Kampung Kaung village about 74 km east of Kota Kinabalu city (Figure 4-12), and there are an elementary school and houses of villagers nearby. The facility of Kadamaian Plant are as summarized in Table 4-17, and the appearance of the facility and rivers are as shown in Figure 4-13.



Source: Excerpts from the material given by Kota Kinabalu city

Figure 4-12 Location of Kadamaian Plant

Table 4-17 Overview of Kadamaian Plant facility

Item	Specifications
Water wheel	• Model: HLA696-WJ-60 manufactured by Zhejiang Jinlun Electromechanical (China) x2 • Output: 1,114 kW • Rotation speed: 1,000 rpm • Head: 59 m • Flow velocity: 2.15 m3/second • Manufactured in: September 2007
Power generator	• Model: SF1250-6/1180 manufactured by Chaozhou Huineng Electric Machinery (China) x2 • Installed capacity: 1,000kW • Voltage: 6,300V • Manufactured in: November 2007
Other/special remarks	• Automatic speed regulator (YWT-600) x2 • Power generator control unit

Source: Excerpts from the material given by Kota Kinabalu city

Figure 4-13 Photograph of Kadamaian Plant

The changes of the annual amount of electricity generated, capacity factor, and proceeds from electricity sales since the plant started to be in operation in August 2009 are as tabulated in Table 4-18, with the capacity factor having been plummeting since 2015. The earthquake occurring in 2015 may have some influence on the nosedive as on SESB's micro hydropower plants; however, detailed investigation need to be carried out on site. According to our interview with the person in charge of the management of the plant, floods come frequently during the rainy season from October to March (Figure 4-14), causing the water wheels to be covered with earth and sand which are carried by muddy streams, and they remove the earth and sand with their own hands. They, therefore, are interested in investing in water wheels that are capable of removing small stones automatically if there is any such wheel.

Table 4-18 Changes in the amount of electricity generated at Kadamaian Plant

Year	Amount of electricity generated [MWh]	Capacity factor [%]
2009※	3,794	52.0
2010	9,443	53.9
2011	12,115	69.2
2012	10,220	58.3
2013	9,824	56.1
2014	9,605	54.8
2015	4,305	24,6
2016	2,915	16.6
2017	2,408	13.7
2018	3,148	18.0

2019	4,088	23.3
2020	3,090	17.6

*The values are for five months because the plant started to be in operation in August 2009.
Source: Produced with reference to the material given by Kota Kinabalu city

Figure 4-14 Photographs of a river stricken by a flood and staff removing earth and sand

4.2.2 Selection of technologies to adopt

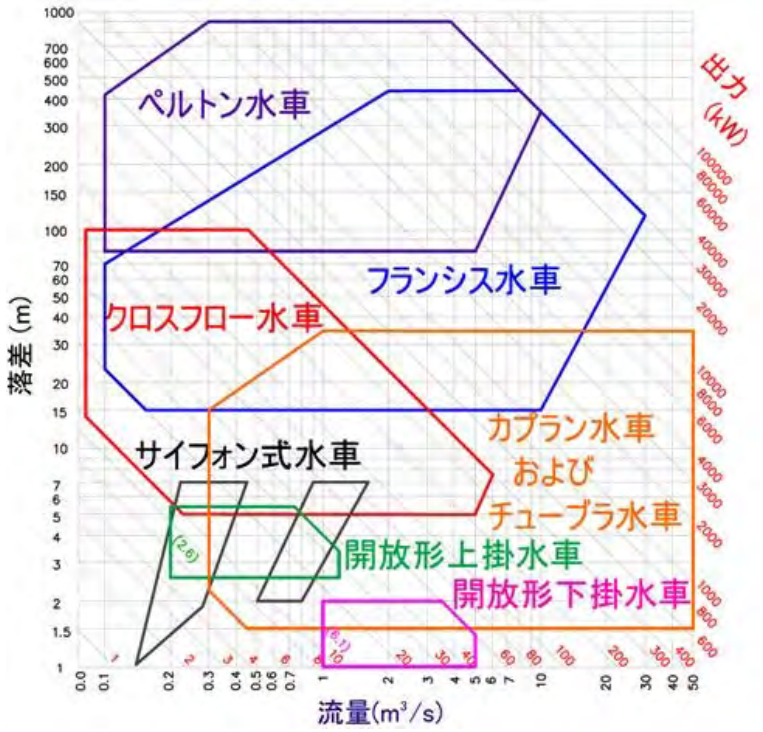
In this survey, we interviewed "National Council for the Promotion of Use of Micro-hydroelectric Power," which studies and researches the diffusion of businesses using micro-hydroelectric power and promotion of use of micro-hydroelectric power in Japan, in order to broadly investigate excellent micro-hydroelectric power generation technologies in Japan. **Table 4-19** outlines the interview.

Table 4-19 Outline of the Interview with National Council for the Promotion of Use of Micro-hydroelectric Power (Dec. 17, 2020)

Participants	National Council for the Promotion of Use of Micro-hydroelectric Power (1 participant), Japan NUS Co., Ltd. (2 participants)
Summary of the interview	・Methods for constructing a micro-hydroelectric power generation system vary, and basically depend on the landform of the site. ・It is composed of mainly (1) civil engineering, (2) waterwheels, and (3) electrical equipment. ・As for (3) electrical equipment, it is necessary to adopt a system suited for the electrical systems, voltage, etc. in each country or region. ・As for (2) waterwheels, we can refer to "Collection of cases of micro-hydroelectric power generation," which is issued every year by the Council. ・The reference unit price for construction is 1 million yen/kW (1 billion yen/MW), which is the Japanese standard. As the scale is smaller, the unit price rises. In general, the required scale for a feasible business is 200 kW to 300 kW.

	・In the prefecture, Hokuriku Seiki and Suiki Kogyo are famous. ・In actual cases, foreign products are often used, because their costs are much lower. ・Especially, German products are high-performance. They possess the technology for developing complicated products, such as waterproof thrust and slanted bearings. ・We think that it is possible to reduce costs, for example, by allowing makers to produce waterwheels freely while giving specs only for major items, such as change in height, flow rate, and output, rather than giving detailed specs, when placing an order. ・When considering the above, it is realistic to dispatch civil engineers (design) who experienced a variety of topographical conditions rather than waterwheels for exporting micro-hydroelectric technologies. ・In Toyama Prefecture, there are many sites that have difficult conditions, so the knowledge of enterprises that dealt with such conditions would be useful in overseas projects. ・In this inter-city collaborative project, it seems advisable to find local providers, form a tie-up with them, and conduct procurement there.

When selecting water wheels in a domestic micro-hydroelectric power generation project, a water wheel selection table is often used according to change in height and flow rate. One example is shown in **Fig. 4-14**, which also provides roughly estimated output.



Source: https://taiyo-gas.or.jp/kurashi/12th/

Figure 4－15 Example of a water wheel selection table

Water wheel makers in Toyama City include Suiki Kogyo Co., Ltd. and Hokuriku Seiki Co., Ltd. as mentioned in the above-mentioned interview. In 2016, the two companies jointly conducted “a survey for launching a project for solving the shortage of electric power by installing a micro-hydroelectric power generation system in canals” (Japan International Cooperation Agency [JICA]), and in that survey, they proposed a water wheel that can generate power efficiently according to water level as a product of Suiki Kogyo. That water wheel is shown in **Fig. 4-16.** The following characteristics are mentioned in the report on that survey.

①That water wheel can be installed in a canal as it is, and it is unnecessary to alter civil engineering structures in most cases.

②With a flow rate adjustment gate, it is possible to generate power efficiently, even if flow rate is low.

③It allows litter to drift downstream. The tip of each blade is made of rubber, to prevent drifting materials from clogging the wheel.

④The domestic selling price of a water wheel is about 600,000 yen/kW, so its cost performance is great.

⑤It can tolerate floods with the function to lift up the wheel.

⑥From 0.5 kW to 30 kW, it is possible to customize the output of the system by choosing an appropriate water wheel and increasing the number of wheels according to available water

volume and flow rate at each site.

⑦The structure of that water wheel is so simple that it can be produced in developing countries.

Source: Report on the completion of the survey for launching a project for solving the shortage of electric power by installing a micro-hydroelectric power generation system in canals in Indonesia (JICA)

Figure 4-16 Water wheel proposed by Suiki Kogyo Co., Ltd. to Indonesia

On the other hand, the capacity of the existing micro-hydroelectric power generation equipment, which was studied in the previous section, is as high as 500 to 5,000 kW, so it is necessary to install multiple units or select a water wheel with an appropriate capacity, although it depends on canals. The report on that survey introduces movable breastshot waterwheels, spiral waterwheels, and propeller waterwheels in addition to the above-mentioned waterwheels, and mentions that they have features described in **Table 4-20**.

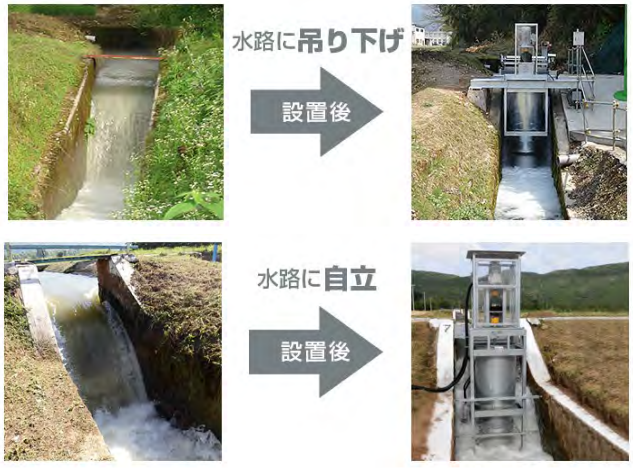
In addition, that company obtained waterwheel-related patents, including those for a floating cleaning machine (1992, No. 3289962) and a pump gate (2004, No. 3605370). Accordingly, it is expected to choose or develop water wheels suited for the site.

Table 4－20 Examples of other water wheels handled by Suiki Kogyo Co., Ltd.

Source: Report on the completion of the survey for launching a project for solving the shortage of electric power by installing a micro-hydroelectric power generation system in canals in Indonesia (JICA)

In addition, according to the website of Hokuriku Seiki Co., Ltd., it developed a water wheel called “Power Archimedes,” and the following features are described (**Fig. 4-17**). Four units of this water wheel have been delivered to the Philippines and Myanmar.

①A power generator can be installed directly in a canal.
②Power generation efficiency is high, even when change in height is small and flow rate is low.
③Its structure is so simple that it can be produced in developing countries.
④The price of the equipment is low.
⑤The installation of the equipment is easy.
⑥Maintenance is easy.



Source: http://www.s-hokuriku.com/product/archimedes

Figure 4－17 Case of installation of Power Archimedes of Hokuriku Seiki Co., Ltd.

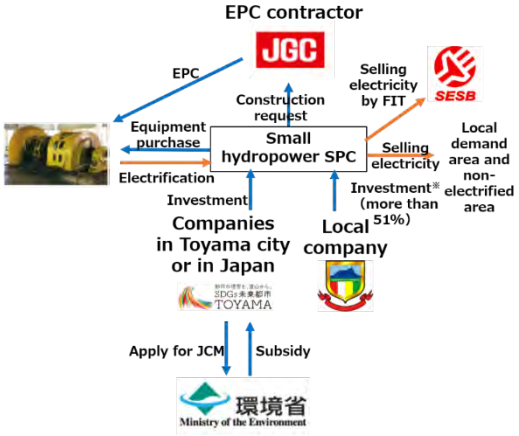
４．２．３　Designing of a business model

1) Envisioned commercialization and execution system

In this survey, we can envision the two businesses shown in **Table 4-21**. One is to replace the decrepit water wheels of micro-hydroelectric power generation stations, which have been operated for over 20 years, with the water wheels of enterprises in Toyama City or Japanese companies to secure output (hereinafter called “Business 1”). In Business 1, an enterprise in Toyama City, which possesses excellent waterwheel technologies or a Japanese company could serve as a representative business operator, form an international consortium with SESB, and make it subject to JCM. Business 1 would facilitate the overseas business expansion of Japanese enterprises, but the owner of power stations is SESB, so there will be no incentives for Japanese enterprises, even if output improves and revenues from sale of electricity increase through the JCM program for subsidizing the installation of equipment, so the merits of participation are not significant. In addition, if the drop in output is attributable to canals, etc. in addition to the deterioration of water wheels, the replacement of water wheels may not improve output.

In order to solve these problems, we can envision a business of establishing a special-purpose company in the target region to own deteriorated hydroelectric power stations and repairing not only power generation equipment, such as water wheels and generators, which are subject to the JCM program for subsidizing equipment installation, but also canals, etc., which cased the drop in output, in cooperation with IPP business operators and enterprises that own deteriorated hydroelectric power stations other than SESB (hereinafter called “Business 2”). In Business 2, Japanese enterprises can receive revenues from sale of generated electricity according to capital injection ratio, etc. and commercialization is possible at low cost compared with the development of new sites, so there are significant merits. As mentioned above, the enterprises in Toyama City and Japanese companies are excellent in overall management and design of micro-hydroelectric power generation projects, including canal design, because they have experiences of power generation in rivers with various conditions. Accordingly, they are expected to exert their strengths to a sufficient degree in Business 2.

Table 4-21 Envisioned commercialization and implementation system

Business 1	Business 2
Case where only the installation of equipment, such as waterwheels, is conducted (Example: micro-hydroelectric power generation by SESB)	Case where investment in micro-hydroelectric power generation business is conducted (Example: Micro-hydroelectric power generation by FIT, IPP, etc.)
Implementation system	Implementation system
	

2) Economical evaluation and effect of reducing greenhouse gas emissions

When discussing commercialization, it is necessary to conduct on-site surveys and estimate costs in detail. Accordingly, in economical evaluation in this survey, we calculated the subsidy and corresponding operating cost for the project in which the cost for reducing CO2 emissions is 4,000 yen/t-CO2 in the case where the JCM program for subsidizing equipment installation is applied to the above 2 businesses under the condition shown in **Table 4-22**, for selecting sites for commercialization from the next fiscal year. Concrete estimation methods are as shown in **Table 4-23**.

Table 4-22 Preconditions for economical evaluation

Item	Unit	Figure	Remarks
Equipment utilization rate after commencement of business	%	70	Announced public equipment utilization rate of Japanese micro-hydroelectric power generation equipment
Revenues from FIT electricity sale	yen/kWh	6.76 6.5	0.2600RM/kWh（≦2MW） 0.2500RM/kWh（＞2MW、≦10MW）
Grid coefficient	t-CO2/MWh	0.5637	OM of Sabah in the material released by IGES was adopted.

Project period	years	22	Legal durable years of equipment, including water wheels

Table 4-23 Estimation methods in economical evaluation

Reference output	By multiplying the equipment utilization rate calculated from the power generation amount in the past 5 years by equipment capacity, we obtained the annual reference output [MWh/year] before project commencement, and calculated the reference output [MWh] by multiplying it by 22 years, which is the project period.
Project output	As the equipment utilization rate after project commencement, we adopted 70%, which was announced as the general equipment utilization rate of Japanese micro-hydroelectric power generation equipment. By multiplying it by equipment capacity, we obtained the annual reference output [MWh/year] after project commencement, and calculated the reference output [MWh] by multiplying it by 22 years, which is the project period.
Reduction amount of greenhouse gas emissions	It was obtained by multiplying the above reference output and project output by the grid coefficient: 0.5637t-CO2/MWh and then calculating the difference between the two values.
Subsidy	It was obtained by multiplying the above-mentioned reduction amount of greenhouse gas emissions by 4,000 yen, which is the reference cost for reducing greenhouse gas emissions in the JCM program for subsidizing equipment installation.
Project cost	It was obtained by assuming that subsidy ratio is 50% and dividing the subsidy by it.

①Case of Business 1 (assuming a micro-hydroelectric power generation plant owned by SESB)

Table 4-24 shows the results of comparison in output between the systems before and after the commencement of Business 1, and **Table 4-25** shows the results of evaluation of the effect of reducing greenhouse gas emissions and economical performance. It was found that the total output of 7 power plants would increase by 35,154 MWh per year and by 773,385 MWh in 22 years. Greenhouse gas emissions would decrease by 19,816 t-CO2 per year and by 435,957t-CO2 in 22 years. Assuming that the JCM program of subsidizing equipment installation covers 50% of costs, it is possible to design a

project with a scale of up to 3.49 billion yen.

Table 4-24 Change in output through Business 1

Basic Info			Before project			After project		
No.	Plant name	Capacity	Capacity factor	Generating capacity	Income	Capacity factor	Generating capacity	Income
		kW	%	MWh/year	USD/year	%	MWh/year	USD/year
1	Naradau, Ranau	1,760	40	6,167	416,892	70	10,792	729,561
2	Carabau, Ranau	2,000	19	3,329	225,027	70	12,264	829,046
3	Sayap, Kota Belud	1,000	36	3,154	213,183	70	6,132	414,523
4	Melangkap, Kota Belud	1,000	6	526	35,531	70	6,132	414,523
5	Kiau, Kota Belud	350	0	0	0	70	2,146	145,083
6	Bombalai, Tawau	1,000	7	613	41,452	70	6,132	414,523
7	Merotai, Tawau	1,000	9	788	53,296	70	6,132	414,523

Table 4-25 Results of evaluation of the GHG emissions reduction effect and economical performance of Business 1

Basic Info			Before project		After project		GHG reduction and economic efficiency evaluation			
No.	Plant name	Capacity	Generating capacity	Income	Generating capacity	Income	Generating capacity After-Before	Income After-Before	GHG reduction	Subsidy
		kW	MWh/year	USD/year	MWh/year	USD/year	MWh/year	USD/year	t-CO2/year	USD
1	Naradau, Ranau	1,760	6,167	416,892	10,792	729,561	4,625	312,669	2,607	2,294,398
2	Carabau, Ranau	2,000	3,329	225,027	12,264	829,046	8,935	604,020	5,037	4,432,360
3	Sayap, Kota Belud	1,000	3,154	213,183	6,132	414,523	2,978	201,340	1,679	1,477,453
4	Melangkap, Kota Belud	1,000	526	35,531	6,132	414,523	5,606	378,993	3,160	2,781,088
5	Kiau, Kota Belud	350	0	0	2,146	145,083	2,146	145,083	1,210	1,064,635
6	Bombalai, Tawau	1,000	613	41,452	6,132	414,523	5,519	373,071	3,111	2,737,634
7	Merotai, Tawau	1,000	788	53,296	6,132	414,523	5,344	361,227	3,012	2,650,725

②Business 2 (other micro-hydroelectric power generation plants)

Table 4-26 shows the results of comparison in output between the systems before and after the commencement of Business 2, and **Table 4-27** shows the results of evaluation of the effect of reducing greenhouse gas emissions and economical performance. It was found that the total output of 2 power plants would increase by 31,683 MWh per year and by 697,022 MWh in 22 years. Greenhouse gas emissions would decrease by 17,860 t-CO2 per year and by 392,911 t-CO2 in 22 years. Assuming that the JCM program of subsidizing equipment installation covers 50% of costs, it is possible to design a project with a scale of up to 3.14 billion yen. Since Sg. Pangapuyan Kota Marudu is the most effective project, we will survey sites where the project could be implemented effectively on a priority basis from the next fiscal year.

Table 4-26 Changes in output and revenues from electricity sale through Business 2

Basic info			Before project			After project		
No.	Plant name	Capacity	Capacity factor	Generating capacity	Income	Capacity factor	Generating capacity	Income
		kW	%	MWh/year	USD/year	%	MWh/year	USD/year
1	Sg.Pangapuyan Kota Marudu	4,500	12.7	4,991	324,441	70	27,594	1,793,610
2	Sg.Kadamaian Kota Belud	2,000	18.2	3,184	215,225	70	12,264	829,046

Table 4-27 Results of evaluation of the GHG emissions reduction effect and economical performance of Business 2

Basic info			Before project		After project		GHG reduction and economic efficiency evaluation			
No.	Plant name	Capacity	Generating capacity	Income	Generating capacity	Income	Generating capacity After-Before	Income After-Before	GHG reduction	Subsidy
		kW	MWh/year	USD/year	MWh/year	USD/year	MWh/year	USD/year	t-CO2/year	USD
1	Sg.Pangapuyan Kota Marudu	4,500	4,991	324,441	27,594	1,793,610	22,603	1,469,169	12,741	11,212,155
2	Sg.Kadamaian Kota Belud	2,000	3,184	215,225	12,264	829,046	9,080	613,822	5,119	4,504,288

4.3 Discussions on problems and countermeasures

This fiscal year, we obtained information on the output at each site, equipment makers, etc. through online surveys, but were not able to conduct on-site surveys due to the novel coronavirus. When discussing micro-hydroelectric power generation business, it is necessary to visit sites, check hydropower equipment, power generators, and civil engineering facilities, including canals, and conduct meticulous surveys on the deterioration and failure of equipment, which cause the decline in output. Next fiscal year, we need to visit sites, carry out on-site surveys, and estimate power generation potential according to the characteristics of each site.

When discussing business using the JCM program for subsidizing equipment installation, it is necessary to involve an enterprise in Toyama City or a Japanese company, in order to establish a business execution system. Accordingly, it is necessary to examine the possibility of business as well as the results of on-site surveys in detail, approach enterprises that may participate in the project with the results of our surveys, and shift from the basic survey phase to the phase of discussing details for commercialization.

4.4 Support for the installation of micro-hydroelectric power generation equipment targeted at environmental education

In this survey, we introduced a hybrid solar and micro-hydroelectric power generation equipment targeted at environmental education, which is set in Iskandar, and exchanged opinions at on-site kickoff meeting and workshop.

At the meeting, the City of Kota Kinabalu expressed its intention to proceed with the electrification project using renewable energy, which is combined with environmental education, as

the urbanization of Sabah has not progressed compared with Peninsular Malaysia and the electrification project is delayed especially in rural areas.

For the purpose of promoting electrification in rural areas, the governments of rural areas and the Ministry of Rural Development have implemented the “rural area electrification program (BELB Programme)” in Sabah and Sarawak. This program is aimed at transmitting electricity to areas outside the jurisdiction of local governments and farming villages and households that preserve a traditional way of life.

There are two concrete measures. The first measure is to connect rural areas by utilizing existing power lines and grids. The second measure is to install generators directly in isolated areas. Actually, most target areas are located far from grids, so it costs a lot to connect them with existing grids, so the second measure is mostly chosen. Through this program, they aim to increase the electrification ratio in Sabah to 90.81% by the end of 2022, so that 335,626 out of 369,578 households will be able to use electricity, and raise the electrification ratio to 95.03% by 2025.

However, as electrification ratio increases, there will emerge problems about the physical access to the target region, the acquisition of land for constructing roads and power lines (Right of way: ROW), the lack of environmental and social data in local governments, etc.

In such regions, electricity is used the most for lighting. In regions where electrification is progressing, it is expected that the educational environment and the environment of medical facilities, including hospitals, will improve, the gender balance will increase, and the inflow to cities will be prevented. These effects are very important from the viewpoint of SDGs.

By interviewing the officials of the City of Kota Kinabalu in this project, we confirmed that there is Kobuni Village, which has a traditional life and is lagging behind electrification, about 20 km distant from Kota Kinabalu. The population of Kobuni Village is less than 300 people, its access to the urban center is poor, and the supply of electricity is not stable, so a power failure occurs frequently there. In addition, Kobuni Village has plentiful natural resources, so many sightseers visit there to see waterfalls, etc. Accordingly, the City of Kota Kinabalu considers this village as the best place for conducting eco-tourism for conserving the environment. Therefore, by implementing a micro-hydroelectric power generation project in Kobuni Village and defining it as a model case, it is considered possible to promote environmental education and apply this model to nearby villages.

A river where micro-hydroelectric power generation is to be conducted has been already designated, but there have been no surveys on feasibility, so we plan to collect data from now on. In addition, the water volume of the target river changes considerably between the dry and rainy seasons, so we are thinking of combining it with solar power generation during the dry season in which the water volume is small.

From now on, we plan to survey the feasibility of installation of renewable energy equipment in Kobuni Village while coordinating with the City of Kota Kinabalu. After implementing the pilot

project, it is also necessary to discuss how to educate local citizens and raise their awareness, to attain the goal of the national renewable energy policy of Malaysia.

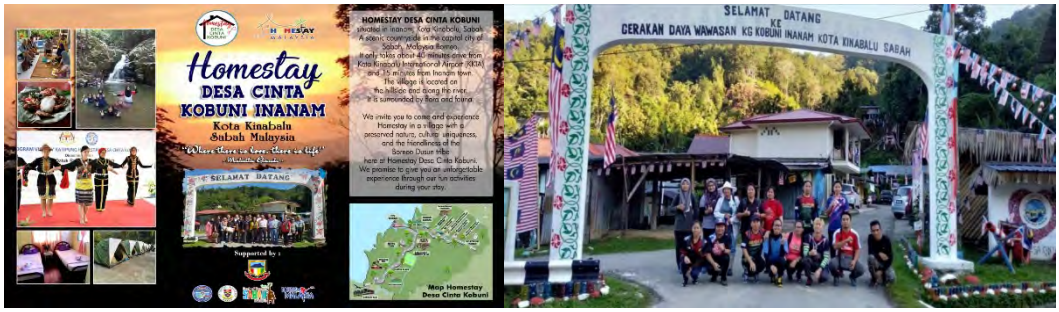


Figure 4-18 Scene of Kobuni Village

Chapter 5 Inter-city Collaborative Activities

5.1 Outline of inter-city collaborative activities

Table 5-1 outlines the inter-city collaborative activities in the project for this fiscal year. This fiscal year, we were not able to conduct on-site surveys due to the novel coronavirus, so all collaborative activities with local municipalities, related organizations and enterprises were carried out online.

Among these activities, the proceedings of kickoff meetings held with IRDA and the City of Kota Kinabalu are outlined by **Tables 5-2** and **5-3**.

Table 5-1 Outline of inter-city collaborative activities

Date	Participants (business operators)	Related project	Agenda
Sep. 1, 2020	MPOB, JGC, JANUS	Biofuel	Interview about the situation and systems of use of biofuel
Oct. 9, 2020	Sime Darby, JGC, JANUS	Biofuel	Interview about the production of biofuel
Oct. 22, 2020	SESB, JANUS	Micro-hydroelectric power	Interview about decrepit micro-hydroelectric power generation equipment
Nov. 5, 2020	IRDA, Toyama City, JANUS	Common	Kickoff meeting
Nov. 26, 2020	MIDA, JANUS	Common	Introduction of the inter-city collaborative project
Dec. 3, 2020	TGES, Hokusan, JANUS	Biofuel	Introduction of the biofuel use project
Dec. 17, 2020	J-Water, Hokusan, JANUS	Micro-hydroelectric power	Interview about micro-hydroelectric power generation technologies
Dec. 17, 2020	Hokuriku Electric Power, Hokusan, JANUS	Micro-hydroelectric power	Introduction of the micro-hydroelectric power generation project
Dec. 21, 2020	Kota Kinabalu, Toyama City, JANUS	Common	Kickoff meeting
Jan. 13, 2021	FASTENAL MALAYSIA, JGC, JANUS	Biofuel	Interview about the possibility of use of biofuel
Jan. 18, 2021	IRDA, JGC, JANUS	Biofuel	Interview about BRT business plans, etc.
Jan. 21, 2021	Sime Darby, JGC, JANUS	Biofuel	Interview about the feasibility of production and use of biofuel
Jan. 26, 2021	Kota Kinabalu, JANUS	Micro-hydroelectric power	Interview about decrepit micro-hydroelectric power generation equipment
Feb. 8, 2021	SEC, JGC, JANUS	Biofuel	Interview about the feasibility

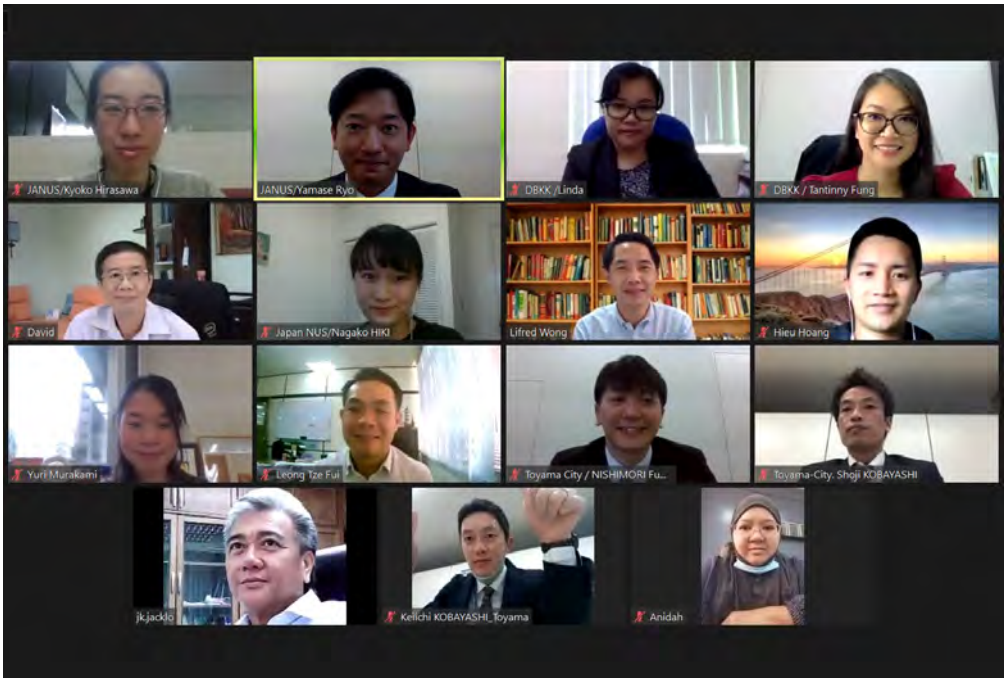
			of the biofuel transportation project
Feb. 25, 2021	IRDA, Toyama City, Ministry of the Environment, Hokusan, Nihon Kucho Hokuriku, JGC, JANUS	Common	Workshop
Feb. 25, 2021	Kota Kinabalu, Toyama City, Ministry of the Environment, Hokusan, Nihon Kucho Hokuriku, JGC, JANUS	Common	Workshop

Table 5-2 Outline of the proceedings of the kickoff meeting with IRDA (Nov. 5, 2020)

Date	Thursday, November 5, 2020; 11:00 to 12:45
Agenda	1. Greetings and introduction of related parties 2. Progress of Low Carbon Society Blueprint, and focusing on the city-to-city cooperation between Toyama City and IRDA / Sustainable Energy for All collaboration 3. Closing
Photos	

Proceedings	1. Public transportation After IRDA explained its desktop survey on projects for realizing low-carbon public transportation, JANUS explained models and technologies used for realizing low-carbon public transportation in the inter-city collaborative project, and exchanged opinions. The overview of the proceedings is as follows. ・In the desktop survey, they studied designs and technologies for construction, infrastructure, and energy, fuels used for them, and so on. As for fuels, they compared and discussed hybrid fuel, bio LNG, electricity, and diesel fuel. (IRDA) ・In the Indonesian project, did local business operators refurbish buses? (IRDA) →Yes, we requested local business operators to do so. (JANUS) ・In Malaysia, too, it may be necessary to find local business operators that could refurbish buses. (IRDA) ・How much can we bring out energy merits through the shift to DDF? (IRDA) →In the case of the Indonesian project, CO2 emissions were reduced by about 40% compared with diesel fuel. This time, CNG/LNG derived from biofuel will be used, so further reduction can be expected. (JANUS) ・The Japanese side, too, requires data on estimated fuel consumption, etc. for discussions. Is it possible to share such data? (JANUS) →It's possible. Please produce the list of necessary data to share. (IRDA) ・The FS business utilizing hydrogen in Malaysia was discussed, and the following problems were confirmed. -Buses are owned by their owners, so it is difficult to refurbish buses without permission, due to guarantee issues, etc. -Compared with diesel fuel, costs can be reduced, but only bus operators would gain profits, and there would be no profits for IRDA. ・The Japanese side has contacted some local candidate enterprises that could supply biofuel, and plans to exchange opinions with SimeDarby, one of the candidates. (JANUS) →If possible, please share the contact information of staff in charge, etc. (IRDA) 2. Eco-town project IRDA briefly explained the eco-town project they are planning, and then opinions were exchanged. The outline is as follows. ・IRDA aims to develop an eco-town based on waste power generation. At present, they refer to the models of Kawasaki City and Kitakyushu City. Does Toyama City implement such measures, too? (IRDA) →Toyama City, too, engages in an eco-town project actively, although its scale is smaller than those of Kawasaki City and Kitakyushu City. Its brochure will be shared. Please refer to it. If necessary, it is possible to introduce business operators. (Chief Kobayashi) →The scale of the eco-town project of Toyama City is close to the assumed scale of the IRDA project, so it is very attractive. We'd like to refer to the know-how of Toyama City. (IRDA) 3. Other ・In early 2021, we plan to hold a seminar (or webinar) with JETRO. We would like enterprises, etc. in Toyama City to participate in the seminar. (IRDA)

Table 5-3 Outline of the proceedings of the kickoff meeting with Kota Kinabalu (Dec. 21, 2020)

Date	Thursday, Dec. 21, 2020; 15:00 to 17:00
Agenda	1. Greetings and introduction of related parties 2. Introduction of Toyama city and background of City-to-City Collaboration Project 3. Explanation about the contents of JCM project and City-to-City Collaboration project plan 4. Explanation about current issues related environment and waste treatment, cooperation expected from Toyama city 5. Closing
Photos	

Proceedings	1. Regarding the inter-city collaborative project Toyama City explained the background for the conclusion of the inter-city collaboration contract between Toyama City and Kota Kinabalu, and then JANUS briefly explained the inter-city collaborative project for this fiscal year. The outline of questions and discussions is as follows. ・Is the project behind schedule due to the novel coronavirus? (KK) →We didn't expect that it would become impossible to visit the site, but we have been gathering information while enlisting cooperation from local staff (JANUS) ・Is there anything the City of Kota Kinabalu can do for cooperation? (KK) →Please let us know policies regarding renewable energy set by the City of Kota Kinabalu, if any (JANUS). ・City of Kota Kinabalu has not set any concrete policies, but basically follows the policies of Sabah. If renewably energy is distributed through the inter-city collaborative project, etc., it is considered possible to attain the target values of Sabah (KK). ・Is the target area of the survey on the feasibility of micro-hydroelectric power generation limited to Kota Kinabalu? In a previous case, micro-hydroelectric power generation was adopted in Sabah, and it was unsuccessful. It is possible to introduce such a case (KK). →Without limiting it to Kota Kinabalu, we would like to consider the entire Sabah. As for the previous case, we would like to know the details of equipment, the reason for the failure, etc. (JANUS) ・Is it necessary to transmit micro-hydroelectric power to the system of SESB without fail? In Kota Kinabalu, there are some small villages not connected to the interconnected power system of SESB, so we would like to discuss a project of installing micro-hydroelectric power generators there and promoting the local consumption of electricity generated there (KK). →After collecting local information and conducting on-site surveys, we would like to have discussions while considering feasibility (JANUS). ・Is there any site where the installation of micro-hydroelectric power generation equipment has been already discussed? (JANUS) →The other day, we met the mayors of cities in the vicinity of Kota Kinabalu, and there are about two candidates (KK). 2. Regarding environmental issues in Kota Kinabalu (disposal of waste) City of Kota Kinabalu explained municipal measures for disposing of waste for tackling environmental issues and their expectations toward Japan. The outline of questions and discussions is as follows. ・We hope that trash will be sorted out appropriately like in Japan. Especially, the amount of food waste from households and restaurants is large, so we previously implemented a project for composting the food waste at households while enlisting support from Akita City, but it could not be applied to cooked food waste, so that project was unsuccessful. Are there any cases of Toyama City's measures for food waste or the like? (KK). →As for the disposal of food waste, including composting, support, such as governmental and municipal subsidies, is considered necessary. Toyama City has not produced the guidelines or the like focused on the composting of food waste, but in some regions, there is a pilot project for collecting food waste and producing biogas fuel as demonstration (Toyama City).

	・Is there any case of recycling of home appliances or the like? (KK) →In Japan, the Home Appliance Recycling Act has been enacted, to promote the recycling of home appliances nationwide and diffuse the idea and system of home appliance recycling. Collected home appliances are disassembled and electronic components are sorted out, and reusable components, etc. are reused or recycled (Toyama City). ・For reference, what is the recycling rate in Sabah? (Toyama City) →At present, it is less than 14%, and we aim to increase it to 30% by 2025 (KK). 3. Regarding the energy saving project and the micro-hydroelectric power generation project in Kobuni Village City of Kota Kinabalu briefly explained the project of saving energy by setting LED street lamps and the micro-hydroelectric power generation project in Kobuni Village, and then exchanged opinions. The outline is as follows. ・What is the reason for the selection of Kobuni Village as a project site? (JANUS) →The access from Kobuni Village to Kota Kinabalu is not good, and electricity supply is unstable, so power outage often occurs in the village. On the other hand, Kobuni Village has plentiful natural resources, and many sightseers visit there to see waterfalls, etc. Accordingly, they put energy into eco-tourism for conserving the natural environment. Therefore, by implementing a micro-hydroelectric power generation project in Kobuni Village and seeing the results as a model case, it would be possible to promote environmental education and apply the model to nearby villages (KK). ・What is the population of Kobuni Village? (JANUS) →About 350 people (KK) ・For that scale, it is unnecessary to install a micro-hydroelectric power generator of the megawatt scale, and a smaller generator would suffice. Are there data on the water volume of the river and the view of the entire river? (JANUS) ・There are no records of feasibility surveys, so we will check the existence of such data with staff in charge, and reply. The water volume of this river varies considerably between the dry and rainy seasons, so in the dry season with a small water volume, it may be necessary to add other power generation methods, such as solar power generation. However, the entire village is covered with trees, so the duration of sunshine is short－direct sunlight reaches the village from 9:00 am to around 3:30 pm. There may exist a variety of problems (KK). ・Who will conduct monitoring and maintenance after the commencement of the project? →A system for implementing the project, including monitoring and maintenance, will be designed through surveys. First of all, we would like to gather local information and discuss details in cooperation with the city (JANUS).

5.2 Seminar

As mentioned above, the project in this fiscal year was affected by the novel coronavirus, and we were not able to visit the site, so we held online workshop seminars with the officials of Iskandar and Kota Kinabalu, as described below.

5.2.1 Workshop Seminar with IRDA (February 25, 2021)

After reporting on this year's survey and future business model, we conducted a question and answer session regarding the survey content and business model, and exchanged opinions on future survey policies. In the question-and-answer session and exchange of opinions, the biofuel utilization business model in the Iskandar region is a very attractive business, so it is possible to include businesses other than Causeway Link, which was the subject of this year's survey, as a subject of consideration. We were able to get a lot of very positive opinions about whether or not the city of Kotakinabalu is planning to introduce a BRT system, and whether or not it is possible to consider a biofuel utilization project in that project as well. In addition, in order to further promote these projects, we were able to confirm from the field that they would like to realize an early field survey.

Table 5-4 Outline of the Proceedings of the Workshop Seminar with IRDA (February 25, 2021)

Date	15.00 – 17.00, Thursday, February 25, 2021
Agenda	1. Greetings & introduction of related parties 2. City-to-city collaboration project background and overview 3. Survey results for FY2020 4. Future development 5. Closing remarks
Photos	

Proceedings	**1. Opening Remarks** Toyama city gave a greeting to the attendees and reflected on this fiscal year's project, including the history of inter-city collaborations with the Iskandar region thus far. **2. Special Remarks** IRDA also gave a greeting to everyone and commented on their relationship with Toyama City so far and the attractiveness of the compact city policy (which Toyama City has also implemented) and expressed his wish to continue the inter-city cooperation into the future. **3. Study Report** JANUS went over the outline and schedule of JCM's schemes and projects, and explained the results obtained from this fiscal year's survey and future research plans. **4. Comment and Discussion** A wide range of topics were raised, including questions on the study report and other views. Below is the summary of the discussion. ・The survey results you explained have clearly been supported by precise data and I feel that this is a very meaningful survey. In particular, I was extremely grateful for your work on the amount of POME generated in the State of Johor, as I had never come across this data previously. (IRDA) ・As indicated in the survey results, there are six bus operators in the Iskandar region besides Causeway Link. Because of the significant economic benefits suggested by the survey results, it is likely that other operators might want to participate in the project. What is your view on the businesses other than Causeway Link to participate? (IRDA) →There is absolutely no problem with other businesses participating and if anything it would be welcomed. (JANUS) ・Do you have any information on what type of buses might be suitable for the DDF technology? (IRDA) →If you could forward the equipment data (engine type, etc.) for specific buses, I would be happy to request information from the company that owns the DDF technology. (JANUS) ・One of the appeals of Toyama City is its focus on the compact city policies and low-carbon policies centered on public transportation. As Mr. Lifred Wong from the City of Kota Kinabalu is also present in today's workshop, I would love to hear his views on these issues, including whether there are plans to set up a public transportation system in Kota Kinabalu. (IRDA) ・Firstly, I am amazed by the very attractive business models which you have developed for us to see from a small number of sources. Kota Kinabalu is indeed currently planning to install a public transportation system. Would it be possible for you to investigate for us, if Kota Kinabalu can also set up a public transportation system utilizing biofuel like the Iskandar region? Sabah has the highest palm oil production in Malaysia, and I would say the potential is quite high. (KK) →Due to the time constraint, we could not include it in today's presentation, but in fact in the 2020 survey we deliberated on a biofuel utilization project in Sabah after looking into the information on palm oil plants. We will share the survey results as a report later. (JANUS) ・Currently, we are looking into not only biofuel-based technologies but also systems using electricity (electric buses and LRT) for the prospective BRT system for Kota Kinabalu City. I would appreciate your input on issues such as whether you would recommend us to focus on

	electricity or biofuels. (KK) ・We at IRDA are currently discussing the three items: electricity, biofuel, and hydrogen. We believe that life cycle costs must be carefully considered. For example, in the case of electric buses, the initial installation cost is high, but if there is a guarantee that they will be used for 7 years or longer, it is expected that recoupment of investment will be possible even after taking the maintenance costs into account, and even a high CO2 reduction effect can be expected. Also, when calculating the service years of the buses, it is necessary to consider the route of the bus and the annual mileage. IRDA also independently asked consultants to perform the fuel comparison for us, and their results for biofuels showed very similar results to the survey presented here. (IRDA) ・When you compare the CO2 emissions of electric buses and biofuel-powered buses, it looks as though electric buses generate zero CO2 emissions when viewed only by the bus usage process. However, considering that the electricity used in electric buses is made from fossil fuels, the total CO2 emissions may be lower when biofuel is used. (IRDA) ・Based on our experiences, the contents of the decarbonization project are of course important, but we believe the support from the policy side is important. Toyama City has been actively working on the policies to attain the SDGs, including decarbonization and low-carbon initiatives, and we are keen to share the knowledge. Using the knowledge gained from our previous projects, we think we could also give advice with broader perspectives on the matters such as choosing among the electricity, biofuels, and CNG technologies. (Toyama City) ・When adopting the new BRT systems, we believe that Toyama City's examples of the LRT development might provide very helpful hints. Currently, I have heard that IRDA is tackling the issue of coexisting with the existing businesses. I think this is a problem that occurs absolutely everywhere when introducing public transportation, and we would appreciate it if you could describe, in the framework of the future projects, how you as the local government body led to solving such problems (JANUS) ・I asked about this in the morning session as well but how will the CO2 credits reduced through this project be allocated? (IRDA) →Under the JCM system, normally 50% will be allocated to the Japanese government, and how to distribute the remaining 50% will have to be discussed. On the other hand, this time round a very large amount of greenhouse gases is expected to be reduced through methane collection, so even a few percent will likely represent a significant amount. (JANUS) ・In the Iskandar region, our target is to reduce CO2 emissions by 58% by 2030, but we have so far only managed about 30%. We are able to work to achieve this target benefiting from the JCM scheme. (IRDA) ・I have heard that a subsidy will be provided for the cost of adopting the DDF technology required for the bus fuel shift. Do you know who will be paying for the equipment? →At present, this has not been finalized, and we are keen to find the best options through the inter-city collaboration projects from 2021 onward. For reference, in Semarang, Indonesia, the city of Semarang allocates a budget to the BRT operator Trans Semarang, which in turn pays for the equipment costs. (JANUS) ・If you have a chance, I would encourage everyone, including those from Kota Kinabalu, to visit Toyama City in 2021 and experience its wonderful public transportation system. (IRDA)

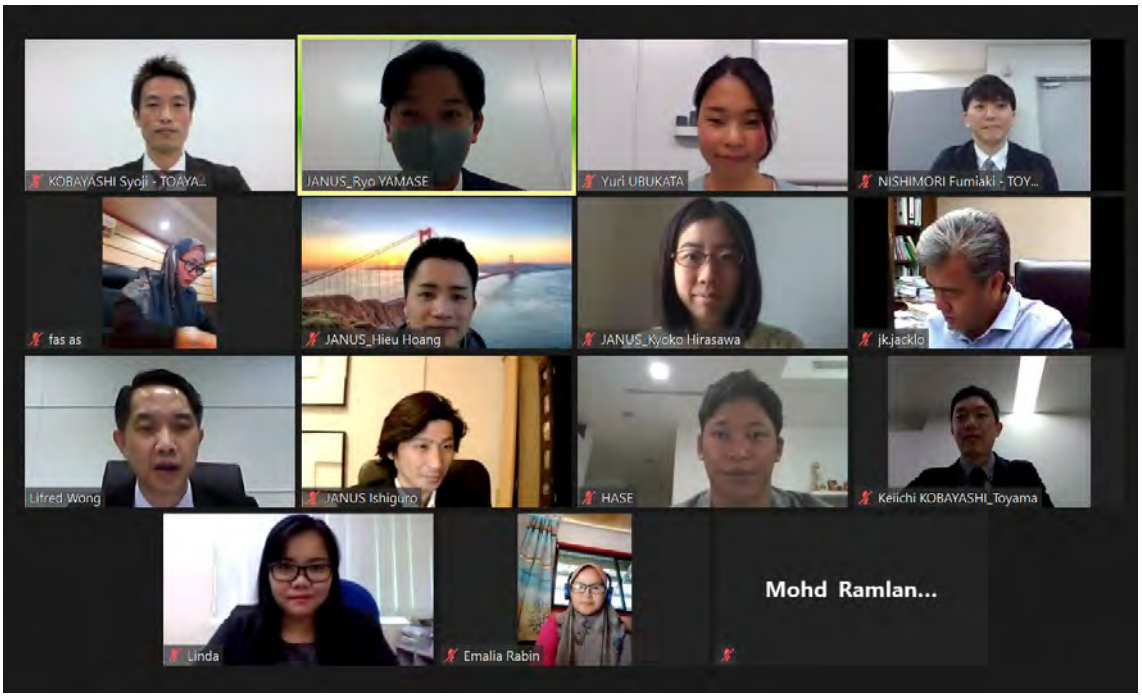
	・[To Mr. Boyd Joeman] I heard that you will be leaving IRDA at the end of February. Would you tell us what kind of projects you will be working on in the future? Also, we would love you to remain involved in giving advice on inter-city collaboration projects with Toyama City even after leaving IRDA. (Toyama City) →After leaving IRDA, I will become the team leader of the EU-funded GCOM Asia project at the Global Covenant of Mayors for Climate and Energy (GCOM). The details of the activities are yet to be decided, but we will be involved in the climate change-related projects and we would love to continue the relationship with Japan in some forms or the other. Mr. Ong Hwa Chung will take over as the chief of the inter-city collaboration projects, and I would like to maintain our good relationship built up over the years and continue to provide advice, etc. (IRDA) ・[To Mr. Boyd Joeman] The current cooperative relationships between Toyama City, the Iskandar region, and Kota Kinabalu City owe so much to you and we are extremely grateful to you and your efforts over the years. We wish you the very best for your future projects. Toyama City) **5. Closing remarks** JANUS thanked everyone for their cooperation in this year's survey and active discussions at the workshop, and also asked for their continued support for this year's activities and beyond, before closing the workshop.

5.2.2 Workshop Seminar with the City of Kota Kinabalu (February 25, 2021)

After reporting on this year's survey and future business model, we conducted a question and answer session regarding the survey content and business model, and exchanged opinions on future survey policies. In the question-and-answer session and exchange of opinions, we thanked not only Kota Kinabalu City but also Sabah as a whole for its extensive research and limited information for deep consideration of feasible business models, as well as environmental education and discussions. From the viewpoint of eco-tourism, we were able to obtain opinions such as expectations for the renewable energy electrification project in Kobuni Village. Regarding environmental education, IRDA explained the technology of the photovoltaic hybrid type small hydroelectric power generation system that has already been introduced in the Iskandar region and the effect of its introduction, and from the aspect of environmental education, the installation and introduction of renewable energy equipment We were able to gain the understanding of Kota Kinabalu city officials about its importance.

In order to further promote these projects, the field wants to realize an early field survey, and at the time of the field survey, etc., regarding the connection to the key person of the project and information gathering. We were able to agree to receive more support than ever before.

Table 5-5 Outline of the Proceedings of the Workshop Seminar with the City of Kota Kinabalu (February 25, 2021)

Date	10.00 – 12.00, Thursday, February 25, 2021
Agenda	1. Opening remarks – Toyama City 2. Opening remarks – Kota Kinabalu City 3. Study report 4. Comments and discussion 5. Closing remarks
Photos	

Proceedings	**1. Opening Remarks** Toyama city thanked the attendees from Kota Kinabalu and IRDA, and told us about the background to the inter-city collaboration with the Iskandar region, as well as his visit to Kota Kinabalu City where he was impressed by the city's natural wealth with mountains and rivers, and that he thought it shares the similar environment to Toyama City. He also spoke about Kota Kinabalu City's hope to grow while preserving its rich natural environment in this inter-city collaboration project, and that they have been contemplating on what kind of contributions they can make to the city from this perspective. **2. Special Remarks** Mr. Lifred Wong delivered a message from the Mayor of the City of Kota Kinabalu who was unable to attend the workshop. Mr. Wong then gave a greeting to all. We learned that he had watched a Japanese TV documentary to learn about Japan and Toyama City, and that he was impressed by Toyama City's efforts for the community. **3. Study Report** JANUS explained this fiscal year's survey results and future survey plans, while covering the outline and schedule of JCM's schemes and projects. **4. Comment and Discussion** A wide range of topics were raised, including questions on the study report and other views. Below is the summary of the discussion. ・Firstly, I would like to express our gratitude for your extensive investigation covering not only in Kota Kinabalu city but also the entire state of Sabah. (KK) ・As Kobuni Village is located in the region where the electrification process is slow, we believe that using renewable energy for electrification could be a catalyst to attract more tourists and investors; therefore, the village is significant in achieving the Green Sustainable Initiatives. (KK) ・In the reference material, there is a mention of the fountains installed on the waterbody that also function as the solar panels in Toyama City. This type of technology looks attractive as part of landscape and is great from the perspective of tourism. Are there any other examples of the environment-tourism combinations in Toyama City? (JANUS) ・We have waterwheels functioning as hydroelectric turbines, taking advantage of Toyama City's abundant water resources, and these are seen as a good example of ecotourism. Toyama attracts many visitors, and in 2021, and the situations permitting, we would like the people from Kota Kinabalu to visit Toyama and see the things for yourself. In Toyama City, we are very mindful of not destroying the rich natural landscape for the economic development. (Toyama City) ・The solar-hybrid type micro-hydroelectric power generation equipment adopted in the Iskandar region is a system that combines tide and sunlight. Although the installed capacity is as small as 1 kW, it has become a tourist attraction similar to Toyama City's waterwheels, and we also believe it has a significance as part of environmental education. (IRDA) →I was not aware that there was a technology in the Iskandar area that could generate electricity through tidal movements. This workshop once again made me realize the importance of obtaining new knowledge, including renewable energy. From this viewpoint, as many tourists who visit Kota Kinabalu often visit Kobuni Village, I would love to see Kobuni to become the place that can provide new awareness by installing facilities that utilize new technologies like those installed in the Iskandar region. (KK)

	・Am I correct in thinking that the subsidies for the JCM equipment subsidy projects will come from the funds of Japan's Ministry of the Environment? (IRDA) →The subsidies provided through the JCM equipment subsidy project is part of Japan's Ministry of the Environment budget, but they are dependent on conditions such as the amount and the potential CO2 reductions. While we could not carry out field surveys in 2020, it is necessary in the hydroelectric power generation projects to conduct field surveys to find out the causes of the reduction in the generated power. We are hoping to resume more vigorous surveys in 2021. (JANUS) ・How will the CO2 reduction credits be allocated? (IRDA) →Normally, 50% will be allocated to the Japanese government, and how to distribute the remaining 50% will have to be discussed. However, since Japan and Malaysia have not concluded the JCM agreement, sorting this out will be the priority. [To Mr. Boyd Joeman] We would be very grateful if you could speak for the JCM agreement when having a chance to talk to people from the Malaysian government. (JANUS) ・Could the credits be allocated to the government of Sabah rather than the Malaysian government? (IRDA) →We think it will be decided in consultation with the governments of Sabah and Malaysia, as well as the relevant business operators. (JANUS) ・We at Kobuni Village are running the homestay program and actively working to attract tourists. For this reason, we believe that electrification projects are very useful, and we have high expectations for them. If there is anything we can do in particular to help you with the 2021 survey, please let us know. (Kobuni Village) ・We are quite hopeful as we believe that running these projects at Kobuni Village will have a positive effect not only on Kobuni Village, but also on the surrounding villages. (KK) →From the SDGs perspectives, we are hoping in this research project to extend such projects to the surrounding area using Kobuni Village as a model, and we are going to continue with the survey to meet your expectations. (JANUS) ・When do you think you might be able to start travelling again in 2021? (KK) →Vaccinations in Japan began last week, and the mass vaccinations are expected to follow, firstly for medical professionals and then the elderly. It is unclear when we might get vaccinated, but as the Olympic games are supposed to be held in the summer, we are hoping to travel to you around that time. (JANUS) ・Malaysia has already begun vaccinating, but its borders are not yet open. It has not yet been officially announced, but it is thought that the borders might reopen around the summer. If you would like to make contact with any relevant persons when you visit Kota Kinabalu, we are more than happy to arrange the meetings for you. (KK) →We would be very grateful if you could introduce us to those who you think could be the key people in the project discussed today. (JANUS) **5. Closing remarks** Toyama City informed that he plans to travel at the earliest opportunity in the future, and that he would like to invite the team from Kota Kinabalu to visit Japan and Toyama City in 2021. JANUS thanked everyone for their cooperation in this fiscal year's survey and active discussions at the workshop, and also asked for their continued support for this year's activities and beyond, before closing the workshop.

Chapter 6　Conclusion

6.1　Achievements in the inter-city collaborative projects this fiscal year

In the inter-city collaborative projects carried out this fiscal year, we successfully obtained information necessary for commercializing the Joint Crediting Mechanism (JCM) as originally expected through online meetings and other similar methods despite the fact that we could not conduct on-site surveys due to the spread of Covid-19. **Table 6-1** tabulates the results that we have obtained, including the aforementioned.

Table 6-1 Summary of the achievements in the inter-city collaborative projects this fiscal year

Project	Achievements
Urban development project centering on biofuel-based, decarbonized public transportation	・ We confirmed the political positions of the biofuel utilization project and public transportation (a project to install the Bus Rapid Transit (BRT) system). ・ We assessed biofuel production potential, selected factories for discussion, and figured out the potential amounts of power generation thereof. ・ We discussed how to transport biofuel, and appropriate costs of selling biofuel on the basis of the expected amount generated and means of transport. ・ We discussed the amount of biofuel expected to be demanded upon adoption of the BRT system, etc.
Renewable energy promotion project centering on micro hydropower generation	・ We discussed locations to install micro hydropower facilities and the potential amounts of power generation thereof. ・ We introduced the hybrid facility of a micro hydropower plant and a photovoltaic power plant installed in Iskandar Malaysia. ・ We were offered information on Kobuni village as a site for the renewable energy adoption project that is aimed at environmental education, and agreed to add the village to the list of places to investigate in the next fiscal year and the years after.
Inter-city collaborative activities	・ We presented Toyama City's efforts and policies in kickoff meetings and workshops. ・ We confirmed that all the parties concerned are

	interested in continuing the inter-city collaborative projects in the next and subsequent years

6.2 Policies on the inter-city collaborative projects for the next fiscal year

The policies to take on each project in the next fiscal year are as shown respectively. As mentioned above, Covid-19 hindered on-site investigation for the inter-city collaborative projects this fiscal year, and some information, which is necessary for more realistic project effect verification and project realization, is missing. Furthermore, the local parties concerned have strongly asked us to come to their country for on-site investigation. As soon as the travel ban is lifted, therefore, we will go there and conduct on-site surveys. In addition, based on our investigation this fiscal year that has suggested that project implementation will offer a certain degree of potential, we will initiate a phase of having in-depth discussion not just among the Japanese side but also with local operators in order to put the JCM project into practice by approaching operators that are likely to join the international consortium and developing a system to implement the project through means such as conclusion of Memoranda of Understanding (MoU) and non-disclosure agreements (NDA).

We will also discuss renewable energy-based electrification of Kobuni village as a new project in which we found value in the course of this fiscal year's inter-city collaborative projects. In addition to strong requests from the local parties involved for our consideration for the project, electrification of the village is expected to bring about beneficial effects, including improvement of the educational environment, the environment of hospitals and other medical facilities, and the gender balance, and prevention of population inflow into urban areas. Furthermore, the village is located in an area that attracts a number of tourists. This means that the project is not only meaningful from the perspective of ecotourism, but also extremely important in terms of SDGs. We intend to continue our discussion about this project in cooperation with Nihonkucho Hokuriku Co., Ltd., a company that is based in Toyama City and has a multitude of photovoltaic power generation technologies, and Professor Hiroyuki Uesaka of Toyama University of International Studies, who also serves as the representative director of J-WatER, a Japanese council for promoting use of micro hydropower.

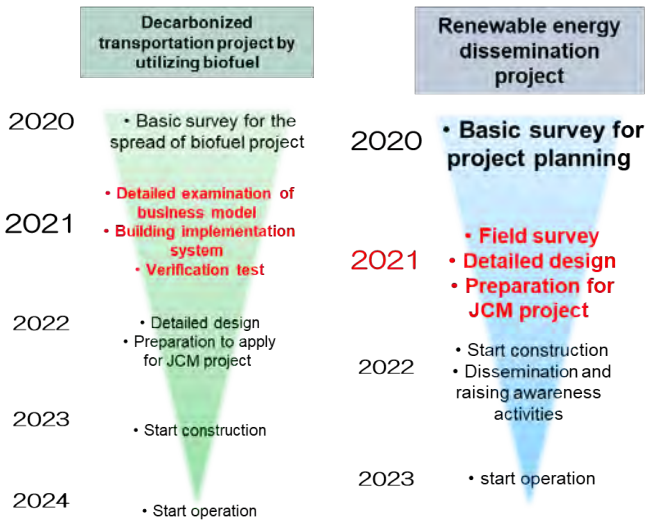


Figure 6－1 Outline of activites in the next fiscal year