REPUBLIC OF INDONESIA

Ministry of Energy and Mineral Resources (Energi dan Sumber Daya Mineral Republik Indonesia: MEMR)
State Electricity Company (PT Perusahaan Listrik Negara: PLN)

REPUBLIC OF INDONESIA

PREPARATORY SURVEY ON ENERGY MANAGEMENT AND RENEWABLE ENERGY DEVELOPMENT PROJECT IN NORTH KALIMANTAN, INDONESIA (PRIVATE SECTOR INVESTMENT FINANCE)

Final Report

May 2023

Japan International Cooperation Agency (JICA)

Kyudenko Corporation (KYUDENKO)

OS
JR(P)
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Currency Conversion List

Field Survey	Date	Currency Conversion (IDR1=\)	Currency Conversion (IDR1=USD)
1st (7 days)	25th September 2022→ 30th September 2022	0.009330	
	1st October 2022	0.009510	
2nd (7 days)	30th October 2022 – 31st October 2022	0.009510	
	1st November 2022 – 5th November 2022	0.009490	
3rd (6 days)	12th December 2022 – 17th December 2022	0.008810	
4th (5 days)	7th February 2023 – 11th February 2023	0.008690	
Report		0.008930	0.000066862

Source: Currency Conversion USD: JICA FY2022 Settlement Rate Chart
Currency Conversion USD: Website of Foreign Affairs (Japan): 1USD = 14,956IDR (1st July 2022, Bank Indonesia)

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Abbreviations

Abbreviations	Indonesia (Bahasa)	English
ADB	-	Asian Development Bank
AE	-	Accredited Entity
AMDAL	Analisis Mengenai Dampak Lingkungan	Environmental Impact Analysis
AR lender	-	Account Receivable Lender
BAPPENAS	Badan Perencanaan Pembangunan Nasional (Kementerian Perencanaan Pembangunan Nasional)	National Development Planning Agency (Ministry of National Development Planning)
Bau	Bisnis Seperti Biasa	Business as Usual
BECCS	-	Bioenergy with Carbon Capture and Storage
BOD	Jajaran Direksi	Board of Director
BOT	-	Build-Operation-Transfer
BPK	Badan Pemeriksa Keuangan	The Audit Board of the Republic of Indonesia (“Audit Board”)
BPP	Pembangkit listrik biomassa	Biomass Power Plant
BRIN	Badan Riset dan Inovasi Nasional	National Research and Innovation Agency
CCS	-	Carbon Capture and Storage
CCUS	-	Carbon Capture Utilisation and Storage
CDM	Mekanisme Pembangunan Bersih	Clean Development Mechanism
CEV	Nilai Ekonomi Karbon	Carbon Economic Value
CFPP	Pembangkit Listrik Tenaga Uap	Coal-Fired Power Plant
COD	Tanggal Operasi Komersial	Commercial Operation Date
CPO	Minyak Kelapa Sawit	Crude Palm Oil
DBU	Dirjen Bina Usaha	-
DGNERE	Direktur Jenderal Energi Baru Terbarukan	Directorate General of New Energy and Renewable Energy
DPDLUK	Direktorat Pencegahan Dampak Lingkungan Usaha dan Kegiatan	The Agency for the Prevention of Environmental Impact from business Activities

DRKH	Daftar Rencana Kegiatan Hibah	List of Planned Grant Projects
EBT	Energi Baru Terbarukan	New and Renewable
EFB	Tandan Kosong Sawit	Empty Fruits Bunch
EMS	Sistem Manajemen Energi	Energy Management System
FFB	Tandan Bush Segar（TBS）-	Fresh Fruit Bunch
FIT	-	Feed-In Tariff
GCF	-	Green Climate Fund
GEF	-	Global Environment Facility
GHG	Gas Efek Rumah Kaca	Greenhouse Gases
HGB	Hak Guna Bangunan	Right to Build
HLPN	Hutan Lindung Pulau Nunukan	Nunukan Island Protection Forest
IEC	Komisi Elektronik Internasional	International Electrotechnical Commission
IIF	-	Indonesia Infrastructure Finance
IMB	Izin Mendirikan Bangunan)	Construction permission
IPB	Izin Panas Bumi	Geothermal Permit
IPP	Pengembang Pembangkit Listrik	Independent Power Producer
ISO	Organisasi Standarisasi Internasional	International Organization for Standardization
ISPO	Sertifikasi Perkebunan Kelapa Sawit Berkelanjutan Indonesia	Indonesian Sustainable Palm Oil
IUPTLS	Izin Usaha Penyediaan Tenaga Listrik untuk Kepentingan Sendiri	Electricity supply business license for its own purpose
IUPTLU	Izin Usaha Penyediaan Tenaga Listrik untuk Kepentingan Umum	Electricity supply business license for public interest
JBIC	-	Japan Bank for International Cooperation
JCM	-	Joint Crediting Mechanism
JICT	-	Fund Corporation for the Overseas Development of Japan’s ICT and Postal Services Inc.
KBLI	Klasifikasi Baku Lapangan Usaha Indonesia	Standard industrial classification of Indonesian Business fields

KEN	Kebijakan Energi Nasional	
KKP	Kementerian Kelautan dan Perikanan	Ministry of Marine Affairs and Fisheries
LCT	LCT	Landing Craft Tank
MEF	Kementerian Lingkungan Hidup dan Kehutanan	Minister of Environment and Forestry
MEMR (ESDM)	Kementerian Energi dan Sumber Daya Mineral	Ministry of Energy and Mineral Resources
MMFA	Kementerian Kelautan dan Perikanan	Ministry of Marine and Fisheries Affairs
MOF	Menteri Keuangan	Ministry of Finance
MOAASP/NLA	ATR/BPN	Ministry of Agrarian Affairs and Spatial Planning/National Land Agency
MW	Megawatt	Megawatt
NDC	Kontribusi Tetap Nasional Indonesia	Indonesia's Nationally Determined Contribution
NDP	Perencanaan Pembangunan Nasional	National Development Planning
NEDO	-	New Energy and Industrial Technology Development Organization
NGO	Lembaga Swadaya Masyarakat	Non-Governmental Organization
NIB	Nomor Induk Berusaha	Business Identification Number
NIDI	Nomor Identitas Instalasi	Installation ID Number
NPWP	Nomor Pokok Wajib Pajak	Taxpayer Identification Number
Nunukan DLH	Kantor Dinas Lingkungan Hidup Kabupaten Nunukan	Nunukan District Environment Office
O&M	Operasi dan Pemeliharaan	Operation and Maintenance
OSS	Sistem Online Single Submission	Online Single Submission System
PBG	Persetujuan Bangunan Gedung	Building Permit
PKS	Cangkang Kelapa Sawit	Palm Kernel Shell
PLN	PT Perusahaan Listrik Negara (Persero)	State Electricity Company
PLT	Pembangkit Listrik Tenaga	Power Plant
PLTA	Pembangkit Listrik Tenaga Air	Hydroelectric Power Plant
PLTB	Pembangkit Listrik Tenaga Bayu	Wind Power Plant

PLT BBN	Pembangkit Listrik Tenaga Bahan Bakar Nabati	Biofuel Power Plants
PLTBg	Pembangkit Listrik Tenaga Biogas	Biogas Power Plants
PLTP	Pembangit Listrik Tenaga Panas Bumi	Geothermal Power Plant
PMA	Penanaman Modal Asing	Foreign Investment
PPA	Perjanjian Jual Beli Listrik	Power Purchase Agreement
PPP	Kerja Sama Pemerintah dengan Badan Usaha	Public-Private Partnership
RPJMN	Rencana Pembangunan Jangka Menengah Nasional	National Medium-Term Development Plan
ROE	-	Reginal Owned Enterprise
RPH	Rencana Penggunaan Hibah	Utilization of Grant Plan
RSPO	-	Roundtable on Sustainable Palm Oil
RTR	Rencana Tata Ruang	Spatial Plan
RTR KSN	Rencana Tata Ruang Kawasan Strategis Nasional	National Strategic Area Spatial Plan
RUED	Rencana Umum Energi Daerah	Regional General Energy Plan
RUEN	Rencana Umum Energi Nasional	
RUKN	Rencana Umum Ketenagalistrikan Nasional	National General Electricity Plan
RUPTL	Rencana Usaha Penyediaan Tenaga Listrik	Electricity Supply Business Plan
RZ KSNT	Rencana Zonasi Kawasan Strategis Nasional Tertentu	Zoning Plan for Certain National Strategic Areas
RZ KAW	Rencana Zonasi Kawasan Antarwilayah	Interregional Zoning Plan
SDM	Mekanisme Pembangunan Berkelanjutan	Sustainable Development Mechanism
SEZ	-	Special Economic Zone
SLF	Sertifikat Laik Fungsi	Certificate of Occupancy
SLO	Sertifikat Laik Operasi	Operation Worthiness Certificate
SMI	Pt Sarana Multi Infrastruktur	-
SNI	Standar Nasional Indonesia	National Standardization Agency of Indonesia
SOE	Badan Usaha Milik Negera	State-owned enterprises
SOP	Standar Operasional Prosedur	Standard Operating Procedure

SPC		Special Purpose Company
SPP	Pembangkitt tenaga surya	Solar Power Plant
SRN PPI	Sistem Registri Nasional Pengendalian Perubahan Iklim	National Registry System for Climate Change Control
TDP	Tanda Daftar Perusahaan	Company Registration Certificate
UIKL	Unit Induk Pembangkitan dan Penyaluran	Generation and Transmission Main Unit
UIW	Unit Induk Wilayah	Regional Main Unit
UKL-UPL	Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup	Environmental Management Efforts and Environmental Monitoring Efforts
UNFCCC		United Nations Framework Convention on Climate Change
WB	-	World Bank

Summary

1. Background and Progress of the Work

Indonesia is an island nation, with 1,766 inhabited remote islands located throughout the country[1]. The Indonesian government has set a goal of achieving carbon neutrality by 2060, and most recently it has also set a government target of increasing the renewable energy ratio in the energy mix to 23% by 2025. However, as of 2022, the ratio is only around 17%.[2] The Indonesian government has judged that in order to increase the proportion of renewable energy, it is essential to introduce it in remote islands which are scattered throughout the country and have a high ratio of diesel power generation, and is accelerating the movement. Due to unstable power generation, renewable energy has not been able to become a key power source in remote islands which lack main power grids. Solar power generation varies greatly between day and night, biomass power generation has a raw material supply risk, and geothermal and hydroelectric power generation is not suitable for locations such as remote islands.

In this project, the feasibility of "hybrid power generation" was investigated. This power generation method uses EMS (Energy Management System) for renewable energy power generation developed by the proposing company, and combines multiple power generation types (solar power and biomass) and large-scale storage batteries, to serve as a stable power source that transmits power 24 hours a day and replace existing diesel power plants. In addition, in preliminary consultations with Indonesia's national electric power company (PT. PLN), the survey sites for this project were set on Nunukan Island and Subatik Island in North Kalimantan Province. Biomass power generation was selected as one of the power source types, with a view to procuring the most suitable raw material locally and stably for a long term toward smooth combustion, preferably a candidate material that has been relatively unused so far. A survey to realize this "local production for local consumption" model was also set as a goal.

2. Business Continuity Review

Local situation

The region (Nunukan Regency, North Kalimantan Province) faces typical challenges related to renewable energy utilization on island areas of Indonesia. They are (1) the local power supply and demand are tight and planned power outages are frequent, (2) the priority in budget allocation within PLN is low, and investments for power generation facilities are not being made as set forth in the country's Electricity Supply Business Plan (RUPTL), and (3) the power grid is weak and solar power generation with a widely varying output cannot be utilized. The two islands alone have a population of more than 100,000, and considering the spillover to similar remote islands in Indonesia, the project is very likely to offer great benefits and to continue.

Status of biomass power generation

Power sources that can produce electricity stably 24 hours a day such as hydroelectric power generation and geothermal power generation cannot be developed in remote island areas. Instead in this project, the focus is placed on biomass power generation as a key power source. The Kalimantan and Sumatra regions are

[1] JICALook it up (2021Year now)

[2] IEAStatistics

world-class oil palm production areas, and are famous for exporting PKS (palm kernel shell) as a biomass raw material. In palm oil production, empty fruits bunch, trunks, leaves and other unused oil palm parts left after oil pressing. If these raw materials can be procured stably at low cost, they can become a major power source and contribute to stable power supply for remote islands and areas. However, these areas lack sufficient transportation infrastructure, and a supply chain must be developed. Also, there is a good possibility to deploy hybrid power generation models such as "biomass + solar power" in other regions (eastern Indonesia, etc.), by cultivating raw materials other than oil palm. Thus, the continuation of the business can be expected once a business model is established in this project.

Bidding system

PLN often invests in its power generation, transmission and transmission facilities based on the government's Electricity Supply Business Plan (RUPTL). However, for the expansion of electricity in remote island areas, PLN tends to solicit IPP businesses (independent electricity wholesale businesses) using the bidding system. September 2022, the "Presidential Regulation No. 112/2022 on Accelerating the Development of Renewable Energy for the Supply of Electricity" had set the purchase price of renewable energy-based power. Since it is relatively difficult to ensure business feasibility in remote island areas due to their scale and locational conditions, the Indonesian government is considering ways to reduce barriers for renewable energy businesses on remote islands, such as the "Remote island coefficient" and "premium price adder for the installation of storage batteries" in this presidential regulation, and this trend is expected to accelerate in the future. However, there is no power purchase system for a "hybrid power generation (power generation by multiple power sources)" business envisioned in this project, and this problem has been raised with the Indonesian government during this survey. It must be recognized as an issue for the future.

Securing land for business

In Indonesia, ownership of land by foreign capital is not permitted as a rule, and in the case of long-term power generation projects such as this project, it is necessary to secure land use rights through the acquisition of construction rights (HGB) and land lease agreements. In this case, the land is divided among many local landowners, and it is expected to take a considerable amount of time to obtain the consensus of all landowners for HGB acquisition. Therefore, it seems optimal to ensure the continuation of the project through long-term leasing of public land such as that owned by the local government (regency-owned land), especially in the demonstration phase.

3. Business Scheme and Financing

Business scheme

In this project, we plan to establish an SPC (Special Purpose Company) for the purpose of supplying electricity using renewable energy in the region, conclude a power purchase contract (PPA) with PLN, and sell 100% of the generated power. In the past, there was a restriction on the ratio of foreign capital in SPC, but it has now been abolished. However, it is necessary to acquire appropriate business qualifications (KBLI, etc.) in line with business activities.

Financing

Although this project will take place on remote islands far away from main electricity consumption areas, it is considered to be of an extremely public nature because it entails power supply to places where tens of thousands of people live. Therefore, we investigated the utilization of various subsidy schemes to achieve low carbon in the region, such as the GCF (Green Climate Fund) and the JCM (Joint Credit Mechanism). Also, it is important to include an appropriate maintenance plan (O&M) in the financing plan, so that the business can operate soundly for 20 years or more.

4. Overview of Hybrid Power Plants

Schematic design of power generation facilities

The goal of this project is to stabilize renewable energy-based power generation and build a system that can supply power 24 hours a day mostly without operating the existing internal combustion power plants. In general, if the capacity of the storage battery is larger, more power can be stored to be supplied at night or in bad weather, and the reliability of the system improves, but on the other hand, capital investment will be excessive. For example, if a facility is configured only with a solar power plant with a power generation efficiency of about 20% and storage batteries, the electricity that should be stored becomes too large, prompting the scale of solar power generation to be further increased, forming a vicious cycle. Therefore, a power source that can generate electricity at a certain level 24 hours a day without being affected by the weather is desirable. As mentioned, this project envisions the adoption of biomass power generation using raw materials that are locally produced for local consumption.

Steps from demonstration to IPP business phase

On the islands of Nunukan and Subatik, which are the target areas of the project, the amount of electricity required is about 17 MW. Meeting the islands' electricity demand with unprecedented hybrid power generation technology has various technical challenges. Even if the endeavor is registered in RUPTL (Electricity Supply Business Plan), the hurdles are too high to aim for 100% renewable energy-based power right away. Therefore, we would like to reduce technical risks by incorporating a technology demonstration step, in which a facility is designed based on hybrid power generation with an aim to stably transmit power to the grid on a small scale. Discussions are underway with the governments of Japan and Indonesia on this policy.

Operation of the system by EMS

Nunukan Island and Subatik Island are close to each other, but basically Nunukan Island is the "main control side" in controlling power generation, and power interchange is carried out via submarine cables installed between the two islands. If renewable energy power generation facilities are introduced in this project, EMS controls the appropriate amount of power to be transmitted in real time and sends power from the combined three power sources (biomass, solar power, and storage batteries) based on the output command from the PLN side. Additionally, it is desirable from the viewpoint of safety to keep the existing diesel generators in some form as a backup, in the demonstration phase and the ultimate business phase. In that case, it is feasible to have EMS follow the operation status of the entire system (mini grid) including diesel generators, and provide PLN with the power generation status of the islands. With the EMS introduction, optimal power transmission is ensured at all times, without manually selecting a power source from the PLN side, which should reduce blackouts and planned power outages in the region.

5. Environmental Impact Assessment

Overview of business components with environmental and social impact

In Indonesia, the power generation business is required to apply for AMDAL (Analisis Mengenai Dampak Lingkungan: environmental impact assessment) if the facility is above 50 MW, or UKL-UPL (Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup: Environmental Management Program and Environmental Monitoring Program) for smaller-scale facilities. The target scale of this project is the latter, and it is necessary to prepare an application for UKL-UPL.

Social environment

Nunukan Regency has a population of 190,000 according to the 2020 census, and has indigenous Tidung, Bajau, and Murut peoples, as well as the Bugis people, who are immigrants from Sulawesi. Nunukan Island has long been a transportation hub in northern Kalimantan, and houses the Nunukan Regency government as well as 100,000 residents. The regency's principal industries are agriculture (mainly oil palm cultivation) and mining, while the island's main industry is seaweed cultivation along the coast. A forest reserve has been established in the central part of the island, but the planned site of this project will be outside of the protected area. The exact location of the site is being discussed with the regency government, etc. in the area, and we will formulate a plan that does not involve the relocation of residents as much as possible.

6. Project Effects

CO_2 emission

The annual greenhouse gas emissions reduction in the demonstration phase of this project is expected to be 7,085 tCO_2/year. The emission factor used is 0.493 tCO_2/MWh.

Economic evaluation

According to the above-mentioned presidential regulation, considerable coefficients are to be applied to the renewable energy-based power purchase price for remote islands, compared to the main island area. If they are applied to the maximum, the business feasibility is likely to be sufficient even with 100% renewable energy power generation. However, due to (1) the lack of tariff for purchasing electricity from hybrid power generation and (2) the need for further feasibility surveys regarding facilities and fuels for biomass power generation, this preliminary survey has not achieved the sound feasibility evaluation, and further investigations are required.

(END)

Chapter 1 Social and Economic Conditions in Indonesia

1-1 Social and economic conditions in Indonesia

After the Second World War, and following a war of independence with the Netherlands, Indonesia became recognized as the Republic of Indonesia in 1949. It is a large nation (approximately 1,920,000 square kilometers: 5 times the area of Japan) with rich resources (oil, minerals, agriculture and fishery products), a population of 270 million (4th in the world) and the largest-scale economy in Southeast Asia (nominal GDP 1 trillion USD) in 2021.

1-1-1 Demographics

Concerning Indonesia's demographic composition, its working-age population ratio is 70.7% (as of 2020), the population continues to increase, and the demographic bonus is expected to continue until about 2040[3]. The population is made up of Javanese 40.2%, Sundanese 15.5%, and including the ethnic minority of people of Chinese descent 1.2%, more than 1,000 ethnic groups.

1-1-2 Economic situation

Except for the COVID-19 pandemic period in 2020, since 2005 the country's economic growth rate has risen constantly by between 5.5% and more than 6%, per year, with nominal GDP per capita exceeding 3,000 USD in 2010, and reaching 4,332 USD in 2021. In terms of scale, industry is made up of manufacturing, at 18% the largest sector, agriculture and fisheries 12%, wholesale and retail 13% and mining 12%. Growth in recent years has been led by manufacturing and distribution/services, while agriculture and fisheries, and mining have shown growth rates lower than that of GDP as a whole [4].

1-1-3 Development policy

Currently, Indonesia's development policy is composed of Long-Term National Development Plans (RPJPN[5]) issued every 20 years, and Middle-Term National Development Plans (RPJMN[6]) issued every 5 years.

In addition, under the National Green Growth Roadmap[7] (2015-2030), centered on the use of low carbon technology, environment-friendly infrastructure development and effective use of natural resources, Indonesia is aiming to realize a low-carbon society by 2050. As one of the programs to realize the National Green Growth Roadmap, the National Development Planning Agency (BAPPENAS) has announced the Indonesia Green

[3] United Nations World Population Prospects 2019
[4] https://perpustakaan.bappenas.go.id/e-library/file_upload/koleksi/migrasi-data-publikasi/file/RP_RKP/Narasi-RPJMN-2020-2024-versi-Bahasa-Inggris.pdf
[5] https://perpustakaan.bappenas.go.id/e-library/file_upload/koleksi/migrasi-data-publikasi/file/RP_RKP/RPJPN%202005-2025-english.pdf
[6] https://perpustakaan.bappenas.go.id/e-library/file_upload/koleksi/migrasi-data-publikasi/file/RP_RKP/RPJPN%202005-2025-english.pdf
[7] http://greengrowth.bappenas.go.id/wp-content/uploads/2018/02/201512221340.GGGI_Roadmap_Full_English_spread_lores.pdf

Growth Program[8]. The Indonesia Green Growth Program is centered on the promotion of sustainable energy, sustainable landscape and sustainable infrastructure within special economic zones.

In 2020, the Indonesia Government decisively implemented business regulatory reform centered on the regulation of employment and foreign investment that covered reform of 79 laws, in one fell swoop.

1-2 Kalimantan Island and plan for new capital

In this survey, the proposed sites for the project, Nunukan Island and Sebatik Island, are islands attached to Kalimantan Island, also known as Borneo Island. Kalimantan Island (area approx. 730,000 km^2, the 3rd largest island in the world by area) is divided into three territories possessed by Indonesia, Malaysia and Brunei, with Indonesian territory (544,000 km^2) being made up the five provinces of West Kalimantan Province, South Kalimantan Province, Central Kalimantan Province, East Kalimantan Province and North Kalimantan Province (formed by a partition of East Kalimantan Province in 2012). Nunukan Island and Sebatik Island are part of the Nunukan Regency in North Kalimantan Province on the border with Malaysia.

1-2-1 Characteristics of Kalimantan Island

Coal, oil, natural gas, iron ore, bauxite, gold, etc. are produced in Kalimantan which is rich in natural resources. Biodiversity is high with extensive rainforest, which is a vast source of carbon capture and carbon storage, and substantial mangrove forest remaining along the coast. During the 1990s and 2000s, deforestation due to illegal logging, forest fires and unregulated plantation development (mainly for oil palm) was a serious problem, however, since 2016 loss of forest area has been halted[9].
Transportation infrastructure, especially road construction is behind, with the main means of transportation within the island being domestic air routes linking the main cities and services such as those operated by ferry and speed boat along rivers and the coast.

1-2-2 Social and economic conditions

The nominal GDP of the 5 provinces of Kalimantan for 2022 was 1,767 trillion Rupiah, accounting for 9% of the national total. Due to the sparse population (approx. 23 million), GDP per capita is second only to Jakarta. Mining accounts for 30.9% of nominal regional GDP (2018), which far exceeds the national average (7.8%). On the other hand, for tertiary industry, especially wholesale/retail and information/telecommunications, nominal GDP is far below the national average, and the nominal GDP composition ratio for tertiary industry overall is 30.1% (national average: 44.5%), the lowest of all regions in Indonesia[10].

1-2-3 Plan for new capital

In September 2019, the administration of President Jokowi Widodo formally decided to relocate the capital

[8] http://greengrowth.bappenas.go.id/en/
[9] World Resources Institute: Global Forest Watch (https://www.globalforestwatch.org/)
[10] Japan Bank for International Cooperation “Indonesia’s Investment Environment / December 2019”

from Jakarta to East Kalimantan Province in Kalimantan Island (Borneo Island). Objectives such as "lessening of overconcentration" in the capital Jakarta and its surrounding area, and addressing the "elimination of regional disparities," which has been a focus of the president Jokowi administration since its inauguration in 2014, form the background to this decision. In the first phase, 2022 to 2024, there are plans to develop core facilities for central government, and to this end, construction of a dam that will meet the demand for water in the new capital, homes for civil servants and other facilities is already underway[11].

1-3 Background to project

With the aim of expanding into Indonesia, a country of many islands, to apply its wealth of experience in stable electricity supply on remote islands and in outlying areas in Japan, KYUDENKO has carried out a demonstration project and field research there since 2016.

1-3-1 Relationship between KYUDENKO and Indonesia

Since 2017, when KYUDENKO President (at that time) Matsuji Nishimura took office as Honorary Consul General of the Republic of Indonesia in Fukuoka, up until the present time, the KYUDENKO chairman has served in this position. In 2017 also, the KYUDENKO Indonesia Representative Office was established in the capital Jakarta, and a demonstration project on Sumba Island[12] commenced. Since 2016, KYUDENKO has accepted about 10 technical interns every year from Indonesia, many of whom after their return, work for PT. DENKI and other related companies in Indonesia.

1-3-2 Background to start of project

KYUDENKO has experience in the construction of many renewable energy power generation facilities in Japan, in particular, its track record for construction of solar power plants has reached approximately 2,200MW (based on panel capacity). Making use of this wealth of experience, the company developed "KYUDENKO EMS," which stabilizes the wide output fluctuation of renewable energy and supplies the power to a grid.

This system is an effective technology for providing stable power supplies on islands and in outlying areas, and was adopted by the Ministry of the Environment, Japan in FY2016 for its "Financing programme to demonstrate advanced low-carbon technology innovation for further deployment in developing countries." Under this programme, a demonstration facility for the system to supply power to a microgrid was built on Sumba Island, East Nusa Tenggara Province in the eastern part of Indonesia, which is transmitting power daily. This initiative was much praised by both the state electricity company, PT Perusahaan Listrik Negara (PLN) and the governing agency, the Ministry of Energy and Mineral Resources (MEMR), and many related persons have visited the island to inspect the facility. At the end of 2021, the verification monitoring period for the facility came to an end, and currently transfer of the facility to the national and regional governments is under negotiation, while power transmission to the local transmission grid is continuing.

[11] JETRO "Indonesia Latest Developments (October 12, 2022)"
[12] Demonstration project in Sumba Island, Indonesia, by Financing Programme to Demonstrate Decarbonization Technology for Realizing Co-Innovation (http://gec.jp/jcm/jp/event/2021Indonesia/S3-4_kyuden.pdf)

In FY2018, KYUDENKO was accepted into JICA's "collaboration program with the private sector for disseminating Japanese technology," with the aim of future commercialization and the goal of spreading this technology in Indonesia. As an undertaking hosted in Japan, related persons from MEMR, PLN and other organizations were invited to Japan, where they inspected EMS demonstration sites, a storage battery factory and other facilities owned by KYUDENKO in Japan. As a result, the Executive Vice President for the Kalimantan Division at the company head office said, "We want to deploy this technology in Indonesia," and "On two islands, we want to end operation of the current diesel and old gas turbine power generation, and replace them with renewable energy power generation."

PLN is anticipating the entry of independent power producers (IPP) into the renewable power generation sector in the region concerned, and with this as a decisive element to the introduction of renewable energy into Indonesia, KYUDENKO and related companies agreed that through this technology, they would aim for the future implementation of the project and accompanying investment. With the objective of gathering information directed towards concrete project formation and execution, application was made for a JICA "Preparatory Survey on Private Sector Investment Finance," which was accepted in FY2020.

Chapter 2 Electricity Sector of Indonesia

2-1 Electricity policy

2-1-1 Energy policy

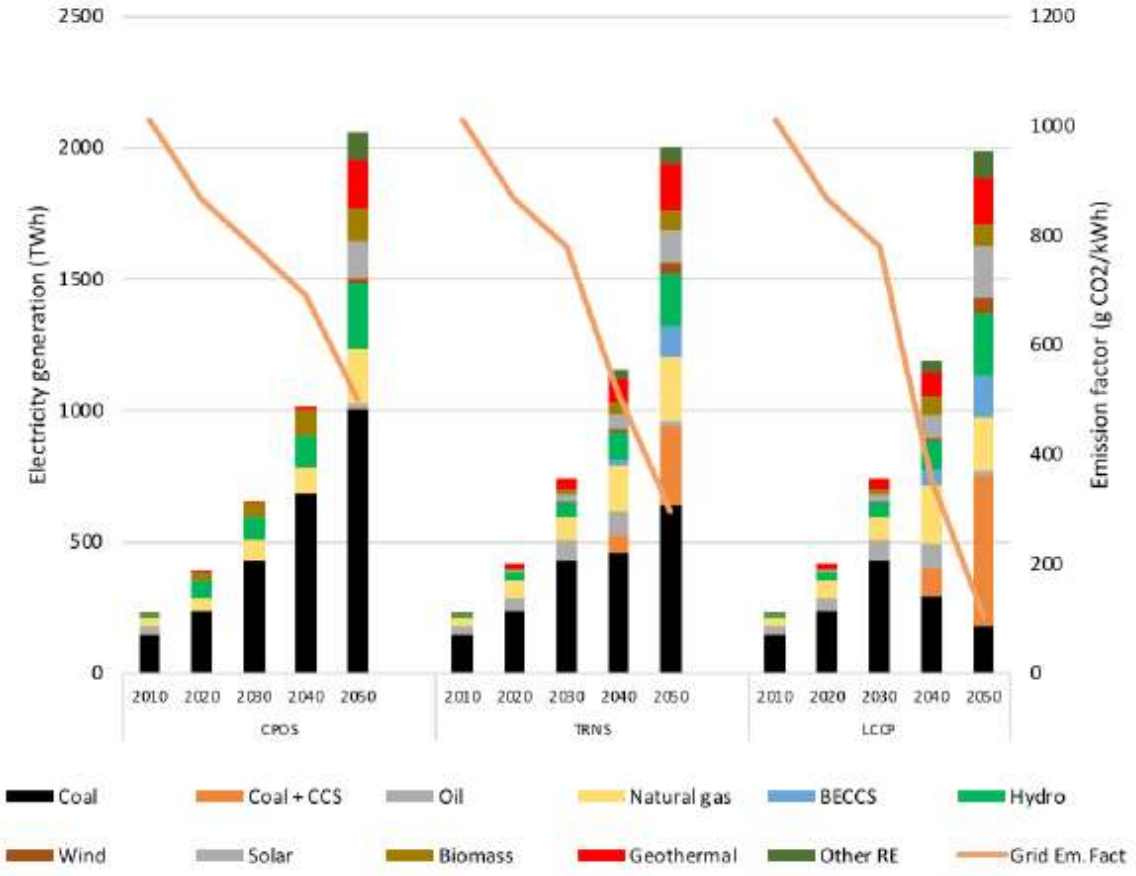
In July 2021, the Indonesian government announced the Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050) and Indonesia's revised Nationally Determined Contribution (NDC) which is the country's emissions reduction goal to be submitted to the UNFCCC (United Nations Framework Convention on Climate Change) secretariat under the Paris Agreement. In the revised NDC, the government presented its goal of carbon neutrality which entails reducing greenhouse gas (GHG) emissions to zero in real terms by 2060 at the latest, 10 years sooner than the original deadline of 2070. The GHG emissions by scenario and sector up to 2030 are given in Table 1. Compared to the Business as Usual (BaU) case without particular countermeasures, the reduction goals are 834 million tons (29% less than BaU) without international assistance (CM1) and 1,185 million tons (41% less than BaU) with international support (CM2), respectively, indicating that international support is indispensable to achieve the long-term goal.

Table 1. GHG emissions by scenario and sector up to 2030

Sector	2010 (record)		2030 forecast			Emissions reduction	
	Million ton-CO2	Rate %	Million ton-CO2			Million ton-CO2	
			BaU	CM1	CM2	CM1	CM2
Energy	453	34.0%	1,669	1355	1223	314	446
Waste	88	6.6%	296	285	256	11	40
Industrial process	36	2.7%	69.6	67	66	3	3.25
Agriculture	111	8.3%	119.66	110	116	9	4
Forest and other land use	647	48.5%	714	217	22	497	692
Total	1,334	100.0%	2,869	2034	1683	834	1,185

(Note) BaU: Compared to the Business as Usual, CM1: without international assistance, CM2: with international support
(Source) Prepared based on the revised NDC of the Republic of Indonesia (2022)

LTS-LCCR2050 states the need to increase the renewable energy ratio in the energy mix by propelling drastic energy transition, improve energy efficiency and substantially reduce coal consumption after 2030. Technologically, the utilization of Carbon dioxide Capture and Storage (CCU), Carbon dioxide Capture, Utilization or Storage (CCUS) and Bioenergy with Carbon Capture and Storage (BECCS) is envisioned. However, power generated with fossil fuels is expected to increase by approx. 40% in a 10-year period, and although its ratio to the total power generation will decrease, it will still be high at around 75% in 2030.



（Note）CPOS: Current Policy Scenario, TRNS: Transition Scenario, LCCP: Low Carbon Scenario Compatible with Paris Agreement Target）
(Source）LTS-LCCR2050 Fig.16
Figure 1 Forecasted power generation composition and grid emission factor in each scenario

2-1-2 Electricity Policy

(1) Policy, system and direction for electric power development

The National Energy Policy (Kebijakan Energi Nasional: KEN) established in 2014 sets out the outline of energy policy up to 2050 as reduction of fossil fuel dependency, promotion of renewable energy dissemination and energy conservation. In 2017, the Grand National Energy Plan 2015-2050 (RUEN) was established, describing specific measures to achieve the goals set forth in the energy policy above.

The Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for Power Supply (PR 112/2022) mandates MEMR to prepare a roadmap that will propel the early elimination of coal-fired power plants. These laws and regulations ban the new development of coal-fired power plants, except for those already included in the Electricity Supply Business Plan (Rencana Usaha Penyediaan Tenaga Listrik: RUPTL) and plants that meet certain criteria. Also, it is stipulated that when PLN prepares RUPTL, it must consider renewable energy development based on the National General Electricity Plan (Rencana Umum Ketenagalistrikan Nasional: RUKN), which at the time of preparing this report means RUPTL 2021-2030.

According to RUPTL 2021-2030, the power generation capacity based on fossil fuels accounts for 87.4% and

that using renewable energy makes up 12.6% of the 2020 total generation capacity. In the 2030 plan, the ratio of the fossil fuel-based capacity is 71.6% and renewable energy-based capacity is 28.4% of the total generation capacity. However, with a drastic demand increase forecasted for the future, the total power generation capacity is expected to rise from 63,336MW in 2020 to 99,208MW in 2030.

In the plan, the coal- and gas-based power generation capacity is to go up from 55,356MW in 2020 to 71,033MW in 2030. Although the ratio of fossil fuel-based power to the total power generation will be smaller in a 10-year period, the actual capacity will be greater and, as a result, GHG emissions will increase. As described in LTS-LCCR2050, the utilization of CCU, CCUS and BECCS is envisioned as the countermeasure. However, there are technological issues facing these techniques at this time; thus, other measures are listed including biomass mixed-combustion, use of waste fuel and hydrogen utilization.

Based on PR 112/2022 and the Minister of Energy and Mineral Resources Regulation No. 50 of 2017 on the Utilization of Renewable Energy Resources for the Production of Electricity as last amended by the Minister of Energy and Mineral Resources Regulation No. 53 of 2018 and the Minister of Energy and Mineral Resources Regulation No. 4 of 2020 (MEMRReg.50/2017), PLN is required to purchase renewable energy (details are given in Chapter 3).

Also, the Minister of Energy and Mineral Resources Regulation No. 39 of 2017 on Utilization of Renewable Energy and New Energy Physical Activities as amended by Minister of Energy and Mineral Resources Regulation No. 12 of 2018 on Amendment of Minister of Energy and Mineral Resources Regulation No. 39 of 2017 on Utilization of Renewable Energy and New Energy Physical Activities (MEMR Reg. 39/2017) stipulates renewable energy procurement by regional governments and other matters. The regional governments are required to procure electricity directly or indirectly from new energy and renewable energy sources, as well as to promote energy conservation.

(2) **Budget and financial resources**

Budgeting for power generation business is generally left to state-run power company PT PLN (hereinafter "PLN") and IPPs (Independent Power Producers) that carry out the business. PLN's income consists of electricity sales income and government subsidy, while expenditures include costs for fuel for power generation, operation and maintenance, labor and amortization, and payment to IPP for purchased electricity. IPPs invest in the construction and operation, and recover such investments by selling electricity to PLN. The electricity sale price is set by MEMR and subject to approval of the parliament.

The costs for the construction of power plants as well as the construction and maintenance of transmission/distribution grids are covered by public funds such as bilateral aid funds including ODA through the Indonesian government, multilateral aid funds, and the funds of the Indonesian government and PLN. However, public funds are not enough, and private funds are also utilized through IPP businesses.

The government subsidy pays for deficits such as power generation cost not covered by PLN's tariff income. The government subsidy in the early 2000s were 3 – 4 trillion IDR., but went up due to higher costs of fuel for

power generation caused by the rise in oil price. The 2021 subsidy was 18 trillion IDR.[13] Efforts are being made to lower the subsidy and ease financial burden by revising the electricity tariff in stages.

(3) Promotion of investments and private businesses

Power plants and other facilities need to be built to keep up with the strong growth in electricity demand. However, as explained above, public funds can only go so far in covering the necessary cost, and as a result, efforts are being made to attract private funds in power generation business. As of 2021, about 27% of electricity is supplied by IPPs.

Financial and non-financial incentives are offered to IPPs to develop power plants that utilize renewable energy. The preferential treatments under the Presidential Regulation No. 112 of 2022 on the Acceleration of the Development of Renewable Energy for the Supply of Electrical Power (PR 112/2022) are listed below[14] (details of such treatments are not defined in the said presidential regulation).

a. Corporate tax reduction
b. Import tariff reduction
c. Real property tax reduction
d. Support for geothermal power development
e. Provision of financial support and/or security through a government-appointed state-run enterprise (PLN)

Also, the presidential regulation on foreign investment restrictions was revised in 2021 and restrictions in many fields including renewable energy were greatly relaxed in Indonesia (Presidential Regulation No. 10 of 2021 on Investment Business Fields as last amended by Presidential Regulation No. 49 of 2021: PR 10/2021)). In the new presidential regulation, 100% foreign investments are allowed in almost all renewable energy-based power generation and transmission/distribution businesses, except for power generation of less than 1MW.

Non-financial incentives are offered by the central and regional governments in accordance with the current laws and regulations,[15] and when a renewable energy-based power plant is developed, Minister of Finance, heads of ministries and agencies and regional governments must offer support based on the respective authorities.

(4) System and policy for hybrid power generation

Of renewable power source development planned in RUPTL, hydroelectric power accounts for about 50% followed by solar (about 22%), and the rest is comprised of geothermal, wind, biomass and "EBT-based power plant." EBT-based power plants are base load power plants that are planned to replace coal-fired thermal power plants and expected to serve the base load together with gas-fired thermal power.

One of the important points of the latest RUPTL is a plan for biomass mixed-combustion power generation. Coal-fired power plants that can be used for mixed combustion (approx. 19GW) were identified. According to

[13] PLN Statistical Report 2021
[14] Based on Article 22 (2), PR 112/2022
[15] Based on Article 22 (3), PR 112/2022

the trial calculation, such endeavor will require 2.7GW from renewable energy and up to 14 million tons/year of biomass fuels. To realize this plan, the biomass supply must be secured and stable biomass price ensured, for which PLN is seeking the government's support in terms and regulations and policy.

Regarding the procurement mechanism and electricity purchase price for renewable energy-based power generation projects, PR 112/2022 has set the latest rules. With this, the electricity purchase price can be increased based on the power plant site, by multiplying the base rate which differs based on the type of renewable power source, by the location factor (F factor). The F factor is set higher for islands and remote areas to take into account the procurement and transport costs and business risk borne by the power producer. The base rate for the single body battery is set, but not for hybrid power sources (multiple types of power sources with battery/BESS) as in this demonstration.

(5) **Move toward total elimination of diesel power generation**

The Minister of Energy and Mineral Resources Decree No. 188 of 2021 MEMR Degree. 188/2021) mandates the diesel power plants to be converted to use renewable energy in stages. First, diesel power plants with a maximum capacity of 250MW that are in multiple locations in Indonesia will be converted to utilize renewable energy. In the second stage, the remaining diesel power plants equivalent to approx. 338MW are to be converted to renewable energy-based power plants that utilize the optimal and economical natural resource of the respective areas[16].

Additionally, PLN has planned three de-dieselization programs for diesel power plants in 2,130 location totaling 2.37GW; namely, (1) conversion to renewable energy-based power plants with a capacity of 500MW, (2) conversion of the plants equivalent to 598MW to gas-fired power plants (gasification), and (3) elimination of diesel power plants equivalent to 1,070MW by expanding isolated transmission grids to form a wide-area transmission grid. The rest of the diesel power plants totaling 203MW are to be used as backup in case of power outage.[17] There are six diesel power plants with de-dieselization potential in North Kalimantan Province[18].

(6) Measures toward smart grid and distributed power sources

The future is likely to see accelerated moves to introduce renewable energy into micro grids on isolated islands and remote areas, and to lower the ratio of internal-combustion power generation such as diesel power generation in stages. In such cases, it will be critical to establish a mechanism that can manage existing power plants and renewable energy-based power plants in a unified manner toward coordinated operation. In the bidding for de-dieselization that PLN held for Selayar Island, South Sulawesi Province and other locations in 2022, this function was included as a bidding condition for the first time.

[16] MEMR news briefing on March 23, 2022. No.121.Pers/04/SJI/2022
[17] MEMR news briefing on March 23, 2022. No.121.Pers/04/SJI/2022
[18] Minister of Energy and Mineral Resources Degree 188/2021

2-2 Electricity sector organizations

2-2-1 Administrative organizations

Indonesia's electricity business is conducted in accordance with the Electricity Law (No. 30/2009) (Undang-undang tentang Ketenagalistrikan: UU Nomor 30 Tahum 2009) and enforcement regulations for such business issued by the government, including the "Government Regulation No. 5 of 2021 on Risk-Based Business Licensing (GR 5/2021)" and "Government Regulation No. 25 of 2021 on The Organization of The Energy and Mineral Resources Sector (GR 25/2021)."

2-2-2 Electric power provider

PLN, a state-owned enterprise wholly funded by the Indonesian government, is responsible for the electric power supply for the entire nation. PLN generates, transmits and distributes electricity based on the Law on State-Owned Enterprises 19/2003 and Electricity Law (No. 30/2009) and under the supervision of MEMR PLN's annual budget, long-term investment plan and financing plan are subject to approval of the Ministry of State-Owned Enterprises, and Komisaris (similar Commissioner) and directors are appointed by the ministry. The domestic electricity retail price must be approved by the government and is kept to the level below PLN's production cost. To address this issue, the Law on State-Owned Enterprises mandates the government to make up for the difference between PLN's production cost and electricity retail price. As a result, such difference plus a certain margin are included in the national budget each year, and paid to PLN. PLN's share in the power generation sector of Indonesia is 73% as of the end of June 2021 (IPPs account for the rest: 27%), and the company has a monopoly on the transmission/distribution sector.

2-2-3 Role of private companies in the electricity sector

Public funds are not enough to cover the cost of building power plants and other facilities that are needed to meet the strong growth in Indonesia's electricity demand, and private funds are encouraged to invest in the power generation business. As of 2021, approx. 27% of electricity is supplied by IPPs. Since PLN's own funds will be insufficient to pay for the development of power sources that will further expand in the future, efforts are made to attract private funds through the introduction of the Feed-In Tariff (hereinafter "FIT") for the development of renewable energy-based power sources (details of FIT are given in Chapter 3).

The business activities of Indonesian power producers are restricted by the Omnibus Law that came into effect in 2020 and partially revised in December 2022. The authority over the business license in the power generation sector is divided based on the business entity and scale. The details are given in the table below:

Table 2. Risk-based business licensing in the power generation sector

Business field			Risk			Required license	Days to approval from application	Expiration date	Government with authority	
			Risk parameter		Risk level					
KBLI	Business name	Activity content	Business scale	Land area					Parameter	Central/Province/Regency/City
35111	Power generation	All	All	NA	High	NIB License Standard certificate	5 days	Expiration date of the electricity supply business license is based on the contract, electricity sales transaction or power purchase agreement. New business license and business extension license included. Expiration date of the electricity supply business license, whether for new or extended business, is based on PPA. Expiration date of the business license can be extended by up to 30 yrs.	Business by state-owned enterprise (BUMN) - Electricity supply business integrated with local business. Integrated electricity supply business with a business domain - Facility installed across provinces, - Electricity sales business across countries and/or, - Electricity sales, and/or grid rental to those with electricity supply business license, planned by the central government for public interest	Minister
		All	All	NA	High	License Standard certificate	5 days	Expiration date of the electricity supply business license is based on the contract, electricity sales transaction or PPA. New business license and business extension license included. Expiration date of the electricity supply business license, whether for new or extended business, is based on PPA.	- Local businesses excluding power generation business. Business domain excluding power generation business, - Facilities installed within a province and, - Electricity sales and/or grid rental to those with electricity supply business license, planned by the central government for public interest	Governor

(Source) PR 05/2021

2 -3 Current electricity condition in Kalimantan Island

2-3-1 Current electricity condition of Kalimantan Island

(1) Electricity development plan in Kalimantan Island

RUPTL states that it is necessary to develop transmission grids in advance with thorough consideration of the areas' guideline, in order to connect renewable energy-based plants to the grids. The connection guideline applied to Kalimantan Island is included in Appendix 4 of the Minister of Energy and Mineral Resources Regulation No. 20 of 2020 on the Electrical Power System Network Rules (Grid Code) (MEMR Reg. 20/2020)." This guideline offers a set of rules, requirements and standards that serve to ensure safety, reliability and efficiency of the Kalimantan electricity system network, with an aim to meet the increasing demand for electricity supply. According to the guideline, IPPs operating solar or biomass power plants can supply electricity to PLN's transmission grids based on the mutually-beneficial mechanism (B to B)[19].

For North Kalimantan, the regional electricity general plan applicable until 2037 is regulated under the "North Kalimantan Governor Regulation No. 43 of 2018 on General Plan for the Regional Electricity of North Kalimantan Province (North Kalimantan Governor Reg.43/2018)." The said regulation allows the general electricity plan to be revised and updated periodically every three years or any time if the following events occur:

a. Situation surrounding electricity in the region changes fundamentally,
b. Strategic environment changes, such as the change in the indices for the electricity plan on a national, regional or international level.

Revisions to the general electricity plan will be decided by the governor after discussion with the Regional House of Representatives of North Kalimantan[20].

(2) Current electricity condition of Kalimantan Island

The 2021 electricity consumption (peak load) and capacity of PLN's Kalimantan units (UIW＝Regional Main Unit, and UIKL＝ Generation and Transmission Main Unit) were 3,157MW and 74.65MW, respectively. Hardly any renewable energy has been introduced in the area and thermal power plants (coal, gas and diesel) serve as the main power sources (see the Table 3).

[19] Included in MEMR Reg.50/2017
[20] Article 6 (2), North Kalimantan Regulation, 43/2018

Table 3. PLN's annual power generation in Kalimantan (2021)

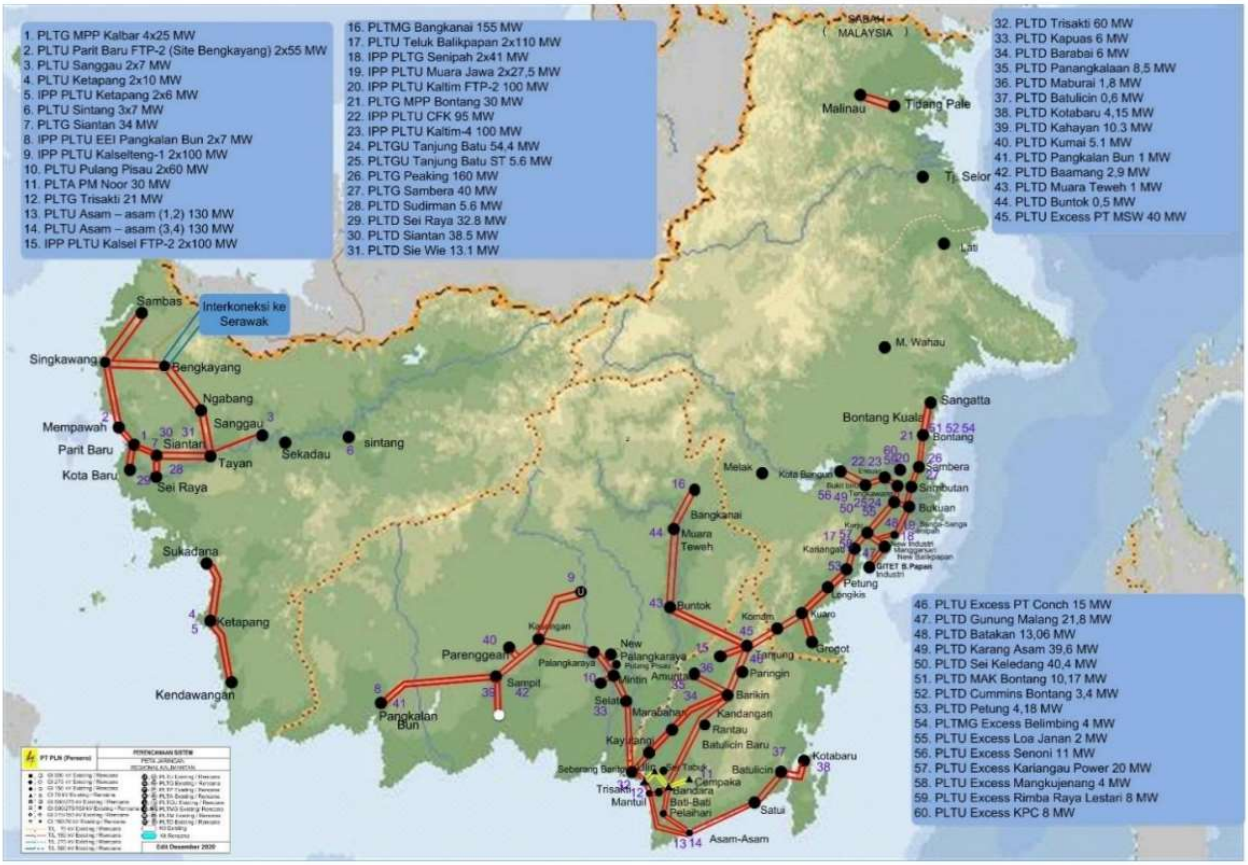
PLN Operational Unit/ Province	Hydro	Mini Hydro	Steam	Gas Turbine	Combined Cycle	Diesel	Gas Engine	Solar	Total (GWh)
UIW Est Kalimantan and North						36.37		0.02	**36.39**
UIW West Kalimantan		1.67				101.44			**133.11**
UIW S and C Kalimantan						68.82			**68.82**
UIKL Kalimantan	189.97		3,804.93	278.98	86.16	567.89	998.87	0.13	**5,926.93**
Total	**189.97**	**1.67**	**3,804.93**	**278.98**	**86.16**	**774.52**	**998.87**	**0.15**	**6,165.25**
%	**3%**	**0%**	**62%**	**5%**	**1%**	**13%**	**16%**	**0%**	**100%**

(Note) UIW: PLN Kalimantan Regional Main Unit, UIKL Kalimantan: PLN Kalimantan Generation and Transmission Main Unit. (Section names at the time of the survey (Oct. 2022))
(Source) PLN Statistical Report 2021

RUPTL describes a plan for a 2 to 10MW-class gas engine power plant for Nunukan Island. However, at the time of the site survey in September 2022, the study team visited the planned construction site and confirmed that no progress was being made with the plan (see the figure below).

(Note) Piling is partially done on what appeared to be soft ground. Materials for gas power generation seem to be kept under the roof seen in the center of the photo.
(Source) Photographed by Survey team
Figure 2 Planned site for PLN's gas engine power plant construction (Nunukan Island)

Since RUPTL is a governmental plan, PLN assumed to build the gas engine power plant as of October 2022. There is also a plan to construct a 150,000V HV main line in North Kalimantan Province, slated for completion in 2024. However, the line has not reached Tarakan City far south.



(Source) PLN Head Office
Figure 3 Electric system diagram of Kalimantan

2-3-2 Renewable energy of Kalimantan Island

As explained above, there are hardly any power plants that utilize renewable energy in Kalimantan at this point. However, great potential for hydroelectric power generation is reported for the basins of Mahakam River in East Kalimantan and Kajan River in North Kalimantan[21]. There is a plan to move the capital functions to East Kalimantan Province (Chapter 1). To meet the electricity demand of the new capital, the work had commenced on March 1, 2023 to build Mentarang Induk Hydropower Plant, which will be one of the largest in Southeast Asia with 9,000MW, in Malinau Regency, North Kalimantan Province.

A biomass power plant and biogas power plant on Kalimantan Island have been registered with the Clean Development Mechanism (CDM) under UNFCCC. There is also a biomass power plant in West Kalimantan, which is the first such plant operated by PLN in Kalimantan in 2018 (see

[21]Announced by F.X. Sutijastoto, Director General of NREEC, EDMS in February 2020. (https://baketrans.dephub.go.id/file/286)

Table 4). Also, multiple mini hydroelectric plants have been built in villages on the island including those in North Kalimantan Province, with the support of international organizations such as Global Environment Facility (GEF).[22]

[22] https://sgp.undp.org/spacial-itemid-projects-landing-page/spacial-itemid-project-search-results/spacial-itemid-project-detailpage.html?view=projectdetail&id=15593

Table 4. Biomass/biogas power plants (PPs) on Kalimantan Island

Type	Capacity	Operation	Location	Operator	Outline
Biogas PP (POME: biogas from palm effluent)	2.1MW	Since 2014	Kutai Kartanegara regency, East Kalimantan	PT Austindo Aufwind New Energy	Registered with CDM. Credits have been issued.
Biomass PP (wood chip)[23]	7.3MW	Since 2012	Kotawaringin regency, Central Kalimantan	PT Kalimantan Sawit Abadi	Registered with CDM. No credit has been issued.
Biomass PP (palm oil waste and agricultural waste such as corn)[24]	7.4MW	Since 2018	Wajok Hulu, Mempawah Regency, West Kalimantan	PLN	First biomass PP that PLN started operation in Kalimantan

(Source) Global Green Growth Institute (2015)[23]

2-3-3 Significance of the project for Kalimantan Island

Kalimantan Island is an area faced with typical issues related to renewable energy utilization in the island areas of Indonesia. The main points of the issues are (1) power supply is tight and planned outages became normal occurrences, (2) although the area is low in priority in PLN's budget allocation and has high expectation for participation by the private sector (IPPs), the business environment remains unimproved, (3) even though the shift from fossil fuel (diesel) to renewable energy has begun, power plants are operated in a limited manner due to the grid vulnerability and O&M system not well established. Since the demonstration of the KYUDENKO EMS is ongoing on Sumba Island to address these issues, the Indonesian government (MEMR and PLN) has shown a high interest in the technology. The needs are clearly there, as EMS can stabilize the renewable power output so that vulnerable distribution grids (micro grids) in the area can allow the connection of renewable power plants.

Kalimantan Island has the largest area in Indonesia and is the site of planned capital relocation. The renewable energy introduction there is inevitable and the island is a suitable site for the project that aims to use renewable energy to serve the base load. Also, the Indonesian government does not think it is possible to eliminate the existing internal-combustion power generation all at once, and instead, seeks the coexistence of such power generation method with renewable energy-based power generation for a certain period of time. Considering above, it can be said that KYUDENKO EMS is superior in that it is capable of integrated, coordinated control of new and old power generation facilities. If the project is proven successful in North Kalimantan while the construction of the new capital is ongoing in neighboring East Kalimantan, the project can showcase a fine example toward dissemination of renewable energy in Indonesia.

[23] Global Green Growth Institute (2015) "Renewable Energy - A Green Growth Assessment in Kalimantan"
[24] https://www.thejakartapost.com/news/2018/04/25/pln-operates-first-biomass-power-plant.html

Chapter 3 Renewable Energy of Indonesia

3-1 Promotion of renewable energy utilization

3-1-1 Policy concerning renewable energy utilization

September 2022, the Indonesian President enacted the Presidential Regulation No. 122 of 2022 on the Acceleration of Renewable Energy Development for Electric Power Monitoring (PR 112/2022). PR 112/2022 mandates MEMR to prepare a roadmap that will propel the early elimination of coal-fired power plants. It also advises that when preparing RUPTL, PLN should examine renewable energy development according to the target energy mix which is based on the National General Electricity Plan (RUKN), and consider the electricity supply and demand balance and the economic value of the renewable energy-based plants as the guideline. At the time of preparing this report, the RUPTL for 2021-2030 that was established by the MEMR Decree No.188.K/HK.02/MEM.L/2021 is the latest.

Biomass power generation is to replace diesel power generation, which is one of the strategic initiatives incorporated in the RUPTL 2021-2030 to raise the target ratio of renewable energy. PLN plans to develop solar power plants to meet the renewable energy goal. PLN is also required to purchase electricity from renewable energy-based power plants. When purchasing electricity from renewable energy power plants, it is done using the Direct Selection and Direct Appointment mechanisms (see Chapter 4).

Renewable energy includes (i) geothermal, (ii) hydroelectric, (iii) solar, (iv) wind, (v) biogas, (vi) biomass, (vii) ocean (wave, OTEC, etc.) and (viii) biofuel. According to GR 79/2014, the optimal primary energy mix is to be achieved as follows:

a. Raise the ratio of new and renewable energy to 23% or more by 2025, and to 31% or more by 2050 (as long as the economic value holds)
b. Reduce the ratio of fossil fuel to 25% or less by 2025, and to 20% or less by 2050
c. Reduce the ratio of coal by 30% by 2025, and at least by 25% by 2050
d. Reduce the ratio of gas by 22% by 2025, and at least by 24% by 2050

MEMR Reg. 39/2017 also stipulates that the government (ministries and agencies) must procure new and renewable energy directly or indirectly, and promote energy conservation.

When an IPP develops a power plant that utilizes renewable energy, it will receive financial and non-financial incentives. The financial preferential treatments are listed below:[25]

a. Corporate tax reduction, etc.
b. Import tariff reduction
c. Property tax reduction
d. Support for geothermal power development
e. Provision of financial support and/or security through a government-appointed SOE

[25]Article 22 (2), PR 112/2022

When a renewable energy-based power plant is developed, Minister of MEMR, the heads of ministries and agencies and regional governments must offer support based on their respective authorities.

Table 5. Stakeholders associated with incentives

No.	Stakeholder	Support
1.	Minister of Energy and Mineral Resources	Preparation of renewable energy-based plant development plan
2.	Ministry of Finance (MOF)	Provision of financial incentives
3.	Ministry of Agrarian Affairs and Spatial Planning/National Land Agency: MOAASP/ NLA)	Prioritization of the development of the renewable energy-based power plant
4.	Regional government	Provision of non-financial incentives

(Source) PR 112/2022

3-2 Current status of power purchase and sale prices (FIT)

PR 122/2022 and MEMR Reg. 50/2017 mandate PLN to purchase electricity from power plants that utilize renewable energy, from the standpoint of sustainable electric power supply.

MEMR Reg. 50/2017 regulates electric power purchase, and PLN is required to practice due diligence regarding the IPP's technological and financial abilities. Such due diligence can be practiced through a procurement agent appointed by PLN.[26] When purchasing electricity, the electricity sales price must be approved by the Minister of MEMR[27], and such approval must be obtained within 5 business days from the completion of the process.[28]

Following documents must be attached to the application for approval of electricity purchase price:[29]

a. Developer appointment letter
b. Draft of the PPA
c. Authorization of PLN's BOD
d. Information on the developer's shares held, including the final beneficiaries, and management
e. Cost structure of the purchase price and financial model

[26] Article 13 of MEMR Reg.50/2017
[27] Article 14 of MEMR Reg.50/2017
[28] Article 14 (2) of MEMR Reg.50/2017
[29] Article 14 (3) of MEMR Reg.50/2017

3-2-1 Current condition of tariff

PR 112/2022 lists the standard price for electricity purchase for solar, hydroelectric, geothermal, wind, biomass, and biomass power generation. The standard price is set by power source, power generation capacity, and region (see the table below). The actual purchase price is set through individual negotiations with PLN or tender, using the standard price as the upper limit. Thus, the presidential regulation does not guarantee the purchase price.

Table 6. Upper limit to electricity purchase price based on PR 112/2022 (price: cent USD/kWh)

Power generation capacity		1MW	1-3MW	3-5MW	5-10MW
Solar (w/o battery/BESS)	1st to 10th year	11.47 x F	9.94 x F	8.77 x F	8.26 x F
	11th -30th year	6.88	5.97	5.26	4.96
Biomass	1st -10th year	11.55 x F	10.73 x F	10.20 x F	9.86 x F
	11th -25th year	9.24	8.59	8.16	7.89

(Note) F (regional factor): 1.10 for Kalimantan, 1.15 for islands in Kalimantan
(Source) PR 112/2022

For solar power plants equipped with battery or other power storage facilities (hereinafter BESS (Battery Energy Storage System)), the BESS price is decided based on the standard price which is up to 60% of the power purchase price. If the BESS price is higher than 60% of the power purchase price, the price must be approved by the minister.[30]

3-2-2 Application of Tariff to hybrid power plants

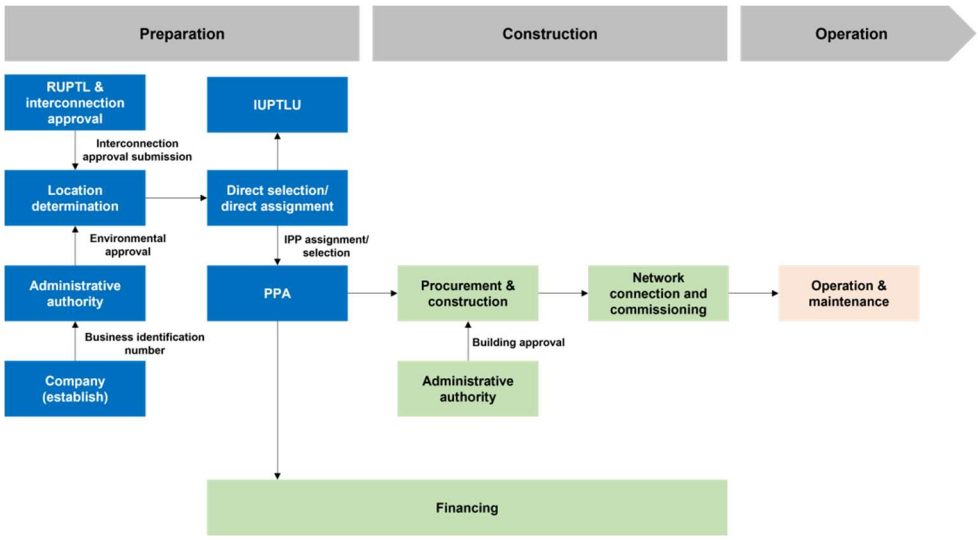
Thanks to the Presidential Regulation 112/2022 above, the tariff for solar power generation combined with BESS will be newly applied, in addition to the conventional electricity sales unit price for solar power generation. However, the unit price for electricity sales for combined power generation methods, such as "renewable energy power plant introduction for base load" aimed for in this project, has not be established.

As the ratio of renewable-energy power generation increases in the region in the future, the introduction of hybrid power generation, which combines power sources capable of continuous and stable power generation (e.g., hydroelectric and biomass) and power facilities with fluctuating output (e.g., solar and wind power), will certainly be considered. However, under the current system, the purchase price differs based on the type of power generation, and it is extremely hard to set the purchase price when electricity is produced with multiple generation methods and transmitted together. The proposing corporation has raised this issue during the meeting of the Resources and Energy Agency's renewable energy utilization working group held in Jakarta in December 2022 and the talk with the MEMR's Directorate General of Renewable Energy and Energy Conservation. The issue was also presented during the Japan-Indonesia Energy Forum (government-to-government dialogue) held in Tokyo in March 2023. MEMR responded that it will start the examination to determine countermeasures for the issue.

[30] Article 10, PR 122/2022

3-3 Systems for renewable energy

Before organizing the systems for renewable-energy business implementation in Indonesia, the process that the IPP goes through when developing a power generation business is shown below:



(Source) KYUDENKO
Figure 4 Process of power generation business development by IPP

The development process and necessary licenses are the same regardless of the power source type. First, the business must be incorporated in RUPTL while the environmental impact assessment is completed and business site is decided. Next, the IPP takes part in the tender, and once selected, obtains IUPTLU and concludes PPA with PLN. Then, the IPP obtains the construction rights and starts the construction. The acquisition of construction rights is later explained in 5.3 “Process for determining the project site (acquisition of right of building)”

One notable point regarding the Indonesian systems for renewable energy is the FIT and tender system. In Indonesia, PR 112/2022 was enacted in 2022 to promote renewable energy introduction, and defines the purchase price and tender system for renewable energy-based power generation. The purchase price and tender method are set by type of renewable energy sources. The purchase price is explained in 3.2 “FIT” above and the tender system later in Chapter 4 (Tender system).

3-3-1 Systems for solar power generation

The development processes and licenses, which are required in the power generation business by IPPs as discussed earlier in this chapter, are applicable to a solar power generation business. Other necessary licenses are not confirmed at this time.

3-3-2 Systems for biomass power generation

The development processes and licenses, which are required in the power generation business by IPPs as discussed earlier in this chapter, are applicable to a biomass power generation business. The point of note is that when concluding a PPA, it is necessary to prove that there is enough biomass material supply to continue

operation for the duration of the PPA, by showing the material supply contract between the IPP and biomass material supplier, as explained later in 7.2.1 “Indonesian national roles and regulations relating to biomass fuel.”

3-3-3 System for hybrid power generation

PR 112/2022 defines the power purchase price and tender method by power generation type. Since the power generation permit is issued and PPA concluded for each of the power generation types, it will be necessary to discuss and make propositions regarding our future task: the creation of systems for hybrid power generation.

Chapter 4 Tender System

4-1 Research of relevant laws and regulations and their enforcement situation

4-1-1 Compatibility with RUPTL

Before a tender is held for a business, the business must be approved by PLN and incorporated into RUPTL. When drawing RUPTL, PLN does so by referring to the development plans of the regional governments. For North Kalimantan, the Regional General Electricity Plan for the period up to 2037 that was prepared in accordance with North Kalimantan Governor Reg.43/2018 will be used as a reference.

4-1-2 Tender method

There are two tender methods; namely, the Direct Selection and Direct Appointment. The method is decided based on the type of power generation.

Table 7. Tender method comparison

	Direct Selection	Direct Appointment
Condition	Defined by PR 112/2022	
	a. PLTA; b. SPP or PLTB (applied regardless of the existence of battery or BESS) c. BPP or PLTBg d. PLTA (used as a peaker), PLT BBN, or tidal power plant	a. PLTA that utilizes a reservoir, dam or irrigation canal owned by the government b. PLTP by those who holds IPB, geothermal permit, cooperative management contract for geothermal development, or geothermal development permit c. Expansion of PLTP, PLTA, SPP, PLTB, BPP, or PLTBg d. Excess electricity from PLTP, PLTA, BPP or PLTBg
	MEMR Reg.50/2017	
	-	a. In cases of insufficient regional grid power or power-supply emergency, b. Purchase of excess electricity c. Expansion at already operating power plant d. Only one business in the concerned area

(Source) PR 112/2022 and MEMR Reg.50/2017

4-2 Verification of tender eligibility

4-2-1 Conditions of tender eligibility

Requirements below must be met before submitting a bid:

a. Establishment of SPC that carries out power generation business
b. Approval of environmental impact assessment
c. Approval of RUPTL

Additionally, in the case of the Direct Selection, PLN presents the candidates and creates a list of businesses eligible for the tender. A business must be included in the above list to be eligible for the tender.

4-2-2 Special complementary schemes for the region

No special complementary scheme for tender in North Kalimantan has been confirmed at this time.

4-2-3 Bidding process

See the table below for the process for each tender method.

Table 8. Process based on the tender methods

	Direct Selection	Direct Appointment
Process	Defined by PR 112/2022	
	a. Preselection by PLN *PLN preselects businesses eligible for participation in the tender. The business list is updated every 3 months. b. Proposal submission by the business to PLN c. Proposal evaluation by PLN d. PPA conclusion	a. Proposal submission from the business to PLN b. Proposal evaluation by PLN c. Negotiation of electricity sales price d. PPA conclusion
Timeline	Completion within 180 calendar days	Completion within 90calendar days

(Source) PR 112/2022, MEMR Reg.50/2017

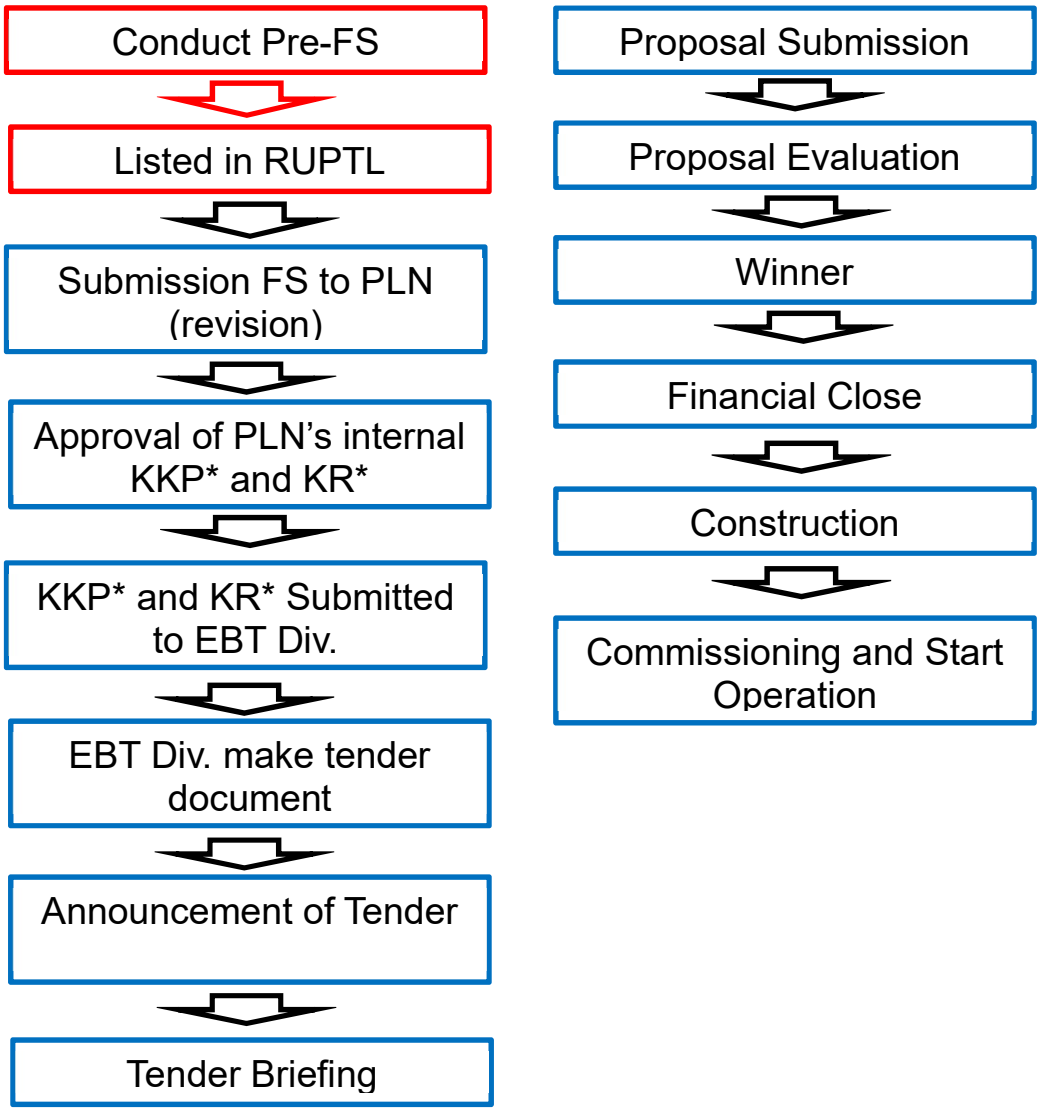
4-3 Inclusion of the technology in the tender requirement document

4-3-1 Discussion of bidding conditions with PLN

The steps in a typical tender for a renewable energy business by an IPP in Indonesia are explained below. In a typical tender, PLN specifies the transmission amount and installed capacity of the project for the tender, and among bidders who meet the conditions, the bidder that submitted the lowest electricity sales price wins the tender. In such cases, the businesses try to keep the facility introduction cost (initial cost) as low as possible,

to earn the maximum operating revenue. The bidder will be potentially lowering its chance of winning the bid when it adds extra value to its technology (EMS function in this project, service life extension through battery utilization in multiple grids, etc.).

Therefore, to ensure that advantages such as those contemplated in this project (stable transmission of renewable energy-based electricity 24 hours a day) are evaluated fairly in the tender, it is important to take a necessary step. It entails encouraging PLN to recognize the merit of such technology, between the time of listing the project in RUPTL and the preparation of the internal report (KKP/KP) by PLN. It is to have those advantages reflected in the report. Then, it will be more likely that conditions that can only be met by such technology are included in the bidding conditions (e.g., 24-hour continuous transmission based on the prescribed installed power generation capacity, keeping the transmission amount as level as possible).



*KKP: Project Feasibility Study
*KR: Risk Study

(Note) The part circled in red is the part to be implemented voluntarily by the project developer. The part circled in blue is the steps required as bidding requirements.
(Source) KYUDENKO
Figure 5 Steps in PLN's typical tender for IPP businesses

4-3-2 Understanding and approval of critical technology by relevant authorities and PLN

The ministry governing renewable energy is the Ministry of Energy and Mineral Resources (MEMR) and the agency in charge is the Directorate General of Renewable Energy and Energy Conservation. They are relatively open to approach from the private sector, and it is certainly possible to explain the technology to the top officials of the division, and to encourage their understanding. However, there are endeavors that are hard for the private sector, such as matching the partner country's policy with the technology, for which KYUDENKO will solicit the support of the Japanese government agencies including JICA and Resources and Energy Agency, while working to disseminate the technology.

Also, PLN is a large organization and its main divisions such as Corporate Planning, Regional Electricity and Renewable Energy are vertically divided. This caused difficulty in securing cooperation of various divisions to promote technology dissemination. However, reorganization took place in the fall of 2022, and the control of the regional businesses was transferred to the group companies such as PT PLN Indonesia Power. As a result, the cooperation among divisions should improve in the future.

Chapter 5 Project Formation

5-1 Project background and necessity

5-1-1 Area's development issues and need for the project

Nunukan Island and Sebatik Island, the target of this study, face typical issues related to renewable energy utilization in Indonesia's island areas. The main points of the issues are (1) power supply is tight and planned outages became normal occurrences, (2) although the islands are low in priority in PLN's budget allocation and have high expectation for participation by the private sector (IPPs), the business environment remains unimproved, (3) even though the shift from fossil fuel (diesel) to renewable energy (solar) has begun, power plants are operated in a limited manner due to grid vulnerability and not-well-established O&M system.

Thanks to the demonstration of the KYUDENKO EMS that is ongoing on Sumba Island to address these issues, MEMR and PLN have shown a high interest in the technology. The needs are clearly there, as EMS can stabilize the renewable power output so that vulnerable distribution grids (micro grids) in the area can allow the interconnection of renewable power plants.

5-1-2 Project outline and basic scope

The goal of the project is to eliminate the electricity supply from "diesel and gas-engine power plants" on "Nunukan and Sebatik Islands" in North Kalimantan Province of the Republic of Indonesia, and to develop infrastructure that will replace almost all such electricity with that based on renewable energy by newly building renewable-energy hybrid power plants. To this end, two plants with a total capacity of 25MW are to be build; specifically, a hybrid power plant with a total capacity of 17MW (solar power 9MW and biomass power 8MW) on Nunukan Island, and a hybrid power plant with a capacity of 8MW (solar power 6MW and biomass power 2MW) on Sebatik Island.

(Source) KYUDENKO

Figure 6 Candidate sites (left): current condition of Nunukan and Sebatik Islands (Malaysian border runs through Sebatik Island), (right): location of Nunukan and Sebatik Islands

During this study, practical research toward commercialization was done on items that will serve as a basis of a shift from diesel power generation to renewable energy-based power generation (solar and biomass),

including land acquisition, biomass fuel procurement, and financing method. Also, matters below were investigated to determine their "benefits" and "compatibility with the needs of the area."

- Feasibility of supplying "100% renewable energy-based" electricity to remote islands with a relatively large population (Nunukan Island: approx. 100,000, Sebatik Island: approx. 80,000)
- Feasibility of "100% local production for local consumption" regarding oil palm-derived materials used at biomass power plants
- Determination of compatibility between the establishment of the first hybrid power plant (solar + biomass) in Indonesia's remote island area, and the electricity policy of the country (at the beginning of the study, "hybrid power generation" was not defined in the electricity sales tariff of Indonesia, and no applicable FIT existed)

5-1-3 Expected project effects

The expected project effects are listed below:

(1) Fossil fuel (natural gas and light oil) consumption can be totally eliminated by transforming the existing gas-engine power plants and existing diesel power plants into renewable power plants
(2) With no fossil fuel consumption, CO_2 emissions reduction and low-carbon can be achieved

Indonesia has launched an electricity supply system reform with an aim to achieve carbon neutrality. The country also seeks a renewable energy dissemination model based on the condition of grids and regions. The purpose of the system featured in this project is to propose and help realize specific measures that will raise the renewable energy ratio in power grids comprised of gas/diesel power generation in remote islands and areas. There are approx. 5,000 inhabited islands in Indonesia, and the system can contribute to raising the renewable energy ratio, and in the final stage, to realizing 100% renewable energy-based power supply in these areas.

5-2 Site selection

5-2-1 Site selection policy

The size of the sites that are needed for hybrid power plant construction on Nunukan Island and Sebatik Island was estimated as 20Ha and 10ha, respectively (see Table 9). The size of the area for biomass fuel storage was calculated based on that of a 4.9MW biomass power plant in Japan which was funded by KYUDENKO (Nanatsujima, Kagoshima City: fuels include palm kernel shell, wood pellet and domestic thinning residue), and the knowledge of PT SANTOMO RESOURCE INDONESIA[31] (hereafter "Santomo") which imports PKS to Japan to be used as biomass fuel.

[31] PT SANTOMO RESOURCE INDONESIA: A business development company group focused on renewable energy with its base of Indonesia. In this survey, Santomo supports in biomass fuel.

The sites that meet the following conditions were researched and selected for both islands:

1. Located on the coast to facilitate the transport of biomass fuel by boat
2. Water depth of 5m or more
3. A jetty can be constructed nearby
4. The sea remains calm throughout the year
5. The ground does not flood with the change of tide or during heavy rain
6. Not included in the regional development plan of the regional government
7. Not located within forests including mangroves
8. Approval of the residents can be obtained
9. Fair land price
10. Water source is available
11. PLN's submarine cable is not far
12. No mountains or trees that affect solar panels (impacting solar radiation)

5-2-2 Progress in site selection

To research the land, an Indonesian expert with ample experience in power plant site acquisition in Indonesia including that for renewable energy plants was hired for the research on Nunukan and Sebatik Islands, (1) from July 31 – August 5, 2022, and (2) January 15 19, 2023.

During the first research, six candidate sites on Nunukan Island and three on Sebatik Island were identified. However, there were too many landowners (10 – 40 or more), and land acquisition was anticipated to be difficult. During the 2nd field survey carried out by KYUDENKO in October 2022, what appeared to be the top candidate was the site planned for PLN's gas-engine plant on Nunukan Island (work was suspended at the time of the survey). However, this construction site had soft ground. Also, when KYUDENKO visited the PLN headquarters (EBT division) during the 2nd field survey, it received a response from the person in charge of renewable energy IPPs that, "the landowner is an IPP. Since a PPA (25 years) has been concluded for the gas-engine power generation business, the PPA will have to be annulled first." This gas-engine power generation business has been included in the latest RUPTL as a "Big Project with a plan to combine multiple power plants," and it will be difficult to change the gas-engine power plant to biomass power plant, according to PLN. Consequently, this site was removed from the candidate list for this power generation project.

(Source) KYUDENKO
Figure 7 Planned site of PLN's gas-engine power plant construction.

5-3 Process for determining the project site (acquisition of right of building)

5-3-1 Legal process for the acquisition of the right of building

In Indonesia, foreign invested-company (Penanaman Modal Asing: PMA) are not allowed land ownership (Hak Millik); therefore, for PMA to conduct an IPP business, PMA will have to obtain land-use rights by acquiring the right of building (Hak Guna Bangunan: HGB) that allows building construction and ownership and is obtainable to PMA, or through land lease contract, etc.

HGB is defined in Law No. 5/1960, GR Reg.18/2021 and ATR/BPN Reg.18/2021. It is granted to Indonesian nationals and corporations including PMAs in Indonesia. HGB is for a maximum of 30 years and can be extended by 20 years and renewed for 30 years after the extension (total of 80 years maximum). Also, the building can be registered, and the land can be mortgaged or transferred. To apply for HGB, the business identification number (nomor induk berusaha: NIB) or company registration certificate (Tanda Daftar Perusahaan: TPD) is required.

When constructing a building, the building permit (Persetujuan Bangunan Gedung: PBG) which proves that the building meets the technical standards is required, in addition to the right of building and land-use rights such as HGB or lease contracts. PBG must be obtained by submitting an application to the regional government, between the time of concluding PPA and start of construction.

5-3-2 Consideration of local partner for the acquisition of the right of building

Two options are possible for it, specifically, (1) the local partner acquires the right of building, and (2) the SPC acquires the right; however, local partner selection and pre-negotiation will be critical in both cases.

5-4 SPC establishment and management

5-4-1 SPC establishment

To establish a SPC (Special Purpose Company), necessary licenses must be obtained and processes followed. Such licenses and processes are determined based on the SPC's ratio of foreign and domestic investment and business activity. As described later in 8.2.1 "Procedure, laws and regulations concerning investment permit," the SPC must obtain a KBLI code based on the standard industrial classification of Indonesian business fields (Klasifikasi Baku Lapangan Usaha Indonesia: KBLI). One of the expected classification codes for SPC is KBL35111 (power generator/generation/supply), which is judged to be a high-risk business according to GR 5/2021, and the SPC will require NIB and business license from the central or regional government to obtain a KBLI code.

Further, the SPC for this project is assumed to be PMA, and attention must be paid to foreign investment regulations. The impact of such regulations is discussed in 8.2.1"Procedure, laws and regulations concerning investment permit" and 8.2.2 "Laws and regulations concerning capital (foreign investment)."

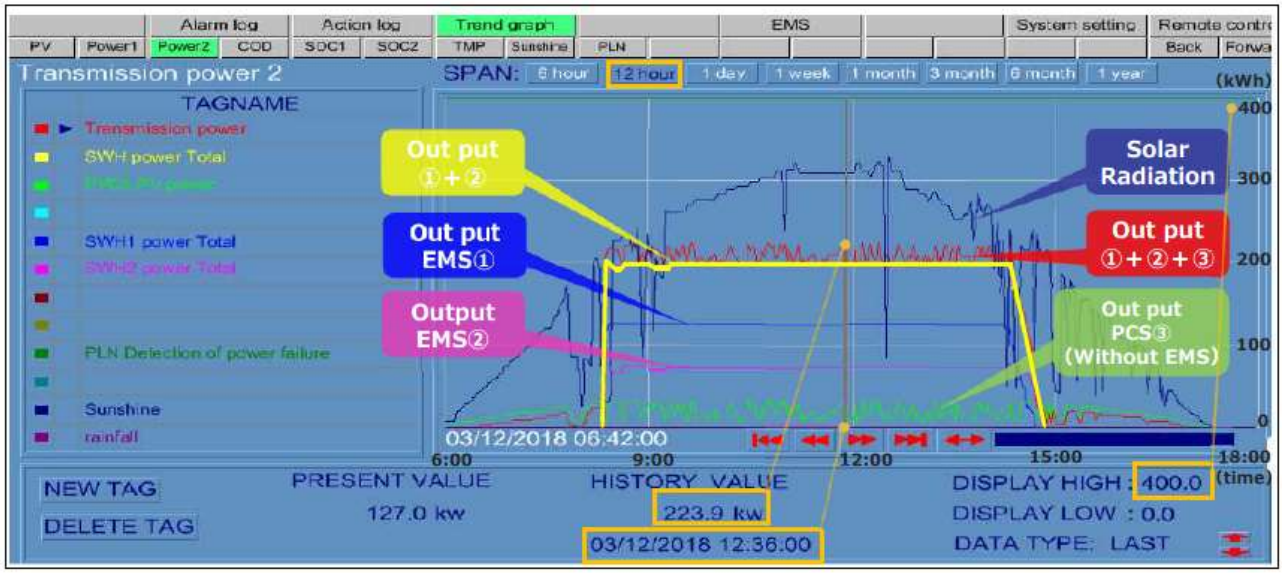
5-4-2 Operation and maintenance (O&M) system

(1) Maintenance plan development

Appropriate inspection and renewal of facilities is indispensable to keep the facilities in sound condition and continue selling electricity over a long period of time. This study revealed that of all the facilities to be introduced, the biomass power facility is the hardest facility to maintain. It will be necessary to create a maintenance system so that daily work can be done locally, including material feeding, ash disposal and impurity cleaning. On the other hand, the solar power facility and BESS can be operated only with annual maintenance. As explained, the frequency of maintenance varies greatly depending on the facility; therefore, the key for smooth operation and maintenance is to prepare an efficient maintenance plan and turn it into reality.

(2) Maintenance cost optimization

The most important thing in optimizing maintenance work on remote islands is to make the best use of the remote monitoring function of the EMS. In other words, in the case of a failure, the maintenance work on site will be greatly reduced by determining the faulty area in advance through remote monitoring. The greatest advantage of the KYUDENKO EMS is the continuous 24-hour transmission of renewable energy, and the remote monitoring is also round-the-clock. However, unlike large power plants which are monitored by the managing staff day and night, the system operates automatically and is managed on the remote monitoring screen (Figure 9). If the screen issues an alarm for an error, the system will shut off automatically and an alarm is sent out to nearby maintenance staff (for this project, on-site local staff are envisioned). However, unmanned biomass plant operation might not be possible; thus, the O&M method will be established in future demonstrations.



(Source) Survey team

Figure 8 EMS monitoring screen of the demonstration facility on Sumba Island

(3) Establishment of maintenance method based on the local system

A system will be created to ensure that moderate and major maintenance work is done by a cooperative firm in Jakarta, in addition to daily maintenance done by the SPC at the site.

Chapter 6 Outline of Hybrid Power Plant

As described in Chapter 5 (5-1-2), the ultimate goal for the hybrid power plants is to cover the electricity demand of Nunukan Island and Sebatik Island by using totally renewable energy-based electricity, without operating the existing internal-combustion power plants under normal demand circumstances. To this end, it is important to create a renewable energy-based power generation system that can transmit electricity with a stable and flexible frequency, to meet the demand that fluctuates throughout the day. The "KYUDENKO EMS" is a system that was developed by the proposing corporation and can control electricity on the renewable energy-based "power generation side" and transmit electricity in a stable waveform.

In this project, a certain amount of required electricity is secured through large-scale solar power generation, which takes advantage of the area's excellent insolation conditions. However, naturally no electricity is produced by solar power plants at night, and power generation drops significantly on bad weather days. To make up for such deficiency, large batteries are installed. However, for the batteries to supply the same amount of electricity at night and on bad weather days, with due consideration for fluctuations in solar power generation, the amount of stored electricity required as buffer becomes extremely large. It will require a great many batteries, and to charge these batteries, the power source (solar panels) must be increased in proportion, which makes the power generation system inefficient in terms of investment.

Thus, it is necessary to have a key power source that can generate electricity reliably regardless of the time of the day for the most part.

6-1 Outline design for solar power generation

6-1-1 Outline design of power generation facilities and related facilities

The area around North Kalimantan Province of Indonesia has the average insolation energy of approx. 4.7kWh/m^2 (NEDO data[32]), and is fortunate in terms of insolation condition compared to Japan's average value (2.5 - 3.0038kWh/m^2, NEDO data32). Electricity is produced from solar power plants during daytime by taking advantage of such condition, which is then stored in the batteries and directly sent to the grid. The EMS will control the process automatically in real-time based on the load (demand side).

In the demonstration stage, an electricity supply system comprised of solar, biomass and BESS will be built on the Nunukan Island side. This is because the Nunukan side functioned as the "parent" among the two islands where power control is concerned. The system is connected to the grid on the Sebatik Island side via submarine cable.

[32] NEDO "Database for Solar Radiation in Asia" (https://www.nedo.go.jp/library/ZZFF_100038.html)

6-1-2 Work plan

As described above, this plan calls for facility introduction in each of the “demonstration” and “business” stages, and two work plans are also needed. Here, the main discussion is on the work plan for the “demonstration” stage. The points to consider when implementing the plan are as follows:

(1) Transport to remote islands

Most facilities and materials will likely be transported from international ports such as Jakarta and Surabaya, whether they are imported or domestically produced. It will be critical to plan the transport so that necessary materials are delivered to the sites in an appropriate manner.

(2) Securing construction equipment

Since the sites are on remote islands, the key point will be whether or not the construction equipment required for plant construction can be secured locally.

(3) Ensuring the quality of civil engineering work

The lead storage batteries to be introduced are extremely heavy and cannot be installed on soft ground. The candidate sites for this project are expected to be near the sea, due to biomass material transport and interconnection with the grid. Boring survey will be needed after deciding on the sites, and the construction period and method will be impacted greatly depending on the geology.

6-2 Outline design for biomass power generation

6-2-1 Outline design of power generation facilities and related facilities

As explained later in Chapter 7, this project aims to achieve “local production for local consumption” for materials used at the power plants. It means avoiding expensive biomass materials for export (e.g., PKS), and instead procuring biomass materials in a reliable manner over a long period of time, which are not effectively utilized in CPO mills, etc. in the regency.

Table 9. Comparison of steam furnace (direct combustion method) and gasification furnace).

Technology	Level	Technical issues	Business issues
Direct combustion (Single-fuel-firing/ Multi-fuel-firing	Commercialization	1. Improving energy efficiency 2. Development of technology suppressing deterioration of power generation efficiency due to Multi-fuel-firing 3. Reduction of pellet/ chip manufacturing cost	1. Stable procurement of fuel 2. Acquisition of sales channel for electricity and heat 3. Attachment to existing heat utilization facilities such as power plant and steelworks, etc
Gasification power generation	Demonstration	1. Reduction of facility cost 2. Tar suppression and recycling	1. Stable procurement of fuel 2. Attachment to existing steelworks or paper mill, etc. 3. The way of utilization of combined electricity and heat

(Source) Ministry of Agriculture, Forestry and Fisheries, Japan

Therefore, in this survey, we investigated suitable gasifier manufacturers and found that there is a limited presence of manufacturers in Japan with a proven track record in burning biomass fuel derived from oil palm. However, we observed that overseas manufacturers (located in India, China, Germany, etc.) have successfully implemented similar fuels in their systems. Nevertheless, given that the biomass boiler is a critical component of this technology and serves as a pivotal aspect of our technical demonstration, it is essential to prioritize a Japanese manufacturer. Consequently, we have decided to pursue collaboration with a Japanese company, which possesses a noteworthy history of burning fuels with significant impurities, including biomass fuel derived from oil palm, in conventional steam furnaces. This partnership will enable us to advance our research and facilitate the introduction of this technology.

6-2-2 Work plan

In the work plan, the biomass power generation facility is comprised mainly of the boiler, turbine, fuel storage facility and control room. However, the work to be done for the biomass power facility is plant construction work, and takes longer to fabricate and construct compared to solar power facility and battery installation.

6-3 Outline design of energy management, transmission and interconnection

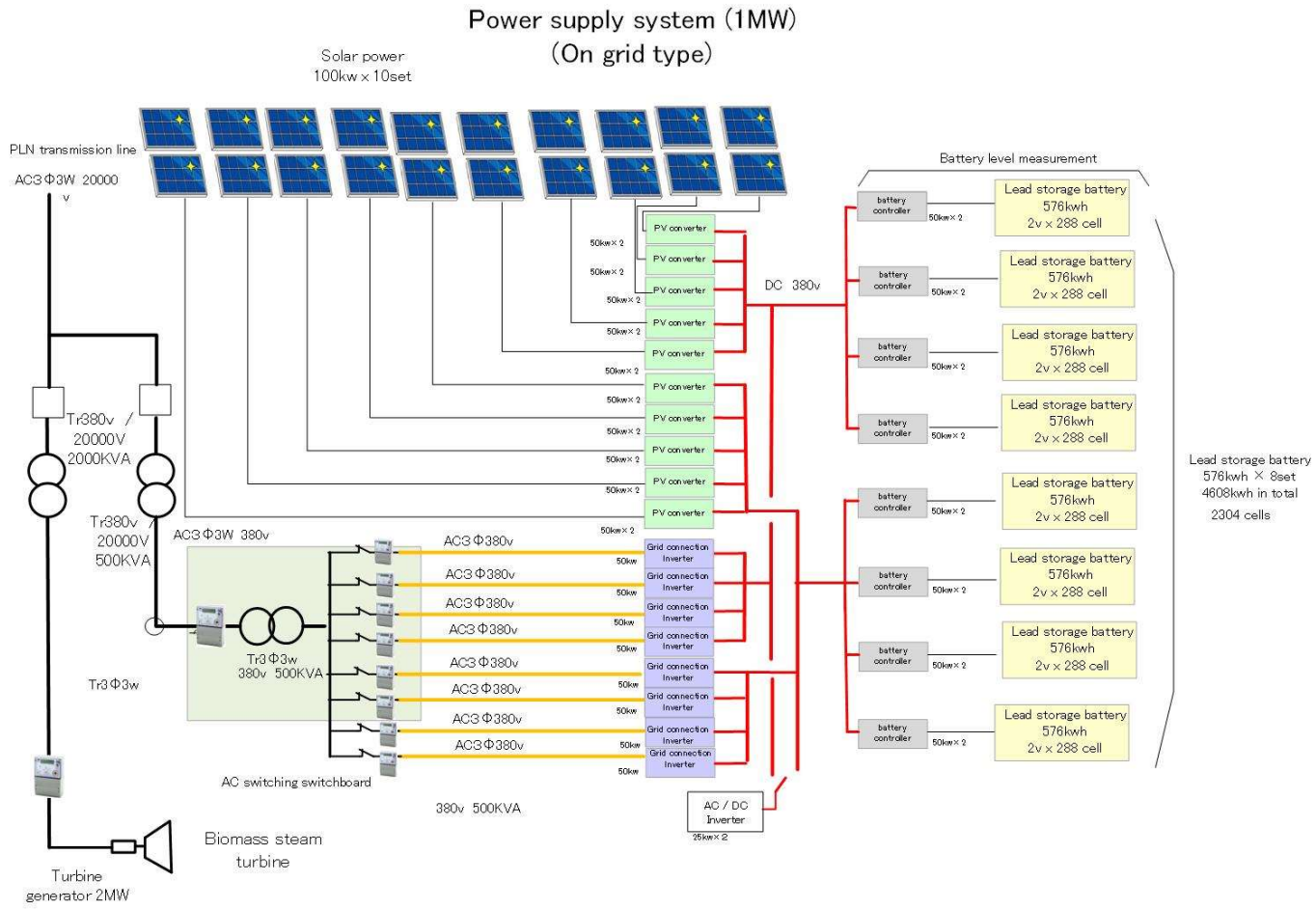
6-3-1 EMS (Energy Management System)

The basic configuration of EMS for the solar power generation and lead BESS used in the demonstration is shown in the figure below. This EMS-based system transforms the electricity produced by the solar panels into DC380V electricity via PV converter, and transmits it within the power supply system via HVDC bus.

Inside the power supply and system, two systems are operating in parallel including the batteries. When EMS in the higher hierarchy receives information of the load site and issues a command to the system side, the EMS operates independently and alternately between the two systems, and an appropriate amount of electricity is sent out after AC conversion.

When the generated electricity is smaller than the demand or when no electricity is produced during nighttime, electricity is sent to the grid by combining that discharged from the batteries controlled by battery controllers. Electricity can be supplied stably through real-time control of these processes.

EMS controls battery charge/discharge through the operation of the dual systems above. Generally, when one system is charging, the other system is discharging. By alternating between two systems on a day-to-day basis, battery charge/discharge is limited to once a day. This can minimize the number of charge/discharge cycles and prolongs the battery life to about 15 years, since the lead storage battery life is determined by the number of such cycles.



(Souce) Survey team

Figure 9 Systematic diagram of equipment for EMS-based system (during demonstrative operation)

6-3-2 Transmission facility

In the transmission facility, the 400V low voltage output from solar power facility and batteries is increased to the distribution grid voltage of 20,000V by the transformer, then connected to the distribution grid. The low voltage of the biomass-produced 400V output is also increased to 20,000V by the transformer for distribution grid connection.

Furthermore, the Vacuum Circuit Breaker (VCB) and relays (e.g., overcurrent relay (OCR), overvoltage ground relay (OVGR) and undervoltage relay (UVR)) are installed on each feeder. This is a safety design, in which if a fault occurs on the power generation side, a signal from the relay triggers VCB's "load current switching" and "fault current interruption" functions to stop the transmission.

6-3-3 Interconnection

The interconnection with PLN's grid will be pursued in the order of: demonstration plan → Nunukan Island → Sebatik Island.

1. Demonstration plan:
   Since the output transmitted from the hybrid power plant is 1.6MW, the existing diesel power plants will

continue being the base load power plants and operate synchronously with the 1.6MW demonstration facility. Inside the hybrid power plant, the solar power and batteries are synchronously* connected to biomass power plant.

2. Nunukan Island:

   The goal after the completion of the demonstration is to cover the entire power supply to Nunukan Island by renewable energy hybrid power generation. Part of the existing diesel power plant will remain as back up. As for interconnection, the renewable energy hybrid power plant will be the base load power plant, and the diesel power plant will be connected to it via EMS.

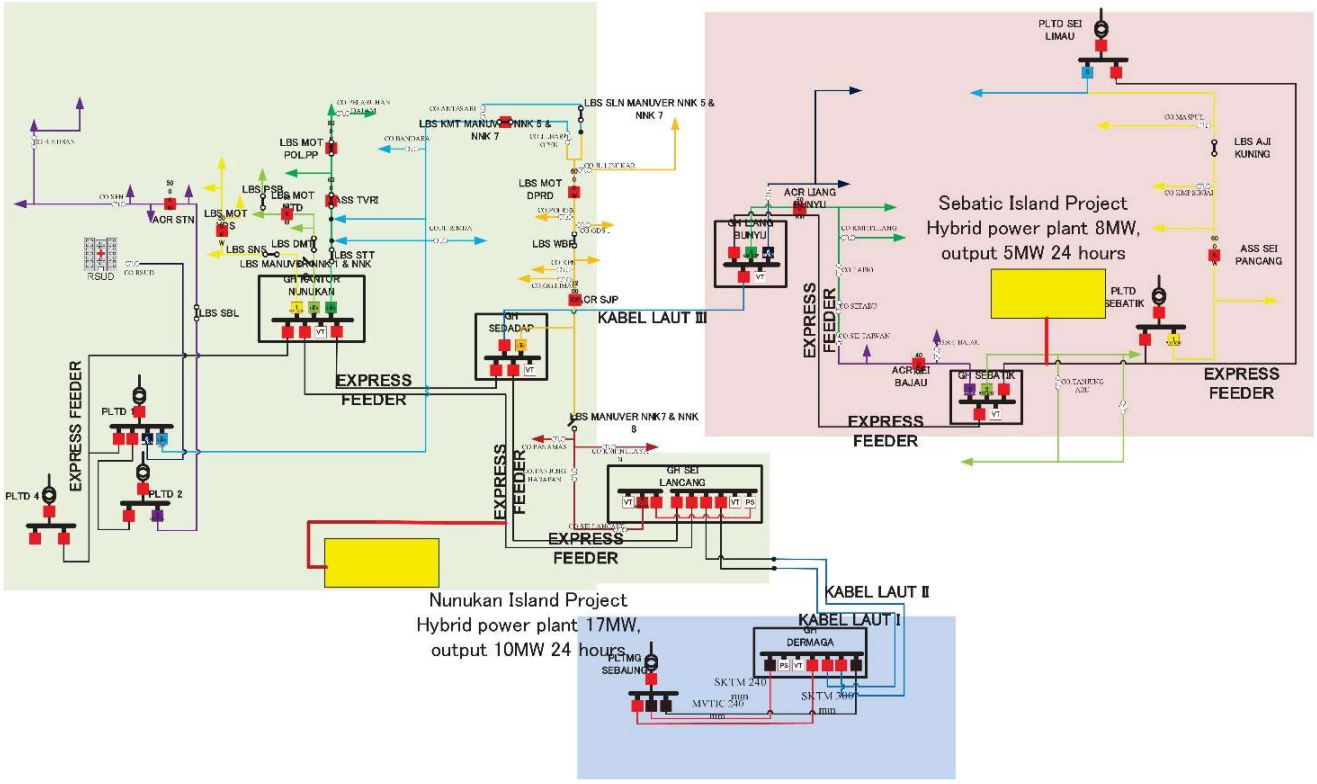
3. Sebatik Island:

   After the facility introduction to Nunukan Island, all electricity supply to Sebatik Island will be covered by renewable energy hybrid power generation. Part of the existing diesel power plant will remain as back up. As for interconnection, the renewable energy hybrid power plant will be the base load plant, as with Nunukan Island, and the diesel power plant will be connected to it via EMS.

4. Interconnection between the islands:

   There is an existing submarine cable (one circuit) between Nunukan Island and Sebatik Island, and power interchange will be done with the utilization of the integrated EMS.

* "Synchronously" refers to the state in which voltage (V), frequency (Hz) and power factor (%) are adjusted to those of the distribution grid, so that the grid will not be adversely affected when unstable renewable energy power sources are connected. The existing distribution grid and interconnection points are shown in the figure below:



(Source) Survey team by hearing from PLN

Figure 10 Diagram of distribution grid on Nunukan and Sebatik Islands

Chapter 7 Procurement of Biomass Fuels

7-1 Types of fuel that can be used in biomass generating facilities

7-1-1 Candidate biomass fuel types

With 26.3 million ha (2018) of land under cultivation, approximately 13% of Indonesia's GDP comes from the agricultural industry. The nation has secured a position as a leading world producer for crude palm oil (CPO), coconuts, mangos, natural rubber, rice, bananas, coffee, pepper, corn, cassava, pineapples, sweet potatoes, oranges, and sugarcane. Of these agricultural products, those with the largest scale of residue-derived bioenergy are oil palm, rice and sugar cane (coconuts 3.4 million ha, 2017). This residue includes palm kernel shells (PKS), empty fruits bunches (EFB), old trees, rice husks, rice straw, sugarcane bagasse, sugarcane tops and sugarcane leaves.

Table 10. Species and availability of biomass fuels in Indonesia.

Fuel type	Utilizable amount (million tons)		
	2025	2030	2050
Palm-related residue (PKS, EFB, old trees, palm oil mill effluent)	201.7	213.1	226.1
Rice husks, rice straw	41.6	41.6	41.6
Sugarcane (bagasse, etc.)	7.5	8.0	8.5
Rubber	12.3	12.9	13.7
Acacia	4.5	4.7	5.0
Cassava pulp	8.9	9.4	10.0
Total	276.5	289.7	304.9

（Source）Prepared by Santomo Resource KK based on International Renewable Energy Agency (IRENA) data

7-1-2 Comparison of biomass fuel types

In the case of the 2022 CPO production volume of 49 million tons[33], the amount of bio-residue generated from palm oil mills can be estimated as shown in the table below.

[33] Indonesian Palm Oil Association (IPOA)：https://gapki.id/en/news/22601/palm-oil-industrys-performance-in-2022

Table 11. Types and amounts of FFB products

		Ratio by weight (%)	Million tons
FFB (Fresh Fruit Bunch)		100	245
	CPO (Crude Palm Oil)	20	49
	PKO (Palm Kernel Oil)	7	17
	PKS (Palm Kernel Shell)	5	12
	EFB (Empty Fruit Bunch)	25	61
	Fiber	15	37
	POME	28	69

(Note) POME: Palm Oil Mill Effluent
(Source) Survey team by several data

7-2 Survey of rules and regulations relating to procurement of biomass fuel

7-2-1 Indonesian national rules and regulations relating to biomass fuel

Currently, the following 4 types of biomass are authorized within Indonesia for use as fuel in biomass power generation: ○ forest biomass, ○ agricultural waste, ○ industrial waste, and ○ municipal solid waste. Concerning the purchase of electric power from biomass power plants by PLN, it is specified that this can only be carried out for IPPs with sufficient fuel supply sources for operation continuity within the period of the power purchase agreement (PPA), and it must be proved that a contract has been concluded between the IPP and fuel supplier[34].

7-2-2 Regional government rules and regulations relating to biomass fuel

Formerly, oil-palm-derived waste (eg: EFB, Fiber, POME) was disposed of by incineration on palm plantations, however currently, incineration is not possible due to smoke pollution regulation, in particular, there is a complete prohibition on outdoor incineration in Kalimantan. Rules and regulations relating to the holding, disposal, etc. of agricultural waste, including EFB, for North Kalimantan Province and Nunukan Regency could not be confirmed, however, under the previously mentioned “Indonesia National Plan for Sustainable Palm Oil,” the establishment by regional governments of incentives relating to renewable energy projects is endorsed.

7-2-3 Rules and regulations relating to biomass power generation

According to “Government Regulation No. 79 of 2014 on National Energy Policy,” a policy that was revised in 2014, the foundation of biomass-derived energy was changed. Concerning biomass power generation, as an alternative to diesel power generation, a strategic initiative to increase the target ratio for renewable energy has become a strategic initiative incorporated into RUPTL (Electric Supply Business Plan) 2021-2030. In 2022, Presidential Regulation No. 112 of 2022 relating to acceleration of renewable energy development for electric power supply was enacted, and under its provisions, purchase price and a bid system relating to biomass power

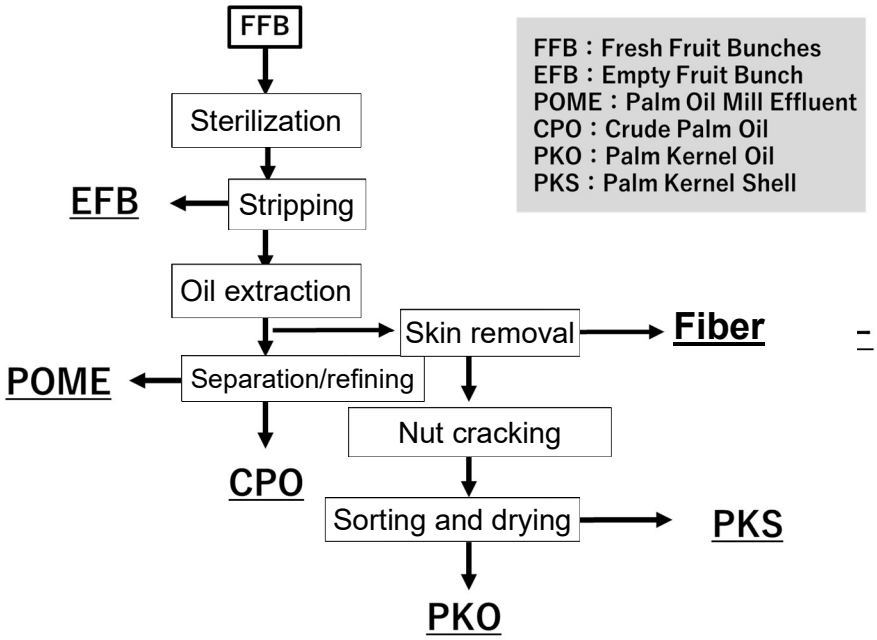
[34] Investment Guideline Bioenergy in Indonesia, 2016.

generation and other renewable energy power generation is defined.
At some existing thermal power plants and others at the planning stage, PLN is planning to increase "co-firing," that is the generation of power using both coal and biomass, and various trials and surveys are now being implemented[35].

7-3 Stably-priced fuel procurement

7-3-1 Biomass fuel production methods

Oil palm is a tree that grows best in a tropical climate (between 15 degrees north and 15 degrees south). Ideal conditions are altitude 1–400m above sea level with humidity in the range of 80–90%. In addition, rainy seasons without flooding and dry seasons with drought together with moderate rainfall throughout the year of about 2,000–2,500mm are necessary. It is possible to harvest FFB about 4 years after seedlings are planted, with the expected harvesting period being approximately 25 years. A typical CPO production plant flow diagram is shown below. FFB are sterilized and stripped, generating EFB.



(Source) Survey team
Figure 11CPO production plant process

7-3-2 Possibility of applying derivative technology for reduction of methane and other gases

(1) Current usage situation (composting, etc.) for EFB, etc.

It is said in general that approximately 20–30% of EFB is reused, for example as cushioning material and for composting, with the remaining 70–80% being dumped/accumulated in palm plantations and compounds of palm oil mills[36]. EFB left out in the open decomposes, contaminating soil, and generating foul odor and

[35] Mitsubishi Heavy Industries, Ltd. press release (March 30, 2022) "Specific approach methodology proposed to Indonesia Government directed at the spread of biomass co-firing in the country" https://www.mhi.com/jp/news/22033001.html.
[36] JICA report (2016) "Final report on survey for proposal creation relating to use of oil palm waste for biomass fuel in Indonesia"

methane gas. At mills visited for an on-site survey, EFB was being used as fertilizer for palm plantations, however, considerable amounts were left out in the open in mill compounds.
Under the Indonesia presidential decree "Indonesian Sustainable Palm Oil National Action Plan 2019-2024 (NAP)," in order to reduce this kind of environmental pollution and compensate for the shortage of electric power needed for economic development, the use of oil-palm-derived waste including EFB (EFB, POME, etc.), for example, as renewable energy fuel, is being promoted.
In addition, under "Indonesian Sustainable Palm Oil (ISPO)," which is established and operated based on Indonesia rules and regulations, disposal, management and use of waste is specified.
In Indonesia, there is a planned project for pelletization of EFB for sale as biomass fuel[37], however, within Nunukan Regency at least this type of project is not being undertaken, and among the mills visited, none of them supplied EFB in pelletized form or had any plans to do so.

(2) POME biomass gasification

POME is highly concentrated effluent discharged from palm oil mills. BOD and COD concentrations rise to 30,000–50,000mg/l and 30,000mg/l respectively. In cases where the application of POME to land or its discharge into bodies of water does not meet government-specified environmental standards, it has been proven harmful to aquatic and vegetative environments. To mitigate contamination of water quality, and with the objective of trapping and making use of methane, the number of mill operators employing covered lagoon systems is increasing. However, because the installation of lagoon covers alone cannot reduce POME BOD concentration to environmentally admissible levels, there is a need for mill operators to take additional measures such as membrane treatment or activated carbon treatment, although the financial burden of this is heavy and at many mills such methods are not being employed.

Under "The Indonesia National Action Plan for Sustainable Palm Oil" the use of POME in particular is recommended as renewable energy, and on Belitung Island in the western part of Indonesia, POME is being used for fuel at a 1.8MW biogas power plant (IPP) which has been in operation since 2016.

[37] Tess Holdings Co. Ltd. Press Release (December 23, 2022)
https://kabuyoho.jp/discloseDetail?rid=20221223582812&pid=140120221223582812

Chapter 8 Business Scheme and Financing

8-1 Business scheme

8-1-1 Business scheme

The scheme for the business is for the establishment of a special-purpose company (SPC) that will carry out renewable energy business in the concerned area during the business period (forecasted to be 20 – 30 years) based on the power purchase agreement (PPA) concluded with PLN. As discussed below, even after the deregulation of foreign investment in Indonesia's electricity wholesale industry, various laws and regulations are still in effect, and an investment and financing mechanism that complies with them will be created.

Also, the possible use of GCF and other Climate Funds is being considered, in addition to various subsidy programs offered by the Japanese government.

8-1-2 O&M (Operation and Maintenance)

One of the main characteristics of the business is that it takes place on remote islands away from densely populated areas. The EMS technology introduced by KYUDENKO has a remote control and monitoring function that uses the LTE network. It basically allows unmanned operation; however, given the fact that a large amount of electricity will be transmitted to the grid, totally unmanned operation will be difficult. Further, it will be necessary to establish the maintenance system that includes regular maintenance.

In biomass power generation, manpower is needed to transport, collect and feed materials on a daily basis. When establishing the system for O&M including the work above, it is imperative to obtain cooperation of PLN that operates power plants in the area. In the future, the portion controlled by the SPC and that covered with the cooperation of PLN (or its affiliate) must be clearly defined. For this study, KYUDENKO had meetings with the PLN offices in Nunukan Island and Sebatik Island and exchanged opinions on the O&M system in case the plan (including demonstration) becomes a reality.

8-2 Investment and financing

8-2-1 Procedure, laws and regulations concerning investment permit

Before the SPC can start business operation in Indonesia, it must be classified appropriately for its business activity, based on the Standard Industrial Classification of Indonesian Business Fields (Klasifikasi Baku Lapangan Usaha Indonesia: KBLI). It is likely that the SPC needs to be classified for two types of KBLI; namely, 35111 (power generation/supply) and KBLI 35121(operation of electric power supply installation).

Table 12. Specifics of KBLI (Standard Industrial Classification of Indonesian Business Fields)

No.	Business field	KBLI	Title and Description	General Requirements	Business Licensing Obligations
1.	Power generator/generation/supply	35111	This group includes the business of producing electric power through the generation of electricity using various types of energy sources. Fossil energy sources include coal, gas, fuel oil, and diesel. Renewable energy sources include geothermal, wind, bioenergy, sunlight, water flows and plunges, movement and temperature differences of ocean layers. Hybrid energy sources combine fossil energy with renewable energy and energy from energy storage technology.	1. Feasibility study of electricity supply business, provided that the document (in Bahasa) contains: a. Financial feasibility assessment; b. Operational feasibility assessment; c. Study of network interconnection; d. Installation location; e. One-line diagram; f. The type and capacity of the business to be carried out; g. Construction schedule; and h. Operating schedule prepared by a certified Business Entity. 2. Agreement on the sale and purchase of electricity between the applicant and the prospective buyer of electric power (Power Purchase Agreement/PPA and its amendments) in accordance with the provisions of the selling price of electricity or has received approval for the selling price of electricity from the Minister or Governor under his authority.	1. Fulfilling Basic Infrastructure Commitments according to Business needs (e.g., Conformity of Space Utilization Activities, AMDAL, Building Approval, SLF, etc.); 2. The installation to be operated must have a Certificate of Operation Worthiness (Sertifikat Laik Operasi/SLO); 3. Operations are carried out by Engineering Personnel who have a Certificate of Competence (Sertifikat Kompentensi); 4. The equipment used complies with the Indonesian National Standard (Standar Nasional Indonesia/SNI) which is enforced Mandatory; and; 5. Report business activities periodically to the Director General.
2.	Operation of electric power supply installation	35121	This group includes operations undertaken by other parties on generating facilities that produce electrical energy, electric power transmission system facilities and electric power distribution systems.	1. Fulfillment of Business Licensing Standards for Operating Services for Electrical Power Supply Installations; and 2. Quality management system documents.	1.Periodic reports to the Director General of Electricity;

(Source) Klasifikasi Baku Lapangan Usaha Indonesia (KBLI)[38]

Restrictions for foreign investment are not applicable to a business of power generation/supply and that operates electric power supply installation according to PR 10/2021, and an operator invested with foreign capital can wholly own the business.

8-2-2 Laws and regulations concerning capital (foreign capital)

The minimal capital of PMA (foreign investment) project is defined by BKPM Reg. 4/2021, and such minimal amount for PMA project is set as IDR 10 billion, excluding land and building for each KBLI per project location. In this business, the SPC is likely to require both KBLI 35111 (power generation/supply) and KBLI 35121 (Operation of electric power supply installation) classifications; thus, the SPC's minimum capital will be IDR 10 billion x 2 = IDR 20 billion.

8-2-3 Potential lenders and investors

The study is implemented for the project on the assumption that JICA's overseas investment and loan scheme will be utilized. However, various ratio and scenarios are expected for the investment in the SPC toward commercialization.

[38] Peraturan Badan Pusat Statistik Nomor 2 Tahun 2020 (https://legalitas.org/KBLI-2020.pdf)

For example, potential lenders include Indonesian financial institutes such as Sarana Multi Infrastruktur: (SMI: government-affiliated infrastructure investment institute) and Indonesia Infrastructure Finance (IIF), with whom KYUDENKO had face-to-face discussions (December 2022 and January 2023). Both institutes assume the ratio of the loan amount to be up to 70% of the business cost. Negation will continue while the investment scheme is concretized.

8-3 Subsidy, etc.

Financing schemes that can be adopted when implementing the project were researched and examined. The two schemes examined in the study were the "Green Climate Fund (GCF)" and "JCM Model Project of the Joint Credit Mechanism (JCM)."

8-3-1 GCF (Green Climate Fund)

GCF is a financing mechanism created under the UNFCCC, and offers support through four financing methods of grant, concessional loan, guarantee and equity. This business will be an IPP business. Since it is a private business, the GCF support is likely in the form of loan. The GCF loans are described as follows:

Table 13. Support to the private sector through GCF loans

Loan period	Up to 20 years
Grace period	Up to 5 year
Interest	0.75% + credit premium – concessionality premium
Service fee	0.5% p.a.
Commitment fee	0.75% p.a.

(source) GCF B.09/08

Also, GCF projects are divided based on the scale into micro (total project cost of 10 million USD or less), small (the said cost of 10 - 50 million USD), medium (50 – 250 million USD) and large (250 million USD or more) projects. In this case, it might be possible to apply for a loan as a small- or medium project. PT SMI is a state-owned enterprise that aims to contribute to the fight against climate change and sustainable development in Indonesia, through loans for infrastructure projects. It is also registered as a GCF-AE (Accredited Entity) of Indonesia. The size of the project implementable with their loan is medium (50 – 250 million USD), and PT SMI falls under Category A which can finance even high-risk projects (projects that can potentially pose serious risk or bring adverse damage that is wide-ranged, irreparable, and unparalleled to the environment or society).[39] Therefore, KYUDENKO visited PT SMI on November 14, 2022 to introduce the project and inquire the possibility for GCF. PT SMI has had one case (Integrated Sustainable Bus Rapid Transit Development in Semarang, 2018[40]) acting as an AE. Based on the experience, it stated that since GCF project formation takes enormous amounts of work and time, it will participate as an AE only if additional significance and merits can be expected from the viewpoint of a financial institute as well as an AR (account receivable) Lender.

[39] https://www.greenclimate.fund/ae/ptsmi
[40] https://www.greenclimate.fund/document/integrated-sustainable-bus-rapid-transit-development-semarang

KYUDENKO plans to horizontally implement the business in Indonesia after confirming the effectiveness in the NEDO demonstration. The company might negotiate with SMI again after combining other project sites to create a 100 million USD-level project and preparing a more detailed business plan that exclude this project.

8-3-2 JCM (Joint Crediting Mechanism's JCM Model Project)

An agreement was reached at COP26 on the implementation guideline for the Paris Agreement Article 6 (Market Mechanism). Article 6 (2) of the Paris Agreement concerning the cooperative approaches including JCM, describes the transfer of internationally-transferable mitigation outcome (ITMOs) and the use thereof to achieve the NDC. Such action became possible; in other words, COP agrees that the JCM credits can be used to meet Japan's NDC. Consequently, the goal of securing approx. 100 million t-CO2 emissions reduction and absorption through JCM implementation by fiscal 2030 was clearly stated in the Plan for Global Warming Countermeasures (Cabinet Decision of October 2021).[41]

The MOE and METI are offering two types of support for the purpose of promoting JCM projects; namely, JCM Model Project by MOE[42] and demonstration project by New Energy Development Organization (NEDO) (Program to Facilitate Private Sector-Led Promotion of Low Carbon Technology Overseas / Program to Promote Market Creation Using Low-Carbon Technology[43]). Through the JCM Model Project by MOE, the subsidy equivalent to up to 50% of the initial investment is offered, which helps reduce initial facility costs and promote IPP businesses. On the other hand, the NEDO demonstration will be conducted for three years with a budget of up to JPY 1 billion, and the demonstration plant can be purchased at the end of the demonstration at the book value. Also, there are others demonstration projects under NEDO that aim to contribute to the spread of Japan's energy-related industries, to energy transition and decarbonization in Japan and abroad, and to Japan's energy security (International Demonstration Project on Japan's Energy Efficiency Technologies[44]). For the demonstration project with a total budget of JPY 4 billion or less, half the amount is subsidized. The demonstration period for the project is three years, the same as the private sector-led low-carbon technology dissemination project above, and the demonstration plant can be purchased at the book value upon completion of the project.

Through NEDO's demonstration projects, technologies already in use in Japan can be demonstrated in various other locations, and facilities can be adjusted to suit the local needs during the demonstration. Such facilities can also be used to demonstrate the technology for the benefit of the stakeholders such as PLN, Indonesian government and Indonesian financial institutes.

The current plan is to confirm the CO_2 reduction effect in the NEDO demonstration, purchase the plant at the book value, and transform the project to an IPP business. KYUDENKO visited Mr. Arief Sugiyanto of PLN System Planning (Vice president of RUPTL controlling) on December 16, 2022, and explained the plan, which was received favorably. KYUDENKO also proposed the same plan to the JCM secretariat in Indonesia on

[41] https://www.env.go.jp/earth/ondanka/keikaku/211022.html
[42] https://www.env.go.jp/press/110847.html
[43] https://www.nedo.go.jp/koubo/AT092_100195.html
[44] https://www.nedo.go.jp/activities/AT1_00175.html

December 13, 2022, and received advice that NEDO had thoroughly examined the transfer of the demonstration plant assets for another JCM demonstration project in Indonesia, and KYUDENKO should use it as a reference after checking with NEDO.

Chapter 9 Environmental and Social Considerations

9-1 Summary of business components that impact the environment and society

The ultimate goal of this endeavor is to build a hybrid power plant (solar power with battery + biomass power:) on Nunukan Island and a hybrid power plant (solar power with battery + biomass power) on Sebatik Island, based on the goal of serving both islands with renewable energy-based electricity. However, the plan for the next stage following this preliminary study is to carry out the demonstration of a hybrid power plant. Here in this chapter, environmental and social considerations are discussed for the hybrid power generation facility that will be constructed for the demonstration.

The Indonesian laws on environmental impact assessment stipulate that a power generation business of 50MW or more must apply for environmental impact analysis (Analisis Mengenai Dampak Lingkungan: AMDAL) while that with less than 50MW in capacity needs to apply for the Environmental Management Efforts and Environmental Monitoring Efforts (Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup: UKL-UPL.) In the case of this project, the application must be for UKL-UPL, for both the renewable energy adoption for both islands and the demonstration. The type of environmental impact assessment is the same for both the demonstration project and commercial plant operation, and is decided based only on the site and power generation capacity.

9-1-1 Site of project implementation

This project entails a hybrid power generation (solar + biomass), which will be on the regency-owned land on Nunukan Island in North Kalimantan Province located in the northern part of Kalimantan Island. The planned project location is shown in .

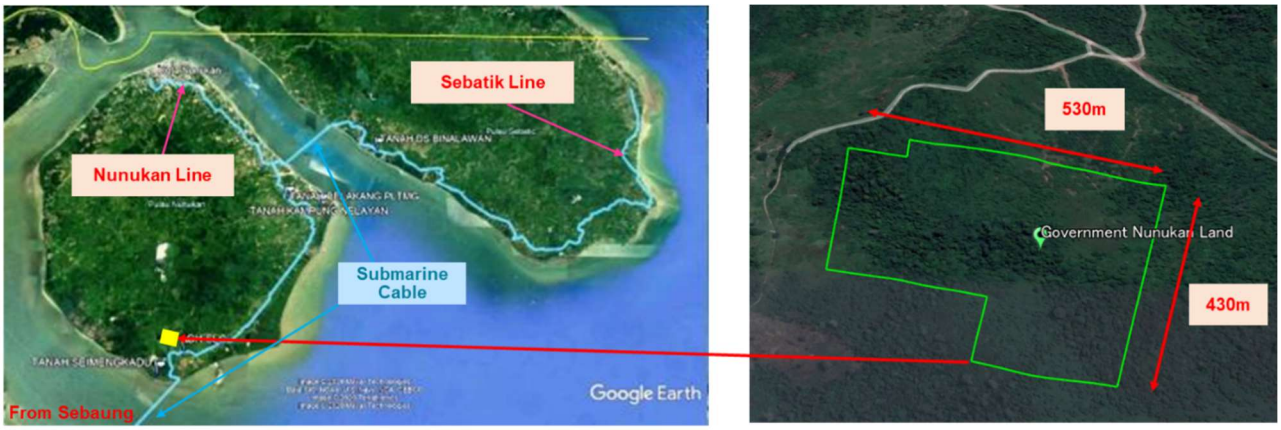
9-1-2 Project outline

This project entails hybrid power generation in Nunukan Island, North Kalimantan

(1) Power generation

Regarding the selection of a suitable site for the hybrid power plant, we have been introduced to available public land (assumed to be prefectural land) by the government of Nunukan. Our intention is to secure this land through a land lease agreement with the government. We are currently in the process of finalizing the agreement to ensure the availability of the site for the project's implementation.

As we approach the completion of our comprehensive study, we have received valuable information from the local government indicating the existence of multiple candidate sites. This provides us with a range of options to consider and evaluate in order to identify the most optimal location for the hybrid power plant. In order to determine the site that best aligns with the project's objectives and requirements, we will conduct a thorough evaluation of each candidate site.



(Source) Survey team by information from Nunukan local government

Figure 12 Planned business site (location)

(2) Jetty

Since there is no oil palm mill on Nunukan Island and biomass fuels cannot be obtained within the island, biomass fuels will have to be transported by boat from the mills located outside of the island (e.g., inland area of Kalimantan Island and Sebatik Island) via river, etc. The use of barges or small wooden boats or LCTs is considered for transport, and a jetty at which these vessels can moor to unload biomass fuels must be secured near the business site. Two options will be investigated in the future, which are (1) renting the existing jetty (including expansion of such jetty), and (2) installing a new jetty.

9-1-3 Work plan

For the detailed work plan, see 6-2-3 “Work plan.”

9-1-4 Biomass fuel supply

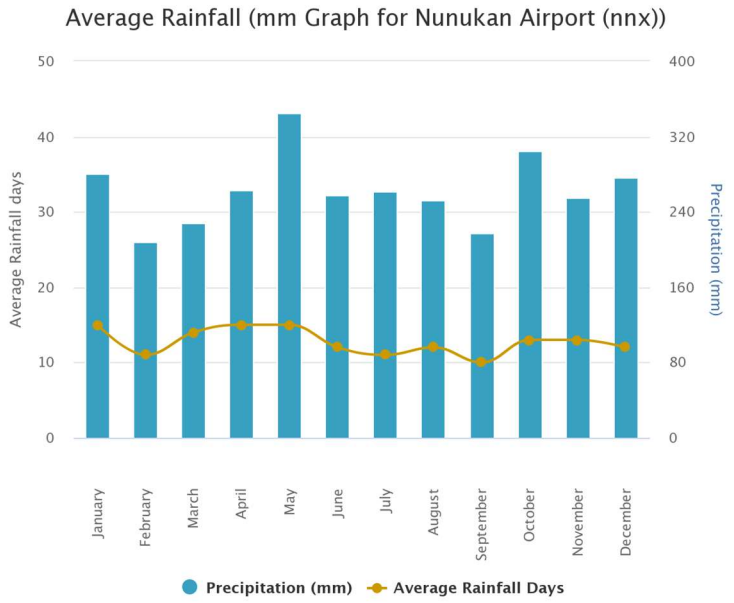
The land might have been used illegally (creating the farm on land for which development is restricted, such as riverbank, peatland, and protected forest area) during the development of some of the oil palm farms. To avoid purchasing biomass fuels from such farms, efforts will be made to purchase biomass fuels from oil palm farms that are certified by RSPO (Roundtable on Sustainable Palm Oil), ISPO (Indonesian Sustainable Palm Oil), etc., as much as possible. To ensure that this new biomass fuels procurement does not lead to the expansion of oil palm farm, a monitoring system will be considered after the start of biomass power plant operation.

9-2 Base state of environment and society

9-2-1 Natural environment

Nunukan Island is located on the equator (latitude 4° north), and with a tropical rainforest climate there are no large changes in rainfall (average 260mm/mth) or temperature (average 30°C) over the year (Nunukan Airport

data[45]). There is no clear distinction between rainy and dry seasons, and annual precipitation is approximately 3000mm. (Figure 1,Figure)



(Source) World Weather Online[45]
Figure 13 Nunukan Airport monthly average precipitation

(Source) World Weather Online[45]
Figure 14 Nunukan Airport monthly average sun hours

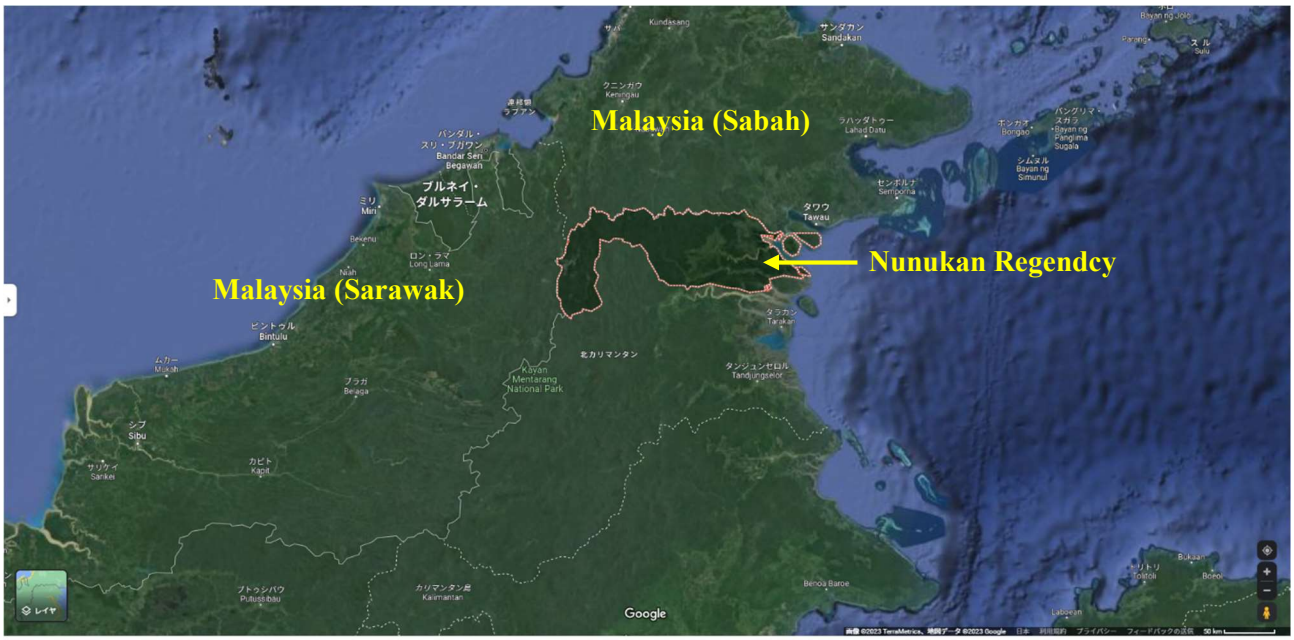
9-2-2 Social environment

(1) Society and economy

Nunukan Regency is located in the northernmost part of North Kalimantan Province and has a border with Nunukan Regency is made up of part of the main island of Kalimantan, Nunukan Island, Sebatik Island and other attached islands with an area of 12,247km^2, of which Nunukan Island accounts for 226km^2. Nunukan

[45] World Weather Online：https://www.worldweatheronline.com/l

Regent's Office is located on Nunukan Island.



(Note) Nunukan Regency has a border with Malaysia to the north and west
(Source) Google Map
Figure 15 North Kalimantan Province and Nunukan Regency

The principal industries in North Kalimantan Province are mining (oil, gas, coal, gold) and agriculture, forestry and fishing (timber, oil palm, fishing), all of which have big potentials[46]. The principal industry in Nunukan Regency is agriculture, forestry and fishing of which the most important on the main island of Kalimantan, and Sebatik Island is oil palm. The most thriving industry on Nunukan Island is seaweed cultivation, and the amount of production there is greater than for anywhere else in Indonesia. Dried seaweed is used as an ingredient in salads and soups, and exported to South Korea and China[47]. Seaweed cultivation on Nunukan Island started a few years ago, and because it provides high cash income, the number of people engaging in seaweed cultivation is increasing year by year. Many island residents have moved from cultivation of rice and crops to cultivation of seaweed and with this there is a considerable amount of agricultural land on the island that is not being used.

[46] Indonesia Investment Coordinating Board (BKPM) : https://regionalinvestment.bkpm.go.id/
[47] https://tabloidsinartani.com/detail/indeks/akuamina/17383-Uniknya-Karakteristik-Budidaya-Rumput-Laut-Nunukan (accessed March 16, 2023)

Table 14. North Kalimantan Province gross regional domestic product (GRDP) by industry

Industry	GRDP (gross regional domestic product) million IDR
Mining	16,710,770
Agriculture, forestry and fishing	11,301,510
Construction	7,858,100
Wholesale, retail, automobile/motorbike repair	7,282,830
Manufacturing	5,548,870
Distribution	3,826,140
Other (education, banking and finance, real estate, etc.)	10,635,770
Total	**63,162,990**

(Source) Indonesia Investment Coordinating Board[46]

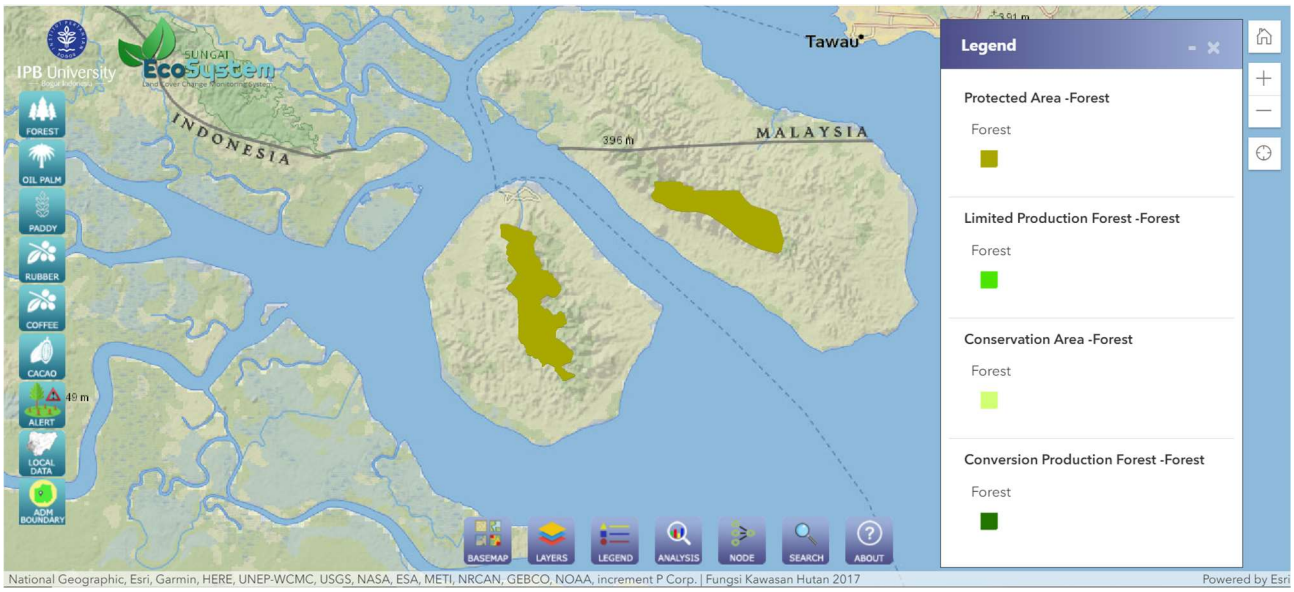
(2) Population and indigenous peoples

In the planned project site and its surrounding areas, there are no issues relating to ethnic minorities or indigenous peoples.

According to the national census, the population of Nunukan Regency was 190,000 in 2020. The population is made up of indigenous peoples: the Tidung Tribe, Bajau Tribe and Murut Tribe, as well as many people of the Bugis Tribe who immigrated from Sulawesi Island. Along with Tarakan Island, which is part of an adjoining regency, Nunukan Island has for a long time been a transportation hub for the northern part of Kalimantan, and even now commerce is flourishing with most products for daily use being imported from Tawau in Malaysia which is across the sea from Sebatik Island. There are also many migrant workers departing for and returning from Malaysia[48].

(3) Land use

The planned project site is not a protected area, the nearest protected area being Nunukan Island Protection Forest (Hutan Lindung Pulau Nunukan: HLPN) in the central part of the island.



（Source） The Good Growth Partnership (GGP)[49] program

Figure 16 State of forest cover on Nunukan Island

[48] M. Ford（2006）"After Nunukan: The Regulation of Indonesian Migration to Malaysia." Mobility, *Labour Migration and Border Controls in Asia (A. Kaur & I. Metcalfe ed.) Palgrave Macmillan London:* pp 228–247

[49] The Good Growth Partnership (GGP): The Good Growth Partnership (GGP): This is the environmental information database which is supported by the Global Environment Facility (GEF), led by the United Nations Environment Program (UNDP), and produced in collaboration with Conservation International, the International Finance Corporation, the United Nations Environment, the World Wildlife Fund, the Government of Indonesia, and others.（https://www.undp.org/facs/good-growth-partnership-0）。

(4) Site acquisition and resident relocation

The planned project site is on land owned by Nunukan Regency, and there are no residents, houses or other facilities within the area (confirmed by satellite photo), however, it will be necessary to carry out an on-site survey to confirm its current state. Currently, the site is owned by Nunukan Regency and there will be no site acquisition or resident relocation associated with the project.

(Source) Survey team
Figure 17 Project candidate site (prefectural land owned by Nunukan Prefecture):
Photo by survey team with prefectural officials in January 2023

(5) Cultural assets

There are no cultural assets such as ruins or places of worship on the planned project site or in the surrounding area.

9-2-3 Work Plan

Since the planned project site was decided on just before completion of the survey project in March 2023, it is planned to progress items such as confirmation of current status and environmental impact assessment associated with the work plan through a feasibility study for International Demonstration Project .

9-2-4 Biomass fuel supply

Within Nunukan Regency there are 20 large-scale plantations with a total planted area of 215,580ha. Within

Nunukan Regency there are 11 palm oil mills, all of which are on the main island of Kalimantan except 1 which is on Sebatik Island (there are none on Nunukan Island). Farmers on Nunukan Island take their harvested FFB to mills on Sebatik Island or the main island of Kalimantan for oil pressing.

Planted areas for Nunukan Island and Sebatik Island are 2,300ha and 12,300ha respectively. The 2 islands have no large-scale corporate plantations, only individual farmers with planted areas of a few hectares each. For Nunukan Island there are no plans for land clearing to create new oil palm farms or plantations (there is no land that can be cleared), however, in addition to oil palm farms there are currently forested sites for papermaking[50].

Eleven palm oil mills are in operation within Nunukan Regency, and as a result of surveying each of these mills concerning items such as production quantity, certifications obtained (ISPO and RSPO), and capital ties.were selected as candidates of biomass fuels supplier.

[50] Information obtained from an interview with Mr. Herman, Department of Agriculture & Food security, Nunukan Regency

9-3 Legal framework concerning environmental and social considerations in Indonesia

9-3-1 Environment-related laws

Regarding Indonesia's environment-related laws, with the enactment of the Omnibus Law (Undang-Undgang Cipta Kerja) in 2021, the Government Regulation No. 22 of 2021 on Environmental Protection, Organisation and Management (GR 22/2021) became the law that covers all aspects of the environmental protection and management. The law covers items below, which are directly related to this power generation business:

a. Environmental impact assessment and technical approval
b. Environmental management and monitoring plan
c. Effluent standard
d. Air quality protection and management (air pollutant emission standard)
e. Waste management and disposal

Biomass power plants are also subject to environmental emission standards for wastewater and exhaust gases similar to thermal power plants in GR 22/2021 (biomass power plants do not have their own set of limits). During the second field survey, the team visited the Nunukan District Environmental Office (Kantor Dinas Lingkungan Hidup Kabupaten Nunukan: Nunukan DLH) with BRIN (National Research and Innovation Agency) officials, who also discussed environmental regulations for biomass power generation facilities. They confirmed that currently there are no local government-specific environmental regulations and that the GR 22/2021 sets uniform standards for the whole country; for PMAs (foreign capital), before applying for the UKL-UPL, they should contact the Ministry of Environment and Forestry in Jakarta (Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia: KLHK) to check beforehand whether there are any problems between the performance of the power generation facilities and various regulatory values before applying for 'technical approval'. The regulatory values are the 'upper limit of emissions without any measures', so even if the specifications of the biomass power plant exceed the regulatory values, it is still possible to obtain technical approval if some measures are taken.

9-3-2 Related organizations (relevant authorities for environmental and social considerations)

The central government, provincial governments and local municipalities tackle the environmental issues, depending on their levels. The Ministry of Environment and Forestry (Kementerian Lingkungan Hidup dan Kehutanan Republik Indonesia: KLHK) was established by combining the Ministry of Environment and Ministry of Forestry in 2014. The Agency for the Prevention of Environmental Impact from business Activities (Direktorat Pencegahan Dampak Lingkungan Usaha dan Kegiatan: DPDLUK) under the ministry plays a leading role in environmental impact analysis (AMDAL) and Environmental Management Efforts and Environmental Monitoring Efforts (UKL-UPL.) After the start of power generation operation, the environmental monitoring data must be reported to the Ministry of Environment and Forestry Nunukan Branch (Kantor Dinas Lingkungan Hidup Kabupaten Nunukan: Nunukan DLH) on a regular basis.

The environmental aspects of the use of boats that transport biomass fuel and new jetty installation are controlled by the Ministry of Marine Affairs and Fisheries (Kementerian Kelautan dan Perikanan: KKP), and the point of contact for direct consultation, etc. will be Nunukan Regency Maritime Affairs and Fisheries

(Dinas Kelautan dan Perikanan Kab. Nunukan).

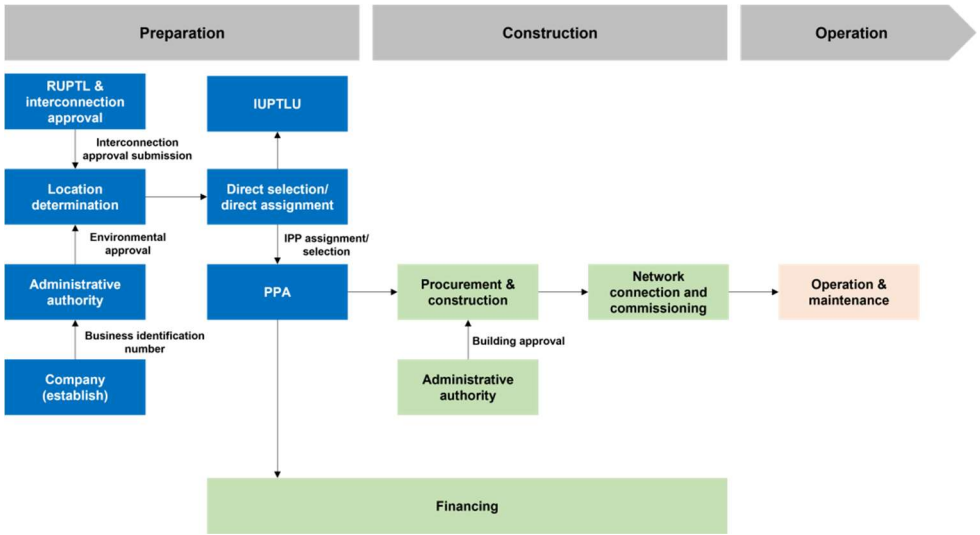
9-3-3 Environmental impact assessment system

The scale of this power generation business is less than 50MW; thus, the application will be for UKL-UPL in Category C, not AMDAL.[51] It is necessary to apply for UKL-UPL before the construction starts (during the planning stage), even if the power generation is for demonstration, not commercial operation. The applicant cannot submit the UKL-UPL application for a power generation business unless such business is included in RUPTL, as a rule. Upon UKL-UPL application, information below must be submitted:[52]

- Description of the activity plan
- Technical approval[53]
- Statement concerning the commitment to environmental management[54]

The applicant may submit an application for businesses that are to be conducted within the same site. In this case, the application can be for a hybrid power plant that includes a solar power plant and biomass power plant. The application form for UKL-UPL can be downloaded from AMDAL-Net.[55]

The business must submit UKL-UP to the Minister of Environment and Forestry of the Republic of Indonesia, provincial governor, or city mayor/administrators. Since this business will be on Nunukan Island in the North Kalimantan Province, the application must be submitted to the governor of the North Kalimantan Province. The UKL-UPL application form is submitted via the OSS System (Sistem Online Single Submission.)[56]



(Source) Survey team

Figure 18Application procedure including UKL-UPL (environmental approval)

[51] MEFR Reg. 4/2021

[52] Article 53 (1), GR 22/2021。

[53] Technical approval refers to approval received from the central or regional government based on Article 1 (93) and other laws and regulations, regarding the protection and management of the environment and traffic impact from business activities.

[54] Article 56, GR 22/2021

[55] https://amdalnet.menlhk.go.id/#/

[56] Article 57, GR 22/2021。

9-3-4 Laws related to biomass material (oil palm)

The laws and regulations concerning the environmental aspect of the biomass fuel used in the business include the Investment Guideline Bioenergy in Indonesia, 2016 and the Presidential Regulation No. 112 of 2022 on the Acceleration of Renewable Energy Development for Power Supply (PR 112/2022). The oil palm-related laws and regulations include the Indonesia presidential decree "Presidential Regulation on the Indonesian Sustainable Palm Oil National Action Plan 2019-2024 (NAP)", the Minister of Agriculture Regulation No. 11 of 2015 on the Indonesian Sustainable Palm Oil Certification Systems"[57] which is the basis for "Indonesian Sustainable Palm Oil (ISPO)," a certification scheme, and the Presidential Regulation Number 44 of 2020 on Certification System of the Indonesian Sustainable Palm Oil Plantation".[58]

9-4 Terms of Reference (TOR) for scoping and survey on environmental and social considerations

9-4-1 Scoping

For projects classified as UKL-UPL, it is not necessary to carry out a detailed impact forecast (scoping). The items to be covered on the UKL-UPL application form are given in Table below. In case a new jetty is to be constructed, the site will be different, therefore a separate UKL-UPL application will be necessary.

Table 15. Items to be covered on UKL-UPL application form

a. Pre-construction stage		
1) Land acquisition	SOP A.2.1	Changes in perception of community associated with land acquisition
	SOP A.2.2	Social conflict caused by land acquisition
	SOP A.2.4	Loss of livelihood associated with land acquisition
	SOP A.2.5	Fluctuations in earnings associated with land acquisition
2) Socialization of business plan	SOP A.1.1	Changes in perception of community due to socialization
3) Collection of data on environmental conditions (initial state of environment)	SOP A.4.1	Changes in perception of community due to collection of data on state of environment (initial state of environment)
b. Construction stage		
1) Land preparation and forming	SOP B.2.1	Degradation of river water and other water quality due to land clearing and formation
	SOP B.2.2	Increase in dust due to land clearing and formation
	SOP B.2.4	Increase in noise associated with felling of trees and land formation
	SOP B.2.3	Increase in runoff volume due to felling of trees and land formation
	SOP B.2.9	Possibility of flooding/water exposure due to land preparation and forming
	SOP B.2.10	Changes in perception of community due to felling of trees and land formation
	SOP B.2.11	Loss of comfort of community due to land preparation and formation
2) Movement of equipment and materials	SOP B.3.1	Increase in noise associated with movement of equipment and materials
	SOP B.3.2	Increase in dust associated with movement of equipment and materials
	SOP B.3.3	Changes in perception of community associated with movement of equipment and materials
	SOP B.3.4	Disruption of transportation associated with movement of equipment and materials

[57] PERATURAN MENTERI PERTANIAN REPUBLIK INDONESIA NOMOR 11/Permentan/OT.140/3/2015

[58] PERATURAN PRESIDEN REPUBLIK INDONESIA NOMOR 44 TAHUN 2020 TENTANG SISTEM SERTIFIKASI PERKEBUNAN KELAPA SAWIT

	SOP B.3.5	Damage to roads associated with movement of equipment and materials
3) Labor recruitment	SOP B.1.1	Increase in employment opportunities
	SOP B.1.2	Business opportunities and income generation
4) Construction of main and auxiliary facilities	SOP B.4.1	Increase in noise associated with construction
	SOP B.4.2	Increase in dust associated with construction
	SOP B.4.5	Degradation of river water and other water quality associated with construction
	SOP B.4.7	Increase in traffic hazard associated with construction
c. Operational stage		
1) Labor recruitment	SOP C.1.1	Increase in employment opportunities
	SOP C.1.2	Increase in business opportunities
	SOP C.1.3	Increase in income
	SOP C.1.4	Increase in anxiety and conflict in local community due to dispatch of labor
2) Business description	SOP C.2.2	Increase in amount of solid waste generated from business activity
	SOP C.2.4	Increase in amount of hazardous waste generated from business activity
	SOP C.2.6	Increase in traffic hazard attributable to business activity
	SOP C.2.8	Deterioration in public health attributable to business activity
	SOP C.2.9	Increase in anxiety and conflict in local community attributable to business activity
	SOP C.2.11	Degradation of river water and other water quality attributable to business activity

(Note) SOP (Standar Operasional Prosedur) details are stated in GR 22/2021
(Source) UKL-UPL Application on AMDAL-NET

9-4-2 TOR for surveys on environmental and social considerations

(1) Surveys required for UKL-UPL application

Concerning the items below considered necessary for UKL-UPL application, surveys will be carried out prior to application (Table 23).

Table 16. TOR for surveys on environmental and social considerations required for UKL-UPL application

Item	Survey item	Survey method
Air pollution	(1) Environmental standards (2) Current air quality	(1) Existing material survey (2) Air quality survey
Water pollution	(1) Environmental standards (2) Current water quality (3) Water quality of biomass power plant water discharge	(1) Existing material survey (2) Water quality survey (3) Survey with biomass power generation equipment maker
Waste	(1) Construction waste disposal methods (2) Types of waste (ash, etc.) discharged by biomass power generation (3) Disposal method for (2)	(1) Existing material and on-site surveys (2) Survey with biomass power generation equipment maker (3) Existing material survey
Noise/vibration	(1) Environmental standards (2) Current noise and vibration (3) Noise/vibration when biomass power plant is in operation	(1) Existing material survey (2) Noise survey (3) Survey with biomass power generation equipment maker
Employment environment	(1) Current state of employment environment	(1) Existing material and on-site surveys
Local community and economy	(1) Current state of community and economy	(1) Existing material and on-site surveys
Discussions with stakeholders (including residents in surrounding	(1) Opinions of related parties including local residents	(1) Holding of discussions with stakeholders

area)		

(Source) UKL-UPL Application on AMDAL-NET

Similar surveys on social and environmental impacts will also be required in the case that a new jetty is to be constructed.

(2) Points for consideration relating to biomass fuel supply

In addition, while it is not directly included in UKL-UPL application, the following types of points for consideration can be raised in relation to the supply of biomass fuel (Table 24). For plantations and mills that have obtained certifications such as RSPO and ISPO, there is a strong possibility that the following points for consideration have already been cleared[59], therefore it is planned to prioritize contract formation for fuel supply with mills that have such certifications.

Table 17. Environmental and social points for consideration in oil palm production

Environmental impact item	Project item
Natural environment	
Aquatic environment: water pollution, ground water pollution	・ If waste and effluent generated from the process of palm oil production is not disposed of appropriately at plantations and mills, there is a possibility that this will cause water pollution. Farms and mills which have introduced waste management facilities and water discharge disposal facilities for the appropriate disposal of waste and effluent will be selected.
Soil environment: soil pollution	・ If waste and effluent is not disposed of appropriately at plantations and mills, there is a possibility that this will cause soil pollution. Farms and mills which have introduced waste management facilities and water discharge disposal facilities for the appropriate disposal of waste and effluent will be selected.
Biodiversity and natural environment	・ At the stage land is cleared to create oil palm plantations, there is a possibility of illegal land use (creation of plantations on land such as riverbanks, peatland, protected forest areas for which development is regulated), therefore purchase of biomass fuels produced on such plantations will be avoided. ・ Even after biomass operation has commenced, monitoring will be carried out to make sure that biomass fuels procurement does not cause the expansion of oil palm plantations.
Social environment	
Impact on indigenous peoples	・ At the stage land is cleared to create oil palm plantations, there is a possibility of land disputes (land seizure, involuntary relocation) with indigenous peoples, therefore confirmation through local area hearing investigations and press information searches will be carried out in advance.

(Source) Survey team

(3) Climate change

In relation to the project, under a. effects of climate change on the project, and b. effects on climate change by the project, the following events are possible:

a. Effects of climate change

- With the change in sunshine hours, there is a possibility that the amount of electricity that can be generated from solar power plants is less than assumed.
- In the case that sea levels rise due to climate change, it is necessary to investigate whether or not biomass and solar power plants would become submerged.
- It is possible that due to climate change, the growth of oil palm will become poorer, thereby

[59] ""Ministry of Agriculture Regulation No. 11/2015 Indonesian Sustainable Palm Oil Certification System (ISPO)" covers all the items in this table as ISPO screening criteria.

fructification and fruit yield would decline, and production of biomass fuels and other parts of oil palm would decrease.

b. Effects on climate change

- Depending on the method used to storebiomass fuels, anaerobic fermentation may progress during storage with the possibility that methane, a greenhouse gas, is emitted.

Concerning a., it is planned to study the use of various tools (S8 downscaler[60], Climocast[61], SLAMM[62]) and other methods for predicting the effects of climate change, and concerning b., it is planned to survey the literature and other sources of information.

9-4-3 Survey methods

In the area surrounding the planned business site, multiple measurement points will be set up, and a certified organization with consultants qualified in environmental impact assessment (AMEDAL) will be hired to carry out an on-site survey of existing conditions.

9-5 Monitoring plan

9-5-1 Power plant monitoring implementation system

The table 25 shows the implementation system for the hybrid power plant environmental management program and environmental monitoring program. The table was prepared based on UKL-UPL, GR 22/2021, and JICA Guidelines for Environmental and Social Considerations. These environmental programs are to be administered by an environmental management unit (EMU) of the SPC (special purpose company, planned to be established), with the aim of creating effective management programs. Overall responsibility for implementing the project will be borne by the SPC, the project owner. The construction contractor (undecided, here referred to as EPC) will prepare and implement a safety and environmental management program (including a scheme of execution). After commencement of operation, the SPC will implement the environmental management program.

[60] Future climate simulation by region, offered by University of Tsukuba（https://s8ds.fkb-japan.com/）

[61] Data on detailed future global climate predictions available, offered by National Institute for Environmental Studies（https://a-plat.nies.go.jp/ap-plat/cmip6/global.html）

[62] The Sea Level Affecting Marshes Model (SLAMM): Simulation model that shows the effects of long-term rises in sea level on wetlands and coastlines, offered by Warren Pinnacle Consulting（https://toolkit.climate.gov/tool/sea-level-affecting-marshes-model-slamm）

Table 18. Monitoring implementation system

Organization	Role
SPC	➢Assuming responsibilities relating to project implementation, management and oversight, including responding to UKL-UPL requirements ➢Overseeing monitoring implemented by EPC and approving results ➢Overseeing environmental monitoring program implemented by EMU ➢Receiving claims, etc. occurring during project implementation
Environmental consultant	➢Preparation of environmental management program and environmental monitoring program ➢Checking of safety management plan prepared by EPC ➢Overseeing of monitoring implemented by EPC ➢Reporting to SPC
EPC	➢Preparation of final design proposal in accord with environmental management program ➢Preparation and execution of safety and environmental management plan (including scheme of execution)
O&M operator	➢Implementation of related environmental monitoring program
EMU	➢Implementation of environmental monitoring program

(Source) Survey team

9-5-2 Power plant monitoring plan

Table19 shows monitoring to be implemented during construction and after commencement of operation.

Table 19. Environmental monitoring plan during construction and after commencement of operation

Survey item	Monitoring item	Frequency	Implementing body	Responsible body
Air quality	TSP PM10 Sulfur Dioxide Nitrogen Dioxide Carbon Monoxide Lead Hydrocarbon	Once per quarter	EPC (during construction) SPC (after commencement of operation)	SPC
Water pollution	pH DO Turbidity BOD5 COD TSS E. Coli NH3-N Oil and Grease	Every month	EPC (during construction) SPC (after commencement of operation)	SPC
Waste	Municipal Waste Unregulated Waste	Every week Every month	EPC (during construction) SPC (after commencement of operation)	SPC
Noise	LAeq LA10 LA90 LAmin LAmax	Once per quarter	EPC (during construction) SPC (after commencement of operation)	SPC
Work environment	Checking of work environment and situation	Once per quarter	EPC (during construction) SPC (after commencement of operation)	SPC
Accidents	Checking traffic situation through patrols	During construction: every week After comm. of operation: every month	EPC (during construction) SPC (after commencement of operation)	SPC

(Note)At the detailed design stage, monitoring points will be considered.
(Source) Survey team

9-5-3 Implementation system for biomass fuel supply monitoring

Concerning the monitoring system relating to the supply of biomass fuel, SPC will prepare an environmental management program, which will be implemented by the biomass fuel supply operator (Supplier) that directly contracts with mills for the procurement of fuel, and the SPC's EMU will oversee this. In addition, a separate agreement will be concluded with a third party (local NGO or other organization) which will be requested to inspect palm oil mills on a regular basis.

Table 20. Biomass fuel supply monitoring plan

Organization	Role
SPC	➢ Preparation of environmental monitoring program ➢ Assuming responsibilities relating to project implementation, management and oversight, including responding to environmental monitoring program requirements ➢ Overseeing monitoring implemented by Supplier and approving results ➢ Receiving claims, etc. occurring during project implementation
Biomass fuel supply operator (Supplier)	➢ Implementing environmental monitoring program
EMU	➢ Overseeing monitoring implemented by Supplier
Third party (NGO or other organization)	➢ Checking of environmental monitoring program prepared by SPC ➢ Visiting mills contracted by Supplier and checking current conditions there ➢ Reporting to SPC

(Source) Survey team

9-5-4 Biomass fuel supply monitoring plan

Concerning biomass fuel supply monitoring, monitoring will be conducted with regard to the following items, including stable fuel supply.

Table 21. Biomass fuel supply monitoring plan

Survey item	Monitoring item	Frequency	Implementing body	Responsible body
Biomass fuel quality	Size Moisture content	Once per quarter	Supplier	SPC
Biomass fuel supply stability	Amount of biomass fuel being supplied	Once per quarter	Supplier	SPC
Work environment	Checking of work environment and situation		Supplier	SPC
Accidents	Checking of status of transportation by accompanying transportation vehicle, etc.	Once per quarter	Supplier	SPC
Tree clearing, etc.	Using satellite images, etc.* to check if illegal tree clearing is occurring in areas surrounding oil palm plantations	Once per month	EMU	SPC
	Conducting on-site surveys by patrolling oil palm plantations and mills	Once every 2 years	Third party (NGO or other organization)	SPC

(Note) To be implemented through use of the satellite tree clearing observation system developed by JICA in collaboration with JAXA (https://www.eorc.jaxa.jp/jjfast//jj_index.html), or the tree clearing observation system used by Nestle and other multinational corporations that purchase palm oil (https://pro.globalforestwatch.org/). Concerning systems for monitoring land use/tree clearing that make use of satellite images, there have recently been remarkable developments in technology, so the latest information on improved monitoring methods will be examined.
(Source) Survey team

9-6 Discussions with stakeholders

Firstly, before KKPR application, responsible persons from related organizations such as the Regent's Office and PLN will be called to join the first stakeholder discussion. Following this, a socialization meeting for local residents will be held. In both discussions, a project overview will be given, then its expected effects and other points will be explained before a question-and-answer session is conducted.

9-6-1 Participants

(1) Participants in first stakeholder discussion

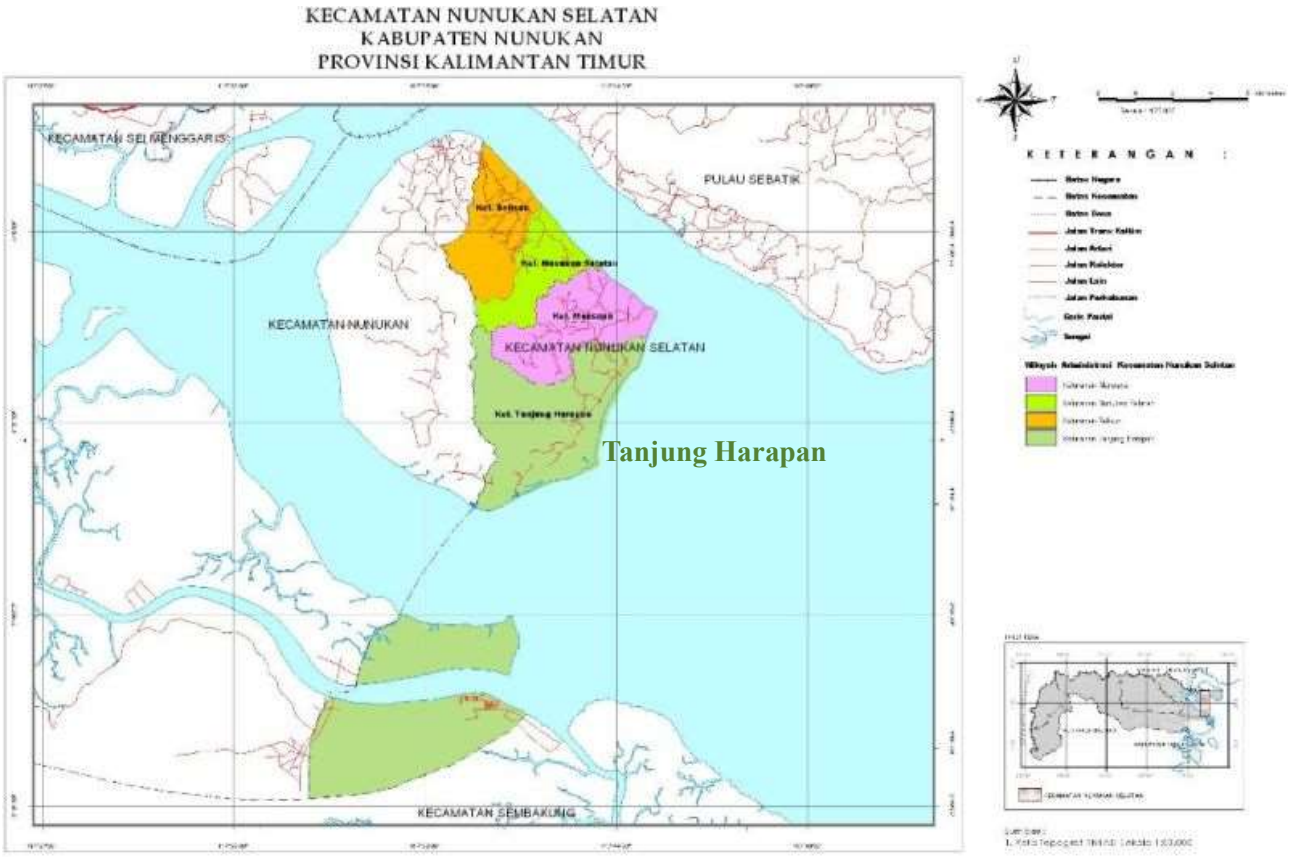
Participants in the first Stakeholder Discussion will be responsible persons from related organizations.

- Nunukan Regent's Office SEKRETARS (Assistant 2)
- Department of Public Works, Spatial Planning in Nunukan Regency (Dinas Pekerjaan Umum, Penataan Ruang)
- Fisheries Service of Nunukan Regency (Dinas Perikanan Kabid Nunukan)
- Regional Development Planning, Research and Development Agency of Nunukan Regency Government (BAPPEDA: Badan Perencanaan Permbangunan Daerah, Penelitian dan Pengembangan Pemerintah Kabupaten Nunukan)
- PLN
- Department of Energy and Mineral Resource in North Kalimantan Province（Dinas MEMR Provinsi Kalimantan Utara）

Except for participants from "Department of Energy and Mineral Resource in North Kalimantan Province," survey team members have already met with participants from these organizations several times during the period of this survey.

(2) Socialization Meeting for local residents

Through the Camat (district leader: representative of Kecamatan = administrative division below regency), Nunukan Regent's Office will call residents from the area surrounding the planned business site for the holding of a Socialization Meeting. It is assumed that the Socialization Meeting participants will include not only residents living close to the planned business site, but also people that earn their livelihoods from marine produce (mainly seaweed cultivation) in the section of sea close to the jetty, which will be used in the transportation of biomass fuel.



(Source) Website of Kecamatan Nunukan Selatan[63]Figure 19 Administrative divisions (Kecamatan) within Nunukan Island (red symbol indicates planned business site)

9-6-2 Agenda for discussions

At the stakeholder discussion and socialization meeting, an overview of the project will be given, then its expected effects and other points will be explained before a question-and -answer session is conducted. These discussions will be held several times in accord with the progress of the project.

[63] https://kecamatannunukanselatan.wordpress.com/peta-kecamatan-nunukan-selatan/

Chapter 10 Business Implementation Plan

10-1 Overall schedule

10-1-1 Steps toward commercialization

The plan had originally called for a prompt facility introduction in the form of an IPP (electricity wholesale) business for the following reasons, 1) there have been cases of commercialization utilizing KYUDENKO EMS technology, and 2) Indonesian Government hopes for early renewable energy introduction. Also in April 2022, working groups (WGs) were established based on the AZEC (Asia Zero Emission Community) concept, with the support of the Agency for Natural Resources and Energy, METI. It was an undertaking implemented with a view to promoting Japanese companies' entry into the renewable energy field in the ASEAN region. KYUDENKO was appointed to lead one of the WGs called the "working group for distributed energy sources by renewable energy on remote islands." It also received advice from the agency that reflected the agency's unique view on the target cases under this JICA study project.

Chapter 11 Project Evaluations

11-1 Effect indicator

11-1-1 Effect indicator (job creation)

The job creation effect below is expected during the demonstration stage and the ultimate business stage of this IPP business plan.

Table 22. Expected job creation effect

	Demonstration stage (persons)	Business stage (persons)
Biomass power plant operation scheme (incl. raw material delivery and feeding)	2 - 3	10 - 15
Biomass material transport (from palm mill to unloading near the power plant)	10 - 15	30 - 40
Solar & BESS system operation	1 - 2	4 - 5
Regular maintenance work	3 - 5	10 - 15

(Source) Survey team

It will be necessary to establish a reliable transport system (supply chain) between palm mills on the main island and the power generation site, especially to ensure a stable supply of biomass fuels. Therefore, it is expected that the business will need to employ a certain number of local personnel for transporting raw materials and feeding them into the furnace.

Generally, solar power systems and BESS can be operated and maintained unmanned. However, once the scale of the systems becomes extremely large, some items might require daily maintenance, which in turn is likely to lead to some job creation.

11-1-2 Carbon dioxide emissions reduction by project implementation

KYUDENKO considers the utilization of the Joint Crediting Mechanism (JCM). With this view, the greenhouse gas emissions reduction was calculated by referring to the JCM-registered methodologies. In this project, it is planned to only store the electricity produced by solar power generation, but not the power produced by biomass power. Therefore, the project can be considered to combine the solar power generation system that includes BESS and the biomass power generation system. For JCM with Indonesia, registered methodologies include AM017 (Installation of Solar PV System and Storage Battery System, Ver. 01.0)[64] for solar power generation system with BESS, and AM027 (Electricity generation by a biomass power plant Version 01.0)[65] for biomass power generation. Also, the greenhouse gas emissions reduction through JCM is calculated by subtracting the project emissions from the reference emissions.

[64] https://www.jcm.go.jp/id-jp/methodologies/78
[65] https://www.jcm.go.jp/id-jp/methodologies/128

(1) Reference emissions

The reference emissions are calculated by multiplying the electricity supplied to the demand side by the predetermined electricity emission factor. In this project, such emissions will be obtained by multiplying the electricity supplied by both the solar power generation system and biomass power generation system to the demand side, by the electricity emission factor. Such electricity is expressed as the electricity supplied from the solar power plant that includes BESS to the demand side in AM017, and in AM027, as the net power generation from the biomass power plant (the amount obtained by subtracting the amount of electricity used at the biomass power plant from the gross power generation). The reference emissions are calculated as follows:

$REp = (EGp + NEGp) \times EF_{RE,elec}$

REp: Reference emissions during the period p [tCO2/p]

EGp: Electricity transmitted from the project's solar system to the demand side during the period p [MWh/p]

NEGp: Net power generation by the project's biomass power system during the period p [MWh/p]

$EF_{RE,elec}$: **Reference electricity emission factor of the project's systems [tCO2/MWh]**

The power grids of Nunukan and Sebatik Islands, the target of the project, are independent micro grids that center on diesel power generation. Their situation falls under the independent grid (Case 3) described in both AM017 and AM027 methodologies, and the conservative value of 0.533tCO2/MWh for diesel power generation is applied as the electricity emission factor.

However, there is a plan to connect the transmission grid of Nunukan via a 150KV power line to the power grid of the North Kalimantan area in 2026, as revealed during the meeting with Mr. Dita (Manager, System Operation) of PLN UIKL Kalimantan Office at Banjarbaru on November 1, 2022. The main transmission/distribution grid in the North Kalimantan area is Tarakan grid, for which the emission factor is set as 0.493tCO2/MW according to the methodologies AM017 and AM027. Since the emission factor for Tarakan grid is more conservative, the emission factor of 0.493tCO2/MWh will be used to calculate the reference emissions.

Also, the supplied electricity (total of EGp and NEGp) is 24,768MWh based on the 3MW power generation capabilities and 8,256 hours of operation per year (2 week- and 1 week-long regular maintenance annually), and by multiplying the amount by the emission factor above, 12,211tons/year is obtained.

(2) Project emissions

The project emissions for solar power generation are 0 (zero) as per AM017. However, AM027 dictates that the project emissions for biomass power generation are the total of emissions from fossil fuels use at the biomass plants and from biomass transportation.

a) Emissions from fossil fuel use at biomass plants

The moisture content of 25% or less is used as the biomass fuel. No other process takes place at the biomass plants. Also, no auxiliary fuel is used in auxiliary burner or other equipment when starting up or operating the plants; thus, no fossil fuel is used at the biomass plants.

b) Emissions from biomass fuel transport

Emissions from biomass fuel transport are calculated using the ton-kilo method, more specifically, by multiplying the transport distance by the transport volume, and then applying the emission factor set for the respective modes of transport. While AM027 sets the emission factor for land transport that uses a 26-ton or smaller truck as 245gCO2/ton-km, it does not give any emission factor for shipping. Therefore, calculations used the emission factor of 39gCO2/ton-km which is for domestic vessels as described in the guideline issued by METI and MLIT (Joint Guideline for the Method of Calculating CO2 Emissions in the Logistics Sector Ver.3.1)[67].

More than 20 biomass fuel suppliers spread around Nunukan Regency, North Kalimantan Province where Nunukan and Sbatick Islands are located. Based on the site survey in November 2022, it is estimated that the distance and frequency of transport by vessels (3000 ton-class barge) is 100km on average and about 6 times a year, and those for land transport by a 10-ton truck is 100km on average and about 1,643 times a year. Thus, the emissions from transport are 875tons-CO2/year.

(3) Greenhouse gas emissions (GHG) reduction

Since the greenhouse gas emissions (GHG) reduction is calculated by subtracting the project emissions from the reference emissions above, the annual greenhouse gas emissions reduction will be 7,085tCO2/year.

11-2 Economic evaluation

In Indonesia, Presidential Regulation No. 112 of 2022 relating to acceleration of renewable energy development for electric power supply was enacted as of September 30, 2022, to lay out new purchase prices for renewable energy including those for remote island areas. The Indonesian government is expected to strengthen measures toward achieving carbon neutrality by 2060 based on this presidential regulation.

The objectives of this plan are to examine the increase of the renewable energy-based power generation ratio for remote islands where tens of thousands of people live, and then to work towards 100% renewable energy-based power generation, with technology demonstration between those stages. In economic and business evaluation, the power purchase price is a fundamental factor that affects the business.

There are factors involved (below) which are uncertain at this stage, and a sound evaluation of the business potential will be difficult unless preconditions are determined through continuous FS in the future.

There are factors involved (below) which are uncertain at this stage, and a sound evaluation of the business potential will be difficult unless preconditions are determined through continuous FS in the future.

(1) Facility investment costs which are hard to estimate at this time

・Whole system for biomass power generation

・Material procurement cost (stable long-term procurement possibility was confirmed in this study, but the cost is unclear)

(2) Items that require negotiation with the Indonesian government in the future

[67] https://www.enecho.meti.go.jp/category/saving_and_new/saving/ninushi/pdf/guidelinev3.1.pdf

・Establishment of power purchase price for “mixed” power generation system comprised of solar＋biomass＋BESS (no provision under the current system)

・Application of the remote island factor (negotiate for the increased power purchase price which is about 150－160% of the mainland price)

・Use of incentives based on the reduction in electricity generated by the existing internal-combustion power plants (there are cases among PLN’s ongoing tenders for de-dieselization, etc. in which the reduction in output from internal-combustion power plants is taken into account)

In any case, it will be difficult to establish a successful business based on the current condition, unless improvements are made in the areas of facility cost and power purchase scheme, for which continuous investigation is necessary.

Appendix

- ANNEX 1: Map of Indonesia
- ANNEX 2: Map of North Kalimanta
- ANNEX 3: MoU with MEMR (copy)
- ANNEX 4: MoU with PLN (copy)