Project commissioned by the Ministry of the Environment in 2022

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

（Zero Carbon City development project through decarbonized transportation and renewable energy）

Report

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Japan NUS Co., Ltd.

Toyama City

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Table of 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 This Project

1. 1 Background of This Project

In November 2016, the Paris Agreement came into effect, and with the year 2020 come and gone, the international treaty is well into its implementation phase. As part of its discretionary contributions (referred to as nationally determined contributions or “NDCs”) under the treaty, the government of Malaysia announced its goal of achieving 35% less greenhouse gas emissions by 2030 from the 2005 baseline as well as reducing the emissions by up to 45% on the condition that necessary international cooperation would take place. In addition, the Malaysian government released its energy supply plan titled Reimagining Malaysian Electricity Supply Industry (MESI 2.0) in 2019 − which includes the country’s goal of increasing the percentage of its renewable energy use among all types of fuels used to generate electricity to 20% by 2025 − while stepping up efforts to reduce greenhouse gas emissions.

Meanwhile, Toyama City − known as a leading SDGs future city − is highly touted for its accomplishment in developing a compact urban environment by redesigning its public transport system and also in utilizing micro-hydro and other renewable energy sources that are uniquely available in the locale. As a result, Toyama City is commended by the United Nations as one of the model cities in the world for remarkable contribution to energy efficiency acceleration, the only municipality in Japan given such recognition. To fulfill its role as environmentally advanced city, Toyama City also entered into cooperation agreements with the Iskandar Region of Johor, Malaysia and Kota Kinabalu, the state capital of Sabah in northern Borneo, for promoting renewable energy and facilitating public transport development, under Toyama City’s broader initiative to apply the technology and know-how that the municipality and local companies have on a global scale for the goal of developing a carbon neutral society.

	
Agreement signing with Iskandar Region	Agreement signing with Kota Kinabalu City

1. 2 Purpose of This Project

While in the Paris Agreement it is stated that the activities of not only central governments but also non-governmental bodies including municipalities and cities are culpable for accelerating

climate change, cities and other municipalities are considered as key players for the examination and implementation of specific measures for mitigating climate change at local level. To achieve a net-zero carbon-emission society globally, it is necessary to accelerate initiatives that are conducive to the development of a low-carbon-emission society first before eventually transforming into a more sustainable carbon-neutral one, especially in Asia that has been undergoing significant economic growth. Since cities are the main drivers of socioeconomic advances, there have been more and more instances of international cooperation in supporting urban projects that lead to carbon emission reduction and elimination.

This project, which is focused on the urban communities of the Iskandar Region and Kota Kinabalu City, entailed examination of the three specific initiatives below with a view toward achieving carbon neutrality by the year 2050:

(1) an urban development project to implement zero-carbon-emission public transport mainly involving biofuels, electric buses, etc.;

(2) a renewable energy promotion project mainly involving micro-hydro and solar power generation; and

(3) a project to supply electricity to off-grid areas by utilizing renewable energy.

This project then had the two cities make their official pledges to achieve carbon neutrality by 2050 through the intercity collaboration programs and also assessed how the aforementioned initiatives would positively impact the cities' plans to reduce greenhouse gas emissions.

1.3 Project Execution Structure

Figure 1-1 indicates the project organization structure for this fiscal year. After Toyama City, Iskandar Region, and Kota Kinabalu City had signed their cooperation agreements based on the framework of intercity collaboration, the project team started engaging the Iskandar Region Development Association ("IRDA") and the Kota Kinabalu City government separately in discussions concerning the initiatives to be covered by the survey in this project as well as how their policy formulation could be supported.

For the feasibility study on the implementation of the aforementioned initiatives, the project team collaborated with several Toyama-City-based private enterprises, among which were Hokusan K.K., a company specializing in industrial gas services that had experience of active participation in the JCM equipment subsidy project (bus fuel conversion for public transport) that resulted from the intercity collaboration program in Indonesia; Hokuden Engineering Consultants Co., Ltd. that was experienced in micro-hydro power generation project syndication and related engineering design; Nihonkucho Hokuriku Co., Ltd. that had experience in engineering design related to solar power generation; Toyama University of International Studies that had been engaged in international cooperation activities; and JGC Corporation that had expertise on biogas liquefaction technology,

among others. In addition, Japan NUS Co., Ltd. was charged with the task of overall project management including gathering of information related to intercity cooperation, provision of support in various survey activities, and facilitation of communication and coordination among the organizations and companies involved in this project.

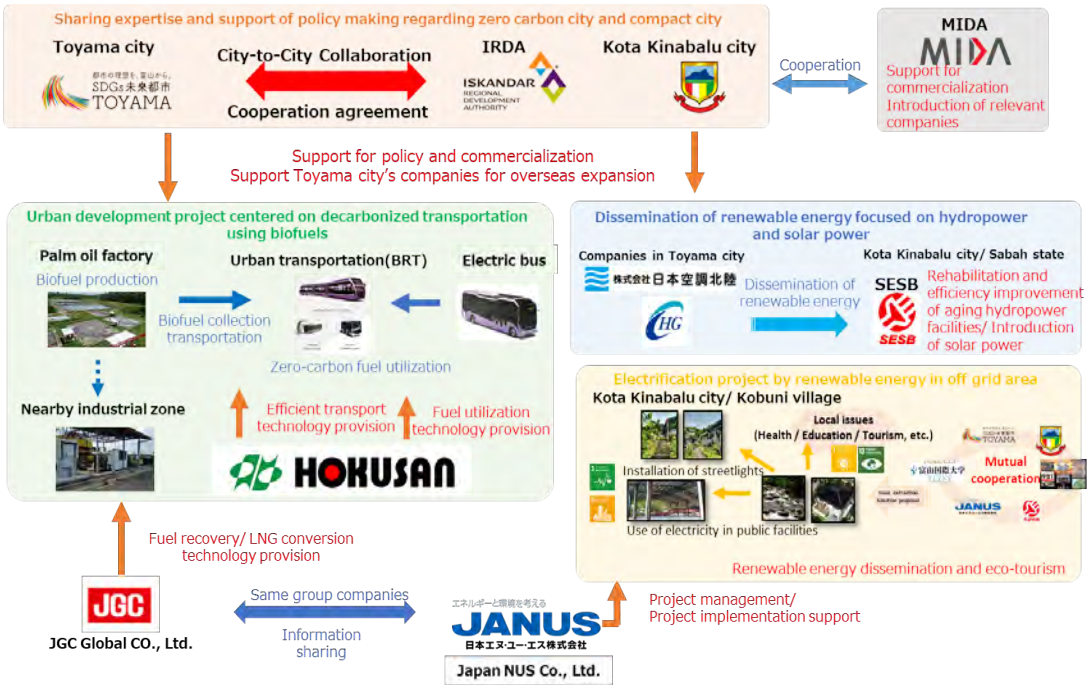


Figure 1-1: Project outline and execution scheme

Chapter 2. Summary of Survey Results From FY 2021 and Preceding Years

While the novel coronavirus pandemic prevented the survey activities of the intercity collaboration programs to take place on actual local sites through FY 2021, the project team was able to gather necessary information for JCM equipment subsidy project qualification that it had planned to obtain through online conferences and other means. **Table 2-1** provides a summary of the results achieved by the programs including key findings from the aforementioned survey activities.

In terms of zero-emission transport, while the project team was able to identify a number of potential palm oil refinery plants, the IRDA had set the policy to pursue its zero-emission goal in public transport mainly through the implementation of electric buses. Therefore, it became clear that, instead of implementing biofuels in the Bus Rapid Transit ("BRT") operation, the program had to look elsewhere besides public transport to widely promote the use of biofuels in the future, which would entail the progressive construction of infrastructure necessary for biofuel applications.

In terms of micro-hydro power generation, the project team was able to narrow down the list of sites that would be examined with priority and also managed to conduct site surveys, etc. online, which resulted in its obtainment of more in-depth information.

As for solar power generation, the project team discovered that installing solar panels, etc. on the roofs of the Kota Kinabalu City Hall might prove to be a cost-effective idea.

As for the electrification project in off-grid areas by way of renewable energy utilization, the project team found out that it might be necessary to examine the potential beneficiaries of such electricity supply, what promotion methods to employ including the development of environmental education programs, and how the project could be applied to other geographic areas, etc. in such a manner that would be helpful in resolving the issues that each locale was faced with, while maintaining the focus mainly on the promotion of renewable energy including micro-hydro and solar power generation.

Table 2-1: Summary of key results achieved in intercity collaboration programs up to and through FY 2021

Project names	Key results
Carbon-free transportation project	・ Identified palm oil refinery plants near Iskandar Region and Kota Kinabalu City and assessed their potential production capacities with a view to expanding the biofuel supply sites. ・ Started approaching palm oil business operators for the goal of establishing viable biofuel supply operations. ・ Conducted technical review of biofuel supply and transport equipment and prepared detailed estimates of the equipment procurement and operation costs.

	・ Identified the benefits of conversion to biofuels for potential implementation on the BRT system and started communicating with concerned local parties to facilitate the fuel conversion initiative. ・ Examined several different business schemes for the goal of biofuel utilization initiative implementation, involving the use of voluntary credits, etc. ・ Surveyed other existing cases of zero-emission public transits that would be relevant to this public transport (BRT) project and held workshops to share key findings and issues from the survey.
Solar power generation project, Small hydropower project	・ Selected potential sites for micro-hydro rehabilitation. ・ Conducted site surveys remotely to investigate the causes of the declining facility utilization rates. ・ Identified causal factors and resultant issues related to the declining facility utilization rates through remote site surveys and literature reviews. Then examined how those issues could be addressed through both hardware- and software-based approach. ・ Identified issues that should be addressed in terms of program design and regulation for the execution of the renewable energy initiative. ・ Selected the potential sites for solar power generation implementation at public facilities, created solar panel installation plans, and estimated their power generation capacities.
Electrification project using renewable energy	・ Identified the key issues that must be addressed related to the use of electricity in Kobuni Village and gathered information on its amount of power consumption and other basic factors. ・ Examined prior cases of electrification projects that took place in other off-grid areas and organized policy on future actions. ・
City-to-city collaboration activities	・ Held workshops and presented relevant information on Toyama City's activities and administrative policies. ・ Hosted online tours of Toyama City and shared information on relevant activities being undertaken by Toyama City and local private enterprises.

Chapter 3. Zero-Carbon-Emission Public Transport Project

While Malaysia is ranked No. 2 globally in terms of palm oil production volume (21,486,000 t as of 2014), Johor State − which includes Iskandar Region − has the third largest palm oil refining capacity (15,890,000 t FFB[Full Fruit Bunches] as of 2015) in Malaysia, with Sabah − where Kota Kinabalu City is located − being the top palm oil refinery state (33,760,000 t FFB as of 2015) in the country. The waste water (POME: Palm Oil Mill Effluent) discharged from palm oil refinery plants typically have high concentrations of organic pollutants, and how to effectively treat them has been a constant challenge for the industry for many years. Especially in the case of Sabah State, where river water is used for ingestion, bathing, and other daily-living activities across many areas, significant POME contamination has been observed with reported instances of health issues induced by POME. To address this issue, the Malaysian government has tightened its environmental regulation on the palm oil industry, whereby specific numerical standards have been set on refinery effluents, requiring the refinery operators to treat their POME properly. Since this new regulation was enacted, the local palm oil refinery plants have been treating their POME by running it through bare effluent reservoirs dug in the ground, known as *lagoons*. However, as the fermentation reaction that occurs in those reservoirs generates methane, which is one of the greenhouse gases, the Malaysian government has issued a recommendation to collect and reuse the methane gas resulting from the POME treating process by the year 2020, while declaring the initiative as one of the National Key Economic Areas (NKEA).

The reality, however, is such that only a limited number of large companies have been able to install methane gas collection and reuse facilities in compliance with the aforementioned recommendation, while the rest of the palm oil refinery business operators continue to treat POME using only the lagoons or discharge their untreated waste water directly into the rivers, as they are seemingly unable to accept the high cost of installing methane gas collection facilities, identify ways to reuse methane gas once it is collected, and find companies that can transport it, which remains a major source of environmental pollution and global warming today.

To address this, the intercity collaboration program examined potentially effective ways to collect POME and use the methane gas that is produced during the treatment process as a carbon neutral fuel (biofuel). During FY 2020 and 2021, the team surveyed the palm oil refinery plants in and around Iskandar Region and Kota Kinabalu City, including their processing capacities, to determine the potential amounts of biofuel supply they would be able to put out and also examined the costs of facility installation and operation that would be required for the biofuel production and transport operations. In addition, the project team conducted a survey of biofuel demands by investigating and organizing data on the potential amount of biofuel that would be used by the BRT that would implemented in Iskandar Region in the near future, and how much greenhouse gas emission reduction and economic impacts, etc. might result from the biofuel use. Meanwhile, in terms of the

issues that must be addressed for the project implementation, the team discovered that Malaysia had such significantly low rates of biofuel utilization across the board that, in order to apply biofuel to public transport operations, it would be imperative to first develop fuel transport and supply infrastructure and widely promote the use of biofuel across its society. Therefore, when the workshops were held during the FY 2021 project, the IRDA issued its request to consider the possibility of precipitating biofuel uses across the whole range of industries that existed in Iskandar Region with a view to eventually achieving zero-carbon-emission in public transits, since it would be difficult to absorb the necessary infrastructure development costs within the region's transport sector alone. Hence in the FY 2022 project, the team strived to identify and examine a new business scheme and to develop a collaborative structure that would promote the use of biofuels across a variety of industries, as requested by the IRDA, in order to turn the applied project plan into a reality.

In addition to examining such technical matters as described above, the project team also organized and shared information on Toyama City's policy on its unique light rail transit ("LRT") system, pledge to become a zero-carbon city, energy vision, and how the municipality's zero-emission initiatives were all interconnected, as a reference case that the IRDA, etc. could use in developing their own zero-carbon-emission public transport system (as detailed in CHAPTER 6), and held discussions on what issues were there that had to be addressed for the realization of a zero-emission transit system in Iskandar Region and also on related future action plans.

3．1　Development of Supply Chains for Biofuel Utilization

As explained above, it became clear that in order for the biofuel implementation to take place in the transport sector, the project would need to see biofuel uses widely spread across other industries also. In addition, since Japan and Malaysia had yet to execute their JCM agreement, the project team facilitated discussions involving various stakeholders from both countries, etc. and examined the design of workable supply chains for the biofuel utilization as indicated in **Figure 3-1** below.

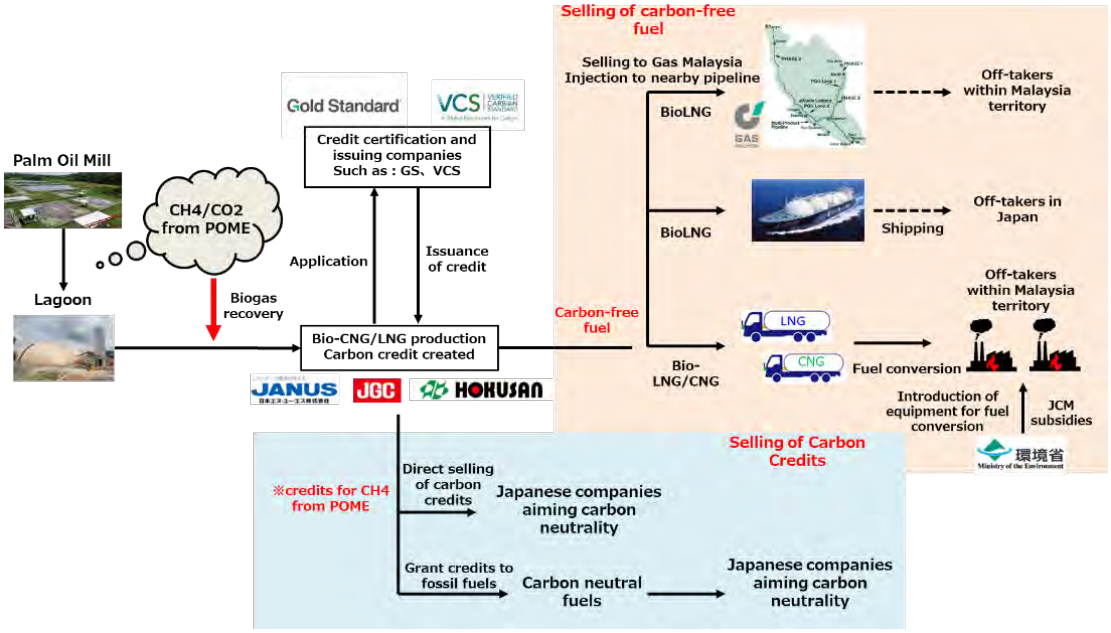


Figure 3-1: Suggested system of supply chains for biofuel utilization

For the purpose of developing the supply chain system as illustrated above, the project team traveled to Malaysia in July 2022 and conducted interviews with Kumpulan Prasarana Rakyat (KPRJ) and Gas Malaysia in Johor State. Summaries of the interviews are provided in **Table 3-1** and **Table 3-2** below. The team was able to obtain forward-looking comments from both of the partner candidates during the interviews. Especially in the case of Gas Malaysia, they already had a pilot project planned to start biomethane collection at a landfill and injection into transmission lines. Therefore, the project team recognized Gas Malaysia as a highly promising business partner candidate and examined key issues relating to it with priority as detailed below.

Table 3-1: Summary of interview with Kumpulan Prasarana Rakyat in Johor State (July 2022)

Attendees	Kumpulan Prasarana Rakyat of Johor State (5 persons), JANUS (2 persons)
Interview summary	・ Some palm oil business operators in the area were using the POME-derived biomethane at their own refinery plants to generate electricity. Therefore, in future instances where biomethane is collected using renovated facilities, we should be careful not to have it compete with the supply for those companies' own use (KPRJ). ・ For the application of biomethane as fuel for buses, sustainability would be a crucial factor. It was understood that collection of methane from POME would reduce CO_2 emissions. However, other key factors must be examined thoroughly in advance, including its cost economy (KPRJ). ・ Concerning LNG liquefaction in particular, the process would consume a significant amount of energy. Therefore, it might be worthwhile to examine the feasibility of using either CNG or LNG for the purpose (KPRJ). ・ If we were to go with the CNG option, it would be still necessary to stabilize the product's quality while also considering the amount of heat the fuel would be able to finally generate. Another important point that must be examined if whether it would be technologically possible to provide steady POME-derived biomethane supply (KPRJ). ・ If the fuel supply in the form of POME-derived biomethane should fall short of demand, it might be worth exploring the feasibility of using methane collected from waste, etc. as a temporary substitute (KPRJ). ・ Most of the palms being grown on plantations were apparently not yet fully matured. Therefore, it would be necessary to contact the plantation operators and determine whether their production volumes would still continue to increase before peaking and declining, or they would be able to provide steady supply of palm oil, etc. (KPRJ).
Photo	

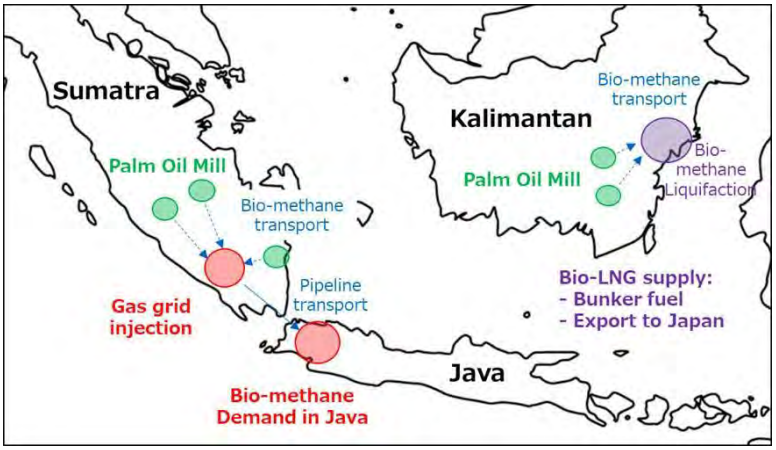
Table 3-2: Summary of interview with Gas Malaysia (July 2022)

Attendees	Gas Malaysia (3 persons), JANUS (2 persons)
Interview summary	・ As the PJ that would test methane collection at a landfill in Johor State was scheduled to commence in August 2022, this opportunity to meet and discuss the related matter was a timely and welcome coincidence (Gas Malaysia). ・ While the team was apparently considering both CNG and LNG as a potential energy source, Gas Malaysia would recommend going the CNG route for the project implementation based on their previous experience especially with respect to cost effectiveness. ・ For the task of infrastructure development, given the small number of public buses with their range averaging between 20 and 40 km, it might not be necessary install major infrastructure in so far as it would be properly managed. ・ In terms of carbon credits trading, Malaysia had yet to design and implement a national program for it, which would have to take place before this project could be implemented with expected results.
Photo	

3．2　Development of Stakeholder Relations for Biofuel Utilization Projects

JGC Holdings Corporation − which is Japan NUS's parent company − is contemplating conducting projects in Indonesia that are similar to the business scheme as indicated in **Figure 3-1** below[1] (**Figure 3 2**). As the project team reckoned that it would be better to leverage the knowledge, etc. obtained from those other projects for the facilitation of this biofuel utilization project to make it a reality as soon as feasible, the team decided to involve JGC Holdings Corporation in the subsequent examination processes.

[1] https://www.jgc.com/jp/news/2022/20220425_01.html



Source: JGC Holdings Corporation's press release

Figure 3-2: Scheme of projects in Indonesia being planned by JGC Holdings Corporation

Focusing on the implementation of the biofuel utilization initiative first, the team visited Gas Malaysia in October 2022 to exchange opinions and discuss policy on future examination activities, a summary of which is provided in **Table 3-3** below.

Table 3-3: Summary of interview with Gas Malaysia (October 2022)

Attendees	Gas Malaysia (3 persons), JANUS (2 persons)
Interview summary	・ In regard to the biomethane projects being planned by JGC Holdings Corporation in Indonesia, Gas Malaysia wanted to know the expected production volumes and the estimated ratio of biomethane and CO_2 that the biogas would contain. →JANUS proposed the three parties, including JGC Holdings Corporation, execute an NDA soon so that they could start exchanging such detailed information as was requested by Gas Malaysia. ・ According to Gas Malaysia's analysis, the POME-extracted biogas in Malaysia typically had about 30% CO_2 content, which was considered higher compared to other countries. So Gas Malaysia wanted to know for sure whether carbon credits could be still issued for the planned biomethane extraction from the biogas that would entail discharging of CO_2 into the atmosphere, if indeed the parties would decide to do it. ・ Gas Malaysia said they were also reviewing the feasibility of a methane collection project that would retrieve methane from organic waste. ・ In terms of the sale of biofuels after they were produced, Gas Malaysia thought there would be demand for it in EU and Singapore. However, they were also concerned about the possibility that the amount of CO_2 that would be emitted during biofuel

	transport could become an issue. ・ Gas Malaysia stated that it had been engaged in joint research with other Malaysian companies to develop a liquefaction system for biomethane, etc. According to Gas Malaysia, this technology would allow them to sell bioLNG in the price range competitive to that of standard fossil-derived LNG.

In line with the policy as stated above, the parties including JANUS's parent JGC Holdings Corporation signed an NDA in January 2023 and held several discussions related to this project between December 2022 and February 2023. This led to the parties' execution of the tripartite MOU in Japan on March 3, 2023 at the public-private investment forum that was organized as part of the Asia Zero Emissions Community (AZEC) Ministerial Meeting. The MOU stipulated the key terms as listed below, pursuant to which the parties consented to proceeding to the next phase of project examination involving more detailed discussions. As for future activities, the parties would set up a special purpose company (SPC) as early as during FY 2023 to officially commence the project, which would be one of the major accomplishments resulting from the intercity collaboration programs.

- Biomethane project development
  - ✓ Development of new biomethane projects
  - ✓ Sale and marketing for existing biomethane projects
- Sustainable palm industry development
  - ✓ Manufacture of EFB pellets for biomass power plants
  - ✓ Development of SAF projects
  - ✓ Development of bio products

3.3 Issues and Policy on Future Activities for Realizing Zero-Carbon-Emission Transport

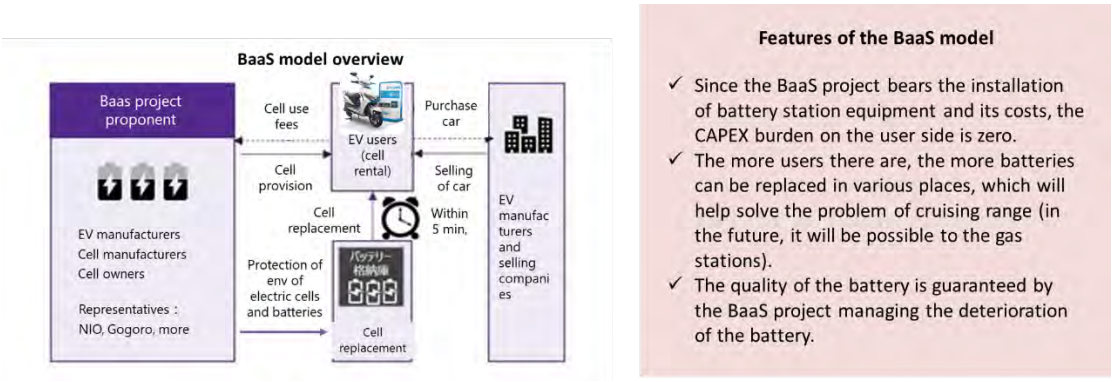
In addition to the biofuel utilization initiative as described above, the project team also continued its examination of methods by which to reduce the greenhouse gas emissions caused in the traffic section that had become an issue in Iskandar Region as well as the challenges that would need to be addressed with the implementation of those methods.

In the previous intercity collaboration programs, the parties had contemplated how to achieve zero carbon emissions with the public transit system (BRT) that the IRDA had intended to implement and agreed that the optimal path to achieving the aforementioned goal would be to implement electric buses and biofuels. Meanwhile, as Iskandar Region had been experiencing high economic growth and seen residential areas develop for Singaporean workers in recent years, motorcycles had become

a popular mode of transport, due to which carbon emissions sharply increased in the form of motorcycle exhaust. (In other words, many Singaporeans living in the region were commuting to their workplaces in Singapore by motorcycle to avoid traffic congestion caused mainly by automobiles.) In addition, as the use of Grab and other food delivery services had quickly become widespread in recent years, it would be inevitable to reduce the carbon emissions from motorcycles going forward in order to achieve zero emissions down the line (**Figure 3-3**).

Figure 3-3: Rows of motorcycles used by food delivery service

During its visit to the IRDA in July 2022, the project team explained about BaaS (Battery as a Service) for electric motorcycles when discussing how to achieve zero carbon emissions in the region's transport sector, a concept already commercially implemented in Taiwan and being piloted in Japan, in which the IRDA expressed a great interest. An overview and key features of the BaaS concept are provided in **Figure 3-4** below. BaaS would be able to not only keep the cost of setting up the battery stations low for the business operators but also help address the shortcomings of electric motorcycles such as battery charge time and range per charge.



Source: https://news.mynavi.jp/techplus/article/qunie-baas-1/

Figure 3-4: Overview and key features of BaaS business operation

In the case of Taiwan, the first-adopter was Gogoro which started offering BaaS commercially in 2015. As of August 2022, Gogoro had acquired roughly 500,000 paying subscribers and built over

2,400 battery stations across Taiwan (**Figure 3-5**). Today, electric motorcycles account for 25% of all new motorcycle sales.

Source: Gogoro website

Figure 3-5: Example of BaaS implementation in Taiwan

Based on the information set forth above, the project team visited the IRDA again in February 2023 to discuss future action plans, etc. with a view to realizing the region's zero-emission transit system, a synopsis of which is provided in **Table 3-4** below. During the interview, the team confirmed IRDA officials' intent to start reviewing a master plan for possible BaaS implementation in the region involving battery-swappable motorcycles as well as for the achievement of zero carbon emissions in the power generation operation for the electricity used to charge batteries for those electric motorcycles and for the overall energy management, from the subsequent fiscal year onward.

Table 3-4: Summary of interview with the IRDA (February 2023)

Attendees	IRDA (3 persons), Toyama City (2 persons), JANUS (2 persons)
Interview summary	[Conversation on Blue Shark] ・ IRDA officials expressed a desire to introduce Blue Shark to the project team, which was a BaaS business operator in Malaysia. According to the IRDA, Blue Shark was the only company that had received the two types of business license from the Malaysian government for operating charging stations and implementing BaaS-compatible vehicles. ・ The IRDA stated that a pilot project was already underway in Kuala Lumpur to obtain various types of data, with a total of four charging stations set up across the capital city. ・ IRDA officials believed electric motorcycles would be a crucial component for Malaysia's achievement of zero carbon emissions in its transport sector although the concept and actual use of electric motorcycles had not become widespread yet. ・ The motorcycle users in Kuala Lumpur were mostly classified as 'B40' (Bottom40: low-income demographic) that would not be able to afford the high purchase prices

	of electric motorcycles. Therefore, IRDA officials thought people classified in the B40 category would be enabled by the BaaS scheme to buy only electric motorcycles without batteries and to share batteries with fellow users, as batteries would account for the majority of the cost of owning and using electric motorcycles. This in turn would help eliminate carbon emissions in an effective manner in the IRDA's view. ・ When IRDA officials met with representatives from Blue Shark, it was learned that many electric motorcycle users would ride theirs to commute to work in Singapore from their residences in Johor State, and that the total number of electric motorcycles used there was about 140,000, so the state would be a good geographic region to target in the future. ・ The IRDA was also apparently attentive to what was going on in Singapore. Specifically, they were aware that the Singaporean government had announced a plan to achieve zero carbon emissions by the year 2050 by actively promoting EVs (including both automobiles and motorcycles). ・ Johor was aiming to set up 1,000 charging stations across the state, with the IRDA becoming the model case for leading FS and testing activities, etc., after which the adoption of BaaS and electric motorcycles would be facilitated across the entire state.

Chapter 4. Renewable Energy Promotion Project Based on Micro-Hydro and Solar Power

The Malaysia government has announced its goal of increasing the percentage of renewable energy among all energy sources used for generating electricity from the current 23% to 31% by the year 2025 as part of its zero-carbon-emission policy. In the case of Sabah in particular, the state government has an official plan to generate 360MW of electricity using renewable energy by 2025. Sabah State − where Kota Kinabalu City is located − is endowed with abundant water resources originating in Mount Kinabalu − the highest mountain in South East Asia − among other sources and operates many micro-hydro power plants across the region, which is similar to the case of Toyama City that is surrounded by the Tateyama Mountains and has abundant water resources because of it. Meanwhile, as those micro-hydro facilities uniformly have low utilization rates, it has been a lingering issue that must be addressed in order to have them function more fully to their potential. The main contributing factors behind such low capacity utilization include frequent equipment malfunctions resulting from temporal deterioration that have significantly reduced the operation rates at certain facilities, while other facilities suffered damage from floods and other disasters but have not been repaired properly, which has kept their operation rates quite low. Furthermore, there are other facilities that have had constantly low capacity utilization since the time of their initial commissioning, which are thought be cases where the facilities were built without thorough review of the rivers' flow rates and conditions, soil condition, and other determinant factors, and the micro-hydro ended up not operating according to plan under the unsuitable hydraulic conditions. Due to such background, there is a plan to actively promote the state's hydroelectric project with priority from 2021 through 2025, as this mode of power supply is more stable than solar power or wind power. As explained above, since the state has many micro-hydro facilities that are unable to function close to their potential despite the abundant water resources available, this intercity collaboration program will aim to either rehabilitate the micro-hydro power plants in Sabah State that have reduced capacity utilization rates or replace them with made-in-Japan facilities with higher efficiency, so that the total electricity generated by the micro-hydro facilities recovers to or surpasses the initial level, thereby replacing the electricity generated using fossil fuels and in turn reducing greenhouse gas emissions.

Another key fact to be considered is that Sabah State has relatively high solar irradiance even among the regions of Malaysia that generally have significant solar exposure across the board, which means that Sabah presents a remarkably high potential for solar power generation also in the context of renewable energy development. Indeed, in its officially announced *Green City Action Plan: Kota Kinabalu* as has been mentioned earlier, the municipal government intends to install solar power generation facilities at 56 different sites including schools, etc. throughout the city that would collectively generate 100MW of electricity.

In this project, the team examined micro-hydro and solar power implementation plans mainly for Kota Kinabalu City that would utilize JCM equipment subsidy programs, etc. with the support of Hokuden Engineering Consultants Co., Ltd. that had conducted numerous micro-hydro implementation feasibility studies before and Nihonkucho Hokuriku Co., Ltd. that had previously worked on many solar power engineering, procurement, and construction ("EPC") projects before, both of which are Toyama-City-based companies.

In terms of the FY 2020 project activities, the team contacted and obtained from the local electric power company and private power plant operator some key data on the micro-hydro power plants being operated in Kota Kinabalu City and elsewhere in Sabah State, of which seven were owned by the electric power company (generating 8.1MW in total) and two were owned by the private operator (generating 3.6MW in total), to learn about the specifications of their power plants and the temporal changes in the amounts of electricity they had generated over the years.

The data then revealed that those power plants were operated at significantly lower capacity utilization rates (averaging around 20%) relative to the mean values normally observed of comparable power facilities in Japan, which indicated that the successful execution of this project would increase the amounts of electricity generated in the region. Then, during the FY 2021 project, the team held discussions with the local electric power company, etc. and selected two sites out of the nine total that were earlier mentioned, which had to be renovated with priority. The team also remotely conducted site surveys and interviews with the business operators to investigate the causes behind the facilities' reduced utilization rates. The team was subsequently able to identify so-called key hardware and software issues − the former including the water channels having points of leaks and undesirable design features, and the latter being suboptimal facility operation and periodical maintenance methods, etc. − and suggested solutions to the business operators.

In addition, in terms of the solar power project, the team consulted with the Kota Kinabalu City government and confirmed the municipality's intent to install self-consumption-type solar power devices at various facilities that were under its management, based upon which the team subsequently selected a total of three facilities across the municipality, including the City Hall, as potential sites for solar power equipment installation. The team then reviewed schematic drawings related to the equipment installation and calculated the effects that would result from it.

In terms of the FY 2022 project, the team continuously worked on the micro-hydro power generation initiative by communicating with the local business operators to confirm their intentions and initiating activities that would culminate in the deployment of both so-called hardware and software upgrades that were previously proposed as explained above. Also, as for the solar power initiative, the project team focused on the roof of the City Hall as one of the potential solar panel installation sites identified during the previous year and conducted detailed examination and design activities involving on-site survey. In addition, since Kota Kinabalu City did not have any financial

support policy such as FIT (feed-in tariff) program for facilitating the adoption of renewable energy, the team shared information with the municipal government on various financial assistance programs and other measures officially run by Toyama City and other municipalities in Japan that would accelerate renewable energy utilization (as detailed in CHAPTER 6).

4.1 Examination of Measures for Recovering or Increasing the Amount of Electricity Generated by Existing Micro Hydro Plants

During the FY 2020 project, the team contacted and obtained from SESB and another private power plant operator some key data on the micro-hydro power plants being operated in Kota Kinabalu City and other parts of Sabah State, of which seven were owned by SESB (generating 8.1MW in total) and two were owned by the private operator (generating 6.5MW in total) and reviewed the specifications of their power plants and the temporal changes that had occurred in the amounts of electricity they had generated over the years. The data indicated that those power plants were operated at significantly lower capacity utilization rates (averaging around 20%) compared to the mean values normally observed of comparable power facilities located in Japan, which meant that the implementation of this project would increase the amounts of electricity generated in the region, but the team was not able to identify the specific causes of such low capacity utilization at those facilities before the year drew to a close. Therefore, as the FY 2021 had begun, the team focused on the Carabau and Naradau power plants in particular that were in need of rehabilitation and conducted literature research as well as remote site surveys using drones, etc. and used the gathered information to identify and examine the key issues affecting those facilities along with potential solutions to address them.

During the FY 2022 project, the team consulted with SESB and selected the Narabau power plant out of the two for conducting on-site surveys and interviews with facility operation staff, etc. and gathering detailed information. The team also shared previously gathered information with the local project collaborators that would shed light on the stable micro-hydro operation technologies that had been developed and implemented in Japan over the years at the country’s micro-hydro sites that are characteristically complex, and how feasibility studies on micro-hydro installation at such difficult sites could be facilitated, as well as how technological exchange activities between Japan and Malaysia in the area of micro-hydro power could be advanced, all of which took place at an event organized by the team entitled a micro-hydro power technology seminar.

The team also held discussions with SESB where the participants discussed new potential initiatives that might qualify as JCM equipment subsidy projects in the future.

4．1．1　Examination of Hardware-Based Measures

1) Overview of Power Plant

The Naradau power plant is situated in the mountainous area near Kundasang City (**Figure 4-2**) which is approx. 100 km east of Kota Kinabalu City. Kundasang is located on the foothills of Mount Kinabalu, the tallest mountain in Malaysia, so the city is a popular spot for tourists that want to go on mountaineering expeditions, etc. in the area.

Built in 1999, the Naradau power plant operates two 880-kW water turbines, has a drop of approx. 150 m, and takes in water from two different rivers, which are its notable features (**Figure 4-1**).

Power generation amount evolution

Year	Generated [kWh]	Capacity Factor [%]
2013	9,805,929	63.60
2014	9,385,730	60.88
2015	8,456,188	54.85
2016	4,035,744	26.17
2017	5,959,392	38.65
2018	5,830,432	37.82
2019	5,756,160	37.33
2020	4,292,640	27.84
2021 ~May	2,131,307	-

Figure 4-1: Location and key facilities of the Naradau power plant

Figure 4-2: Views of Kundasang

In terms of the status of power generating activities taking place at the Naradau power plant in recent years, the amount of electricity generated at the facility declined sharply in 2015 and 2022, as indicated in **Table 4-1** below. Based on information obtained from SESB, the first decline that occurred in 2015 was due to a major earthquake that struck Sabah State that damaged and rendered inoperable one of the two water intake facilities. As for the second decline in the amount of electricity generated that occurred in 2020, it was apparently caused by a nozzle malfunction coupled with the effects of landslides that had occurred during the rainy season in that year as well

as the power outage resulting from SESB's facility-wide inspections.

Table 4-1: Temporal changes in the Naradau power plant's power-generating efficiency

Year	Generated [kWh]	Capacity Factor [%]
2013	9,805,929	63.60
2014	9,385,730	60.88
2015	8,456,188	54.85
2016	4,035,744	26.17
2017	5,959,392	38.65
2018	5,830,432	37.82
2019	5,756,160	37.33
2020	4,292,640	27.84
2021 ~May	2,131,307	-

2) Site Survey

During the FY 2021 project, the project team focused on the Carabau and Naradau power plants as the two sites that especially required rehabilitative measures and conducted literature research and site surveys remotely using drones, etc. However, as was later determined that it would be necessary to inspect the sites' circumstances in-situ and formulate measures, the team first conducted an on-site survey of the Naradau power plant in July 2023.

The following is a report of the on-site survey, providing summarized information on the access to the power plant and the status of the water intake facilities, turbines, etc.

■ Access to Power Plant Facilities

As mentioned earlier, the Naradau power plant takes in water from two different rivers, namely the Mesilou River and the Liwagu River. In the case of the intake facility on the Liwagu River side, it is located deep in the mountains, several hundreds of meters away from the nearest road accessible by car. In addition, the access road is mostly an unstable gravel path running past some precipices that would be susceptible to landslides during rainfalls. As heavy precipitation had occurred on the previous day when the team visited the site, it was evident that large volumes of additional soil and debris had entered into the area (**Figure 4-3**). Based on this observation, it was clear that some measure must be considered and implemented to improve construction vehicles' access to the site for the plant rehabilitation work.

Meanwhile, in the case of the water intake facility connected to the Mesilou River, the access

would be much easier than the Liwagu's case, so much so that any vehicles can get to the area adjacent to the water intake site without issue. There were apparently some local residents' houses near the site, and they were seen conducting agricultural farming (**Figure 4-4**).

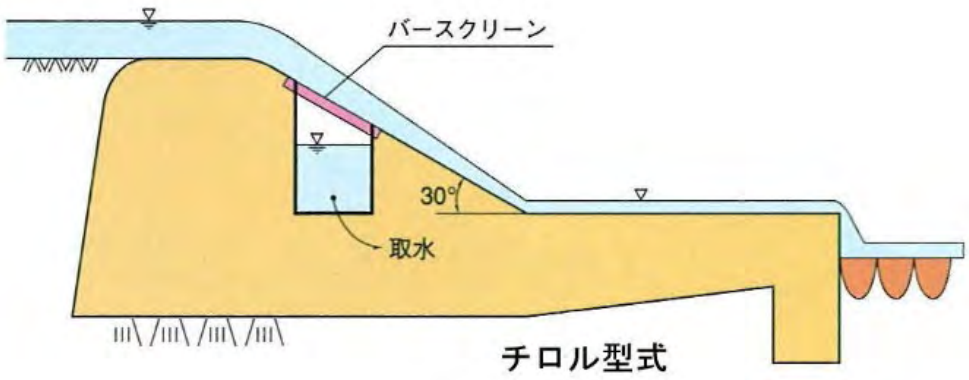
Figure 4-3: View of access road near the water intake from the Liwagu River

Figure 4-4: View of access road to the water intake from the Mesilou River

■ Water Intakes

The water intake from the Liwagu River was a Tyrolean type facility (**Figure 4-5**). Actual images of the intake are provided in **Figure 4-6** below. As heavy precipitation had occurred around the time of the team's visit to the site for the survey, the flow rate of the river was higher than usual.

Meanwhile, the section of the intake marked by the red box in one of the photos had such a shape that would catch many dead leaves, debris, etc., which was apparently compromising the intake capacity. The survey team was told that regular maintenance on the intake was conducted a few times a year, including removal of debris, etc. from the intake, with the river flowing as it normally does.



Source: Website of the Japan Water Agency's Mie Canal Operation and Maintenance Office

Figure 4-5: Tyrolean type water intake

Figure 4-6: Water intake from the Liwagu River

The water obtained from the water intake as described above is subsequently guided through the route as indicated by the red dotted arrows in **Figure 4-7** and passed through an open settling pond (**Figure 4-8**). While the settling pond is created to remove from the water the fine particles of soil, sand, and other debris that could not be filtered out at the water intake, using sedimentation, given it is an open pond, there were apparently some dead leaves and other debris that had gotten into the water, many of which were seen clogging up the screen that was installed at the water outlet. As the clogging of the screen was apparently seen significantly reducing the flow rate in the settling pond, due to which a large portion of the water was routed back to the river through the drainage of the settling pond. To address this issue, maintenance was apparently conducted every day, which involved workers removing dead leaves and debris from the water (**Figure 4-9**). Also, in terms of the sedimented soil accumulation in the pond, it is reportedly removed through the line installed at the bottom of the pond several times a year.

After the water passes through the outlet of the pond, it enters into a pipeline with a diameter of roughly 1 m, which carries the water all the way to the power plant by the drop in elevation (**Figure 4-10**).

Figure 4-7: Route from the water intake to the settling pond

Figure 4-8: View of the entire settling pond (captured by a drone during the FY 2021)

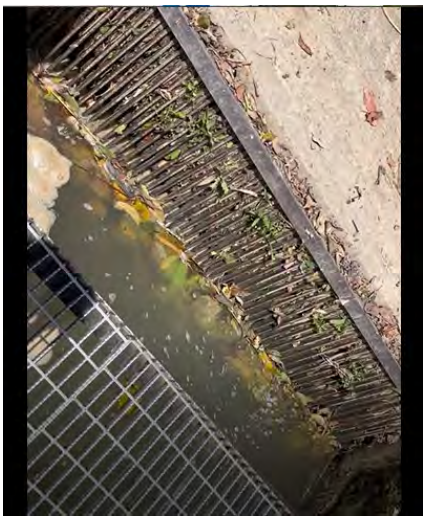



Figure 4-9: Liwagu River water outlet and maintenance work

Figure 4-10: Pipeline for water transport

In terms of the water intake from the Mesilou River, it is the same Tyrolean-type design as the one used in the Liwagu River. Meanwhile, as was previously explained by SESB, the intake structure became partially damaged by the 2015 earthquake, which had rendered the facility entirely inoperable (**Figure 4-11**). Indeed, there were two specific causal factors behind the total failure of the intake function, one of which was that the earthquake had caused the river flow to shift as indicated in the photo below on the left, making it more difficult for the water to reach the intake. The second factor was that, as the earthquake had caused a landslide in the area shown on the right that used to be part of the water channel, all the water now flows into and through the area. As a result, the intake had become entirely incapable of taking in any water at all.

Figure 4-11: Damage caused to the water intake from the Mesilou River

Next, the focus of the survey shifted to the settling pond, which also existed at the Mesilou River facility, although it was out of commission because the water intake operation had to be ceased there. It was then observed that the sediment that accumulated during the time when the intake facility was still operation was still remaining (**Figure 4-12**).

Figure 4-12: Views of the settling pond at the Mesilou River facility

Although it was out of service due to the lack of water intake, the Mesilou River facility also had a pipeline with a diameter of approx. 1 m, similar to the one used at the Liwagu River facility, for transporting water from the river to the power plant.

Figure 4-13: Overground penstock from the Mesilou River water intake

While the water intake operation had been suspended at the Mesilou River facility, the team confirmed with SESB that a civil engineering work was scheduled to commence from the spring of 2023 to restore the intake facility to an operable condition.

■ Power Plant (Turbine Building)

The turbine building had two Turgo turbines and a power generator. However, since the water intake from the Mesilou River had become unavailable, only one of the two turbines was in operation (**Figure 4-14**).

Figure 4-14: Interior views of the Naradau power plant building (turbines and power generator)

The power plant had a control room where momentary output data could be monitored on the electronic control panel. The room also had a simple system for controlling the opening and closing operations of the valves, which allowed the operator to suspend or resume the plant operation on demand from the control room. Since the restarting sequence would only require about 15 minutes, which is relatively shorter than the case of a typical thermal power station, the plant's operation manual required the operator to immediately suspend its operation the moment any abnormality was detected. In the building, at least one operator was on duty at all times, as there were basically two operations that were SESB employees working eight-hour shifts, taking turns operating and managing the power plant.

As the Naradau power plant did not have any system installed for exporting acquired operation data into electronic data files, the operator had to manually check and copy the monitored output data to a log book every hour (**Figure 4-15**). While the Carabau power plant also had a similar system, other SESB-owned power plants were apparently equipped with a system that automatically saved monitored data as electronic data files.

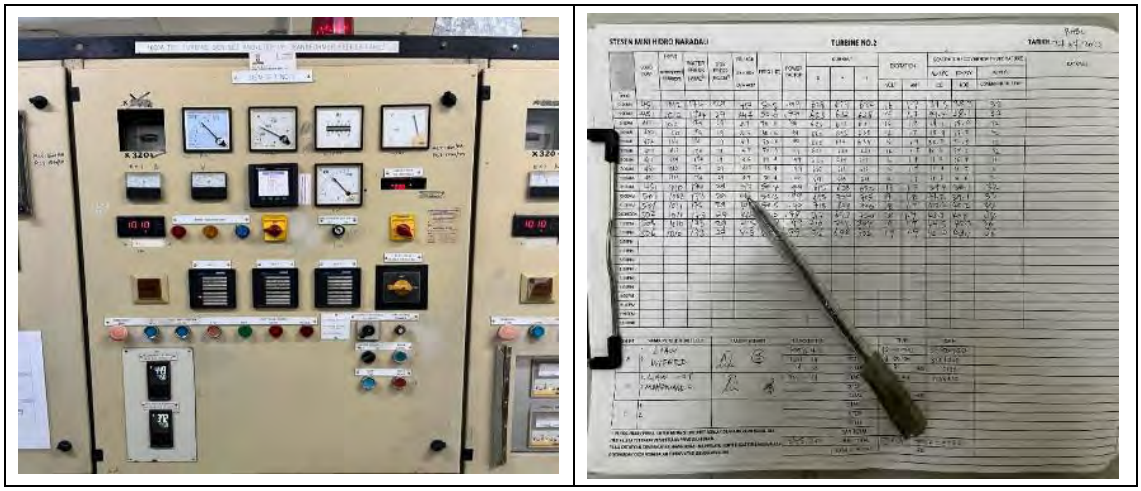


Figure 4-15: Naradau power plant's control panel and power output data sheet

3) Issues to Be Addressed in the Future

The main issue that must be addressed going forward is the fact that the power output is significantly insufficient at each of the two power plants relative to their potential capacity. When the site surveys were conducted remotely during the FY 2021 project, the team came up with several solutions, including a functional investigation of their water intake facilities to inspect possible spots of water leaks and circulation losses at and around the water intake and repairing those spots as needed, and also an inspection of the facilities as to their locations and structural designs to ensure they were all correctly installed and renovating them as needed. As this latest site survey that was conducted in person had provided new information that had not been obtained previously, the project

team makes the following additional suggestions to improve the situation.

Because the areas where the Naradau and Carabau power plants are located tend to have much ingress of turbid water with high concentrations of gravel and mud resulting from the rainy and dry seasons manifested in Malaysia's unique climate, not many effective measures had been implemented to prevent the soil from entering into the facilities, which apparently compromised the facilities' ability to conduct stable water intake and transport operations. According to Hokuden Engineering Consultants Co., Ltd. that has designed many micro-hydro power plants in Japan and possesses significant expertise on the topic, the main contributing factor to this undesirable situation might be stemming from the decision to adopt the Tyrolean-type water intakes in the first place. Indeed, when constructing water intake facilities in areas where floods frequently occur or the water is turbid, it is usually the case to choose the lateral water intake method over other designs for risk control, which comes with the additional advantage of allowing for safe debris removal. **Table 4-2** below lists the pros and cons of the two water intake methods.

Table 4-2: Comparison of water intake methods

Rating [◎: significant advantage; ○: advantage; ×: disadvantage]

Type	Lateral water intake method	Tyrolean-type water intake method
Construction cost (ratio)	1.0	0.9（○）
River water intake (reliability)	◎The lateral water intake design prevents water ingress while allowing for constant water intake even during floods. ・In Japan, the water flow rate at the water intake must not exceed 1.0m/s.	×If soil accumulation occurs at the water intake (as seen in the photo), normal water intake is not possible. ・In Japan, it is generally required that about 0.1m^3/s of water intake capacity is secured per 1 m of water intake width.
Facility maintenance and management (maintainability)	◎The design usually prevents large amounts of soil, driftwood, and other debris from entering into the facility even during floods. ◎The design allows for safe debris removal work conducted from atop the water intake.	×Large amounts of soil could easily enter into the facility during floods. ×When the screen is clogged up with driftwood, stones, and other debris, it becomes impossible to take in any water.
Evaluation	Based on the above comparison, the better choice would be the lateral water intake method if stable water intake is important. Since the bottom (Tyrolean) water intake method does not allow for stable water intake, it is often implemented to take in water from mountains streams mainly as auxiliary water supply.	

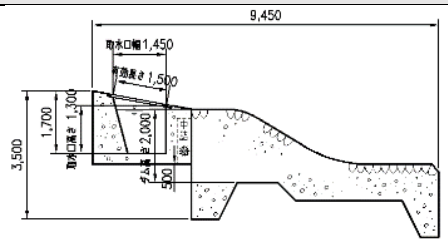
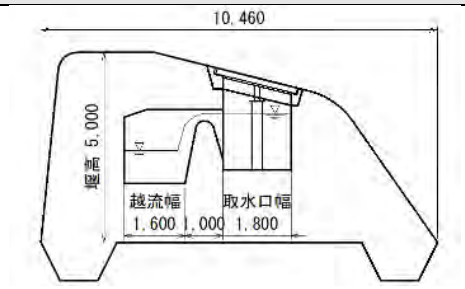
Source: Hokuden Engineering Consultants Co., Ltd.

Meanwhile, if the existing facilities must be renovated to significantly change their water intake methods, major construction works will be required. So, to avoid going to all this trouble, it might be a reasonable option to modify and improve the existing Tyrolean-type structures. **Table 4-3** compares the features of two different versions of the method, one of which only takes in water with

low soil concentration instead of accepting all the water that falls through the intake screen.

Table 4-3: Comparison of different versions of Tyrolean-type water intake design

Rating [○: advantage; ×: disadvantage]

Item	Tyrolean-type water intake method [Standard design]		Tyrolean-type water intake method [Improved submerged-groin design]	
Overview				
Water intake method	This standard Tyrolean-type water intake design allows all the water that falls through the horizontal screen to enter into the facility.		This modified design only accepts the top portion of the water that falls through the horizontal screen.	
Ingress soil prevention	As it directly takes water in from the river, it is highly likely for the ingress soil that passes through the intake to flow downstream along the water route.	×	As it only accepts the top portion of the water it is unlikely that any ingress soil that comes in would flow downstream along the water route.	○
Facility maintenance and management (maintainability)	It is necessary to periodically open the gates of the diversion dam and the settling pond / water tank to flush out accumulated sediments.	×	The gate operations as described on the left do not have to be conducted as often.	○
Construction cost (ratio)	0.7	○	1.0	×
Evaluation	If the site is prone to the risk of ingress soil from river water intake during floods, the improved submerged-groin design would be the more advantageous choice, as its structure can effectively prevent any ingress soil from entering and flowing downstream to the settling pond, headrace, water tank, etc.			

Source: Hokuden Engineering Consultants Co., Ltd.

As SESB has made clear its plan to perform a restorative work on the water intake from the Mesilou River at the Naradau power plant, the project team confirmed with SESB that it would share related information at the micro-hydro power seminar, which will be explained below in more detail and also reflect the changes that would result from the restoration work in the facility design, etc.

In this connection, as any additional technological review and facility design tasks beyond this point would require major investigative work including a series of surveys, etc., the project team intends to proceed accordingly in collaboration with SESB and partnering Japanese companies, which might get spun out as a separate project altogether.

4．1．2　Examination of Software-Based Measures

Through the online opinion exchanges between SESB and Japanese companies and online site surveys implemented in FY 2021, it was found that there is room for improvement of not only hardware, but also software such as operation and maintenance methods, in order to improve the utilization rate of facilities.

Therefore, in this project, in order to share the knowledge of Hokuden Engineering Consultants Co., Ltd. , who have a lot of experience in equipment design and operation in Hokuriku region where there are many rivers that are especially difficult in Japan to operate stably, with local companies, a micro-hydro power generation technology seminar was held at sites (SESB, Toyama City, Japan NUS, etc.) and online (Hokuden Engineering Consultants Co., Ltd., etc.) in February 2023.

Table 4-4 is a seminar agenda for the day. The explanatory materials used in the day are attached materials 8.1 and 8.2. At the seminar, many technical questions were asked by SESB, and it was a very meaningful opportunity for both countries (**Figure 4-16**).

Table 4-4: Agenda for a micro-hydro power generation technology seminar

Feb. 15th (Wed), 2023 Online workshop	
Time in Malaysia (in Japan)	Contents
9:00-9:10 (10:00-10:10)	**Opening Remarks** - by Mr. Keiichi Kobayashi, Project Director of Environment Policy Division, Toyama City - by Ms. Linda Manahan, Engineering Department, Kota Kinabalu City Hall
	Special Remarks -by Mr. Terrence Kouju, SESB
Photo：Turn on the video	
9:10-9:50 (10:10-10:50)	**Introduction on the small hydro projects in Japan** - by Mr.Masamichi Oe, consultant, Hokuden Engineering Co., Ltd. (Japanese and consecutive translation into English, 15 min each) 10 min Q&A session
9:50-10:30 (10:50-11:30)	**Presentation of the current and future projects carried out by SESB in Sabah State** - by Mr.Terrence Kouju, SESB (Japanese and consecutive translation into English, 15 min each) 10 min Q&A session
10min Break	
10:40-11:00 (11:40-12:00)	**Results on the City-to-City Collaboration Project** - by Ms. Kyoko Hirasawa, Japan NUS Co., Ltd. (English only 10 min) 10 min Q&A session
11:00-11:50 (12:00-12:50)	**Panel discussion** - with all the participants ✧ the operation and maintenance practices of small hydro projects ✧ Future projects prospects
11:50-12:00 (12:50-13:00)	**Closing remarks**

Figure 4-16: Scene from the micro-hydro power generation seminar

4．1．3　Possibility of New JCM Projects

As the Malaysian government had already announced its formal plan to achieve carbon neutrality by the year 2050, renewable-energy-related businesses would likely be developed at an accelerated pace across the country in the coming years. As this intercity collaboration program had allowed the team to build a close working relationship with SESB, the largest power company in Sabah State, the team interviewed SESB representatives to obtain their input on potential projects that could qualify as new JCM projects and on possible collaboration with Japanese companies in the future.

First of all, it was noted that SESB had set the goal of achieving carbon neutrality by the year 2050 and reducing its greenhouse gas emission factor by 45% by 2030 before that, in response to the Malaysian government's aforementioned long-term emission reduction plan. The electric power sector of Sabah State where SESB was based had its emission factor at around 0.525tCO2/MWh, which would be a relatively high figure compared to Japan's electric power sector (**Figure 4-17**). This was attributable to the fact that nearly 75% of all electricity generated in Sabah was from natural gas.

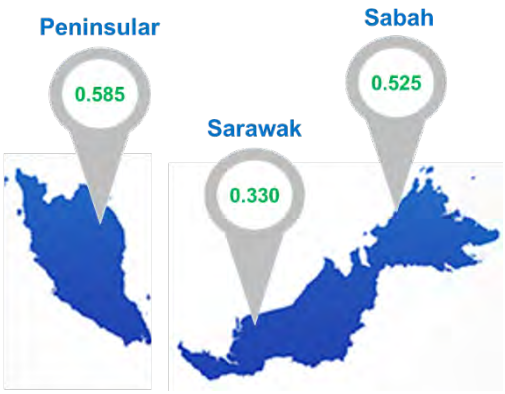


Figure 4-17: Emission factors of Malaysia's electric power sector by state

SESB had been actively implementing renewable energy facilities since the 2010s in order to achieve the long-term emission reduction goal. **Figure 4-18** provides a comparison of relevant data between 2010 and 2022. As for specific figures, while 106.5MW of electricity in total was generated mostly from hydro and biomass sources in 2010, the amount of electricity generated using renewable energy would almost double to 218.1MW by 2022, largely due to a sharp increase in solar power utilization.

Renewable energy utilization status in 2010

Renewable energy utilization status in 2022

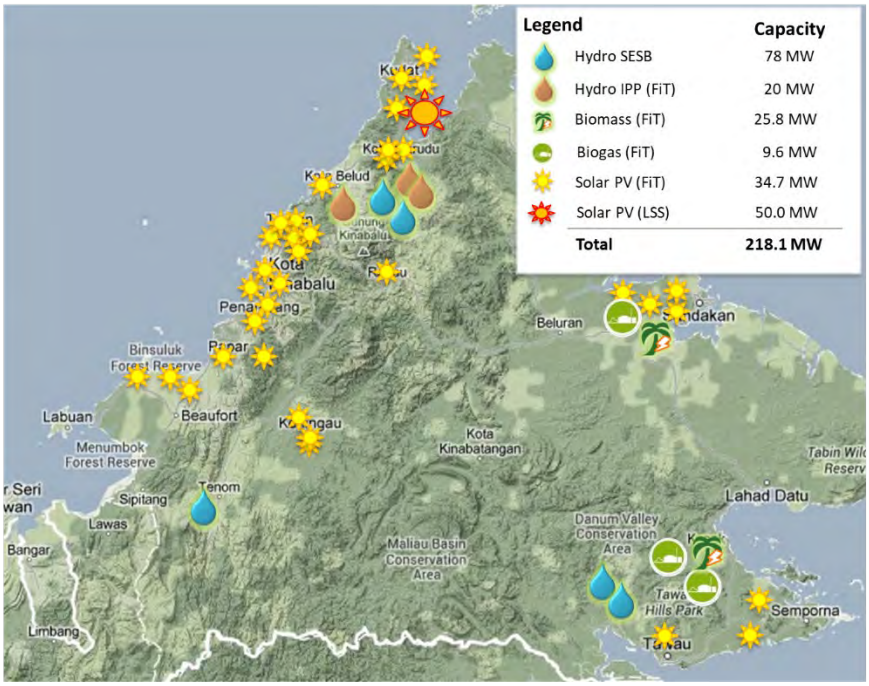


Figure 4-18: Comparison of SESB's renewable energy utilization status

As for its future plans, SESB was intent on exploring the possibility of biomass, biogas, and geothermal power generation in addition to hydroelectric and offshore wind power generation as indicated in **Figure 4-19** below. During the interview, the project team also confirmed that SESB was highly interested in pursuing business development opportunities that would involve technical support from, and joint investment with, Japanese companies.

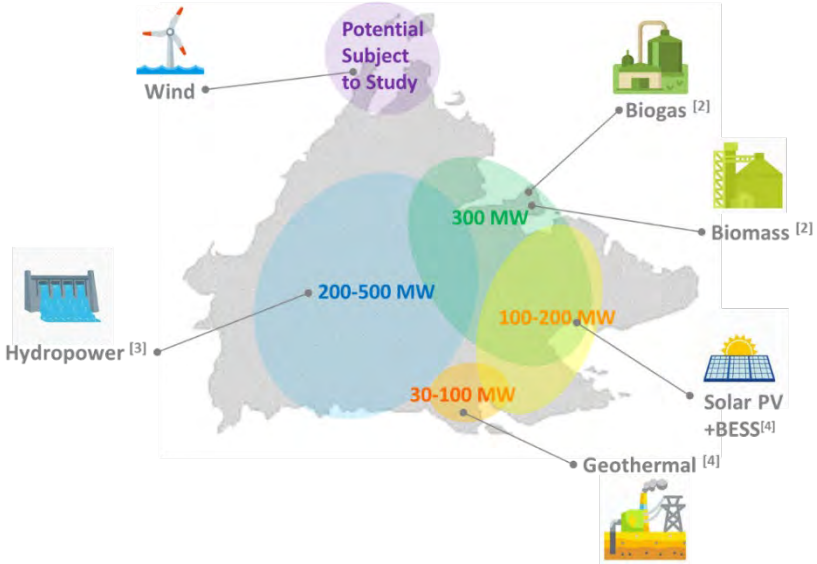


Figure 4-19: Outline of SESB's renewable energy development plan for the future

4. 2 Formulation of Solar Power Generation Plans for Public Facilities

As Sabah State has relatively high solar irradiance even relative to the rest of Malaysia that generally has exposure to abundant sunlight, it has great potential for solar power generation as part of renewable energy development. In its Green City Action Plan: Kota Kinabalu as previously mentioned, Kota Kinabalu City has clearly stated its goal of installing solar power devices at 56 different locations across the municipality, including several schools, that would jointly generate 100MW of electricity. During the FY 2021 project, interviews were conducted with SESB and the Sustainable Energy Development Authority ("SEDA") representatives and it was determined that no FIT program could be applied. Then, the project team held a discussion with the Kota Kinabalu City government and determined that the three particular sites as indicated in **Table 4-5** that were operated under the municipality's purview might be the suitable candidate facilities in terms of their status as public institutions and their likely ability to consume self-generated electricity during the day. The team then reviewed aerial photos and other data relating to those locations on Google Maps, etc., examined device installation drawings, and calculated the approximate effects of solar power installation for the three sites.

In terms of the FY 2022 project, the team conducted on-site surveys of the three potential locations that were identified in the previous year, and performed in-depth simulations of the solar power installation plan, based upon which the final investment decision would be made. In addition, as Kota Kinabalu City did not have any subsidy policy for financially facilitating renewable energy implementation in the form of FIT or other programs, the project team shared information with the municipal officials on the financial aid policy, etc. that had been adopted by Toyama City and other Japanese municipalities to promote renewable energy utilization, and helped them formulate policy that could facilitate renewable energy use at public facilities in the future (as detailed in CHAPTER 6).

Table 4-5: Potential sites of solar panel installation that were surveyed during the FY 2021 project and key survey data

① Kota Kinabalu City Hall	② Pasar Tanjung Aru	③ Anjung Selera
		

4.2.1 On-Site Survey Results

The project team conducted on-site surveys of the three potential sites in July 2022, the key results of which are provided below.

1) Kota Kinabalu City Hall

The Kota Kinabalu City Hall consists of multiple buildings that were constructed at different times. In terms of its main structures, the premises can be divided into five main areas, which are the three main buildings, the roofless parking lot, and the roofed parking lot (**Figure 4-20**). The following describes key findings from the on-site surveys on each of the five areas.

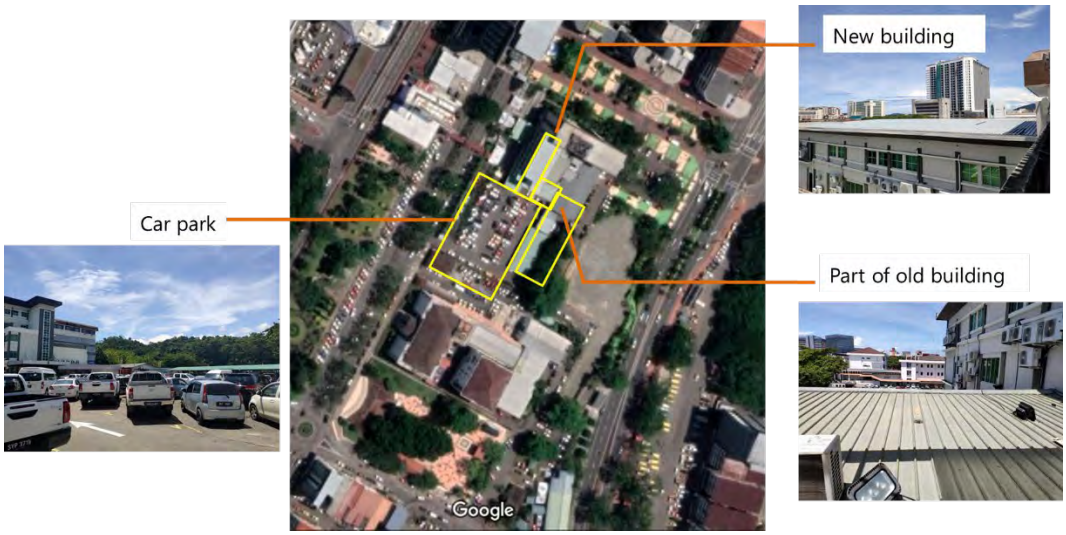


Figure 4-20: Overview of the Kota Kinabalu City Hall

■ Area A: Newest Building

In terms of the roof material placed atop the building in Area A, it was some type of steel plates. As with the exterior walls of the building, the structural material underneath the steel plates was concrete, so it appeared to be a suitable site in terms of load-withstanding capacity. While the roof surface was slightly sloped, the roof could secure a certain amount of area to install solar panels (**Figure 4-21**). Meanwhile, as the route of access from inside the building onto the roof was limited, it would be difficult to execute a panel installation work by directly accessing the rooftop from within the building, if it should be executed at all. Therefore, it would appear necessary instead to install scaffolding, etc. in order to access the roof from outside the building to install solar panels, perform maintenance, etc., which meant that additional cost had to be factored in for the scaffolding, etc. As a side note on this topic, when the project team was previously engaged in discussion with Kota Kinabalu City officials on the feasibility of solar power installation in the municipality, they commented about the necessity to consider how to prevent potential theft of solar panels, cables, and

other equipment. In so far as this Area A is concerned, however, the difficulty of access to the rooftop might lower the risk of such larceny.

Figure 4-21: View of the roof in Area A

- Area B: Old Building (Small)

In terms of the material and structural design, the roof of the building in Area B is similar to the roof of the building in Area A. While this building in Area B was built before the one in Area A, it had more noticeable spots of rust, etc. However, as the building had an array of outdoor units installed for air-conditioning, the building appeared to be capable of withstanding the loads of solar panels, etc. without issue (**Figure 4-22**). The area where panels can be installed is small. In addition, since the roof was accessible directly from the second floor of the building, it appeared as though solar installation and maintenance tasks could be carried out with ease. Furthermore, since the roof of this building would be difficult to access from outside, the risk of theft should be quite low.

Figure 4-22: View of the roof in Area B

- Area C: Old Building (Large)

As it was difficult for the team to climb up to the roof of the building in Area C for direct

assessment due to how it was structurally set up, the roof was visually checked from the window of the adjoining building. In terms of its material, the roof surface appeared to consist of steel plates although the team was unable to make out what the material was underneath it, which meant that further investigation was necessary to verify the roof's load-withstanding capacity (**Figure 4-23**). A certain amount of space can be secured for installation of panels. In terms of the roof's accessibility, there was not direct route through which to access it from inside the building. However, since it is a single-story building, which would allow for scaffolding, etc. to be built from the ground in short order, no major construction project would be required.

Figure 4-23: View of the roof of Building C

- Areas 4 & 5: Parking Lots

Finally, the Kota Kinabalu City has a roofless parking log and a roofed parking lot with enough space for roughly 100 vehicles, as well as a roofed parking space for around 30 motorcycles that is also equipped with a theft prevention function.

First, focusing on the roofed parking lot, the roof is made of steel plates but its load-withstanding capacity might not be so high. Therefore, if any solar panels are to be installed there, it might be necessary to limit the number of panels (**Figure 4-24**). A certain amount of space can be secured for installation of panels.

Next, shifting focus to the roofless parking lot, the team initially considered the possibility of installing car ports that are equipped with solar power generators (**Figure 4-26**), which are serviced by Nihonkucho Hokuriku Co., Ltd., a collaborator in this project. However, after consultation with Kota Kinabalu City, the decision was made to not implement this idea in this project, which was mainly due to the concerns voiced by municipal officials of high cost and the fact that the parking lot would have to be closed while the construction work was underway (**Figure 4-25**).

Finally, concerning the roofed motorcycle parking space, while the roof itself appeared sturdy enough, it would offer only a small area where solar panels, etc. could be installed, and so the decision was made to exclude the motorcycle parking space from the scope of the project (**Figure 4-27**).

Figure 4-24: Roofed parking lot

Figure 4-25: Roofless parking lot

Source: Nihonkucho Hokuriku

Figure 4-26: Car-port-type solar power system

Figure 4-27: Roofed motorcycle parking space

2) Pasar Tanjung Aru

Pasar Tanjung Aru is a market (*pasar* in Malay) that is managed by the Kota Kinabalu City government, a facility where numerous small-scale merchants set up shop, selling daily necessities and food products mainly.

The roof of the building was flat and consisted of steel plates, so its load-withstanding capacity appeared to be fine (**Figure 4-28**). In addition, as there were several parking lots around the premises, the project team initially assumed that the car-port-type solar power facilities could potentially be installed there (**Figure 4-29**). However, when the team contacted those shops to obtain

more information on the matter, it was revealed that they were mostly using electricity to operate simple cooling fans and lighting equipment and did not have many large air-conditioners, refrigerators, freezers, etc. installed, although those appliances would typically be the main sources of power consumption across South East Asia. As mentioned earlier, Sabah State did not have any available FIT program that could be applied to this project, which left the team with no choice but to pursue the self-consumption-type solar installation route. However, the investigation had revealed that the market facility would not be consuming much electricity, the decision was made to exclude it from the scope of this project.

Figure 4-28: Views of the commercial space at Tanjung Aru and its roof

Figure 4-29: Parking lots around Tanjung Aru

3) Anjung Selera

Anjung Selera is a commercial complex that houses restaurants mainly targeting tourists visiting the seaside, as well as daily necessity stores, an athletic gym, and other establishments (**Figure 4-30**).

Most of the first floor of the main building is occupied by a space for holding various events with a stage set up, and a food court. Although when the team surveyed the area at a time tourists had not fully returned due to the coronavirus pandemic, there were relatively many local people seen there. The second floor was mainly used by a market for shopping daily necessities and several offices (**Figure 4-31**). In terms of sources of power consumption at the facility, there was no air-

conditioning seen, but the team observed people using lighting equipment, large cooling fans, electric cooking appliances, refrigerators, freezers, etc. Meanwhile, the roof there consisted of steel plates, but it had an arced shape, so it would be necessary to apply additional technology, technique, and ideas to ensure that solar panels would be properly installed. Furthermore, as the building had no walls, and its entire structure was supported only by columns, it would be important to pay extra attention in making sure that the structure as a whole would be able to withstand the loads of the solar panels, if they are to be installed at all.

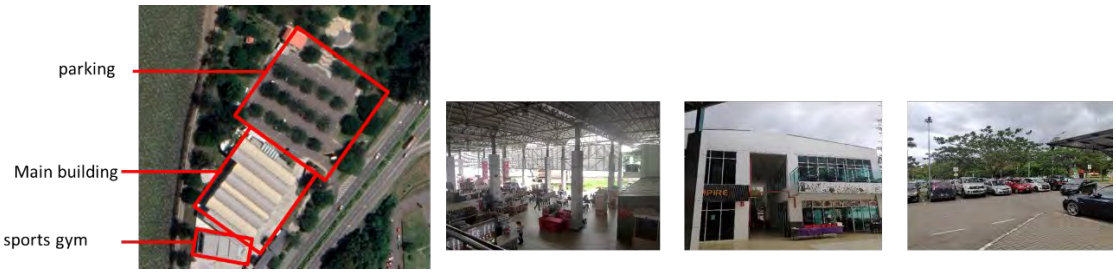


Figure 4-30: Overview of Anjung Selera

Figure 4-31: Food court at Anjung Selera and offices on the second floor

Next, the team surveyed the athletic gym next door. Compared to the main building, the gym was much smaller size. However, its entire structure was made of concrete and, therefore, appeared to have high load-withstanding capacity (**Figure 4-32**). Adjacent to the building, there was also a parking lot that could hold about 100 vehicles. There was an area on the premises that had a car port (**Figure 4-33**). However, as the aforementioned spaces were outside the purview of the Kota Kinabalu City government, the decision was made to exclude them from the scope of this project.

Figure 4-32: Views of one of the parking lots and the annex building at Anjung Selera

Figure 4-33: View of another parking lot at Anjung Selera

4) Summary

After organizing the findings from the aforementioned on-site surveys and consulting with Kota Kinabalu City officials, it was decided that the project would focus solely on the Kota Kinabalu City Hall for further review, mainly due to the municipal office's high power consumption, the availability of a sufficient area for solar panel installation, and the ease of electricity usage data collection. The following sections explain the specific details of the implementation feasibility review.

4.2.2 Power Demand Data and Demand Simulation

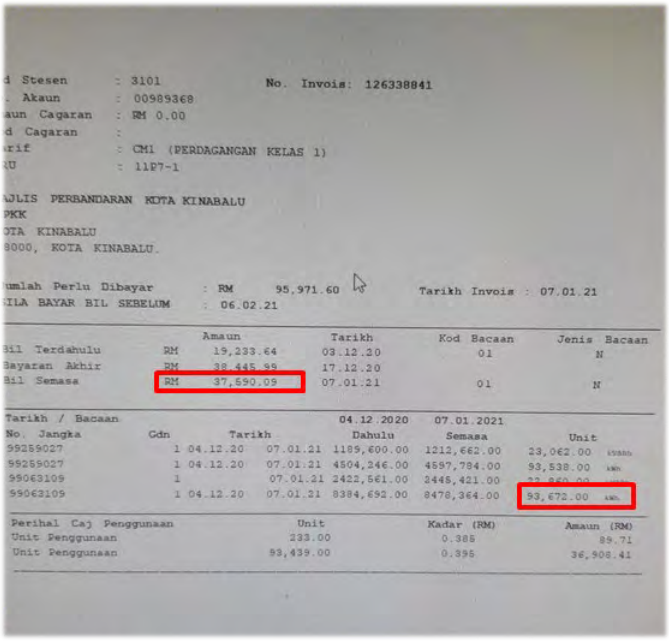
The project team investigated the data that would indicate the power consumption across the entire Kota Kinabalu City Hall, mainly because any solar power installation project for self-consumption, such as this one, had to be carefully planned to generate power within the range of normal self-consumption, as any electricity generated above it would go to waste. For this purpose,

the project team requested Kota Kinabalu City Hall to provide copies of electricity bills issued by the power company (**Figure 4-34**) that would include the municipal office's power consumption data, extracted monthly power consumption data, and converted it to annual power consumption data. The team obtained and reviewed the electricity bills from 2021 for the most current data as well as data from 2019 for reference purposes, as the year preceded the outbreak of the coronavirus pandemic.

Table 4-6 and **Table 4-7** indicate the municipal office's power consumption data from the aforementioned years, respectively.

From the data, the project team had learned that, although the climate in Sabah State consisted of both rainy and dry seasons, no major change in month-to-month power consumption was seen in the data, as the temperature remained more or less constant at around 30℃ all year round. Meanwhile, it caught the project team's attention that the figure from August 2021 was significantly low compared to the rest of the months. To investigate this, the team made an inquiry to Kota Kinabalu City and learned that the sharp decline in August was due to an adjustment made to correct for the municipal office's lower-than-expected power consumption in 2021, as the power company calculated the amount it would charge the municipality based on its power consumption from January through July 2021.

In terms of the municipal office's annual power consumption, it used 112,392kWh of electricity in 2019, and 85,127kWh of electricity in 2021, roughly indicating a 24% drop. When the team inquired municipal officials on this point, it was explained that several factors played a role in causing the decline, one of which was the spread of the novel coronavirus infection, which caused many municipal employees to work from their homes starting February 2021. It was attributed to the fact that, although the municipality had been accustomed to holding events often at night before the pandemic, they were not longer able to continue holding events with the same frequency in 2021. However, as the municipal office was apparently intent on gradually increasing the frequency of such events going forward, the project team assumed that the municipal office's annual power consumption would come back up to around 100MWh eventually.



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JLIS PERBANDARAN KOTA KINABALU
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TA KINABALU
8000, KOTA KINABALU.

umlah Perlu Dibayar : RM 95,971.60 Tarikh Invois : 07.01.21
ILA BAYAR BIL SEBELUM : 06.02.21

		Amaun	Tarikh	Kod Bacaan	Jenis Bacaan
Bil Terdahulu	RM	19,233.64	03.12.20	01	N
Bayaran Akhir	RM	38,445.99	17.12.20		
Bil Semasa	RM	37,690.09	07.01.21	01	N

Tarikh / Bacaan 04.12.2020 07.01.2021

No. Jangka	Gdn	Tarikh		Dahulu	Semasa	Unit
99259027	1	04.12.20	07.01.21	1189,600.00	1212,662.00	23,062.00 kWh
99259027	1	04.12.20	07.01.21	4504,246.00	4597,784.00	93,538.00 kWh
99063109	1		07.01.21	2422,561.00	2448,421.00	25,860.00 kWh
99063109	1	04.12.20	07.01.21	8384,692.00	8478,364.00	93,672.00 kWh

Perihal Caj Penggunaan	Unit	Kadar (RM)	Amaun (RM)
Unit Penggunaan	233.00	0.385	89.71
Unit Penggunaan	93,439.00	0.395	36,908.41

Figure 4-34: Electricity bill issued by the power company

Table 4-6: Kota Kinabalu City Hall's consumption of electricity from December 2018 to November 2019

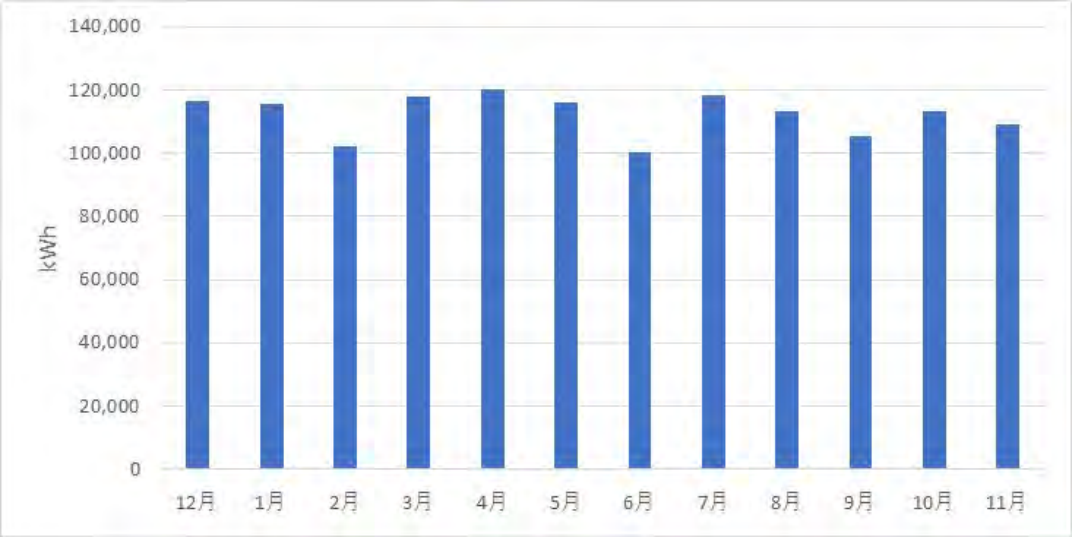
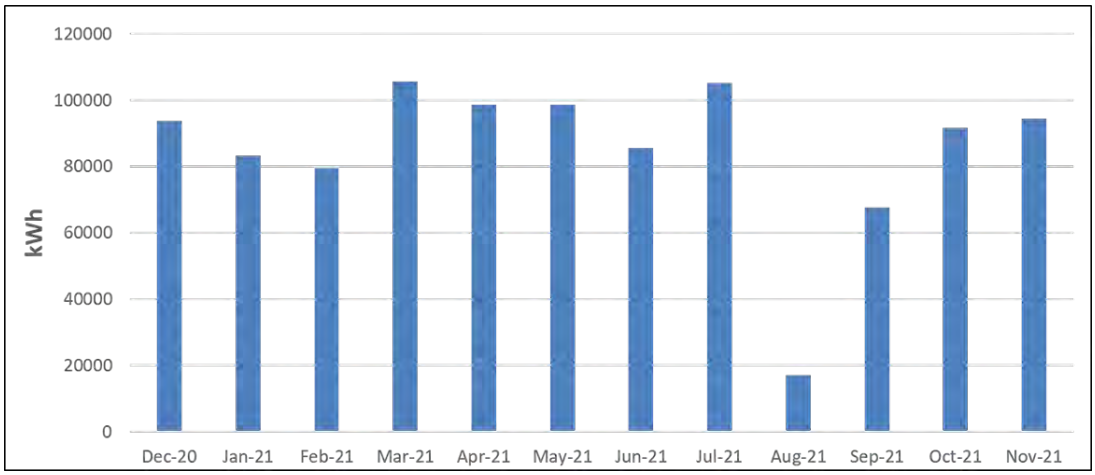


Table 4-7: Kota Kinabalu City Hall's consumption of electricity from December 2020 to November 2021



The project team then intended to review the municipal office's power consumption data at 30-minute intervals but learned that no more granular data than the monthly one had not been obtained. Therefore, as a stopgap measure, the team brought up sample data of electricity consumption by public facilities in Japan that showed changes at 30-minute intervals for reference and mapped it onto the Kota Kinabalu City Hall data and simulated what the municipal office's power consumption pattern would shift every 30 minutes on weekdays and weekends.

The simulation result is indicated in **Figure 4-35** below. In the case of the sampled public facilities in Japan, the power consumption would gradually increase on a weekday from around 8:00 a.m. when work begins until around noon, temporarily dip during lunchtime, start climbing again from around 13:00 as work resumes, and slowly descend around the early evening. Meanwhile, on a typical weekend, the power consumption would remain more or less constant, albeit it fluctuates slightly here and there. After interviewing Kota Kinabalu City officials, the project team was able to verify that their power consumption trend would closely track the simulation although the typical work hours were different between the two countries. In addition, the project team visually checked the reading on a power consumption meter that was installed at the municipal office for the four-day period from December 19 to 22, 2022 three times a day at 8:00, 13:00, and 17:30 to verify the simulation data and determined that the two were reasonably close.

In terms of specific power consumption levels at different points in time, the peak daytime consumption on a weekday was 160kwh while it was 20kwh for nighttime, and on a typical weekday the consumption level remained at around 20kwh.

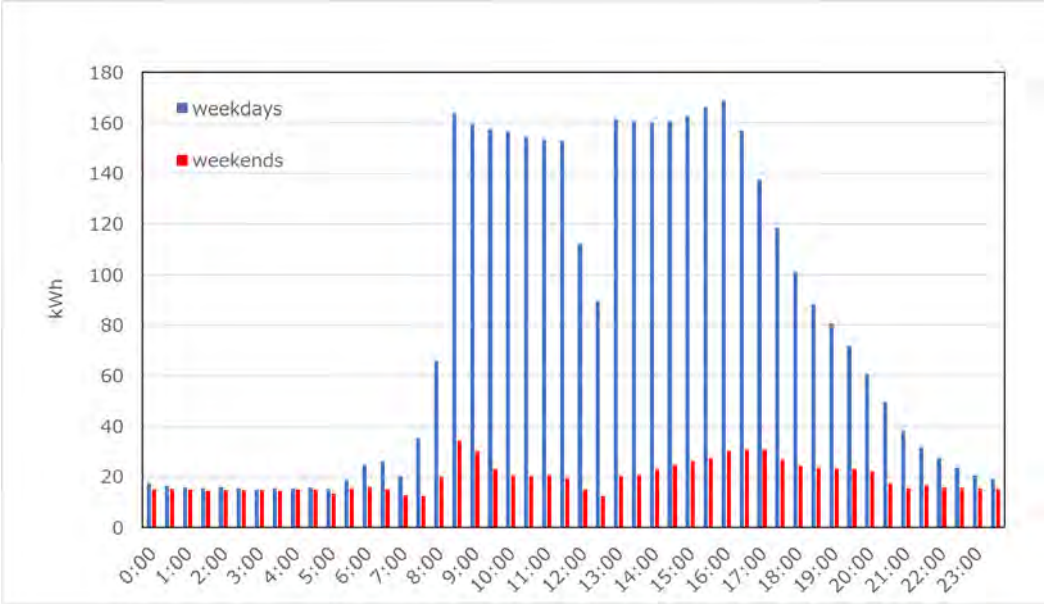


Figure 4-35: Simulation of annual power consumption at the Kota Kinabalu City Hall by hour of day

Also, in terms of the cost of electricity that the municipal office had been paying the power company, the project team checked the figures in the electricity bills and determined that the annual cost was around USD 94,400 (≈JPY 1,000,000).

4.2.3 Examination of Facility Installation Feasibility and Power Generation Amount Simulation

As mentioned earlier, since Sabah State did not have any FIT program and would not be able to purchase excess electricity generated at different locations across the state, the project team thought it desirable to create a power generation plan such that the power plant's capacity to generate electricity would be close to the bottom of the expected power consumption range. The drawings of the solar panel layout that the team had created based on such assumption are provided in **Figure 4-36**. According to this plan, there would be a total of 129 solar panels installed atop the buildings and the roofed parking lot as were described earlier, which would generate 80.46kW of electricity. **Figure 4-37** indicates the possible power output from this solar panel set-up by hour of day, alongside the power consumption simulation data that was explained above. While the plan would result in a small amount of excess electricity generated around lunchtime on weekends, this solar power system would be able to generate 145,624kWh of electricity annually.

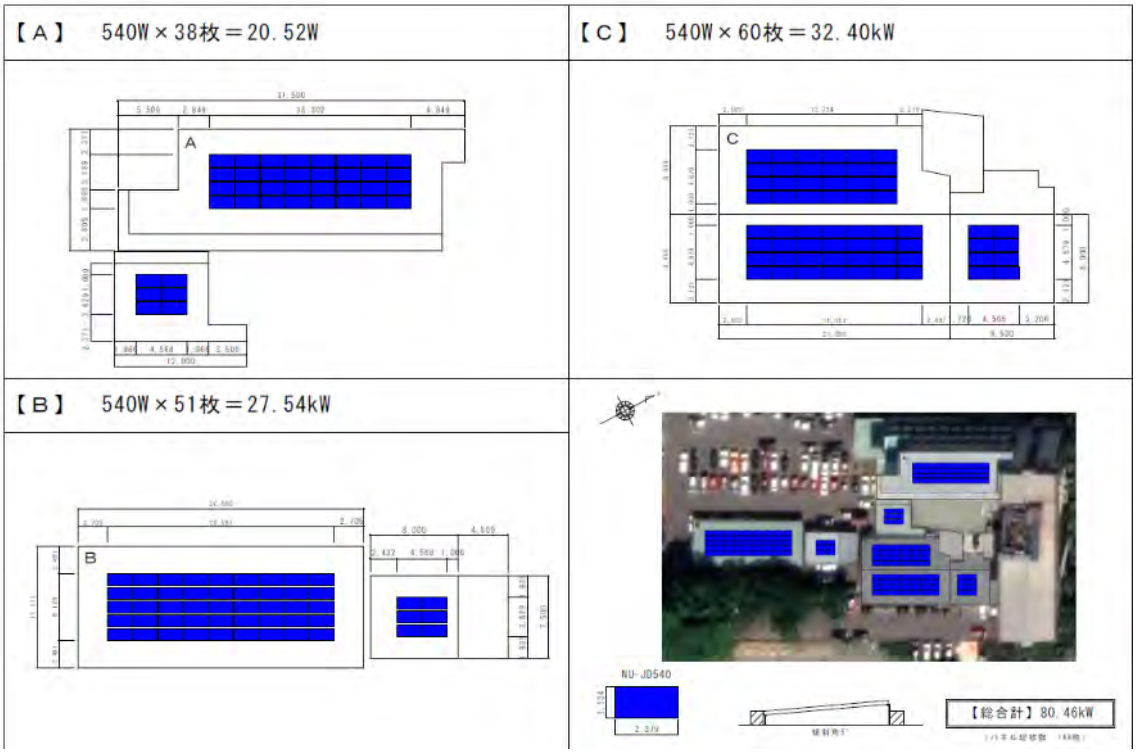


Figure 4-36: Suggested solar panel installation plan

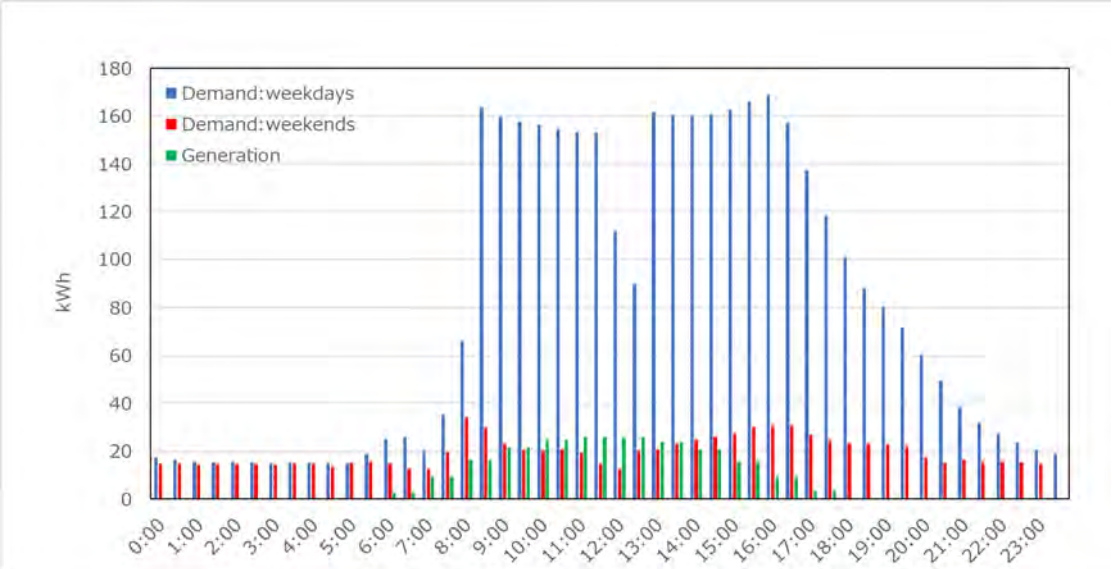


Figure 4-37: Comparison of power output and power consumption after solar power system installation

(green: power output; blue: power consumption on weekday; red: power consumption on weekend)

4．2．4　Examination of Project Execution Structure

As there had been no JCM treaty signed between Japan and Malaysia yet, the project team verified the intention of the Kota Kinabalu City government to minimize the cost of solar power system implementation to the extent possible. Based on the input, the team contemplated a plan where the key components that would comprise the power generation system − such as solar panels and power conditioner − would be procured from Japanese manufacturers while locally procuring the platforms and construction services. Then in July 2022, the project team conducted yet another local survey and also held a conference with a local company named Recoveane Ent that was considering implementing solar power equipment, etc. The team learned that this company was specializing in the business of electrical equipment installation and also had experience of installing floating solar and other solar power devices in different projects as well as O&M (**Figure 4-38**). As Recoveane Ent also had obtained a license from SEDA for solar panel installation, the project team thought that it would likely collaborate with the company in the future. Taking all these into consideration, the project team put together a final proposal on the project implementation scheme as indicated in **Figure 4-39** below and presented it to the Kota Kinabalu City government, which apparently expressed an interest.

Figure 4-38: Solar power projects where Recoveane Ent was involved

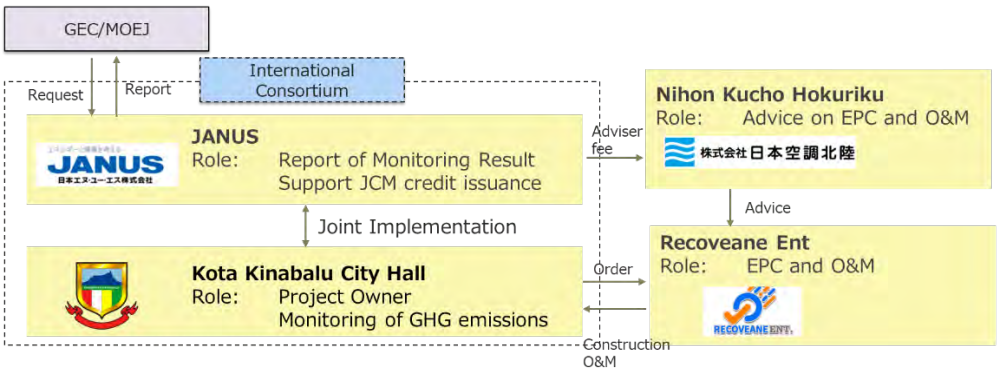


Figure 4-39: Project implementation scheme (proposal)

Chapter 5. Renewable-Energy-Based Electrification Project for Areas Without Electricity

While Kota Kinabalu is the largest city in easter Malaysia, there are a number of farming villages in the region that have been unable to receive electricity supply. To address this issue and increase the rate of electrification across the region, Sabah State and Sarawak State have been implementing their Rural Electricity Supply (BELB) Programme for further electrification. According to the initiative, there are two different ways of electrifying the areas without electricity supply, the first of which involves connecting the existing power grid to the farming villages being targeted by the initiative. The second approach is to install power generation facilities directly near those targeted villages. Generally, the areas without electricity supply are far away from the grid, the first approach of expanding the grid coverage to those villages might not be cost-effective at all, and so the second option is chosen in most cases. Due to the aforementioned state initiative, the rate of electrification across Sabah State had increased to 90.81% as of the end of 2012. However, there are still a number of areas without electricity supply.

To address this, this intercity collaboration program decided to focus on Kobuni Village, which is located approx. 20 km from the city center of Kota Kinabalu and started examining the feasibility of an electrification project that would combine multiple renewable energy sources such as micro-hydro and solar power to facilitate electrification based on the demand for electricity in each targeted community. As such project in success could help enhance the local educational and medical environment including hospitals and clinics, achieve sound gender balance, turn back the tide of urban migration, etc., it would be a meaningful undertaking in terms of SDGs also. In addition, there are several other areas nearby that are without electricity supply, the implementation model of Kobuni Village could be applied to those other areas in the future.

5.1 Gathering of Information Necessary for Enterprise Model Examination

During the FY 2021 project, the team remotely held interviews with concerned local parties and conducted site surveys online in order to examine the current status of electricity supply in Kobuni Village, the local residents' needs related to electricity, and the potential of renewable energy implementation. While the online surveys clarified the village's demand for electricity and potential for generating electricity from renewable energy locally, the scale of the facility would be too small for the project team to raise funds internationally including JCM equipment subsidy program utilization, especially if the project would only involve renewable energy facilities.

Meanwhile, as the project team researched past cases that were similar to this project, some of them were apparently able to obtain international funding successfully by also integrating other technological solution components that could directly address the issues unique to each locale, such as water purification facilities, LED lighting, electric vehicles, etc.

Therefore, during the FY 2022 project, the team conducted on-site surveys and interviewed local stakeholders in July and October of 2022 and was able to comprehend the current status of Kobuni Village and its needs related to the project and how it should unfold in detail. Furthermore, the project team formed a new collaborative arrangement with Toyama University of International Studies ("TUINS") that previously worked on electrification projects similar to this one, so that the parties could work together to identify the issues that the village had been faced with, and examine ways of electricity utilization that could address those issues. They also examined promotion methods that would also involve environmental and educational program development as well as how the model case could be applied to other local communities, etc.

5．1．1　Overview of Kobuni Village

Kobuni Village − located approx. 12 km away from the city center of Kota Kinabalu − is a community with relatively good accessibility, a mere 20- to 30-minute drive from the city (**Figure 5-1**). The village has a population of approx. 300 and its residents belongs to the Kadazan community as with the areas that surround the village. The Kadazans are the largest of the 32 ethnic group indigenous to the state of Sabah[2] (**Figure 5-2**). A view of entire Kobuni Village is provided in Figure 5-3. It is a fairly small community with many residential houses and communal facilities existing in a highly condensed manner.

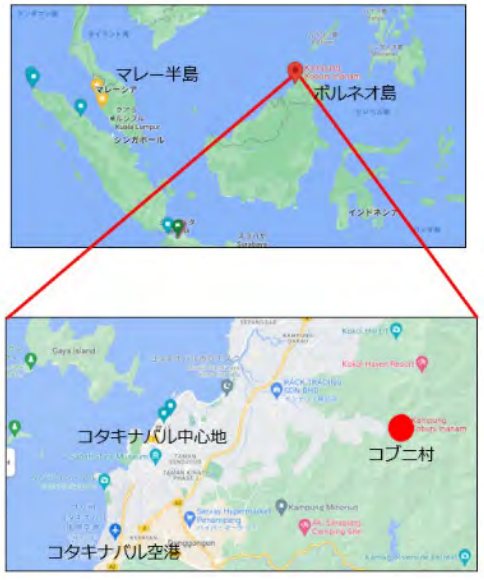


Figure 5-1: Location of Kobuni Village

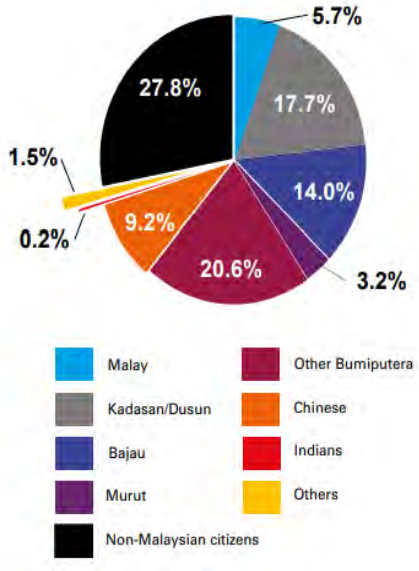


Figure 5-2: Ethnic composition among Sabah State residents

[2] https://www.malaysia.gov.my/portal/content/30114

Figure 5-3: View of entire Kobuni Village

5．1．2　Kobuni Village's Potential for Power Generation

Two rivers run through Kobuni Village, which are the Inanam River and the Kobuni River (**Figure 5-4**). While the Inanam River runs from south to north, the Kobuni River flows in the opposite direction. During the FY 2021 project, the project team conducted site surveys remotely and was able to observe the status of the rivers, etc. but could not determine the rivers' flow rates, etc. During the FY 2022 project, the team was able to conduct on-site surveys in person to take necessary measurements and investigated the potential that the village had for micro-hydro implementation.

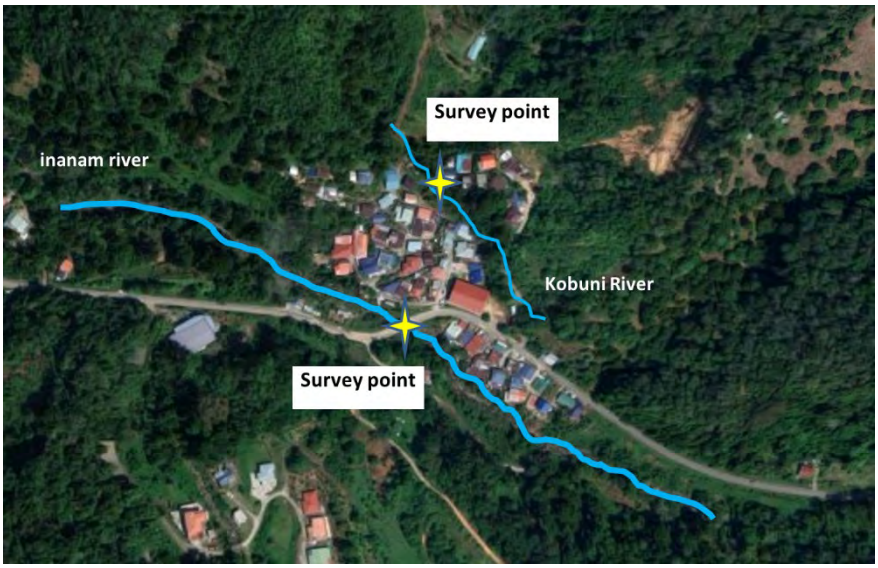


Figure 5-4: Locations of the Inanam River and the Kobuni River

First, in the case of the Inanam River, as shown in **Figure 5-5**, there were several large rocks but the amount of water that flowed through the river throughout the year appeared to be sufficient. In terms of elevation, the team checked data on Google Earth and confirmed that around 10 m of elevation was present inside the village. As there was enough space on both sides of the river, it was determined

that small turbines and power generators could be installed there.

Figure 5-5: View of the Inanam River

In terms of the amount of water that the river carried and its velocity, the project team used a simple flowmeter to take necessary measurements in-situ. As for the specific measurement procedure, the width of the river was first measured at a random point, then measured the height from the river bottom to the surface at the center of every 1 m of the river width, and extrapolated the river's catchment area in a simplified manner. Then, the team measured the flow velocity at the center using the flowmeter, and multiplied it by the catchment area to calculate the amount of water that flowed through the river (**Figure 5-6**). The measured data is provided in **Table 5-1** below, based upon which the project team determined that a flow rate of approx. 0.28m^3/s was always reliably available. In this connection, when the survey was conducted in July, it was the rainy season and so there was relatively much water in the river due to precipitation. However, according to the local residents that the team interviewed, the amount of water in the river apparently would not change much during the dry season. Therefore, it was assumed that the aforementioned level of water flow would always be available all year round.

Figure 5-6: Flow velocity measurement in the Inanam River

Table 5-1: Estimated flow velocity and flow rate of the Inanam River

Measured locations	Measured data items	Measurement results
-	Width	2 m
Location ①	Depth	30 cm
	Flow velocity	41.9 cm/s (mean value)
	Flow rate	0.126 m^3/s
Location ②	Depth	44 cm
	Flow velocity	34.8 cm/s (mean value)
	Flow rate	0.153 m^3/s
Total flow rate		**0.279m^3/s**

Next, in the case of the Kobuni River, it cuts across the northern part of the village. Compared to the Inanam River, the Kobuni is much smaller in terms of river width and flow rate. However, the drop in elevation is more significant than the Inanam, the project team thought that the Kobuni River might be reviewed as a candidate site for micro-hydro installation (**Figure 5-7**). However, as both sides of

the Kobuni River had highly dense vegetation, it was assumed that the installation site should be carefully selected if indeed the project would decide to install a micro-hydro there.

Figure 5-7: View of the Kobuni River

An image of how flow velocity measurement was conducted in the Kobuni River and the measurement results are shown in **Figure 5-8** and **Table 5-2**, based upon which it was determined that a flow rate of approx. 0.04m^3/s was always reliably available from the Kobuni River.

Figure 5-8: Flow rate and flow velocity measurement (Kobuni River)

Table 5-2: Measured flow rate and flow velocity data of the Kobuni River

Measured data items	Measurement results
Width	1 m
Depth	17 cm
Flow velocity	23.46 cm/s (mean value)
Flow rate	0.040 m^3/s

5．1．3　Demand and Needs for Electric Power in Kobuni Village

During the FY 2021 project, the team conducted online interviews, etc. to obtain key basic information on the use of electricity in Kobuni Village. Then, during the FY 2022 project, the team carried out on-site surveys to observe the facilities that were mentioned during the interviews from the previous year in order to determine the status of their use. The team then interviewed local residents to learn about the issues and needs that were being experienced in their daily living and also identify what facilities could be the sources of power consumption as well as power utilization.

First, as for the main public facilities that were in Kobuni Village, there were a mosque, a school (nursery), a community hall, and a soccer court in the center of the village. During the FY 2021 project, the team had already noticed and calculated the power consumption by all these facilities combined, which turned out to be approx. 350 kWh per month (**Table 5-3**).

Table 5-3: Power consumption by village facilities and sources of power consumption

No.	Name of facility	Date / power consumption (kWh)		Power purpose
①	Soccer court	September 2021 / 26.00		• Lights
② + ③	Mosque, school	March 2021 / 99.00	September 2021 / 288.00	• Lights • For prayer Speaker broadcasting (5 times a day)
④	Community hall	March 2021 / 18.00	September 2021 / 23.00	• Lights • Computer • Air conditioner

Source: Information provided by local people concerned with this project

Views of the facilities, etc. that were surveyed are provided in **Figure 5-9**. The mosque was equipped with loud speakers that would be used during prayers and also air-conditioning. The nursery and the community hall had lighting equipment installed. The soccer court gets converted into a market on weekends and holidays, but is usually used as a playground by young children.

In addition, it was noticed that SESB was supplying electricity to each of the homes in Kobuni Village (**Figure 5-10**). Meanwhile, as was confirmed during the previous year's interviews, there were several SESB-installed streetlights along the pedestrian roads but almost all of them were out of order, which meant that they had not been repaired since the previous year. Additional interviews with local people revealed that the road that was used to get to the nursery was particularly dark and posed danger. Therefore, it would be necessary to swiftly repair the nonfunctional lights or install new lighting equipment, etc. (**Figure 5-11**).

soccer court

community hall

nursery school

Mosque

Figure 5-9: Main facilities in Kobuni Village

Figure 5-10: Power grid connected to Kobuni Village

Behind the nursery school

Main road to nursery school

Main road to nursery school

Figure 5-11: Areas requiring streetlights

Next, the project team interviewed people from Kobuni Village and Kota Kinabalu City to ask them about the needs they had besides electricity supply and learned that water supply also had some issues that had to be addressed. The current system being used in Kobuni Village for drinking water supply involves storing of water in the blue purification tank (approx. 1m ^{3}) as indicated in **Figure 5-12** before people used it. Meanwhile, the water drawn to the tank is sourced from the river, people told the team that after heavy rainfalls, muddy water would flow into the tank and significantly compromise the tank's filtration function. It was also reported that the pipeline extending to the water intake would sometimes become clogged due to turbid water caused by heavy precipitation, in which case, local residents had to manually repair the pipeline, etc. (**Figure 5-13**). Although the water tank had been in use for over a decade, local people had no recollection of its filter being replaced, etc. Therefore, it would be reasonable to assume that the water tank's original filtration function had been significantly compromised or become nonexistent by then. As the same drinking water supply system had been used in other local communities nearby that had no tap water or sewerage system, it was assumed that the level of water filtration was similar among them.

Figure 5-12: Water filtration system in Kobuni Village

Figure 5-13: Water intake line being repaired

When the project team interviewed Kota Kinabalu City officials on these topics, the municipal government was apparently concerned with the issues. The questionnaire survey that the team had conducted revealed that sufficient infrastructure was lacking for both water supply and filtration in roughly 80 geographical areas (communities, etc.) (**Table 5-4**). This survey targeted the three local areas of Inanam, Manggatal, and Nulu around Kota Kinabalu City to learn about the status of water supply there, covering 33 villages, 26 villages, and 16 villages, respectively.

The approximate locations of these areas are indicated in **Figure 5-14** below. The survey also revealed that about five villages lacked any water supply entirely, while others did not have stable supply of water, the populations of which were 2,000 and approx. 20,000, respectively.

In terms of the mode of water supply, the project team learned that most of the villages surveyed were using the same gravitation-type filtration system as was seen in Kobuni Village, which was commonly referred to as *gravity water*, to source water from the river and use the water. The engineering department of the Kota Kinabalu was sending its members to attend conferences of the regional activity committees, observe the regional circumstances, and exploring ways to address the identified issues. The team also confirmed that the municipality would like to consider implementing any suitable Japanese technology.

Table 5-4: Status of water supply in villages near Kota Kinabalu City (excerpted)

REVIEW OF CLEAN WATER SUPPLY IN HOUSING AREA AND KAMPUNG AREA AT N18 INANAM.

(1). REGION	(2). ARE SUPPLIES OF CLEAN WATER (PAIP WATER)		(3). IF THERE'S A SUPPLY OF CLEAN WATER " WHICH SIGN IS RELATED				(4). IF THERE IS NO SUPPLY OF CLEAN WATER (PAIPED WATER), WHERE ARE THE SOURCES OF CLEAN WATER SUPPLY (GRAVITY WATER, RAINWATER, RIVER WATER, TEARS)
	THERE IS A SUPPLY OF CLEAN WATER (PAIP WATER)	NO SUPPLY OF CLEAN WATER (PAIP WATER)	NO INTERRUPTION (A)	SUPPLY THERE ARE ONCE INTERRUPTIONS (B)	WATER SUPPLY DISORDERS FREQUENTLY APPLY (C)	WATER SUPPLY DISTURBANCE TOO FREQUENTLY APPLIES (D)	
PULUTAN VILLAGE	50%	50%					GRAVITY WATER
MANSIANG VILLAGE	50%	50%					GRAVITY WATER
KELIANGAU VILLAGE	50%	50%					
BERDATO VILLAGE	50%	50%					GRAVITY WATER
KOKOL VILLAGE	GONE	100%					GRAVITY WATER, RAINWATER
NEW BINAUNG VILLAGE	GONE	100%					GRAVITY WATER, RAINWATER
BUKIT PERMAI VILLAGE	30%	70%					GRAVITY WATER, RAINWATER
NEW MUHIBBAH VILLAGE	80%	20%					RAINWATER, NEAREST RIVER
SINOMPURU VILLAGE	GONE	100%					GRAVITY WATER
NEW PEOPLE'S VILLAGE	90%	10%					RAINWATER, NEAREST RIVER
TENGILING VILLAGE	GONE	100%					GRAVITY WATER
NAALAP VILLAGE	GONE	100%					GRAVITY WATER
LOBOU BUKIT VILLAGE	GONE	100%					GRAVITY WATER
LOBOU ONE VILLAGE	70%	30%					GRAVITY WATER
SAFE LABAU VILLAGE	70%	30%					RAINWATER
MANSIANG ULU VILLAGE	GONE	100%					GRAVITY WATER
NEW MANSIANG VILLAGE	GONE	100%					GRAVITY WATER
NEW PULUTAN VILLAGE	GONE	100%					GRAVITY WATER
TOBOBON VILLAGE	100%						
KEMBIRIAN-DOMBUNG VILLAGE	100%						
NEW KELIANGAU VILLAGE	100%						
NEW KEPAYAN VILLAGE	GONE	100%					GRAVITY WATER
NEW PERMAI VILLAGE	GONE	100%					GRAVITY WATER
NEW PADAS VILLAGE	70%	30%					
RUKUTAN VILLAGE	70%	30%					
GETTING WEEK	100%						

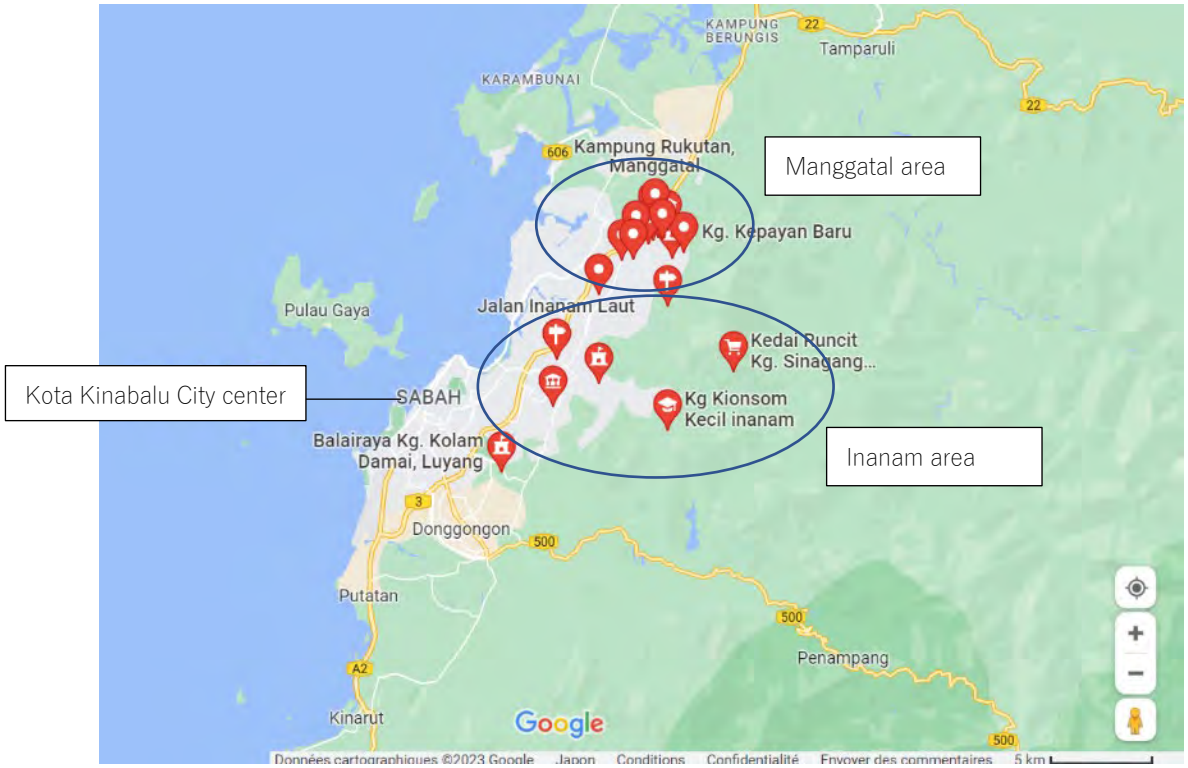


Figure 5-14: Areas covered by the survey on water supply

In addition, at one of the conferences that were held with Kota Kinabalu City officials, the project team shared some relevant information that had been published by JICA (**Figure 5-15**) and

discussed what the suitable solutions might be that could effectively address the water supply issue that was impacting those local areas.

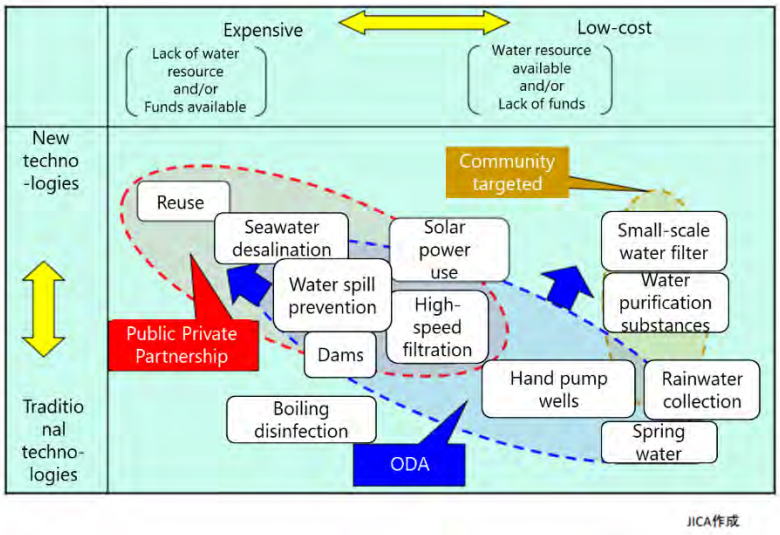


Figure 5-15: Water supply and purification technologies and related projects

As indicated above, the system that could be implemented in a given project is determined by the condition of the local water source as well as budget availability. While the areas covered by this survey had abundant water supply from the various local rivers, they would fluctuate seasonally as explained earlier. In addition, as the rainy season would cause the water to become muddy, making it all the more necessary to treat the water. Therefore, the team estimated that the areas had high demand for new water purification systems. Alternatively, it might be possible to consider utilizing other sources of water besides the rivers (e.g., groundwater, rain water, etc.). Therefore, the project team believes that it should obtain more detailed information on all available water sources across the areas in future surveys. It might also be necessary to recognize that the existing mechanical facilities had not been properly maintained and managed locally so far. Hence, the project team might not only have to help select the suitable technological solutions but also consider how to facilitate proper equipment maintenance and water supply operation in each local community based on some long-term vision.

5.2 Examination of Environmental Education Programs and Promotion Methods for the Subsequent Implementation of the Enterprise Model Elsewhere

Since around 2017, Kobuni Village, in conjunction with Kota Kinabalu City's department of tourism, has been operating a homestay program, which was initiated by a Kota Kinabalu City official that had the chance to attend a JICA-hosted event in Japan was touched by the level of hospitality that was

extended by the local residents of the area where the event took place. So the municipal official became motivated to promote a similar hospitality enterprise in Kota Kinabalu. To design and operate a homestay program that leveraged the distinct features of Kobuni Village, Kota Kinabalu City had partnered with Universiti Malaysia Sabah (“UMS”) to formulate the plan. One of the unique initiatives being implemented by Kobuni Village, which the team thought was important, was the formation of female villagers’ community, one of the specific goals of which was to develop business models that female villagers (homemakers) that did not have jobs to make their living off of.

In this connection, UMS is a national university of Malaysia that was founded in 1994 as the ninth university in the country, which today offers courses in science, technology, agriculture, etc. which are highly reputed. UMS has formed numerous partnerships with foreign universities and companies in recent years mainly from Asia and Western Europe, which also has established ties with several Japanese institutions, including Kindai University, Kochi University, and AEON. UMS has also formed partnerships with many other known entities such as Huawei, Shell, National University of Singapore, UNICEF, etc.

Eligible participants in the home stay program also include various types of schools and other organizations, both domestic and international, and the Kota Kinabalu City government is managing all bookings, etc. Although the novel coronavirus pandemic forced the city to suspend the home stay operation temporarily, the program gradually reopened and took in 75 university students from within Malaysia in April 2022.

In addition, Kobuni Village has several tourist spots nearby, including Kionsom waterfall and Mari Mari Cultural Village. Kionsom waterfall is located upstream the Inanam River as was mentioned earlier, which has an over 10-m drop in elevation and actually consists of a series of waterfalls. The surrounding natural areas are also managed and operated as tourist spots by local residents. Visitors must pay fees to enter into those areas where toilets, etc. are also installed. Outside those areas, there are souvenir stores and parking spaces for tourists.

Figure 5-16: View of Kionsom waterfall

Mari Mari Cultural Village is a facility whose main purpose is to introduce to the visitors the dietary culture and history of the Kadazans. In terms of program offering, the visitors have options to experience the ethnic group's housing construction, indigenous clothes, traditionally consumed food, and other aspects of their lifestyle. At the end of each program, the visitors can watch the traditional dance performance involving the use of bamboo sticks and learn about the indigenous culture in great detail. The facility receives as many as 100 visitors per day.

Mari Mari Cuttural Village entrance

Folk dance

Guides at inside the facility

Figure 5-17: View of Mari Mari Cultural Village

As the information provided above indicates, an effective income-generating model of facility and service operation mainly grounded in tourism is well-established in Kobuni Village and its surround area. Meanwhile, based on the project team's interviewing of local officials and business operators, there was a growing consensus that environmental education would be crucial in terms of enhancement of the village's enticing features.

The project team then held discussions with local stakeholders, etc. to identify ways of promoting ecotourism by integrating various environmental components such as renewable energy into the aforementioned programs in the future. **Table 5-5** and **Table 5-6** below provide key information from the interviews that were conducted with the department of tourism at the Kota Kinabalu City government and UMS, both of which are important stakeholders.

Table 5-5: Interviews with Kota Kinabalu City and UMS (July 25, 2022)

Attendees	Kota Kinabalu City government (1 person), UMS (1 person), JANUS (2 persons)
Interview summary	・ When the city government official visited Japan in 2017 to attend a JICA-related event at Tokushima University, the level of hospitality extended by the residents of local villages was quite impressive. Inspired by the experience, Kota Kinabalu City started contemplating about its own ecotourism enterprise (Mr. Fauziahton, a city government official in charge of the project is especially enthusiastic about this enterprise.) ・ Then, the professor from Universiti Malaysia Sabah (UMS) joined the discussion and

	conducted a feasibility study of the enterprise the same year. ・ Kota Kinabalu is supervising the operation including managing the roster of homestay participants and making sure that all payments are properly made. ・ The roadmap for this ecotourism enterprise has been created and being executed progressively, which is in the final monitoring phase, or Step 5. Specific objects of such monitoring include the economic benefits yielded by the enterprise. ・ It would be highly desirable if the enterprise could integrate some environmental components that would also be conducive to the promotion of renewable energy, through collaboration with this project, to make it more appealing. ・ The eventual goal is to promote Kobuni Village as a model case and apply it to other villages in the area.

Table 5-6: In-person interview with UMS (July 25, 2022)

Attendees	UMS (4 persons), JANUS (2 persons)
Summary	・ It would be welcome to form cooperative ties with universities from other countries. ・ As for the types agreement, there would be two options, namely ①MoU or ②Research agreement. ・ In the case of a research agreement, it can be executed at staff level, focusing on a single topic. ・ If cooperation on a specific project is needed, UMS would prefer to execute a research agreement.

So far the Kota Kinabalu City government and UMS has expressed their consent to facilitate the ecotourism enterprise along with the opinion that the choice of Kobuni Village would be optimal considering its history, operation structure, ability to revitalize the local community, and applicability to other adjacent areas.

In terms of other related activities, the project team has been continuously conducting interviews and conferences in person with Kobuni Village residents, TUINS representatives, and Toyama City officials and has developed relationships with all stakeholders. Based on the information obtained from the local communities, and the current circumstances, the policy for FY 2023 and subsequent years has been formed, which is described below.

5.3 Suggested Enterprise Model and Policy on Future Activities

Based on the on-site surveys and interviews as have been described above, the project team learned that, although Kobuni Village is connected to the power grid, it lacked basic infrastructure for people's daily living, such as nonfunctional and few streetlights, faulty water supply, etc. while

local residents also have not been able to earn enough income. In terms of issues related to poor water supply, there were many other local communities around Kobuni Village that had been experiencing similar or more serious issues.

To address these issues, the project team formulated and would like to suggest the enterprise model as indicated in **Figure 5-18** below, which is grounded in the collaborative relations developed over the years with other partnering entities, the inter-municipal cooperation between Kota Kinabalu City and Toyama City, and joint research, etc. between UMS and TUINS.

Figure 5-18: Enterprise model scheme formulated in this project

Concerning the objective of facilitating renewable energy use such that local resources are fully utilized while sustainable development is promoted, the team will help install micro-hydro, solar power, and other renewable energy facilities to stabilize electricity supply, and also implement water supply and purification systems that could improve people's standard of daily living while consuming the electricity generated locally. For the implementation of this enterprise model, there is another model case that will be referenced, which is the Doyuno micro-hydro power plant project commissioned by Toyama City. As Dr. Uesaka of TUINS was involved in this project as the designer of the plant's overall energy management system, the insights, lessons, and other useful information learned from the Doyuno micro-hydro project might be applied to the enterprise model that has been formulated in this project. In terms of facility maintenance and management, it is assumed that only such tasks that the local residents could handle on their own should entail. It is also part of the plan for the two universities representing their cities to collaborate in generating such ideas that could enhance the ecotourism programs

The enterprise plan review process will involve Toyama City and Kota Kinabalu City

collaborating with each other while simultaneously engaging the local residents in thorough review and discussion. The team will also leverage the know-how and other advantages that Toyama-City-based partnering companies could contribute and then identify and propose suitable solutions.

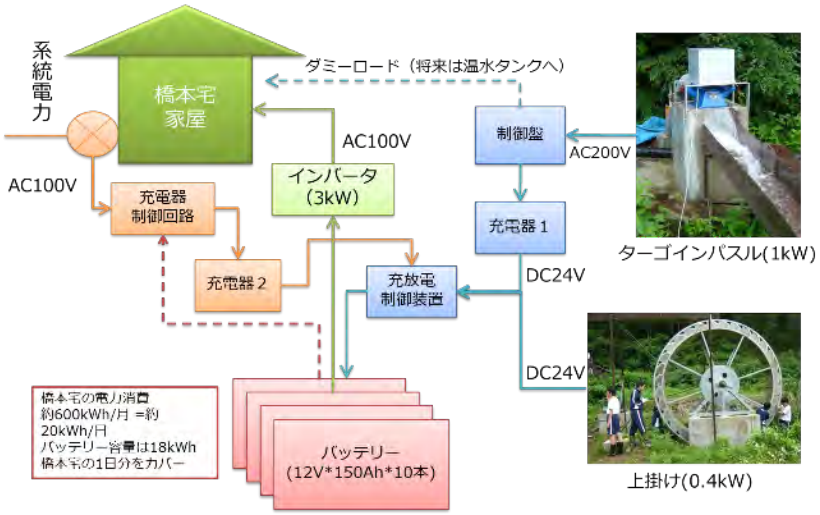


Figure 5-19: Overview of micro-hydro power plant in Doyuno, Toyama City (household-use scale)

In terms of the ecotourism initiative, the team will help integrate new environmental components into the current tourism program being offered by Kobuni Village with a view to enhancing its appeal and improving the income of local people. Specifically, the team is currently contemplating a program that would allow the visitors to make their favorite items and souvenirs, using the electricity generated by micro-hydros, which themselves are unique local resource, along with local food ingredients and other unique resources. In addition, as Toyama City has been playing an active role in synergizing ecology and tourism as a leading environmental future city and SDGs future city, it would be able to impart useful knowledge to Kota Kinabalu City as to how it might be able to support and facilitate various activities from the viewpoint of an optimized municipality.

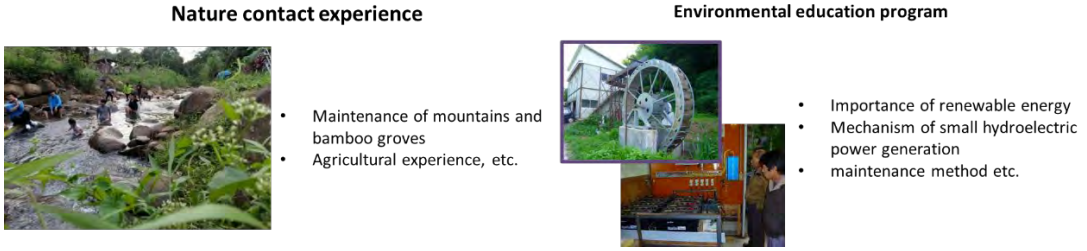


Figure 5-20: Ecotourism programs

Finally, to allow all these initiatives to come to fruition, the team will help promote the active exchange of students, professionals, etc. between Japan and Malaysia with a view to inducing regional revitalization. This would eventually lead to the development of technologists well-versed in renewable energy that could be recruited by local group companies of Japanese origin or get hired to work as expatriates in Japan, etc.

In terms of how the conceptual plan envisioned above could be brought to reality, the team intends to execute it through the JICA Partnership Program. As for the enterprise operation structure, the scheme shown in **Figure 5-21** explains it. The two universities representing Toyama City and Kota Kinabalu City, which have formed cooperative alliance of their own, will cooperate with each other to facilitate the enterprise. In addition, for the aspects of the enterprise that would require implementation of new technology or equipment suitable for local operation, Toyama-City-based companies would be able to provide superb carbon-emission-elimination technology.

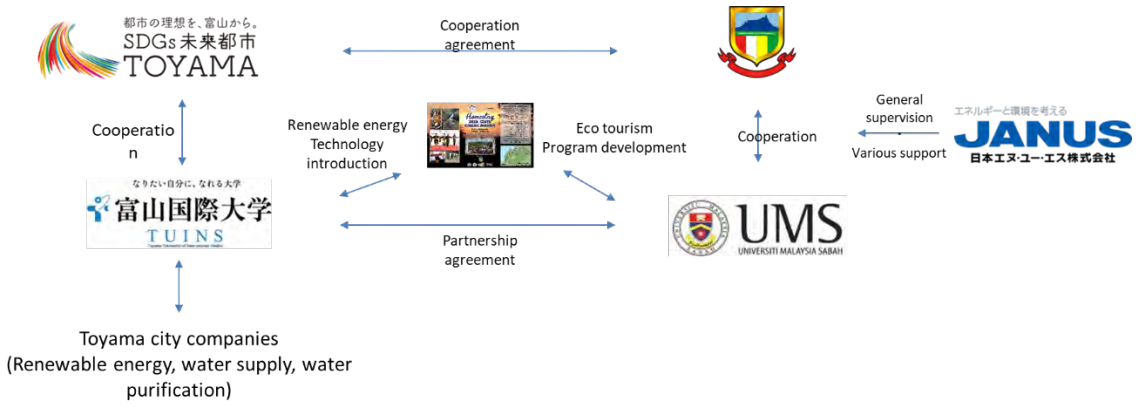


Figure 5-21: Suggested future enterprise operation scheme for Kobuni Village

Table 5-7: Assignment of functions under the enterprise operation scheme

Concerned parties	Assigned functions
Toyama City	Support for collaboration with Kota Kinabalu City, support for human resource acceptance in Japan
Kota Kinabalu	Support for collaboration with UMS, support for human resource acceptance in Malaysia
Toyama University of International Studies (TUINS)	Facilitation of overall enterprise operation, dispatchment of students, etc.
Universiti Malaysia Sabah (UMS)	Development of ecotourism programs
Toyama-City-based companies	Provision of technology and knowledge suitable for local adaptation in Malaysia
Japan NUS	Overall supervision, technical support for various projects, programs, enterprises, initiatives, etc.

Chapter 6. Institution building support and city-to-city collaboration activities

6. 1 Overview of city-to-city collaboration activities

Since the travel restrictions due to the influence of the Covid-19 have been lifted this fiscal year, in addition to being able to travel to the site and conduct field surveys, we have been able to conduct a wide range of activities, including the two municipalities face-to-face meetings through the city-to-city collaboration workshop and small hydroelectric power generation seminar.

In October 2022, Toyama City visited the local government for the first time and confirmed the continuation of the collaboration (Table 6-1, Table 6-2).

Table 6-1 Overview of IRDA visits and opinion exchanges (October 2022)

Date and time	October 18, 2022 @ IRDA meeting room	
Participants (titles omitted)	IRDA	Dato Dr Badrul Hisham Kassim Chief Officer, Rudyanto Bin Azhar Head of Iskandar Rapid Transit Department, Ezani Bin Mohamad Deputy Head of Iskandar Rapid Transit Department, Muhamad Nizam Bin Daud Deputy Head of Iskandar Rapid Transit Department, Kamisah Mohd Ghazali Head of Resilient Environment Department, Ong Hwa Chong Resilient Environment Deputy Director, Dr. Nafisah Resilient Environment Department
	Toyama City	Kobayashi, Kurokawa
	JANUS	Yamase, Hirasawa
Overview	Explanation and discussion on the history of cooperation between Toyama City and IRDA, and the outline and results of the study on city-to-city cooperation so far.	
Pictures	 	

Table 6-2 Overview of Kota Kinabalu City Visits and Discussions (October 2022)

Date and time	October 17, 2022 @ Kota Kinabalu City Hall	
Participants (titles omitted)	Kota Kinabalu City	Mayor Noorliza Awang Alip, General Manager Junainah Abbie, Director of Design and Development Abdul Manaf Rajikan, Director of Engineering Jack Lo, Director of Urban Planning Tantinny Fung, Director of Engineering Linda Manahan
	Toyama	Kobayashi, Kurokawa
	JANUS	Yamase, Hirasawa
Overview	Explanation and discussion on the history of cooperation between Toyama City and Kota Kinabalu City, and the outline and results of research on city-to-city cooperation so far.	
Pictures		

6.2 Seminar

Since this fiscal year's project is the third year of the city-to-city collaboration project, a seminar was held in Malaysia in February 2023 to share the achievements of the three years, to discuss about the significance and purpose of the Zero Carbon City Declaration and its effects. The agenda and notes on the discussions of the day are presented below.

6.2.1 City-to-City Collaboration Seminar with IRDA

Table 6-3 shows the agenda of the city-to-city collaboration seminar held at IRDA on February 16, 2023, and Table 6-4 shows the summary of the discussions (seminar materials: 8.3, 8.4).

Table 6-3 Agenda for City-to-City Collaboration Seminar (IRDA)

Feb. 16th (Thu.), 2023 Online workshop	
Time (Malaysia)	Contents
14:00-14:10	**Opening Remarks** -by **Dato' Dr. Badrul Hisham Kassim**, Chief Executive, IRDA -by **Mr. Keiichi Kobayashi**, Project Director of Environment Policy Division, Toyama City
14:10-14:25	**Presentation and exchange on the results of the 3 - years' City-to-City collaboration study (JANUS)** -by **Ms. Kyoko Hirasawa**, Japan NUS Co., Ltd. (10 minutes presentation followed by 5 min Q&A session)
14:25-14:50	**Share of experience of the Zero - Carbon City Declaration** -by **Mr. Kazuhiro Kurokawa**, Project Director of Environment Policy Division, Toyama City (Presentation in English (15min) followed by 10 min Q&A session)
14:50-15:15	**Status of the Low-carbon society blueprint for IRDA** -by **Ms. Choo Hui Hong**, Resilient Environment, IRDA (Presentation in English (15min) followed by 10 min Q&A session)
15:15-15:25	**Discussion and update for future collaboration projects and opportunities** -by all participants 10min Comments and Discussion, translated when needed
15:25-15:30	Closing and group picture

Table 6-4 **Summary of City-to-City Collaboration Seminar (IRDA)**

Participants (titles omitted)	IRDA	Dato Dr Badrul Hisham Kassim, Rudyanto Bin Azhar, Mamdoh B. Dat Hj Yusof Malim Kuning, Ong Hwa Chong, Dr. Nasfisah Abdul Rahiman, Choo Hui Hong
	Bus operator	Sharom Tabil, Ramli
	Toyama	Kobayashi, Kurokawa
	JANUS	Yamase, Hirasawa

Contents	After introductions and greetings by each attendee, the results of the review of the biofuel utilization project in Iskandar was remined, and discussions were held on the details and issues to be considered from the next fiscal year, including the establishment of decarbonized transportation. In addition, Toyama City explained the history of the zero-carbon city declaration and its merits, and IRDA explained the contents of the Low-carbon society blueprint 2030 and exchanged opinions toward a “zero-carbon domino”. ■ Biofuel utilization project ・ Bus operator companies are also beginning to consider switching to biofuels. Please let us know how much biomethane can be recovered from POME and the results of the economic studies. (Sharom Tabil) →Since the details are described in last year's report, we will share it after the meeting. (JANUS) ■ Future issues and considerations for the next fiscal year and beyond for the realization of decarbonized transportation ・ There are a large number of motorbike users in Johor Bahru State, and the amount of CO2 emitted by motorbike users is increasing. It is also a major challenge between two countries, as many of the users are commuting to Singapore. In that sense, the BaaS project of battery exchange type electric motorcycles that utilize renewable energy is very interesting. (IRDA) ・ For future consideration, we have started contacting Blue shark, which is developing a BaaS project using electric motorcycles in Peninsular Malaysia. (IRDA) ・ Also, regarding the carbon credit system, the Malaysian government is beginning to consider the introduction of a carbon credit system. As IRDA is also able to make recommendations to the government, we would like to see such policy proposals included in the review for the next fiscal year. (IRDA) ■ About the decarbonization plan of each city ・ Regarding LCSIM2030, IRDA has set a higher target than the one set by the Malaysian government. What is the reason? (Toyama City)

	→ One factor is that the target value is set in the form of GDP-based carbon density. Since IRDA's GDP is higher than that of Malaysia as a whole, the target is naturally higher. On the other hand, in order to be conscious of "decarbonization" in the projects promoted within IRDA in the future, there is also the intention to set ambitious targets. In the future, we believe that this is an achievable goal because there will be a lot of support from the government, such as the introduction of renewable energy, the suspension of coal-fired power generation, and the establishment of a carbon credit market. (IRDA) ・ What kind of project do you have with GCOM? (Toyama City) → We are collaborating with GCOM on capacity building. (IRDA)






Figure 6-1 Pictures from the City-to-City collaboration seminar (IRDA)

6.2.2 City-to-City Collaboration Seminar with Kota Kinabalu City

Table 6-5 shows the agenda of the city-to-city collaboration seminar held at Kota Kinabalu City Hall on February 13, 2023, and Table 6-6 shows the summary of the discussions (seminar materials: 8.3, 8.5).

Table 6-5 Agenda for City-to-City Collaboration Seminar (Kota Kinabalu City)

PROGRAMME

Feb. 13th (Mon.), 2023 Online workshop	
Time (Malaysia)	Contents
10:00-10:10	**Opening Remarks** -by **Datuk Noorliza Awang Alip**, Mayor of Kota Kinabalu City Hall -by **Mr. Keiichi Kobayashi**, Project Director of Environment Policy Division, Toyama City
10:10-10:25	**Presentation and exchange on the results of the 3 - years' City-to-City collaboration study (JANUS)** -by **Ms. Kyoko Hirasawa**, Japan NUS Co., Ltd. (10 minutes presentation followed by 5 min Q&A session)
10:25-10:50	**Share of experience of the Zero - Carbon City Declaration** -by **Mr. Kazuhiro Kurokawa**, Environment Policy Division, Toyama City (Presentation in English (15min) followed by 10 min Q&A session)
10:50-11:15	**Status and updates of the Green City Action Plan Kota Kinabalu** -by **Ms. Tantiny Fung**, City Planning Department, DBKK (Presentation in English (15min) followed by 10 min Q&A session)
11:15-11:25	**Discussion and update for future collaboration projects and opportunities** -by all participants 10min Comments and Discussion, translated when needed
11:25-11:30	Closing and group picture

Table 6-6 Summary of the City-to-City Collaboration Seminar (Kota Kinabalu City)

Participants (titles omitted)	Kota Kinabalu City	Noorliza Awang Alip, Junainah Abbie, Abdul Manaf Rajikan, Jack Lo, Tantiny Fung, Linda Manahan, Fauziahton Ag Said
	malaysia national University of Sabah (UMS)	Pr. Ir. Dr. Peters Robert
	SESB	Terrence Kouju

	Kobuni village	Emalia Rabin, Noorlizahwati
	Toyama	Kobayashi, Kurokawa
	Nihon Kucho Hokuriku	Nishikawa
	JANUS	Yamase, Hirasawa

Contents	After introductions and greetings by each attendee, the survey results and future policies for the City-to-City collaboration project were explained, mainly focusing on the consideration of the introduction of solar power generation equipment and the consideration of renewable energy introduction in Kobuni Village. In addition, Toyama City explained the history of the zero-carbon city declaration and its benefits, etc., and Kota Kinabalu City explained the contents of the Green City Action Plan Kota Kinabalu (GCAPKK) and exchanged opinions toward a "zero carbon domino". ■ About solar power generation project ・ We understand that the next step is to calculate costs and consider financing. Currently, JCM cannot be applied in Malaysia, so I feel that Kota Kinabalu City also needs to consider the budget. Once the project costs to some extent become clear, I would like to consider the finance source. (Kota Kinabalu City) ・ In the future, it seems that it will be necessary to obtain approvals and licenses (“Approval of endorsement”) when actually introducing solar power facilities. (SESB) ・ How long does it take to obtain a permit? (Kota Kinabalu City) → Approximately 2 weeks to 1 month is a guideline. (SESB) ■ About the project of Kobuni Village ・ Regarding the project in Kobuni village, I understand that we will make a proposal to the JICA project after completing the City-to-City collaboration survey. Kota Kinabalu City has experience with JICA projects, so I think it is a good proposal. In addition, Kota Kinabalu City is currently trying to horizontally develop community tourism projects in three nearby villages, modeled on the project in Kobuni Village, so it would be good if the project could be promoted in conjunction with that movement. (Mayor of Kota Kinabalu) ・ Since the situation in Kobuni Village and its surrounding villages is similar, it would be better to expand the scope of the survey in the future. In addition, UMS understands the information and situation of the surrounding environment, so I think it can be of

	help in this project. Collaboration with Toyama University of International Studies is also welcomed. (Pr.Robert) ・ How about incorporating the contents of the Kobuni Village project into the environmental education activities of Kota Kinabalu City? (Pr.Robert) → Elementary school students in Kobuni Village attend primary school in Kionsom Village next door. It may be good to conduct activities there (Kota Kinabalu City) ■ About the decarbonization plan of each city ・ Kota Kinabalu City was selected by ADB as a candidate city to introduce a low-carbon plan, but it is not a scheme in which ADB gives a specific budget for equipment installation. (Kota Kinabalu City) ・ **Kota Kinabalu City wants to start the realization of the current low-carbon plan from public transportation policy, so knowing how Toyama city went through the consideration of transportation policy, then compact city to the zero-carbon city declaration is a good reference for us. (Kota Kinabalu City)** ・ I would like to know how the development of light rail system progressed in Toyama City. Kota Kinabalu City has also been considering LRT and BRT, but it is difficult to introduce LRT due to land acquisition issues. (Kota Kinabalu City) →In Toyama City, there was an existing railway and the introduction of LRT was considered as a plan after the end of the previous train operation. We were aware that LRT had cost issues, but as a long-term policy, we wanted to aim for convenience and prevention of traffic congestion in the city, so in the end we chose LRT. (Toyama City) ・ Currently, there are about 700 bus operator companies in Kota Kinabalu City, and we feel that it is necessary to organize with them first, and we plan to hold discussions with stakeholders, including bus companies, next month. In addition, Kota Kinabalu City has a thriving tourism sector, so we would like to consider the conversion of sightseeing buses to EVs. (Kota Kinabalu City) ・ UMS is also introducing EVs and self-generated renewable

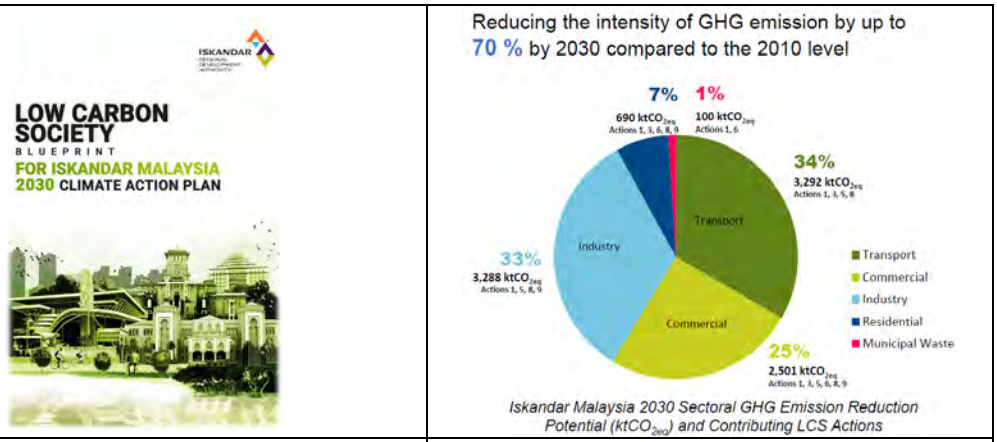
	energy on campus to promote low-carbon technology, and plans to become a green campus by 2023. (Pr.Robert) ・ Another sector that Kota Kinabalu City would like to focus on is the introduction of energy-saving streetlights (replacement with LEDs). It is about 1/25 of the required number. We also work on waste management policy, municipal wastewater issues, and green building. In any case, the funding from the government is very low, so it is implemented as a public-private initiative such as a joint venture. (Mayor of Kota Kinabalu)

Figure 6-2 Pictures from the City-to-City collaboration seminar (Kota Kinabalu City)

6. 3 Policy System building support

As shown in the previous section, in this year's project, at the city-to-city collaboration seminar held in February 2023, we shared knowledge about transportation policies and decarbonization policies in Toyama City and exchanged opinions with the locals.

In the Iskandar region, the Low Carbon Society Blueprint for Iskandar Malaysia 2030 (LCSBIM2030) was published in February 2023 (Figure 6-3). The plan includes a form that partially reflects the results of this city-to-city collaboration project. Toyama City is also mentioned on the page on cooperation with various stakeholders.



Cover of LCSIM2050	GHG reduction potential in 2030

Figure 6-3 LCSIM2050

Chapter 7. Summary

7. 1 Results of this fiscal year's City-to-City Collaboration Project

As mentioned above, in this year's city-to-city collaboration project, it became possible to travel to the local area, which was not possible in the previous year's studies and the project was implemented with many results, such as local field surveys and seminars held locally. We were able to. A summary of the results including these is shown in Table 7-1.

Table 7-1 Summary of achievements of the City-to-City collaboration projects this fiscal year7-

Project	Achievement
Carbon-free transportation project	· Business schemes and implementation systems for biofuel utilization projects have been examiend. · For business realization, we contacted Gas Malaysia and encouraged them to participate in the project. · As a result of the above, an NDA was signed between Gas Malaysia, JGC Holdings, and our company to study the details of the business, and a MoU was signed at the AZEC Ministerial Meeting Public-Private Investment Forum. · In parallel with the above, opinions were exchanged on policies and issues for establishing decarbonized transportation in Iskandar region. · As a result of the discussion, it was confirmed that the next target would be motorcycles as a means of transportation for citizens, and the consideration of a master plan for the BaaS project targeting electric motorcycles with exchangeable batteries.
Solar power generation project	· As a result of conducting field surveys of three candidate sites for introduction that were considered by the 2021 project, and discussing with Kota Kinabalu City, "Kota Kinabalu City Hall" was selected as a candidate site for introduction. · Together with Nihon Kucho Hokuriku Co., Ltd., a field survey on the roof of Kota Kinabalu City Hall has been conducted. After confirming the strength of the roof, possible installation locations were confirmed. · Based on the power consumption data received from Kota Kinabalu City Hall, a daily power demand curve simulation was conducted. · **After examining the installation capacity of the photovoltaic power generation equipment suitable for the power demand curve, a power generation simulation and a power supply and demand simulation were conducted.**

	· The project implementation, operation and maintenance systems for future project promotion have been examined.
Small hydropower project	· A field survey of the Naradau power plant has been conducted and local conditions and operation practices that were not noticed from the online survey have been confirmed and identified. · **A small hydroelectric power generation technology seminar was held to share knowledge on small hydroelectric power generation that has been cultivated over many years in Japan.** · SESB's future project plans related to renewable energy have been introduced and possibility of collaboration with Japanese companies in the future has been confirmed.
Electrification project using renewable energy	· A field survey was conducted in Kobuni Village, the water flow in the rivers were measured, and the introduction potential of hydroelectric power generation was confirmed. · Interviews were conducted with local residents to confirm their requests regarding the use of electricity. · **The future project plan and implementation system have been examined.**
City-to-city collaboration activities	· At the city-to-city collaboration seminars held locally, Toyama City's zero carbon city declaration has been introduced, as well as related initiatives and its relationship with transportation policies, and exchanges of opinions with the local government have been made. · In the Iskandar region, the "Low Carbon Society Blueprint for Iskandar Malaysia 2030 (LCSBIM2030)," which includes the results of city-to-city collaboration projects, was announced.

7. 2 Project plan for the next fiscal year and beyond

■ Carbon-free transportation project

In this year's project, we examined the business scheme and implementation system for the biofuel utilization project. As one of the results of this project, Gas Malaysia, JGC Holdings, and our company were able to conclude an MoU for detailed business consideration. In the future, we plan to start the project between the three companies, working together to conduct detailed studies on project realization and encourage stakeholders to join in the project. If JCM agreement is concluded between Malaysia and Japan, we plan to consider using the JCM scheme.

In addition, in order to establish decarbonized transportation, we understood that there is a need to decarbonize some parts other than public transportation. In particular, due to the rapid spread of workers, food delivery services, Grab, etc. to Singapore, the number of motorcycle users is increasing rapidly, and countermeasures against them are urgently needed. IRDA confirmed their intention to solve these

problems by introducing a BaaS (Battery as a Service) project that utilizes battery-swappable electric motorcycles. In addition, by combining this service with a photovoltaic power generation system, which is a renewable energy source, it is believed that further introduction of renewable energy will be possible through decarbonization of electricity and implementation of energy management. As a result of discussions with IRDA, first of all, interest on elaborating a master plan, including the feasibility of technical introduction and policy support, during Phase 2 of the city-to-city collaboration project has been shown. We are considering cooperation with New Japan Consultants Co., Ltd., a company in Toyama City. In Indonesia, the latter has already started a demonstration of a battery-swappable electric motorcycle BaaS project with a local company (Figure 7-1)[3], and we plan to make considerations adapted to the situation in Iskandar Malaysia by referencing to the company's experience.

Figure 7-1 Battery-swappable electric motorcycle under consideration by New Japan Consultants Co., Ltd.

■ Solar power generation project

In this year's project, we examined the introduction of a self-consumption type solar power generation system to Kota Kinabalu City Hall and confirmed the appropriate installation capacity and management system. Going forward, Kota Kinabalu City Hall plans to make investment decisions after clarifying the specific construction process and construction costs in cooperation with local EPC companies. After that, when implementing the project, depending on the JCM conclusion status, if the JCM

[3]https://www.shinnihon-cst.co.jp/news/20221216-2.html

between Malaysia and Japan is concluded, we will consider using the JCM equipment subsidy.

■ Small hydropower project

In this fiscal year's project, we conducted field surveys at candidate rehabilitation sites and were able to confirm the status of failure points. In addition, we were able to share knowledge on water intake methods based on Japan's experience at the small hydroelectric power generation technology seminar. In the future, for the implementation of the project, we will be in the phase of selecting and designing equipment after conducting detailed field surveys including water flow and civil works measurements. It is difficult to implement them in this City-to-City collaboration project due to budget constraints. On the other hand, despite the support of the Japanese government, SESB intends to proceed with the rehabilitation of the site and has already secured a budget for the study and rehabilitation within the company. If we find a company willing to participate in the project, we will consider using JICA and other governmental budgets.

■ Electrification project using renewable energy

In this year's project, we were able to confirm the introduction potential of local renewable energy, local power demand needs, and the situation of neighboring villages through field surveys and interviews. Utilizing this information, next fiscal year, we will consider applying for JICA grassroots technical cooperation projects (regional revitalization type). When applying for the project, the cooperation agreement between Toyama City and Kota Kinabalu City will be utilized, and universities in both regions will collaborate to promote the project. Along with this, it is envisioned that the excellent decarbonization technology of companies in Toyama City will be provided when introducing technologies and equipment suitable for the local area.

■ City-to-City collaboration activities

Through this fiscal year, the cooperation between Toyama City and the two cities in Malaysia was greatly strengthened because it became possible to travel to the site. In particular, at the city-to-city collaboration seminar held in February 2023, Toyama City's zero-carbon city policy and transportation policy were shared, and a very lively exchange of opinions took place. It has also been an opportunity to confirm their intention to carry out activities for the formation of a zero-carbon city.

Based on the above situation, the Iskandar region is considering applying for the Zero Carbon City Model Region Formation project as Phase 2 of the City-to-City collaboration project. The outline of the project is shown in Figure 72. Continuing from the contents so far, it is assumed that three projects will be considered under the cooperation agreement between Toyama City and IRDA.

Figure 7-2 Projects scheduled to be applied for Phase 2

First, we would like to consider a master plan for a BaaS system for battery-swappable electric motorcycles, as requested by IRDA, “Considering the introduction of a BaaS system for establishing decarbonized transportation”. Secondly, we would like to consider carbon-zero model areas for the six model areas that are being developed by IRDA. As for the third point, we will consider introducing a solar power generation system and an electric power management system as energy to support the development of the above two projects.

The end.