Project commissioned by the Ministry of the Environment in FY2022

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

（City-to-city collaboration project for realize decarbonization society by Toyama City and Bali province）

Report

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Japan NUS Co., Ltd.

Toyama City

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Table of Abbreviations

Abbreviation	English/Indonesian	Japanese
100RC	100 Resilient Cities	100 のレジリエント・シティ
BAPPEDA	Badan Perencanaan Pembangunan Daerah	地方開発計画局
BAU	Business as usual	成り行きシナリオ
BOE	Barrel of Oil Equivalent	石油換算トン
BRT	Bus Rapid Transit	バス高速輸送システム
CAPEX	Capital Expenditure	設備投資コスト
CNG	Compressed Natural Gas	圧縮天然ガス
DDF	Dual Diesel Fuel	ディーゼル油/CNG の混合燃料
DEPO	Depot	中継施設
DKP	Dinas Kebersihan dan Pertamanan	美化局
ESDM	Ministry of Energy and Mineral Resource	エネルギー鉱物資源省
FIT	Feed-in Tariff Program	固定価格買取制度
GNSSA	GERAKAN NASIONAL SEJUTA SURYA ATAP	屋根置き太陽光発電促進国民運動
IPP	Independent Power Producer	独立電源事業者
IRR	Internal Rate of Return	内部収益率
JCM	Joint Crediting Mechanism	二国間クレジット制度
KEN	Kebijakan Energi Nasional	国家エネルギー政策
MRU	Mobile Refueling Unit	コンプレッサー搭載ガス供給車
NDC	Nationally Determined Contribution	自国が決定する貢献
PLN	Perusahaan Listrik Negara	インドネシア電力公社
PPA	Power Purchase Agreement	電力売電契約
RAD-GRK	Rencana Aksi Daerah Penurunan Emisi Gas Rumah Kaca	地方温室効果ガス排出削減行動計画
RAN-GRK	Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca	国家温室効果ガス排出削減行動計画
RPJMD	Rencana pembangunan jangka menengah daerah	地方中期開発計画
RPJMN	Rencana pembangunan jangka menengah nasional	国家中期開発計画
RUED	Rencana Umum Energi Daerah	地方エネルギー総合計画
RUEN	Rencana Umum Energi Nasional 2015-2050	新国家エネルギー政策

RUPTL	Rencana Usaha Penyediaan Tenaga Listrik	インドネシア電力供給事業計画
SDGs	Sustainable Development Goals	持続可能な開発目標
SPBG	Stasiun Pengisian Bahan Bakar Gas	ガス充填ステーション
TPA	Tempat Pembuangan Akhir	最終処分場
TPS	Tempat Pengolahan Sampah	一時集積場
JANUS	Japan NUS Co., Ltd.	日本エヌ・ユー・エス株式会社（本都市間連携提案事業者）

1. Background, Objectives, and Implementation Structure of Project

1.1. Background and Objectives

With a consensus document produced at the 2021 United Nations Climate Change Conference (COP26) held in November 2021, it was confirmed that a new global goal is to keep the increase in air temperature since the industrial revolution by no more than 1.5℃. In order to attain this goal, it is indispensable to accelerate initiatives at various levels, including provincial, municipal, and ward levels, in each country. The Japanese government, too, declared that it aims to realize a decarbonized society by decreasing the net emissions of greenhouse gases to zero by 2050, and the number of municipalities that have declared that they will decrease the net CO_2 emissions to zero increased rapidly to over 600 (as of April 30, 2022). Based on the roadmap for decarbonization in each region, which was formulated in June 2021, advanced measures have been designed in each region, and activities for spreading them nationwide are ongoing.

Thus, the role of cities and local governments in considering and implementing specific local climate change measures and projects is becoming increasingly important. In order to realize a decarbonized society all over the world, it is necessary to accelerate the movement toward building a sustainable decarbonized society, especially in Asia where economic growth is remarkable. There is a growing international movement to support the efforts of cities to decarbonize and lower the carbon footprint of their activities, as these cities are the places that support social and economic development.

In addition, amid the lingering COVID-19 pandemic, cities have to deal with the challenges related to the spread of the infection and readjust and discuss new measures to achieve sustainable development, so collaboration among cities to build new methods and new cities is extremely important. In this project, Japanese research institutes, private companies, universities, etc. as well as Japanese cities that have experience and know-how in building a carbon-free and low-carbon society will conduct a research project to support overseas local governments in their efforts to build a carbon-free or low-carbon society and to install equipment that will contribute to the realization of a carbon-free or low-carbon society.

In this task, for the above objectives, Bali Province, Indonesia and Toyama City will collaborate to support the efforts of the two municipalities that are proactive in decarbonization policies. They will deepen their cooperative relationship while working together with companies in Toyama City to create a next-generation city.

Toyama City is a future city for attaining SDGs, and has been promoting various initiatives with the aim to contribute to Indonesia by collaborating with local governments there. Toyama City has a deep connection with Indonesia. In 2014, under a technical cooperation agreement with Tabanan Regency, Bali Province, Toyama City introduced a small-scale hydroelectric power generation system utilizing JICA projects, and since then, the city has made cooperation agreements with Semarang, Banda Aceh, and Tobintinggi

Figure 1-1 The Minister of Interior offering a letter of appreciation to Toyama City

Cities, as well as Tabanan, Klungkung, Lebong Regencies, etc., and has organized projects that contribute to achieving the SDGs.

In 2018, Toyama City became the first Japanese municipality to receive a letter of appreciation from Indonesia's Ministry of Home Affairs for its achievements. As a future city for attaining SDGs, Toyama City has positioned itself as an advocate of SDG 17 aiming to "revitalize global partnerships" with its initiatives, and plans to promote further international collaboration.

Bali has been implementing the "Future Tourism City Support Project by Toyama City and Bali Province through Inter-city Cooperation," as a JCM inter-city cooperation project. The project provided support for the low-carbon tourism sector, mainly in the hotel and transportation industries. In addition to providing support to establish policies for fuel shifts, the project provided support in applying for JCM equipment subsidy projects, business matchmaking, and workshops as part of JCM project formation activities.

As projects for energy saving and the adoption of renewable energy in large hotels were taking shape, the spread of COVID-19 made investment in tourism businesses difficult.

Therefore, in the fiscal year before last, we shifted our focus to the greatest environmental challenge facing Bali Province, which is traffic congestion and the resulting air pollution and CO_2 emissions caused by exhaust gas, and discussed countermeasures.

The Dual Diesel Fuel (DDF) system, which is a technology applied to the FY 2018 JCM Subsidy Project, "Introduction of Compressed Natural Gas (CNG) and Diesel Co-firing System to Public Transport Buses in Semarang" realized by Toyama City in Semarang, was considered as a promising technology. From the viewpoint of reducing emissions by using fossil fuels with lower emission factors, this is only a transit point toward decarbonization, but the low-carbonization enabled by this technology is highly feasible in the transportation sector, and can be expected to have some emission reduction effect.

On the other hand, the gas distribution situation in Indonesia cannot be said to be optimal. Although the government is implementing measures to promote the use of its large natural gas reserves in response to the decline in oil production, most of the natural gas produced is either exported or supplied to large-scale consumers (such as LNG-fired power plants), and the country was not equipped to meet the potential urban demand.

In addition, G20 held in Bali in 2022 motivated the Bali government to endeavor to more advanced initiatives for coping with climate change. Then, they requested Toyama City to cooperate in utilizing hydrogen, which would improve the effectiveness of solar power generation, which has great potential, but has not been diffused sufficiently due to the grid problem, instead of natural gas, which is a fossil fuel, distributing EVs, and solving the waste issues.

This fiscal year, we decided to discuss the possibility of adopting technologies for waste management and production of hydrogen from plastic waste in addition to the utilization of hydrogen based on solar power generation and the use of EVs for realizind decarbonization. Regarding solar power generation, business-based initiatives with PPA, etc. are ongoing, so we also decided to discuss the activities utilizing the JCM equipment subsidy program for the above projects.

1.2. Implementation structure and details of this task

The implementation structure and outline of this project are as shown below.

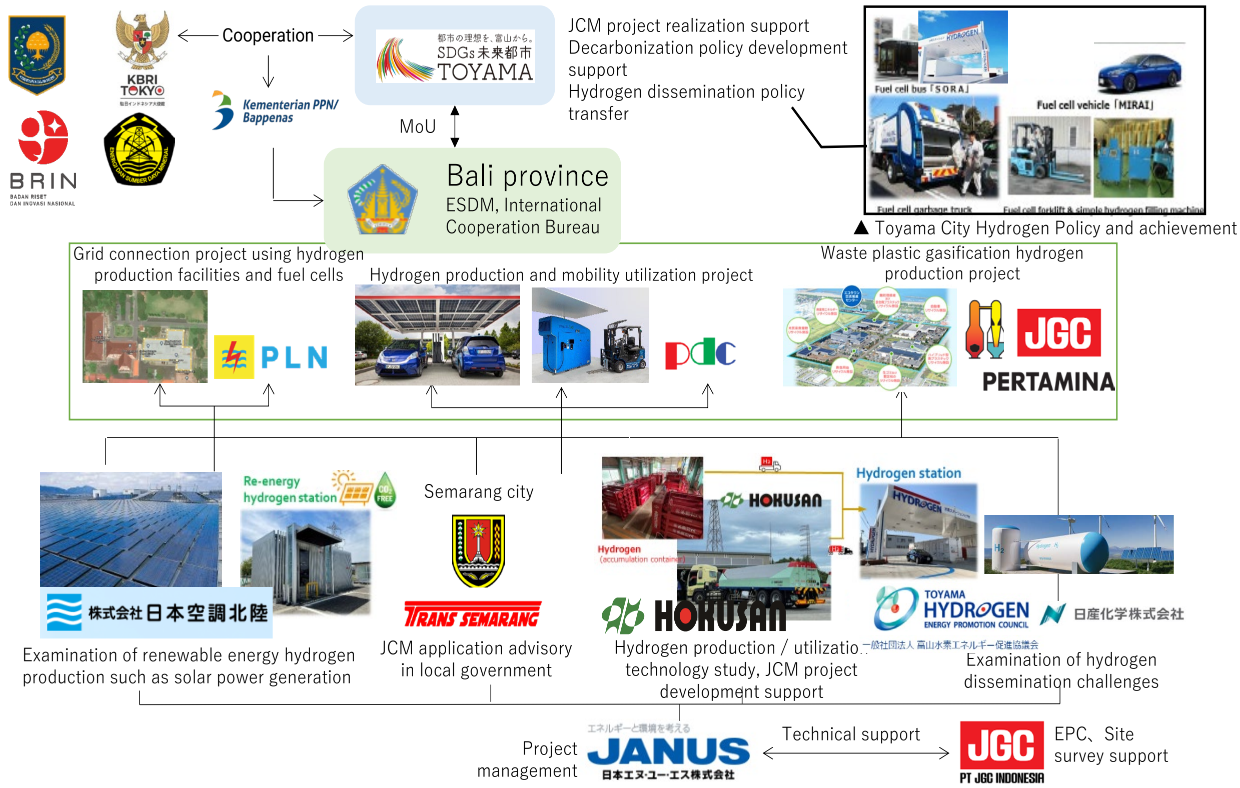

Figure 1-2 Entire implementation structure for this task

Source: Produced by JANUS

2. Discussion on a Commercialization Plan

2.1. Indonesia's Low-carbon Initiatives

2.1.1. Low-carbon Policies of Indonesia' Central Government

One of the pillars of Indonesia's low-carbon policy is the "National Action Plan for Greenhouse Gas Emission Reduction (Rencana Aksi Nasional Penurunan Emisi Gas Rumah Kaca: RAN-GRK)," which was formulated as a presidential decree in 2010.

The plan calls for a national commitment to reducing greenhouse gas emissions targeting a 29% reduction from the (business as usual: BAU) scenario by 2030. However, since the government has also announced its goal of reducing greenhouse gas emissions by 41% with international support, the Joint Crediting Mechanism (JCM) is also expected to be utilized. In this context, Japan and Indonesia signed the JCM in October 2013, and Indonesia became Japan's eighth JCM target country.

According to "Long-term strategy of Indonesia for low-carbon society and climate resilience 2050" set in July 2021, they aim to achieve carbon neutrality by 2060.

The goal of virtually zero greenhouse gas emissions was submitted to the UN for the 26th Conference of the Parties (COP26) at the UN Framework Convention on Climate Change (UNFCCC) in Glasgow as a long-term strategy for low-carbon society and climate resilience. However, it maintains the existing target for 2030, which is a 29% reduction in greenhouse gas emissions compared to the case where no additional measures are taken (BAU), and a maximum reduction of 41% with international aid.

The reduction targets in respective sectors are 24% for forestry and other land-use sectors and 16% for energy. In the energy sector, the plan includes phasing out coal-fired power generation, accelerating the shift to hydropower, biomass power energy, hydrogen, floating and roof-mounted solar power, geothermal power, and shifting from high-cost diesel to gas power and new renewable energy.

While Indonesia's domestic system has many challenges to overcome in the rapid transition to renewable energy, including the fact that the supply of cheap energy to low-income groups is an important element of the government's support base, the new National Energy Policy (Rencana Umum Energi Nasional 2015-2050: RUEN) formulated in 2015 sets a target to reduce the share of oil from 49% to less than 22% in the country by 2025. In addition, the shares of natural gas will increase from 20% to 22%, coal from 24% to 32%, and renewable energy from 6% to 23%. With the above revision of the NDCs and the gradual reduction of coal-fired power generation, the National Energy Strategy is also expected to be revised in the future, but for the time being, it is expected that measures will be taken in line with the above goals.

The National Energy Policy (RUEN) encompasses low-carbon policies with the power generated with natural gas and renewable energy, and it can be understood as low-carbon.

The overall picture of the policies and low-carbon measures using the power generated with natural gas and renewable energy are summarized in Table 2-1.

Table 2-1 Positioning of the power derived from natural gas and renewable energy in the national energy policy

Item	Details
Goals	・ To increase the roles of businesses that lead the transition to a market economy for the efficient operation of the economy ・ To develop energy to be exported, and strengthen the base for use of energy for domestic consumers ・ To cement strategic partnerships inside and outside Japan ・ To become less dependent on foreign countries, and enhance local content
Strategies	・ To correct the difference in price between domestic and exported ones ・ To help design a master plan for energy ・ To introduce the market mechanism involving producers and consumers ・ To allocate the roles of the private and public sectors in large-scale development ・ To support the private sector in energy development ・ To promote the development of technologies and personnel ・ To establish a framework for cooperation among energy-related staff ・ To brush up the business management skills in energy-related sections
Action plan (electricity and electrification)	・ To enhance power generation with renewable energy, diversify fuels for power generation, and reduce petroleum consumption ・ To export electric power generated at distant places to neighboring countries ・ To develop new power generation technologies, such as cogeneration and fuel cells ・ To establish power generation operation methods for environmental conservation
Action plans (consumer-use, commercial section)	・ To recommend energy-saving devices ・ To convey information on energy-saving devices to consumers ・ To develop transportation technologies, small-scale storage facilities, etc. for facilitating the shift to natural gas consumption
Action plans (industrial section)	・ To promote the switch from in-house power generation to the sale of electricity to electric power suppliers ・ To promote the use of cogeneration-type power generators ・ To promote the use of local energy in regions where electrification has not been conducted ・ To use briquettes in small factories, including tea plantations, rubber factories, and greenhouse farms
Action plans (transportation section)	・ To develop biodiesel fuel ・ To develop electric vehicle systems for public transportation in urban areas ・ To set automobile fuel standards

Source: Produced with reference to "PERATURAN PRESIDEN REPUBLIK INDONESIA NOMOR 22 TAHUN 2017 TENTANG RENCANA UMUM ENERGI NASIONAL" in the website of Department of Energy & Mineral Resources; https://www.esdm.go.id/assets/media/content/content-rencana-umum-energi-nasional-ruen.pdf, acquired on Jan. 20, 2020

2.1.2. National Medium-term Development Plan (RPJMN)

In January 2020, the Indonesian government announced a new National Medium-term Development Plan (Rencana pembangunan jangka menengah nasional: RPJMN). The plan assumes an average annual growth rate of 5.7 to 6.0% in real GDP, which will require an investment of approximately 35,000 trillion rupiah to achieve. It had also set a goal of raising gross national income (GNI) per capita to 5,810 to 6,000 US dollars in 2024[1]。

In the RPJMN, the President's nine missions and five directives have been established, and from these, seven development challenges are presented as below. The development challenges include the consideration of the environment, improvement in resilience against disaster, and measures against climate change.

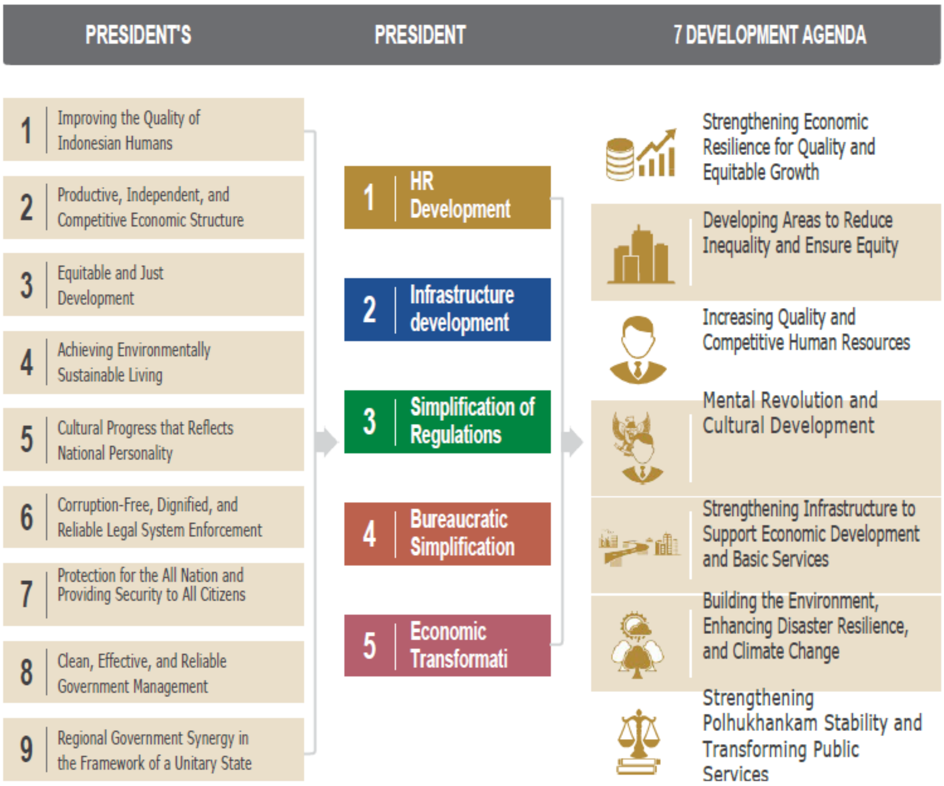

Figure 2-1 Mid-term development plan (RPJMN), presidential directives, and 7 development challenges

Source: Medium-term development plan (RPJMN, 2020-2024)

The RPJMN's macro-development goals also mention GHG emission reduction targets, with a target of 27.3% GHG reduction by 2024 in order to achieve the 29% reduction in 2030, compared to BAU, listed in the aforementioned NDC (see the figure below).

[1] Ministry of National Development Planning of Indonesia, "Rencana Pembangunan Jangka Menengah Nasional 2020-2024, Narasi (Mid-term National Development Plan)"

Figure 2-2 Mid-term management plan (RPJMN), macro-development goals for 2020-2024

Source: Medium-term development plan (RPJMN, 2020-2024)

Energy development plans show that the country continues to rely on fossil fuels, and energy self-sufficiency, which was 75% as of 2018, is expected to decline to 28% by 2045. In order to compensate for this, the government is promoting the use of renewable energy, as stated in the aforementioned RUEN, with the goal of increasing their share to 23% by 2024.

The plan outlines the following policies for energy development

1) Accelerating the development of renewable energy
2) Increasing the supply of biofuel
3) Enhancing energy security and energy conservation
4) Increasing energy supply to industry
5) Development of NRE (New/Renewable Energy) and support for industry

In achieving the target of increasing renewable energy, the government has also specified that it will focus on the development of renewable energy derived from oil palm, with an expected investment of 32 trillion rupiah by 2024.

The diversification of power sources has not kept pace with the demand for electricity in urban areas, and dependence on energy derived from fossil fuels persists. Photovoltaic power generation has not been widespread, but this is considered because available solar panels are limited to expensive domestic panels of low quality, and the development of the grid and a purchase system has not progressed sufficiently to create a foundation for the use of renewable energy.

2.2. Results of the Project Survey

2.2.1. Bali Province's Initiatives for Realizing a Low-carbon Society

(1) Primary Policies and Measures

Indonesia has formulated the RPJMN, and in line with this, provincial medium-term development plans (Rencana pembangunan jangka menengah daerah: RPJMD) have been formulated in each province. The latest RPJMD in Bali is for the period from 2018 to 2023[2]。

The RPJMD is closely related to the RPJMN, and the 22 development missions set out in the Bali RPJMD (2018-2023) are set to align with the seven development missions of the RPJMN (2015-2019).

Regarding the statements related to energy development in the Bali RPJMD, Mission 21 out of the 22 missions is relevant. The following is an excerpt from Mission 21, which is related to the environment, of the 22 missions. Each mission has its own set of targets, and each target has its own set of indicators for achievement.

Table 2-2 RPJMD of Bali Province: Mission 21

Mission 21: To actualize a Bali Krama lifestyle by developing a clean, green, beautiful environment							
Goal 2: To realize a clean, green, beautiful living environment							
Index: Environmental index (IKLH)							
Index	Unit	2018 (reference year)	2019	2020	2021	2022	2023
1. Water quality index	Index	63.2	64.7	66.2	67.7	69.2	70.7
2. Air quality index	Index	92.0	92.4	92.9	93.4	93.9	94.4
3. Reduction of GHG emissions	(%)	8.4	9.4	10.4	11.4	12.3	12.3
4. Ratio of renewable energy	(%)	0.4	0.4	1.1	7.1	13.8	20.0

Source: Mid-term development plan of Bali (RPJMD)

(2) **Energy-related Policies of Bali Province**

1) **Energy Policy of Bali Province**

Bali Province has been developing policies to promote the development of renewable energy, and according to interviews with government officials of the province, the relevant laws and regulations include the following.

- Regulations relating to Bali Province's Comprehensive Energy Plan (2020-2050) (Rencana Umum Energi Daerah: RUED) (No.9/2020)
- Governor's Regulations on Clean Energy in Bali Province (No. 45/2019)
- Governor's Regulations on Battery Powered Electric Transport Machines (No. 48/2019)
- Governor's Regulations on Energy Planning in Bali Province 2020-2039 (No. 123/03-M/HK/2020)

[2] Mid-term development plan of Bali (RPJMD, 2018-2023)

2）Integrated Energy Plan of Bali Province (RUED)

In Indonesia, based on its National Energy Policies (Kebijakan Energi Nasional: KEN) and its New National Energy Policies (RUEN), each province has developed a comprehensive energy plan (RUED).

In September 2020, Bali Province also formulated the "Regulations relating to Bali Province's Comprehensive Energy Plan (2020-2050)," which stipulates policies to promote the use of clean energy. Clean energy in this context refers to natural gas and new and renewable energy. In its long-term energy plan, Bali Province aims to increase its share of renewable energy in its power supply structure from 0.27% in 2015 to 11.5% in 2025 and 20.1% in 2050. In principle, the RUED plan will be reviewed every five years.

In terms of the ratio of fossil fuels in the power supply composition, the plan is to reduce the ratio of coal-fired thermal power in the future and eliminate it by 2050. Oil use will be reduced from what was 75.7% in 2015 to 45% by 2050. Regarding the share of gas in the power supply structure, it was 4.4% in 2015, but is slated to increase to 56.2% by 2025, after which it is expected to decrease.

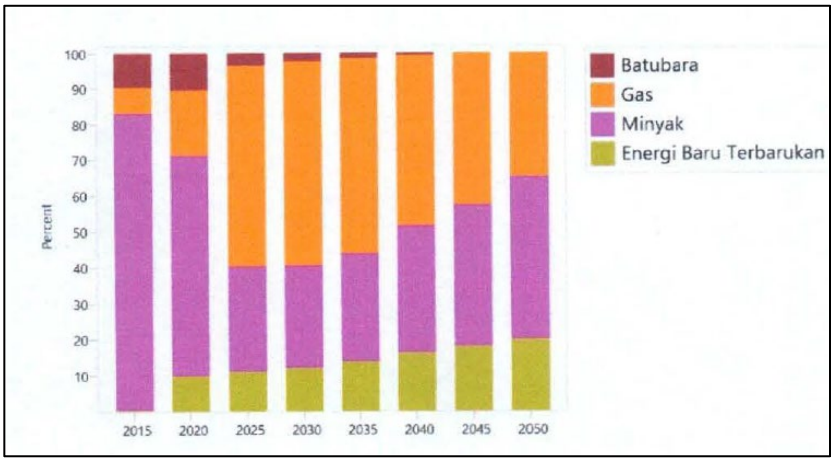

Figure 2-3　Future Power Source Composition in Bali Province

Source: Regulationon the Comprehensive Energy Plan for Bali Province (2020-2050) (RUED) (No.9/2020)
Legend from top right: coal, gas, oil, renewable energy

Table 2-3　Future Power Supply Composition in Bali Province

Energy category	2015	2025	2050
	(%)		
Coal	19.6	3.3	0.0
Gas	4.4	56.2	34.9
Petroleum	75.7	29.3	45.0
New/renewable energy	0.3	11.5	20.1

Source: Regulation　on the Integrated Energy Plan for Bali Province (2020-2050) (RUED) (No.9/2020)

In addition, the long-term greenhouse gas emissions in RUED are as follows (Table 2-4). As a result of future economic growth and increased consumption, emissions are expected to increase from 6,154,000 t-CO_2/year in 2015 to 9,296,000 t-CO_2/year in 2030 and 21,279,000 t-CO_2/year in 2050.

It can be observed that the impact of the transportation sector is particularly large in this category, accounting for nearly two-thirds of the total. Considering the fact that diesel fuel is the primary fuel used in the transportation sector in Bali, the low-carbon potential of fuel change in the transportation sector is significant.

Table 2-4 Projected Greenhouse Gas Emissions in Bali Province
(in thousands of metric tons of CO_2)

Sector	2015	2020	2025	2030	2035	2040	2045	2050
Industry	167	202	246	317	415	556	742	936
Transport	4,236	4,878	5,524	6,342	7,518	9,115	11,133	13,570
General household	353	434	486	503	517	527	535	542
Commerce	597	707	771	1,096	1,580	2,260	3,125	4,154
Other	801	844	879	1,039	1,238	1,465	1,762	2,076
Total	6,154	7,065	7,906	9,296	11,268	13,923	17,298	21,279

Source: Regulations regarding the comprehensive energy plan of Bali (2020-2050) (RUED) (No. 9/2020)

The Bali Province RUED sets out three main policies, and concurrently, six supporting measures have been developed to support them. The following are excerpts from the main policies of the Bali RUED regarding gas supply and renewable energy.

Table 2-5 Bali Energy Development Plan (RUED, 2020-2050) Primary policies for gas supply and renewable energy development

Strategy	Program	RUED Activities	Related institutions	Period
Policy 1: Access to energy according to local demand for energy				
Policy 3: Use of renewable energy in local areas				
Promotion of use of new/renewable energy	Improvement in the share of new/renewable energy in the composition of power sources	New/renewable energy development goal to be attained by 2025: 228 MW 1) Solar power: 213 MW 2) Micro-hydroelectric: 2.8 MW 3) Rooftop solar panels: 10 MW 4) Biomass: 0.9 MW 5) Wind power: 1.3 MW New renewable energy development goal to be attained by 2050: 537 MW 1) Solar power: 500 MW 2) Micro-hydroelectric: 6 MW 3) Rooftop solar panels: 20 MW 4) Tidal power: 4 MW 5) Biomass: 3 MW	Ministry of Labor, Land, and Immigration, Development Bureau, private enterprises, Ministry of Transportation, Ministry of Marine Fisheries, and Ministry of Public Works	2020-2050

Strategy	Program	RUED Activities	Related institutions	Period
		6） Wind power: 4 MW		

Source: Regulations regarding the comprehensive energy plan of Bali (2020-2050) (RUED) (No. 9/2020)

The six measures that support the primary policies are as follows:

- Support Measure 1: Energy conservation and diversification
- Support Measure 2: Environment and safety
- Support Measure 3: Energy pricing, subsidies and incentives
- Support Measure 4: Infrastructure development and access to infrastructure for residents and the energy industry
- Support Measure 5: Research, development, and application of energy technologies
- Support Measure 6: Institutions and financial contributions

The following is a selection of policies related to renewable energy.

Table 2-6 Bali Energy Development Plan (RUED, 2020-2050) Primary support measures for gas supply and renewable energy development

Strategy	Program	RUED Activities	Related institutions	Period
Supportive measure 3: Energy prices, subsidies, and incentives				
Fair energy price	Calculation of appropriate energy prices for supplying renewable energy by utilizing local resources	● Survey on the feasibility of development of systems for solar power, bio energy, wind power, and tidal power generation ● Setting of special/clean electric power prices for producing opportunities to invest in renewable energy, and establishment of regulations for the cooperative scheme	ESDM, Bali Development Planning Bureau, and private enterprises	2020-2050
Incentives for use of renewable energy	Provision of energy subsidies and incentives	● Design of measures regarding the subsidies for electric charges to poor citizens and the development of a new scheme for subsidies for electric charges (funded by local budgets)		

Source: Regulations regarding the comprehensive energy plan of Bali (2020-2050) (RUED) (No. 9/2020)

In addition to the RUED, the Governor's Regulations on Clean Energy in Bali Province (No. 45/2019) outlines measures for independent clean energy production in the province, and as part of its efforts to promote renewable energy, the government has stated that it will replace the use of diesel and heavy oil with gas, rooftop solar power, biofuels, and other potential renewable energy sources.

The following table shows the roof-mounted solar PV installation projects underway in 2020.

Table 2-7 Rooftop solar power generation projects underway in Bali in 2020

Funding source	Facility capacity [kWp]
Funds from ESDM Renewable Energy/Energy Saving Bureau, Phase I (7 sites)	270
Funds from Korean KEA and BAPPENAS (including recharging equipment installed in solar power systems)	6.6
Funds from ESDM Renewable Energy/Energy Saving Bureau, Phase II (2 sites)	150

Source: Produced with reference to "Proposal Bali Mandiri Energi Dengan Energi Bersih Di Provinsi Bali" in Bali (2020)

(3) Demand for Electric Power and the Potential for Renewable Energy in Bali Province

Currently, approximately 70% of the electricity supply to Bali Province is generated within Bali, with most of the power coming from thermal power, and the remainder procured via undersea cables from the Java Island. The composition of thermal power generation within the Bali Province is dominated by coal-fired power generation, with natural gas being used for the rest. There is also a diesel power plant, but it is currently inactive.

The total installed capacity of electric power in Bali Province is 926 MW as of 2019, which would be 1,261 MW if the inactive diesel oil-based generation capacity is included. The province aims to increase its installed capacity by 6% annually until 2039, and aims to expand it to 3,206 MW around 2035-2039[3] (Table 2-8).

As the installed capacity increases, Bali Province plans to increase the ratio of gas-fired power generation. In accordance with PLN's Indonesia Power Supply Business Plan (Rencana Usaha Penyediaan Tenaga Listrik: RUPTL) 2019-2028, the government plans to shift to natural gas as fuel for thermal power generation, and a 350 MW × 2 gas-fired power plant is to be developed in Celukan Bawang, in the northern region of the Bali island, to meet future electricity demand.

Table 2-8 Future power generation capacity and forecast for Bali

	2020-2025	2025-2030	2030-2035	2035-2039
Target facility capacity [MW]	1,418	1,897	2,539	3,206
Peak demand [MW]	1,091	1,459	1,953	2,466

Source: Produced with reference to "Proposal Bali Mandiri Energi Dengan Energi Bersih Di Provinsi Bali" in Bali (2020)

As of 2019, the installed capacity of renewable energy is 1.8 MW for small hydropower and approximately 4 MW for solar power, which is less than 1% of the power supply composition. On

[3] Bali (2020) "Proposal Bali Mandiri Energi Dengan Energi Bersih Di Provinsi Bali" (Policy for self-sufficiency of energy supply by adopting clean energy)

the other hand, however, Bali's renewable energy generation potential is estimated to be as high as 3,686 MW, and future development is anticipated.

Table 2-9 Potential for Bali Province's Generation of Renewable Energy

Category	Tidal	Wind	Biogas	Biomass	Solar	Water	Geo-	Category
Facility capacity [MW]	320	1,019	45	147	1,254	624	262	15
Total [MW]	3,686							

Source: Produced with reference to "Proposal Bali Mandiri Energi Dengan Energi Bersih Di Provinsi Bali" in Bali (2020)

(4) **Challenge of Distributing Renewable Energy in Bali**

In 2021, electricity supply in Bali hit a new high for both private-sector business and consumer households, reaching 88% of the total electricity supply capacity of 4.7 terawatt-hours based on installed equipment. Electricity in Bali comes from the Java-Madura-Bali grid and independent power producers (IPPs) connected to the grid, or from off-grid power plants.

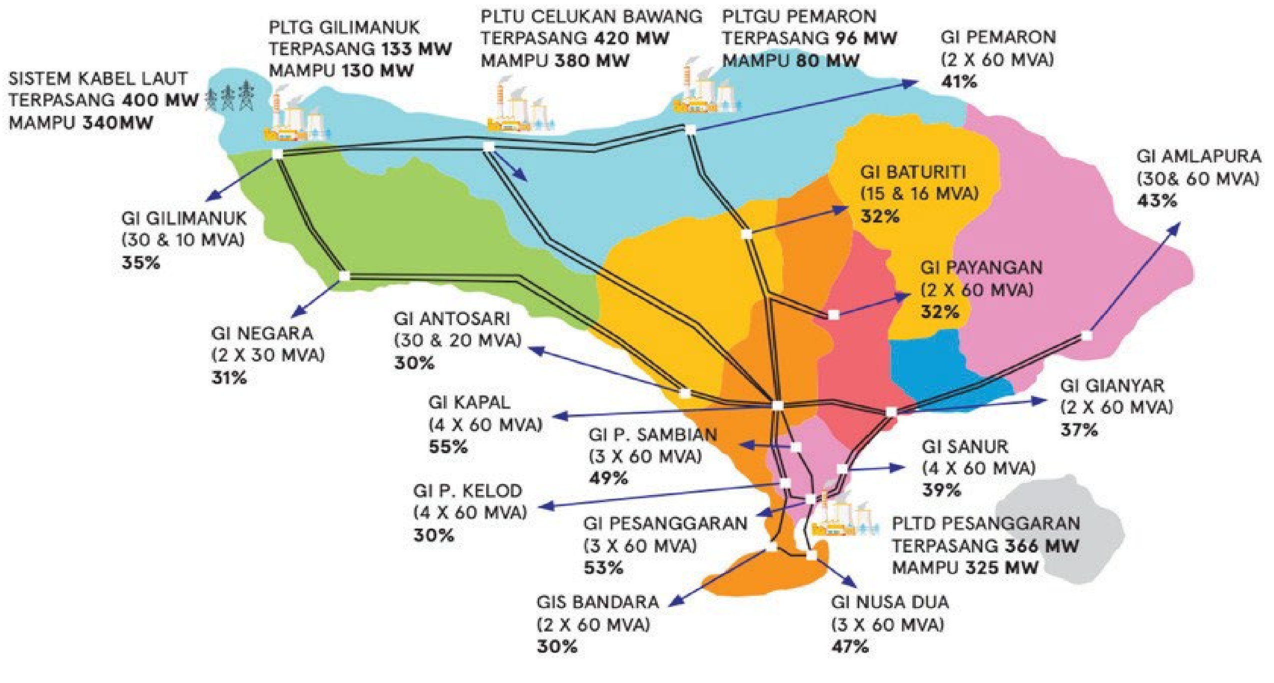

Figure 2-4 Electricity Grid Map in Bali

The supply capacity of existing power plants is not considered sufficient, however, taking into consideration the intermittent nature of renewable energy, Perusahaan Listrik Negara (PLN), which manages and operates the electrical power system, does not seem to be positive about connecting renewable energy to the power grid.

In formulating the Rencana Umum Energi Daerah 2020-2050, Bali Governor I Wayan Koster stated that the capacity of all power plants in Bali in 2019 was 1,440.85 MW, and explained that it includes 400 MW from Java through submarine cables, 426 MW from Celukan Bawang coal-fired power plant, 201.60 MW from Pesanggaran gas-fired power plant, 240 MW, and 410.85 MW from diesel-fired power plants in Gilimanuk, Pemurong, and Pesanggaran, which are being suspended.

The generatable power is 927.20 MW, however, because the diesel-fired power generation facilities are normally on standby (they do not operate except emergency situations), and the maximum peak load reaches 920 MW, which makes the reserve power in Bali only 0.77% of rated power. Since it is recommended that 30% of peak load capacity be set as reserve power, securing reserve power is a major challenge.

For the reserves needed for availability and security of energy, the province of Bali offers two options. The first option is to receive electricity supply from the Paiton thermal power plant in East Java and include fuel gas supply from Java, in order to make up the shortfall. The second option is to expand the existing power generation capacity in Gilimanuk, Pemaron, Serkan Bawang, and Pesanggaran.

Under these circumstances, the impact of the inflow of renewable energy into the grid on supply stability has become a concern for the government-run power PLN, creating a situation where it is difficult to obtain permission for reverse power flow not only on the scale of mega-solar power, but even solar power generation (self-consumption) for household consumption. As described in the results of interviews with Bali Province Solar Power EPC (Engineering, Procurement, and Construction) business operators shown in the next chapter and beyond, the PLN has approved the following installation models as solar power deployment schemes for households and business operators.

Business Model Utilizing Solar Power in Indonesia

① A model in which PLN installs a rooftop solar power system on the roof of a customer's building and is responsible for the operation of such system. The customer bear the initial investment.
② A model in which PLN provides a comprehensive solution of installing and maintaining a rooftop solar power generation system, and customers pay their electricity bills as usual while receiving special pricing (amount stipulated by the government and PLN). PLN bears the initial investment.
③ A model that allows a customer to work with an entity to install a rooftop solar power generation system on the customers' building. The financing and management of rooftop solar power generation systems shall be determined by agreement between the two parties. Initial investment is borne by the service provider.
④ A model in which a customer work with an Engineering Services Company, ESCO, or other organization to install or manage a rooftop solar power generation system on the customer's building. Initial investment is borne by ESCO operators.

However, as mentioned above, the concern about the grid impact of these renewable energy inflows have prevented PLN from smoothly processing reviews in the process of PPA and net metering, and many cases have been put on hold or delayed.

The same applies to mega-solar projects under the Feed-in Tariff Program. PT Medco Solar Bali Barat and PT Medco Solar Bali Timur, subsidiaries of Meco Power, which is a major private oil and gas distributor in Indonesia, have signed the PPA for solar power generation in March 2022 in East and West Bali with an installed capacity of 25 megawatt-peaks each. Medco Power had set a goal to complete this construction of the solar power plant in 2022, however, negotiations on purchasing electricity from PLN's grid have been protracted. Even though the PPA was signed in March 2022, the construction has not yet begun as of February 2023.

As for the background of the system, it can be considered that the constraints of the electricity grid as infrastructure are currently hindering the promotion of the policy, while they are promoting the decarbonization. While there are some criticisms against PLN and there are differences in the policies between the government and electric power companies, it is also necessary to understand the situation of PLN in terms of preventing technical problems from occurring from the aspect of stable power supply.

In such reality, the immediate solutions to accelerate the domino effect to execute decarbonization are to use systems (storage batteries, etc.) that enable a stable supply while utilizing renewable energy, or an off-grid electricity supply model.

Based on the above considerations, this study will examine the potential use of hydrogen and storage batteries for meeting electricity demand in the transportation field, which is expected to be decarbonized in the future.

2.2.2. Study for the Grid Connection Project Utilizing Hydrogen Production and Fuel Cells

(1) Assessment of Compatibility of H2One™ System of Toshiba Energy Systems & Solutions Corporation

1） Summarizing the results of previous studies conducted by Toshiba Energy Systems & Solutions Corporation

① Background of the study

Hydrogen fuel can be produced from a variety of materials and is classified according to the production method and the intensity of CO_2 emission. When hydrogen is produced from fossil fuel and no treatment is made on the CO_2 emitted in the process, it is called the "gray hydrogen." Secondly, when hydrogen is produced from fossil fuel and CO_2 emission is reduced by capturing, storing, and utilizing the CO_2 emitted in the production process, it is called the "blue hydrogen." Finally, when CO_2 is not emitted in the process of water electrolysis-based hydrogen production using renewable energy-based electricity is classified as the "green hydrogen."

Figure　2-5　Classification of hydrogen

From the viewpoint of decarbonization, this project mainly targets solar power as a renewable energy source. In general, the green hydrogen is considered to have challenges in terms of economic viability, however in Bali, as mentioned above, there are aspects where the adoption is advantageous based on the following circumstances:

・Bali has great potential for solar power generation and is expected to adopt the solar power generation as a central part of the renewable energy promotion plan, however, as the output of solar power generation fluctuates according to the weather, it is difficult to control under Bali's weak infrastructure of power transmission and distribution, and the grid connection process is not progressing.

・Even if the grid connection is established, the grid will have to rely on fossil fuel-derived power plants in terms of securing base load power sources for grid stability (supplying backup power sources in the event of zero output due to cloudy weather, etc.)

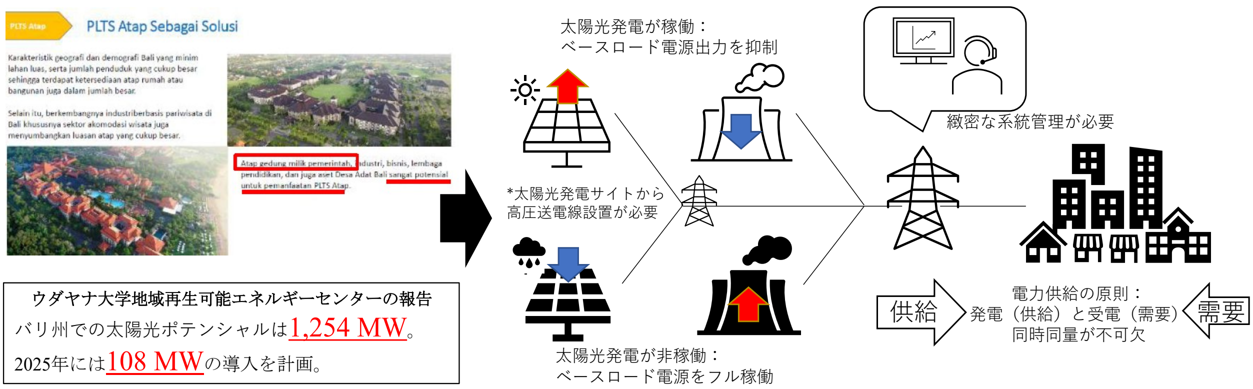

Figure 2-6　Solar Power Potential and Problems with Adoption in Bali

In short, even though it sits in the environment in which a large amount of electricity can be generated using solar power generation, it does not have established infrastructure to make effective use of such environment, and abundant photovoltaic energy cannot be put to good use.

A comparison with storage batteries is also necessary from a viewpoint of stable output on the power generation side. Lithium-ion batteries are said to have charge-discharge efficiency of 90-95%, and they can be used to build a stable private power generation system as they store surplus power and discharge the electricity when the power supply is insufficient. On the other hand, the larger scale of a storage battery, the more issues arise in cost and installation area. Furthermore, taking into consideration the self-discharge, it is difficult to support long-term power storage.

Given such restrictions of storage batteries, the method of storing power in the form of hydrogen (Power to Gas) and generating power with fuel cells is advantageous for cases above a certain size with possible uses other than electricity. The energy efficiency of hydrogen is (80% of electrolysis efficiency) × (55% of power generation efficiency by fuel cells) = approximately 44%, and even if heat is also used in the co-generation system (supplying both heat and electricity), energy efficiency is considered to be about 70%. However, simply adding more hydrogen storage tanks can easily and inexpensively increase the capacity. In addition, large-scale energy storage is possible across seasons and years since there is no self-discharge from the storage tanks.

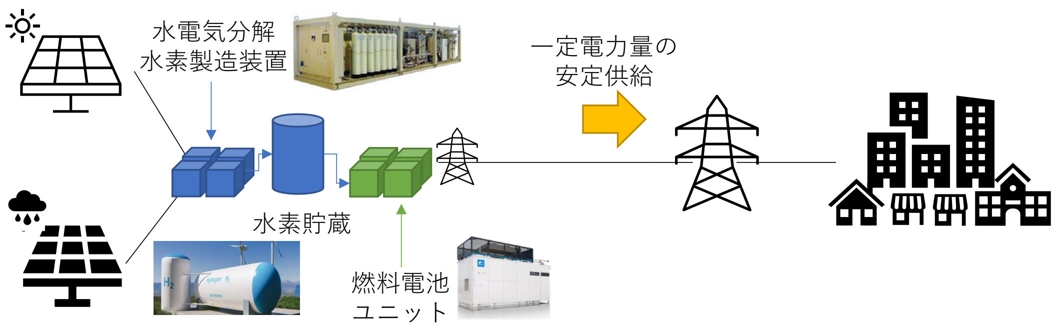

Figure 2-7　Schematic diagram of stable electricity supply utilizing hydrogen

In Japan as well, efforts to produce hydrogen from surplus power of renewable energy as a regulator of renewable energy have been underway in recent years. This is because water electrolysis, which is used to produce hydrogen from electricity, has excellent load responsiveness and can be utilized for grid frequency adjustment by viewing it as demand response. This is based on the idea of effective use of surplus power that is subject to output control in Japan. However, if all of the renewable energy is used for hydrogen production, the generated power can be used effectively and it is not subject to the restrictions of output control, as the water electrolysis equipment can absorb the load as described above.

Moreover, hydrogen has the advantage of being used not only for power storage, but also as a fuel for transportation and other applications. Compared to gasoline and diesel fuel, most of which are currently imported into Indonesia, hydrogen derived from renewable energy sources can be supplied at stable prices as domestically produced fuel, and the advantage can be found in being carbon-free.

Indonesia, a country that produces natural gas, is promoting the use of natural gas in the transportation sector, and has been studying its potential in previous inter-city cooperation projects. On the other hand, there were some challenges, such as that the construction of a huge natural gas infrastructure must be a prerequisite, and that decarbonization was not achieved while low-carbon effects were seen. Economic challenges in the use of hydrogen remain, however, this project advances the study with the aim of demonstrating the system that will serve as a foothold, since the possibility of hydrogen diffusion in the future can be fully considered, when looking ahead to the utilization of subsidies including JCM projects, the significance of decarbonization, and soring energy prices.

Nonetheless, in the above mentioned net-zero emission plan for Bali by 2045, the promotion of electric vehicles has just been addressed. In addition to conducting this study while paying attention to the optimal segregation of electric vehicles and hydrogen vehicles, useful proposals for electric vehicles will be made based on the results of efforts in Toyama City, and contribution to the promotion of Bali’s plan will be considered. The application to transportation will be discussed in detail in the next chapter.

② Results of literature study and interviews

This study reviews a model in which renewable energy-based power is stored in the form of hydrogen, and then electricity generated through fuel cells is consumed. In Toyama City, the Toyama Hydrogen Energy Promotion Council has adopted Toshiba Energy Systems & Solutions Corporation’s H2One™ system, a packaged technology that integrates renewal energy, fuel cells, and a control system, to promote the adoption of hydrogen infrastructure to realize a low-carbon society, and the system is now in operation. Further, the company is a regular member of the Toyama Hydrogen Energy Promotion Council.

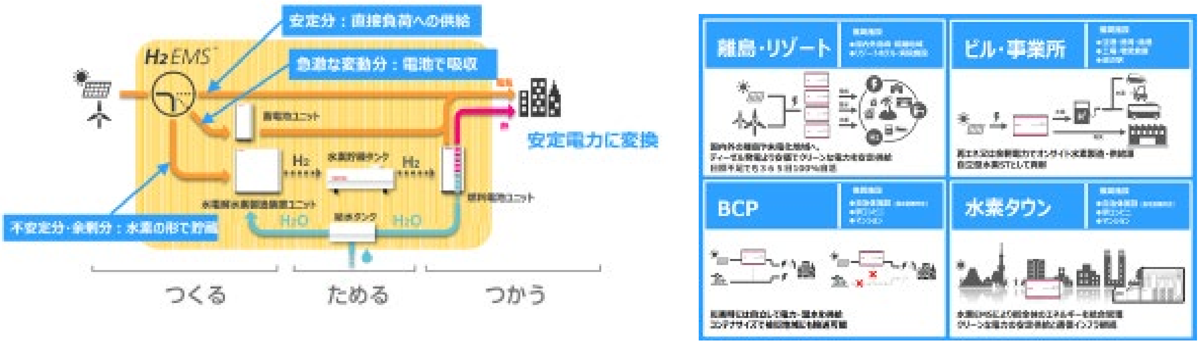

Figure 2-8　Overview of H2One™ System (left) and Examples of Applications (right)

Source: Toshiba Energy Systems & Solutions Corporation

Figure 2-9　Toyama City Hydrogen Station (left) and the Opening Ceremony (right)

Source: Toyama City and Toshiba Energy Systems & Solutions Corporation

Toshiba Energy Systems & Solutions Corporation is conducting site selection, planning and economic feasibility assessments in Indonesia, as part of the “Project Development Study on the Application of Self-Sustained Hydrogen Energy Supply System for Remote Islands in Indonesia and the Philippines” under the “FY2018 Feasibility Study on Overseas Development of High-Quality Energy Infrastructure” by the Ministry of Economy, Trade and Industry. In that survey, they mentioned the compatibility of H2One™ in rural areas of Indonesia where electricity rates are high, and reported that economic viability can be established in areas where electricity rates are generally 4,000 IDR/kWh (approximately 40 yen) or higher.

Here, let us see the electricity rates in Bali (Java-Bali Grid).

The rate structure in Indonesia is somewhat complex, with 37 different applicable rate systems. Subsidies are applied to a portion of this rate structure, from the perspective of poverty alleviation, etc.

PLN

PENETAPAN

PENYESUAIAN TARIF TENAGA LISTRIK *(TARIFF ADJUSTMENT)*

JANUARI - MARET 2023

NO.	GOL. TARIF	BATAS DAYA	REGULER		PRA BAYAR (Rp/kWh)
			BIAYA BEBAN (Rp/kVA/bulan)	BIAYA PEMAKAIAN (Rp/kWh) DAN BIAYA kVArh (Rp/kVArh)	
1.	R-1/TR	900 VA-RTM	*)	1.352,00	1.352,00
2.	R-1/TR	1.300 VA	*)	1.444,70	1.444,70
3.	R-1/TR	2.200 VA	*)	1.444,70	1.444,70
4.	R-2/TR	3.500 VA s.d. 5.500 VA	*)	1.699,53	1.699,53
5.	R-3/TR	6.600 VA ke atas	*)	1.699,53	1.699,53
6.	B-2/TR	6.600 VA s.d. 200 kVA	*)	1.444,70	1.444,70
7.	B-3/TM	di atas 200 kVA	**)	Blok WBP = K x 1.035,78 Blok LWBP = 1.035,78 kVArh = 1.114,74 ****)	-
8.	I-3/TM	di atas 200 kVA	**)	Blok WBP = K x 1.035,78 Blok LWBP = 1.035,78 kVArh = 1.114,74 ****)	-
9.	I-4/TT	30.000 kVA ke atas	***)	Blok WBP dan Blok LWBP = 996,74 kVArh = 996,74 ****)	-
10.	P-1/TR	6.600 VA s.d. 200 kVA	*)	1.699,53	1.699,53
11.	P-2/TM	di atas 200 kVA	**)	Blok WBP = K x 1.415,01 Blok LWBP = 1.415,01 kVArh = 1.522,88 ****)	-
12.	P-3/TR		*)	1.699,53	1.699,53
13.	L/TR, TM, TT		-	1.644,52	-

Catatan :

*) Diterapkan Rekening Minimum (RM):
RM1 = 40 (Jam Nyala) x Daya tersambung (kVA) x Biaya Pemakaian.

**) Diterapkan Rekening Minimum (RM):
RM2 = 40 (Jam Nyala) x Daya tersambung (kVA) x Biaya Pemakaian LWBP.
Jam nyala : kWh per bulan dibagi dengan kVA tersambung.

***) Diterapkan Rekening Minimum (RM):
RM3 = 40 (Jam Nyala) x Daya tersambung (kVA) x Biaya Pemakaian WBP dan LWBP.
Jam nyala : kWh per bulan dibagi dengan kVA tersambung.

****) Biaya kelebihan pemakaian daya reaktif (kVArh) dikenakan dalam hal faktor daya rata-rata setiap bulan kurang dari 0,85 (delapan puluh lima per seratus).

K : Faktor perbandingan antara harga WBP dan LWBP sesuai dengan karakteristik beban sistem kelistrikan setempat ($1,4 \leq K \leq 2$), ditetapkan oleh Direksi Perusahaan Perseroan (Persero) PT Perusahaan Listrik Negara.

WBP : Waktu Beban Puncak.

LWBP : Luar Waktu Beban Puncak.

Figure 2-10 Electricity Rates in the Java-Bali Grid

Source: PLN https://web.pln.co.id/pelanggan/tarif-tenaga-listrik/tariff-adjustment

This study is intended to include government, industrial, and office facilities that are not eligible for subsidies. The base rates in the non-subsidized rate system are as shown below.

Table 2-10 Basic Rate Schedule in Non-Subsidized Rate System

Rate Classification	Contracted Electricity	Price (rupiah per kWh)
R-1	TR900VA	1,352.00
R-1	TR1300VA	1,444.70
R-1	TR2200VA	1,444.70
R-2	TR3500-5500VA	1,699.53
R-3	＞TR6600VA	1,699.53
B-2	TR6600VA-200kVA	1,444.70
B-3	>TM200kVA	1,114.74
I-3	>TM200kVA	1,114.74
I-4	>TT30,000kVA	996.74
P-1	>TM200kVA	1,522.88
Public lighting	TR	1,699.53
L	TR,TM,TT	1,644.52

Source: Kompas “Daftar Harga Listrik Per kWh 2022 untuk Golongan Tarif Non-subsidi

October 12, 2022 https://money.kompas.com/read/2022/07/03/130130526/daftar-harga-listrik-per-kwh-2022-untuk-golongan-tarif-non-subsidi?page=all (Press article related to the price revision in 2022)

In Bali, the maximum electricity rate for the industrial sector without subsidies for electricity costs and government-related sectors including public lighting is 1,699.53 rupiah/kWh, which is not even close to the rate at which H2One™ is expected to be competitive, which is 4,000 rupiah/kWh.

On the other hand, in the mountainous areas and remote islands, there are areas that rely on small-scale diesel power generation and have high generation costs (Lembongan, Nusa Ceningan, Nusa Penida, etc.).

These areas are considered to be the areas for which PLN has incentive to reduce the cost of power generation, even though subsidies are applied to end-users. For example, the Ministry of Energy and Mineral Resources published that the cost of power generation in Nusa Penida, a remote island in Bali, exceeds 2,000 rupiah[4].

Moreover, as grid-connected power is more economical in terms of price, it is suggested that it is important to evaluate the overall effect and identify potential users, taking into account heat utilization and other factors, in addition to reducing the cost of power generation by H2One™ by utilizing JCM equipment subsidies.

From the perspective of heat utilization, the utilization of the system for hospitals could be an option. Bali is promoting measures of Green Hospital Implementation, which includes the maximum use of renewable energy, and the efforts are underway at both public and private hospitals.

In the case of Surya Husada Hospital in Denpasar, the grid electricity accounts for 46.5%, fuel 32.5%, and LPG 6.8% of the hospital's energy consumption.[5] Accordingly, it can be inferred that there is a certain level of heat demand. Therefore, for this year, we visited hospitals in Bali and exchanged opinions on the feasibility of installing H2One™.

2） Interview surveys

① Bali Provincial Department of Energy and Mineral Resources

Bali, as an advanced region with measures against climate change, has been working with the Indonesian National Development Planning Agency (BAPPENAS) on initiatives, including projects that contribute to decarbonization. This background provided an opportunity to exchange views with BAPPENAS as well.

With regard to hydrogen, there was a comment that Bali does not have sufficient knowledge on

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[4] KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL "Puncak Mundi, Desa Wisata Energi di Puncak Nusa Penida",2007.
https://www.esdm.go.id/id/media-center/arsip-berita/puncak-mundi-desa-wisata-energi-di-puncak-nusa-penida

[5] JGG-Jurnal Green Growth dan Manajemen Lingkungan Vol. 8 No. 2 Desember 2019
p-ISSN: 2303-2332; e-ISSN: 2597-8020" EVALUASI IMPLEMENTASI MANAJEMEN RUMAH SAKIT DALAM RANGKA GREEN HOSPITAL DI WILAYAH BALI"

the subject, and that they would like to have an opportunity to share information with Udayana University and the Bali Provincial Agency for Technology and Innovation (BRIN). In 2022, the G20 was held in Bali, which showed its openness about adopting advanced technologies, and also demonstrated its intention to take proactive measures against climate change. BAPPENAS also commented that they are ready to work together with Bali to proceed with the efforts, which are in line with the plan that Agency is promoting with Bali. Based on the positive responses from various sources, we coordinated with the Bali side last year, which led to holding the Toyama and Bali Hydrogen Seminar. While the seminar is expected to deepen the understanding of hydrogen technologies and the current technological issues and dissemination issues, we were able to confirm the policy of considering the adoption by utilizing various programs.

In this fiscal year's study, we have continued to exchange opinions with Bali on the possibility of considering the use of hydrogen. During the exchange, the team found that the lack of infrastructure and engineers has become an issue for the use of hydrogen, and obtained the view that H2One™ as a packaged technology is suitable. Based on that, we are in the process of obtaining referrals to hospitals as potential users as described in the next section.

② **Interviews with potential local users**

As mentioned above, Bali is committed to promoting environmental friendliness in hospitals, and both public and private hospitals are working to implement such policy. Particularly, there are many challenges in waste management and energy utilization. With regard to energy, the maximum use of renewable energy sources such as solar power generation is being promoted. Under these circumstances, Bali Mandara Public Hospital, located in the center of Bali, has been coordinating with hospitals in Bali, and been actively engaged in activities including holding seminars to exchange information on green technology. The hospital was introduced to us through Bali, and we conducted interviews with them.

Figure 2-11 Bali Mandara Public Hospital

The hospital's current status shows that the hospital's main users are in the middle/high-income brackets, and the hospital seems to have an intention to maximize the use of renewable energy in a financially viable manner.

Currently, the hospital has solar panels that could generate 100 kilowatts installed, as hospitals located in the province are recommended to obtain 20% of their electricity capacity from rooftop solar panels in accordance with Bali's Governor's Decree No.45/2019. On the other hand, the amount of electricity is not sufficient for the entire amount of electricity required for the hospital, and the hospital aims to increase the ratio of renewable energy ultimately to 100% over a period of several years.

In addition to welcoming proposals that would contribute to the Green Hospital concept, including the installation of H2One™, we obtained information that the current system allows public hospitals to procure equipment directly without going through the bidding process. From the interviews, it was considered viable to proceed with proposals from the perspective of energy management for the entire hospital, adoption of renewable energy, and use of fuel cells that would contribute to a stable supply, so we obtained a consent from them to share detailed information on energy use in the future.

3) Calculation of scale of installation (equipment capacity and power output)

In order to calculate the scale of installation, it was necessary to first grasp the energy consumption (electricity and heat) on the demand side as well as fluctuations of demand, energy costs, a list of energy-consuming equipment, the area where solar panels can be installed (roof, etc.), and sites where the equipment can be installed.

We are in the process of compiling a list of these necessary information and requesting such information from Bali Mandara Public Hospital as a candidate.

The following is the list of data we are requesting from Bali Mandara Public Hospital.

Table 2-11 List of Data Requested from Bali Mandara Public Hospital

Necessary Data	Unit	Notes
Energy Consumption (Electricity)	Kilowatts per year	Actual results for 2022
Energy Consumption (Heat)	(Diesel oil, etc.) Litter per year (LPG, etc.) LSP or m^3 per year	Actual results for 2022
Daily Fluctuation of Energy Consumption (Electricity)	Data by hour, day, month	
Daily Fluctuation of Energy Consumption (Heat)	Data by hour, day, month	
Electricity Cost	Rupiah per year	Actual results for 2022
Other Energy Costs	Rupiah per year	Actual results for 2022
List of Energy Consuming Equipment	Medical equipment, office equipment, lighting, air conditioning, hot bath facilities,	

	etc.	
Area Available for Solar Panel Installation	Area m²	
Sites Available for Equipment Installation	Sites and area	

Out of the necessary information above, the area where panels can be installed and the sites where equipment can be easily identified with reference to Google Earth data and other sources. Therefore, we use the following values as reference values.

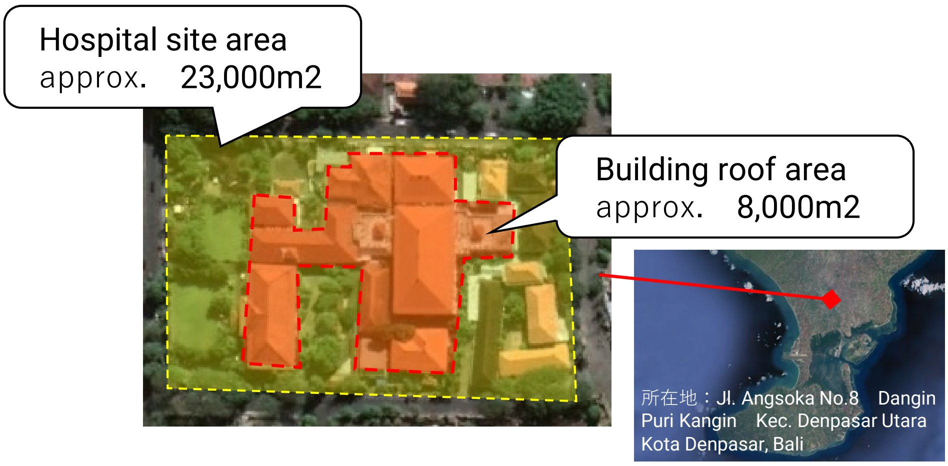

Figure 2-12 Area for Panel Installation and Sites for Equipment Installation at Bali Mandara Hospital

As shown in the figure, we identified that Bali Mandara Hospital has a lot area of approximately 23,000 m^2 and a building roof area of approximately 8,000 m^2.

When installing H2One™, it is necessary to consider the appropriate size based on their energy consumption, and the size of equipment that was demonstrated and installed at Kawasaki Maruen can be used as a reference.

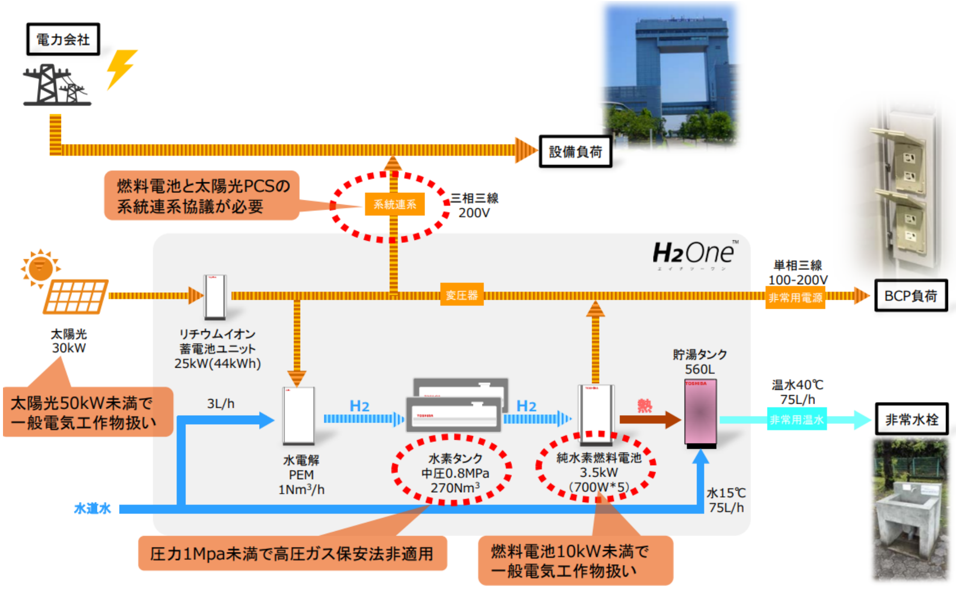

Figure 2-13 Example of Installation at Kawasaki Maruen

This system consists of 30 kW photovoltaic panels, 3.5 kW fuel cells for power generation, and equipment for supplying 40°C hot water at 75 liters per hour.

Since the area required to generate 1 kilowatt by solar power is estimated to be about 10 to 15 m^2, the area required for 30 kW solar panels would be approximately 300 to 450 m^2. The roof area and lot size of the hospital are sufficient for the installation.

The grid emission factor in Bali is 0.613 tCO_2/MWh. Generating 3.5 kilowatts of electricity would be equivalent to supplying 27,720 kilowatts of electricity per year, assuming that facility utilization rate is 90%. Emission reduction amount would be approximately 17 tons per year, or 170 tons per year, assuming a 10-year service life. The scale of the project would be rather small for the JCM equipment subsidy projects, however, in addition to using heat and utilizing more roof area, we will study models utilizing the JCM equipment subsidy project in the future, with a view to potential emission reduction through energy management for the entire hospital.

(2) Study of Local Cooperating Companies

1) Interviews with Local Related Parties

In Indonesia, the financial burden caused by oil import has long been a national issue, and the country has been promoting measures to reduce oil import by increasing the use of coal and natural gas that can be produced domestically. The Pertamina Group is also involved in development and distribution of biofuel as well as efforts for renewable energy based on these national imperatives, and its efforts in this area have become even more active in recent years. As for hydrogen, Pertamina Geothermal Energy ("PGE"), a special purpose company ("SPC") of the Pertamina Group for geothermal power generation, produces about 8,600 kilograms of hydrogen per day. In addition, efforts have been initiated to produce blue hydrogen at the Plaju and Cilacap refineries and to produce water electrolysis hydrogen using electricity derived from renewable energy sources.

In the course of such efforts, we presented the hydrogen utilization initiatives that Toyama City has been promoting, which received a high level of interest. We agreed to exchange information and jointly study hydrogen production using renewable energy in Bali. We also worked with Hokusan Co., Ltd. to provide basic information that will serve as the basis for the study, including information on comparison in price per thermal unit between diesel fuel and hydrogen.

Fuel	Price(YEN)/Unit(MMBTU)	Price(IDR)/Unit(MMBTU)
City gas (LNG)	1,982-3,398	258,453-443,100
Diesel	3,605	470,093

Fuel			Cost(YEN)/Unit(MMBTU)	Cost(IDR)/Unit(MMBTU)
Hydrogen	By-product hydrogen	Caustic soda	570	74,328
		Steel	684-912	89,193-118,925
		Petrochemistry	570	74,328
	Purpose production (existing facility)	Petroleum refining	656-1,055	85,542-137,572
		Ammonia	N. A.	N. A.
	Purpose production (New facility)	Fossil fuel reform	884-1,654	115,274-215,682
		Water electrolysis	2,395 (grid power) 2,167-3,878(solar, PV)	312,309 (grid power) 282,577-505,693(solar, PV)

※Retail price for hydrogen is 2,999 YEN (390,777 IDR)/ MMBTU

1MMBTU=28.32m^3　1Nm^3=0.03507MMBTU　1ℓ=38.04MJ=0.036055MMBTU
1m^3=35.17MJ=0.033335MMBTU　1YEN=130IDR

Figure 2-14　Comparison in Price between Diesel and Hydrogen Presented to Pertamina Gas

For Pertamina Gas, it would be the first time to produce and supply this type of fuel, and we were able to confirm that the company wishes to develop the fuel in stages through small-scale demonstration and other means. Furthermore, they are highly interested in the example made by Toyama City, and plans to visit the city in March 2023 to see the H2One™ site and exchange opinions with the operator, Hokusan Co., Ltd.

2) Interviews with Candidates for Cooperating Companies

To execute items for this study, it is essential to collaborate with local contractors of Engineering, Procuring, and Construction ("EPC") for solar power generation, etc. Therefore, we conducted interviews with the following companies that are executing EPC for solar system installation in Bali.

Table 2-12　List of EPC operators for Solar Power Generation

Business operator	Business overview
PT. Bintang Terbarukan	An EPC operator for solar power generation providing services within the province of Bali, which has experience installing solar power generation systems for government facilities, shopping malls, and small businesses. They are capable of undertaking system installation related to solar power generation.
PT. Nusa Mata Terbit	They provide solar power generation consulting services, EPC operations, and maintenance business throughout Indonesia. They have a track record of

	installing solar power generation systems in the factories of Japanese companies.
PT. Solar Power Indonesia	They provide project design, technical consulting, and EPC operations for solar power generation, throughout Indonesia. In Bali, they are involved in residential projects as well as resorts. They also have experience in off-grid design.
PT. Ineco	They are engaged in EPC operations for solar power throughout Indonesia, after its establishment with investment from a Malaysian company. They are developing their business for business offices and industries in Jakarta and Surabaya. They have high interest in the use of hydrogen.
PT.Fuji Home	A Japanese company that started its business by selling single-family houses, which is also involved in installing solar power generation equipment in hotels and hospitals.
PT. Pramana Putra	They have experience in solar EPC operations throughout Indonesia. They have experience in the construction of mega-scale solar power generation systems.

PT. Nusa Mata Terbit

PT. Solar Power Indonesia

PT. Ineco

EPC operaters such as PT. Pramana Putra

Figure 2-15　Exchanging Opinions with an EPC Operator for Solar Power Generation, etc.

All EPC operators we visited provided information on the stagnation of processes for signing grid connection contracts caused by PLN as a common issue. In Bali, grid connection has been particularly difficult due to the lack of grid capacity, etc., and they are in a situation where installation cannot be promised even though there are many customers who wish to implement solar power generation.

Under such circumstances, there are some companies that consider deploying off-grid operational packages with storage batteries, and the number of customers who wish to switch from on-grid to off-grid is on the rise. While they all recognized that hydrogen is a technology of the future, they all commented that they can handle the installation of panels on the solar side by cooperating and collaborating with the manufacturers of fuel cell systems, when it comes to the installation of a packaged system with solar power generation. As for solar panels, the majority of them are made in China, however, some panels made in Europe are also distributed in the market.

2.2.3. Discussion on the Project for Utilizing the Mobility of FCVs and EVs

(1) Feasibility of introduction of FCVs

Hydrogen can be used as a transportation fuel in addition to electricity, which is an advantage. The introduction of fuel cell vehicles (FCVs) came to be required and it is necessary to solve cost-related issues; however, their high energy density makes them more cost-effective than electric vehicles (EVs) due to better mileage. Since the infrastructure development for hydrogen refueling is an issue in the region, it is expected to be suitable for industrial vehicles that will continue to run for long periods of time in a relatively small area.

While the development of hydrogen stations for vehicles has been a challenge in terms of cost, PDC Machines LLC, based in Pennsylvania, the U.S., manufactures a compact packaged water electrolysis-based hydrogen generation and fueling unit called "SimpleFuel™" and has previously installed more than 500 units. In Japan, the system has already been installed for forklifts at Toyota's Motomachi Plant in Toyota City, Aichi Prefecture, and to fuel hydrogen buses at the Harumi Hydrogen Station in Toyosu, Tokyo.

会社設立	1977年
従業員数	約180名
生産拠点	アメリカ ペンシルベニア州（第4工場建設中）
	ISO9001認定工場
	ASME Section VIII, Division 1 認定工場
販売拠点	アメリカ、中国、韓国、日本、ドイツ
代表取締役社長	Kareem Afzal
製品	ダイアフラム式圧縮機/水素ステーション用パッケージ
納入実績	累計約4,000台の圧縮機を世界中に販売
	水素充填用途、累計約520台の出荷
	（マーケットシェア約60%）
認証/規格対応	ASME, ANSI, AWS, CSA, CE, SQL, KGS, KOSHA, NEC, NFPA, OSHA, KHK, UL

Figure 2-16 Overview (left) and achievements (right) of PDC Machines LLC

Source: PDC Machines LLC

Figure 2-17　Overview (left) and system configuration (right) of SimpleFuel™

Source: PDC Machines LLC

"SimpleFuel™" can automatically and seamlessly produce hydrogen, boost pressure, and fuel machines by supplying electric power and water, and has the potential to decarbonize vehicles in warehouses, airports, ports, factories, etc., when installed in combination with fuel cell forklifts and other equipment.

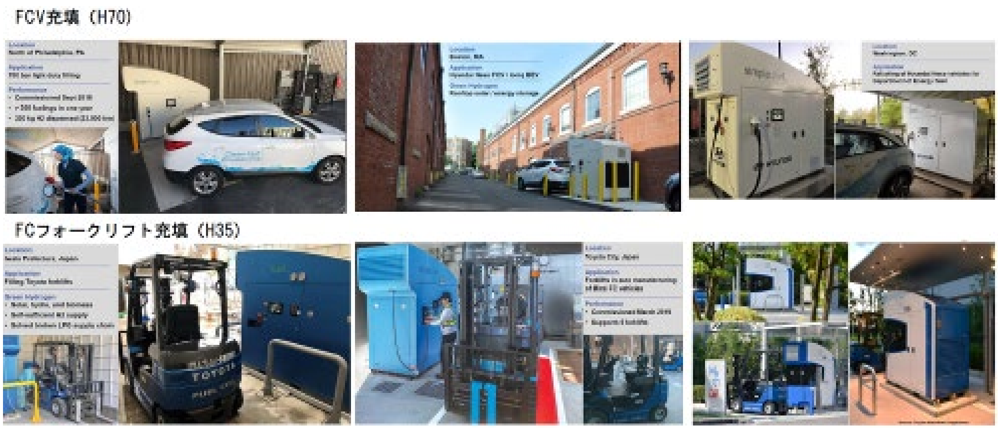

Figure 2-18　Cases of installation of SimpleFuel™

Source: PDC Machines LLC

In this survey, we will work with PDC in the U.S. and PDC Machines LLC in Japan to select candidate sites and formulate an implementation plan in Bali Province. "SimpleFuel™" can produce 20 kg of hydrogen per day with a power supply of 100kW and a water supply of 12L/h. For a 1.8-ton fuel cell forklift, the amount of hydrogen required for 8 hours of operation is estimated to be 1.0 kg, which can be used to operate 20 forklifts. The cost of installing the global model of the "SimpleFuel™" system is 100 million yen per unit.

Bali Province is considered suitable for the introduction of forklifts used within a limited area due to advanced measures to popularize electric vehicles and the challenge of installing stations, which is an issue in popularizing hydrogen vehicles.

Since forklifts and other cargo handling equipment have many applications in ports, the analysis will be conducted at the Port of Benoa, Bali's main port.

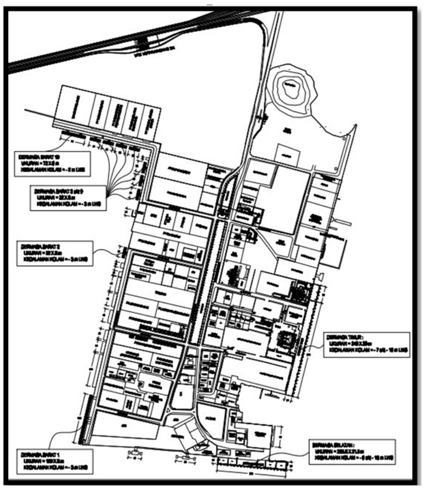

Figure 2-19 Port of Benoa

The Port of Benoa is the gateway port to Bali and supports the provinces' economy and tourism. It is a natural harbor favorably shielded by Serangan Island and Cape Benoa.

Since sightseeing and fishing boats, as well as cargo ships dock at the port, the use of forklifts is expected, especially for cargoes.

According to interviews with the Bali Provincial Department of Energy and Mineral Resources, the Port of Benoa has launched a green port concept and has developed plans for energy conservation, sewage treatment, and protection of the surrounding environment[6].

Moving forward, information will be gathered via the Department of Energy and Mineral Resources on the items listed below to examine the potential use of hydrogen in the forklifts to be utilized.

Table 2-13 Items to be discussed regarding the potential use of hydrogen in forklifts

Items	Objectives
Annual cargo tonnage	Optimal forklift specifications will be deliberated based on the amount of cargoes handled
Detailed diagram of the cargo-handling yard	To check whether sufficient space is available for fuel supply and security
Number of forklifts	To confirm the current number of units in operation
Forklift specifications	To confirm the year of introduction, specs, etc.
Forklift fuel consumption	To calculate annual fuel consumption and mileage

Based on the information collected, we plan to examine the feasibility of introducing fuel cell forklifts, their economic efficiency, and their effectiveness in reducing CO_2 emissions.

[6] https://matadewata.com/28/12/2022/pelabuhan-benoa-terima-penghargaan-green-port-awards-2022/

(2) **Feasibility of adoption of EVs**

1) **Measures to promote EVs**

Bali Province aims to lead the nation in its strategy to promote electric vehicles. Bali Governor's Regulation No. 48/2019 specifies policies for the promotion of electric vehicles, including the introduction of EVs in public institutions, etc., and an ambitious action plan that calls for the distribution of 1,000 electric motorcycles by 2021 and up to 8,000 by 2025, 100 electric four-wheel vehicles by 2021 and 800 by 2025, with 40 buses to be in use by 2021 and 200 by 2025. To realize them early, it is necessary to develop systems and capabilities to support EV development, and design and implement corresponding policies.

The implementation process outlined in the action plan is as follows.

a. Preparation and Establishment of Regulations

To approach government and other stakeholders, and actively engage. This phase will begin with a limited range of possible investment considerations.

b. Development of Standard Business Processes and Market Mechanisms

This phase requires the involvement and technical input of stakeholders interested in the development of smart cities and smart transportation. In many cases, the government will be involved in the process, with support from NGOs, CSOs, and think tanks.

c. Development of the Market System

In this phase, business feasibility is secured. In many cases, the support of the main state enterprise and also the support of the private sector are required.

d. Implementation

This phase involves social dissemination and promotion targeting the entire potential market.

Due in part to the impact of the recent pandemic, we are still in the [a] (Preparation and Establishment of Regulations) phase, but as a government initiative in line with [a], the "EV Promotion Committee" has been established and is currently discussing the nature and direction of regulations with a view to establishing special zones for EVs.

Figure 2-20 EV distribution targets in Bali Province

The action plan identifies the following key stakeholders for EV distribution.

- Provincial Government

Consists of several departments responsible for transportation, infrastructure, urban and regional planning, information, energy sstems, etc. Some departments play an important role in facilitating the licensing and investment process, while others function solely as agencies providing technical data.

- Civil Society Organizations and Think Tanks

Civil Society Organizations (CSOs) and Think Tanks are part of the government supporting structure that provide the scientific and substantive grounds for enacting regulations. In Bali, there are several global CSOs/think tanks active with an interest in developing smart cities and smart transportation means. The most powerful and potentially relevant is the German International Cooperation Agency (GIZ), and the World Resources Institute (WRI) could be a strong partner in providing data for a smart transportation system.

- Local Communities

Local communities have a strong interest in creating an environment for realizing smart cities and smart transportation.

The Special Committee on Acceleration of Distribution of EVs, established under the Bali Provincial Government, is a special task force formed as a coordination platform for promoting the adoption of EVs and has significant authority.

An element of specialized organizations will also be critical for supporting the feasibility of any future programs. Associations of urban development planners, architects, green builders, and such must provide technical guidance and culturally rooted approaches in the development of infrastructure for EVs.

Universities will be key partners in terms of technical and human resource support, as they are necessary in order to encourage sustainable schemes.

- State Enterprises

PLN is currently the only provider that can meet the needs for electric charging stations in Bali. Although the optimal design has not yet been drawn and its scope of operations is narrow, it has the vision to provide electric charging stations to support the G20 to be held in October 2022. Therefore, a planned synergy design (from technical and business scope perspectives) is needed to ensure that there is no redundancy in the provision of EV charging stations.

In Sanur, the state-run INNA Group (Hotel Indonesia) is engaging in a large-scale development in a special economic zone (SEZ). The development theme of this SEZ is health and wellness tourism. This is considered a very compatible plan for the creation of an EV ecosystem in Sanur, which is oriented toward a low-carbon economy.

- Private Sector

Transportation service providers can be divided into two main categories: conventional and unconventional (modern). Conventional transportation service providers have been incorporated into the land transportation association (Organda), which operates all public transportation in Bali. On the other hand, non-conventional transportation service providers can be described as MaaS-related operators that have not yet been optimized, such as the Grab Platform.

There is a trend that new measures related to transportation services are tied to the promotion of EV adoption.

On the other hand, the number of EVs for private use in Bali remained below 20 in early 2022. The trigger for the spread of EVs was the G20 Summit held in Bali in November 2022[7].

Table 1 shows the latest status of EV adoption.

Table 2-14 Status of EV adoption in Bali Province

Companies & Projects	Vehicle Type	Number of vehicles
Joint EV Smart Mobility Project conducted by five major Japanese automobile companies	Small BEVs, PHEVs, electric trucks	30 (Toyota)
Toyota	BEV	100
Hyundai Motor Co.	BEV	Approx. 200
INKA	Electric buses	40
Wuling Motors	BEV	300
Bluebird (Indonesia's largest taxicab company)	Electric taxicabs (BYD-made)	Approx. 50 (2000 vehicles are to be introduced by 2050)
Gogoro and Gojek	Electric motorcycles	20 vehicles and battery replacement stations (number unknown)[8]
PLN and Hyundai Kefico	Electric motorcycles	20 vehicles and battery replacement stations (number unknown)[9]

[7] Brief business report of JETRO "Five Japanese automobile brands' project for demonstrating the operation of EVs in Bali" https://www.jetro.go.jp/biznews/2022/06/624f4851ed00f37a.html

[8] Gogoro "Gogoro Brings Smartscooters and Battery Swapping to the G20 Summit in Bali, Indonesia": https://www.gogoro.com/news/g20-2022-indonesia-electrum/

[9] VOI.id "PLN will collaborate with Hyundai Kefico to develop SPBKLUs for electric motors": https://voi.id/ja/ekonomi/227898/pln-gandeng-hyundai-kefico-kembangkan-spbklu-untuk-motor-listrik

Figure 2-21 Electric bus under development by INKA

Figure 2-22 Electric vehicle of Bluebird

Figure 2-23 Toyota-Astra Motor's EV station in Nusa Dua area

Figure 2-24 Location of Toyota-Astra Motor's EV Station

Figure 2-25 Electric motorcycles provided for the Bali G20 in 2022[10]

According to Dharmawan et al. (2021), as of 2021, 166 SPLUs (general power supply stations) and 5 SPKLUs (public electric vehicle charging stations) had been installed in Bali Province, while no SPBKLUs (public electric vehicle battery replacement stations) had not been installed. Since then, we heard that Taiwan's Gogoro installed several charging stations in the province in 2022. The cumulative power consumption of all charging stations in Bali from 2019 to 2020 was only 169 MWh, indicating that EVs had not been widely adopted in the province of Bali.

[10] Gogoro "Gogoro Brings Smartscooters and Battery Swapping to the G20 Summit in Bali, Indonesia": https://www.gogoro.com/news/g20-2022-indonesia-electrum/

Table 2-15　Number of SPLUs established in Bali Province (Dharmawan et al., reported in 2021)

No	Regency/Municipality	No. of SPLUs
1	Singaraja	47
2	Denpasar	42
3	Negara	20
4	Tabanan	19
5	Gianyar	11
6	Klungkung	11
7	Kuta	6
8	Bangli	6
9	Karangasem	4
	Total	166

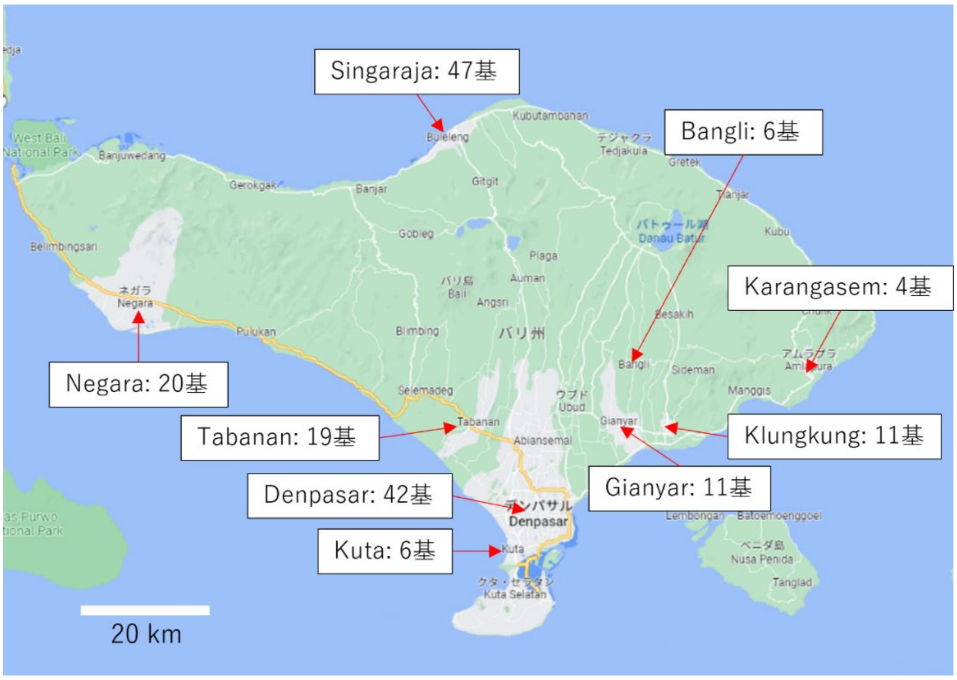

Figure 2-26　SPLU locations in Bali and the number of the facilities in each location as of 2021

EV charging stations in Indonesia are classified into the following categories.

- SPLU (General Power Supply Station): Charging stations for electric vehicles and electric motorcycles
- SPKLU (Public Electric Vehicle Charging Stations): Charging stations exclusively for electric vehicles, providing fast-charging services.
- SPBKLU (Public Electric Vehicle Battery Replacement Stations): Stations where electric motorcycle batteries and electric bicycles can be replaced.

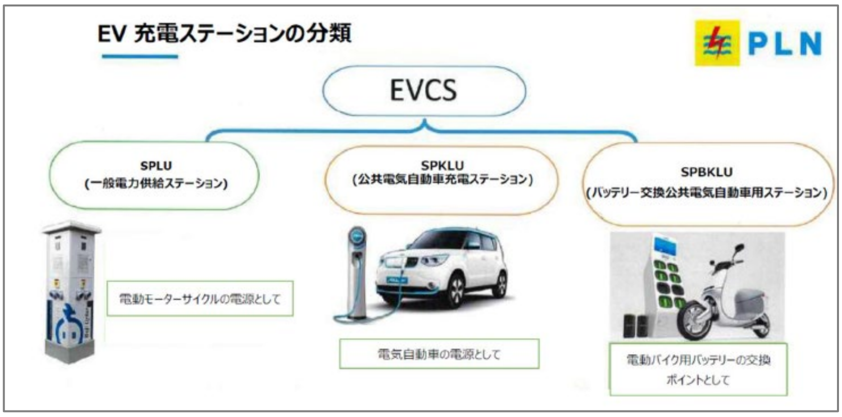

Figure 2-27　Classification of EV stations in Indonesia [11]

充電設備の種類		普通充電			急速充電
		コンセント		ポール型普通充電器	
		100V	200V	200V	
					
想定される充電場所(例)	プライベート	戸建住宅・マンション、ビル、屋外駐車場等		マンション、ビル、屋外駐車場	— (ごく限定的)
	パブリック	カーディーラー、コンビニ、病院、商業施設、時間貸し駐車場等			道の駅、ガソリンスタンド、高速道路SA、カーディーラー、商業施設等
充電時間	航続距離160km	約14時間	約7時間		約30分
	航続距離80km	約8時間	約4時間		約15分
充電設備本体価格例(工事費は含まない)		数千円		数十万円	百万円以上

Figure 2-28　Classification of general charging stations [12]

SPBKLU is a station for changing batteries of electric motorcycles. Figure 2-29 shows SPBKLU installed in Jakarta. Several companies, including Gogoro (Gojek), have entered the market, but batteries are not always compatible with those of different manufacturers.

In addition to state-run GESITS, other electric two-wheeled vehicle manufacturers include SMOOT, VIAR, VOLTA, GOGORO GOJEK, and HONDA PCX. The cost of battery replacement is 5,000 rupiah per unit (approximately 40 yen per unit). Figure 2-30 shows the distribution of SPBKLUs in the southern region of Bali.

[11] Ministry of Economy, Trade and Industry and Ministry of Land, Infrastructure, Transport and Tourism, "Guidebook for the Installation of Charging Facilities for Electric and Plug-in Hybrid Vehicles, December 2010": https://www.mlit.go.jp/common/000130845.pdf

[12] Ministry of Economy, Trade and Industry and Ministry of Land, Infrastructure, Transport and Tourism, "Guidebook for the Installation of Charging Facilities for Electric and Plug-in Hybrid Vehicles, December 2010": https://www.mlit.go.jp/common/000130845.pdf

Figure 2-29　SPBKLU in Jakarta[13]

Figure 2-30　Distribution of SPBKLUs in Bali

[13] carmudi "SPBKLUs for electric two-wheeled vehicles officially introduced": https://www.carmudi.co.id/journal/spbklu-untuk-sepeda-motor-listrik-resmi-diperkenalkan/

Figure 2-31　Location of SPBKLUs in Bali and the number of the facilities in each location as of 2022

In November 2020, the Governor of Bali initiated an electric bus operation trial in the National Tourism Strategic Areas of Bali.

Twelve electric buses run five routes from 6:00 AM to 6:00 PM (weekdays) and from 6:00 AM to 5:00 PM (weekends).

The electric buses are operated fare-free from November to December 2020, and a fare of 35 rupiah (0.28 yen) was charged from January 2021. According to the drivers of the electric buses, only Route 4 was in operation due to a decrease in the number of passengers during the pandemic of the novel coronavirus.

路線1	路線2	路線3	路線4	路線5
				
経路 I Gusti Ngurah Rai Airport Central Park Kuta Ubung Menguwi Begudul Singaraja	経路 I Gusti Ngurah Rai Airport Sanur Ubud Kintamani Singaraja	経路 Singaraja Menjangan TamanNasional Bali Barat	経路 I Gusti Ngurah Rai Airport Goa Lawah Padangbai Manggis Amuk Amed	経路 I Gusti Ngurah Rai Airport Sanur Klungkung Besakih

Figure 2-32　Electric bus routes

PLN has declared its support for transportation and traffic operations and the promotion of use of EVs at the G20. It plans to build 21 new EVCSs in Bali Province, aiming for completion by January 2022. The EVCSs to be built are SPKLUs with 25kW and 50kW charging capacities.

The 21 EVCSs will be installed in 15 locations in Bali Province, and the construction cost is budgeted by PLN. 15 units will be installed in Nusa Dua, the site of the G20, and will be relocated elsewhere (outside Nusa Dua) after the event is over. The remaining 6 units will be located outside of Nusa Dua (either in the PLN office area or at the airport).

No	Lokasi （場所）	Titik（種類）	Jumlah（数
SPKLU DI LUAR ITDC			
1	Wisma PLN Bedugul	Tipe 1 / 2x25 kW	2
2	Kantor ULP Singaraja	Tipe 2 / 1x50 kW	1
3	Lahan Aset PLN (Jl. Hayam Wuruk)	Tipe 2 / 1x50 kW	1
4	Rumah Kreatif BUMN (Jl. Raya Sesetan)	Tipe 2 / 1x50 kW	1
5	Bandara I Gusti Ngurah Rai	Tipe 2 / 1x50 kW	1
SPKLU DI ITDC／ITDC での充電ステーション			
1	ITDC	Tipe 1 /2x25 kW	10
2	ITDC	Tipe 2 /1x50 kW	5
TOTAL			21

Figure 2-33　EVCS construction plans for the G20

Currently, the electricity for EV stations is provided from the power grid. As mentioned above, the Bali's grid is connected to Java and Madura, and includes coal, gas, and diesel power plants. Therefore, grid-derived EVs are not decarbonized.

On the other hand, Rizki et al. (2021)[14] mentioned that only the shift to EVs have a certain amount of CO_2 emission reduction effect. This study estimates the CO_2 reduction amout when tourists visiting Bali use EVs. In this study, based on a questionnaire survey that analyzed the dynamics of tourists, the GHG reduction amount is calculated using three scenarios, assuming that the use of mobility was replaced with EV vehicles.

Table 2-16 Estimated GHG emission reductions through the shift to EVs

Table 6. Estimation of emission savings.

Scenario	Total Rental Vehicle [a]	% Shift	Type of Vehicle	Average Travel Distance (km/Day) [b]	Net Savings/Year [c] (Ton CO_2)	Total Net Savings (Ton CO_2)
1	3300	70.73	Car	19.9	1742	1945
	1100	80.35	Motorcycle	16.5	203	
2	3300	68.35	Car	19.9	1683	1885
	1100	80.15	Motorcycle	16.5	202	
3	3300	66.87	Car	19.9	1646	1848
	1100	79.96	Motorcycle	16.5	202	

[a] Based on an interview with the rental companies association in Bali Province in 2021; [b] data from the questionnaire; [c] total days a year is assumed at 300 days in consideration of the tourist seasons.

In Scenario 1, it is assumed that 70.73% of the rental cars rented in Bali are replaced by EVs and 80.35% of motorcycles are replaced by electric ones. In this case, the annual GHG emissions reductions are 1,742 tons from the adoption of EVs and 203 tons from the adoption of electric motorcycles, for a combined annual GHG emissions reduction of 1,945 tons. Even more reductions can be expected by using renewable energy sources for these sources.

2） Candidate sites for EV stations

As mentioned above, EVs and EV stations have already begun to be popularized. On the other hand, the use of renewable energy for EV stations has not progressed. Based on the use of land in the vicinity of EV stations, photovoltaic facilities could be installed in the following regions and sites.

Region: Denpasar and Kuta areas in southern Bali
Sites: Shopping malls, government agencies and other public facilities, schools, hospitals, golf courses, coves, airports, and agricultural land (solar sharing)

[14] Rizki et al., 2021「Electrifying Tourist Mobility in Bali, Indonesia: Setting the Target and Estimating the CO2 Reduction Based on Stated Choice Experiment」
https://www.mdpi.com/2071-1050/13/21/11656#B16-sustainability-13-11656

Figure 2-34 SPLU locations in southern Bali

Figure 2-35 Commercial facilities and schools in the vicinity of SPLU DPS01

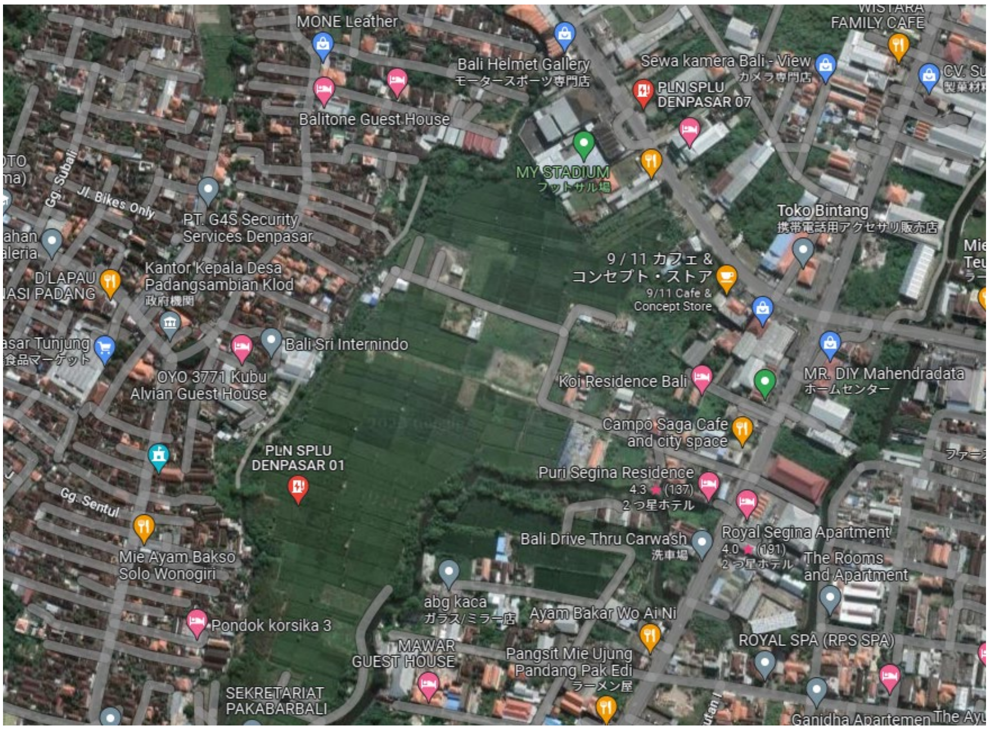

Figure 2-36　A farm in the vicinity of SPLU Denpasar01

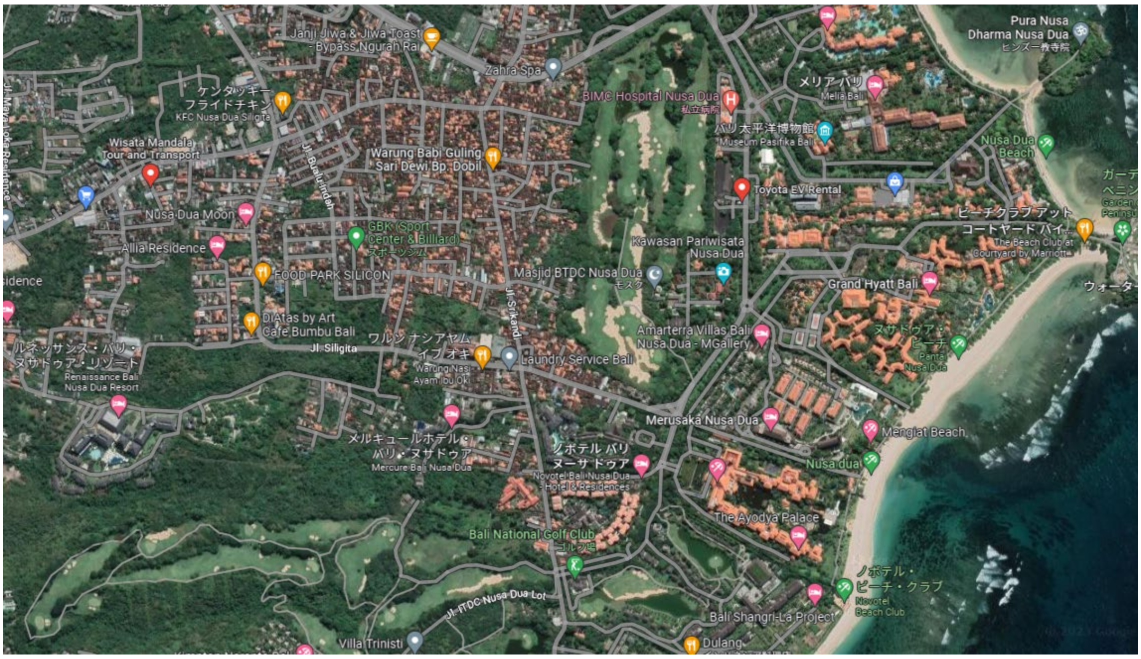

Figure 2-37　Golf course in the vicinity of Toyota-Astra Motor's EV station

Going forward, we will contact the owners of the EV stations to discuss the possibility of supplying electricity from renewable energy sources and the use of the surrounding land mentioned above.

On the one hand, plans for solar-powered charging stations appear to be progressing for electric motorcycles.

As is widely known, Indonesia bristles with motorcycles, with the number of motorcycles owned being approximately 127 million while the number of passenger cars is 19.15 million[15].

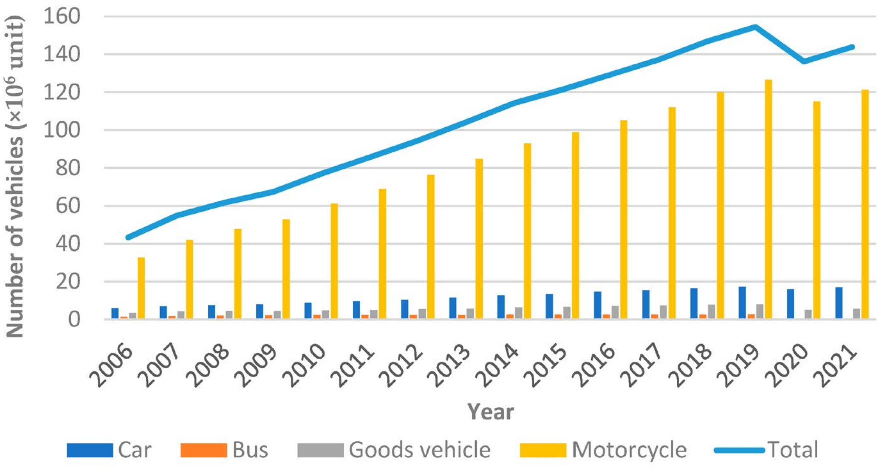

Figure 2-38 Variation in the number of each kind of vehicles in Indonesia

According to the statistics of registered vehicles published by the Indonesian police, the total number of vehicles in Bali was 4,726,000 as of January 27, 2023. Of these, 4.05 million are motorcycles, accounting for 85.7% of the total. Since there has been little progress in introducing electric motorcycles in Bali, almost all of them are internal combustion engine vehicles that use fossil fuels.

Table 2-17 Number of Registered Vehicles in Bali (as of January 27, 2023)[16]

POLRES/TA	MP	BUS	MB	Motorcycles	RANSUS	TOTAL	%
DENPASAR	213,224	3,395	52,347	1,343,996	349	1,613,597	34.14
BADUNG	108,413	1,732	25,403	732,538	110	868,271	18.37
GIANYAR	44,344	600	16,296	429,635	93	497,001	1052
BULELENG	27,055	580	15,273	414,136	90	457,269	9.67
TABANAN	35,174	709	18,825	386,357	95	441,187	9.33
JEMBRANA	14,353	401	11,472	241,047	64	271,116	5.74
KARANGASEM	14,449	242	11,22	210,077	62	236,113	5
KLUNGKUNG	17,295	217	8,772	175,683	53	202,853	4.29
BANGLI	9,094	100	10,358	116,997	33	138,928	2.94
(TAK DIISI)	0	0	0	12	0	12	0
TOTAL	483,401	7,976	169,966	4,050,478	949	4,726,347	

Considering this reality, this study examined the feasibility of installing solar power generation

[15] Korlantas Polri "No. of registered vehicles in Indonesia"
http://rc.korlantas.polri.go.id:8900/eri2017/laprekappolda.php
[16] Korlantas Polri "No. of registered vehiles in Bali"
http://rc.korlantas.polri.go.id:8900/eri2017/laprekappolres.php?kdpolda=2&poldanya=BALI

systems at EV stations for motorcycles.

3) Interview with EPC Companies Building EV Stations

The challenges in introducing electric vehicles in Indonesia are said to be vehicle costs, batteries, charging time, and other technical issues (e.g., voltage standards)[17]. Moreover, in terms of decarbonization, charging stations are being built to receive electricity from the PLN grid, and there is not enough infrastructure for realizing decarbonization through the widespread use of electric vehicles.

The use of photovoltaic power generation for charging stations, etc. is a possible way to promote electric vehicles in a way that is as close to decarbonization as possible.

In terms of the issue of time required for recharging, the system is expected to be more user-friendly and to spread quickly among motorcycles with replaceable batteries.

Accordingly, the feasibility of solar power generation projects for EV charging stations utilizing the JCM equipment subsidy was discussed while checking whether or not they have plans to install solar panels in existing regarding stations for motorcycles and conducting interviews with builders of motorcycle charging stations.

PT. Bintang Terbarukan is one company with experience of installing solar panels on charging stations for motorcycles.

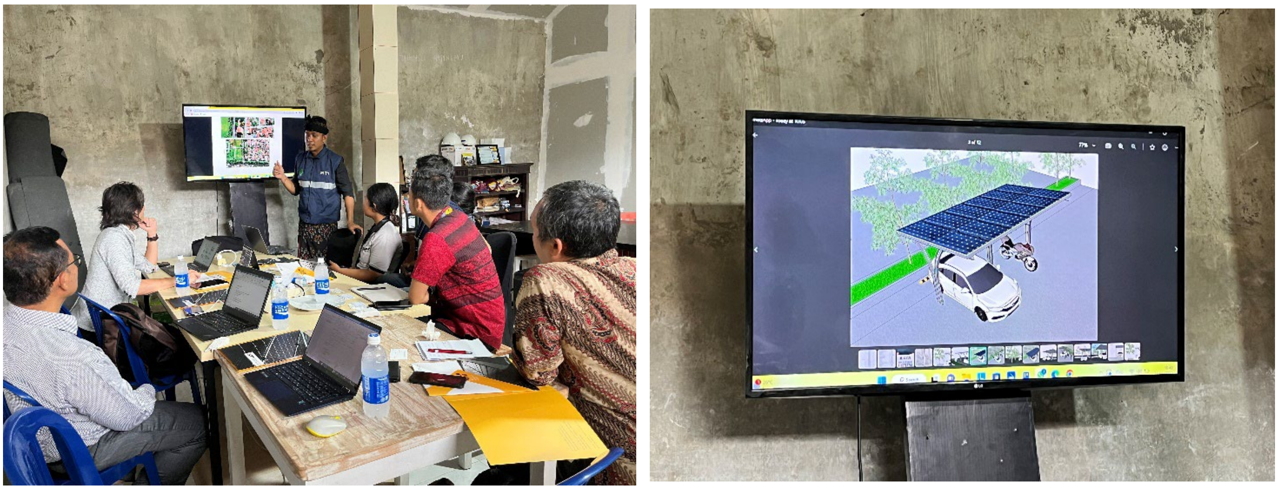

Figure 2-39 Interview with PT. Bintang Terbarukan

The company also sells electric motorcycles and plans to build 20 charging stations to meet orders from the manufacturer. The manufacturer is Oyika in Singapore.

[17] https://www.mongabay.co.id/2021/03/02/ini-rencana-aksi-kebijakan-kendaraan-listrik-di-bali/

Figure 2-40 Electric motorcycle of Oyika

In addition, the company plans to work with SWAP, an Indonesian electric motorcycle manufacturer, to launch 50 stations in cooperation with Minimart.

Figure 2-41 Electric motorcycle of SWAP

One specific site for installation is the Central Park in Denpasar. Currently, the company is in the process of designing the charging station with a motorcycle port (rain shelter) and plans to install solar power generation on its roof.

PT. FUJI HOME is also considering using the land of its office to install solar panels and construct a charging station for electric vehicles.

It is expected that the number of such projects will increase in the future, but since individual stations tend to be too small to qualify for JCM equipment subsidies, it would be best to work with EPC enterprises and owners to bring multiple stations together for commercialization.

The company will compile multiple construction proposals and examine the feasibility of integrating them into a MW-scale project.

The proposed project structure is shown below.

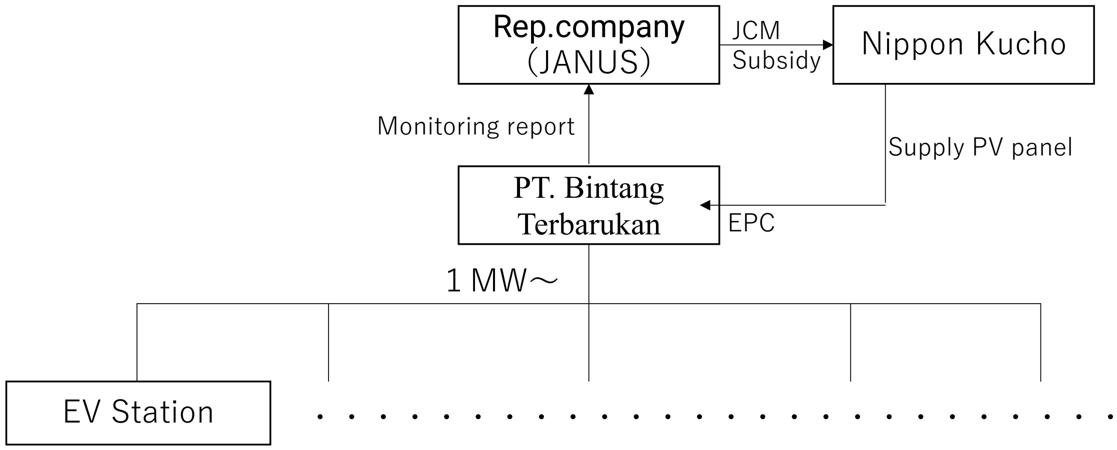

Figure 2-42　Diagram of the JCM Equipment Subsidy System

2.2.4. Support for optimization of waste disposal for decarbonization

(1) Problems with waste management in Bali and discussions on the applicability of the ecotown project of Toyama City

1） Gathering of information on waste management in Bali

In Bali, 4,281 tons of waste is generated per day. About 4% of the waste is recycled, about 44% is used for reclamation at the final disposal site (Tempat Pembuangan Akhir: TPA), and the remaining 52% is illegally dumped or burned in the open air in an inappropriate manner.

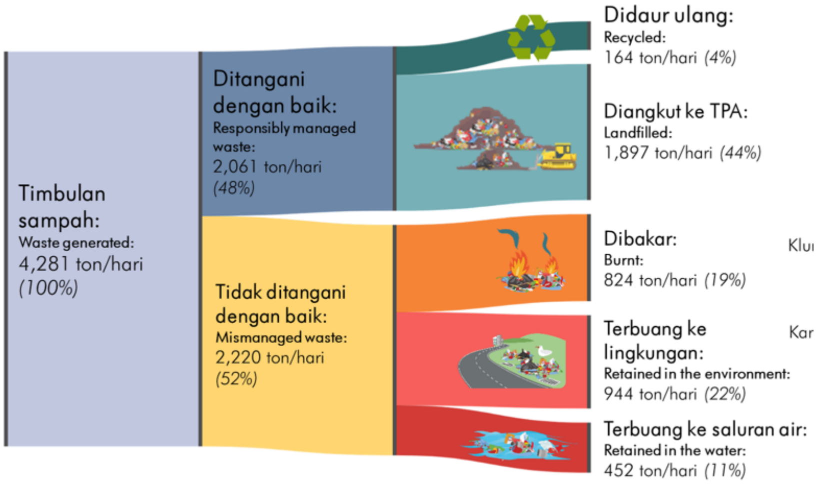

Figure 2-43 Amount of waste generated in Bali and its breakdown[18]

According to some research, the amount of plastic waste entering rivers is estimated to be 32,623 kg/year, and this value is increasing year by year. One of major reasons is that the waste amount went beyond the capacity of the final disposal site.

Figure 2-44 The final disposal site TPA Sarbagita (Sep. 27, 2019)

Source: BPBD Bali/Mongabay Indonesia

For example, the waste generated in Kota Denpasar, Kabupaten Badung, Kabupaten Gianyar, and Kabupaten Tabanan in southern Bali is transported to the final disposal site Sarbagita in Suwung in southern Kota Denpasar. The waste generated in the above 4 regencies in southern Bali is said to account for 80% of the total waste amount in Bali. This is the largest TPA in Bali. The daily amount of waste transported to the final disposal site was around 800 tons in 2014, temporarily decreased to 500-600 tons amid the coronavirus pandemic, and currently stands at around 1,150 tons[19]. The governor of Bali declared that this final disposal site would be closed on January 1, 2022, but available disposal sites are insufficient, so the waste generated in Kota Denpasar and Kabupaten Badung is transported to there, and it will be continued until March 2023.

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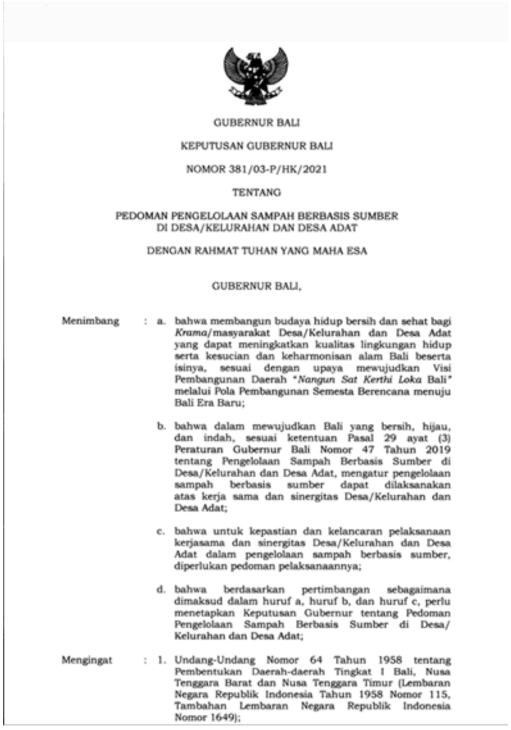
[18] Bali Partnership Platform, https://www.balipartnership.org/en_gb/resources/

[19] Tribun-Bali, “Sampah ke TPA Sarbagita Suwung Mencapai 1.150 Ton per Hari, Bali Rencanakan Bangun PSEL”, https://bali.tribunnews.com/2020/11/21/sampah-ke-tpa-sarbagita-suwung-mencapai-1150-ton-per-hari-bali-rencanakan-bangun-psel?page=1, Obtained in Feb. 2021

In order to cope with the above-mentioned problem with waste disposal caused by the insufficiency of final disposal sites, the Bali government issued the order of the governor for waste disposal in each village (Desa) which generates waste (Keputusan Gubernur Bali Nomor 381/03-P/HK/2021) in March 2021, to promote the disposal in each region.



GUBERNUR BALI

KEPUTUSAN GUBERNUR BALI

NOMOR 381/03-P/HK/2021

TENTANG

PEDOMAN PENGELOLAAN SAMPAH BERBASIS SUMBER
DI DESA/KELURAHAN DAN DESA ADAT

DENGAN RAHMAT TUHAN YANG MAHA ESA

GUBERNUR BALI,

Menimbang :
a. bahwa membangun budaya hidup bersih dan sehat bagi *Krama*/masyarakat Desa/Kelurahan dan Desa Adat yang dapat meningkatkan kualitas lingkungan hidup serta kesucian dan keharmonisan alam Bali beserta isinya, sesuai dengan upaya mewujudkan Visi Pembangunan Daerah "*Nangun Sat Kerthi Loka* Bali" melalui Pola Pembangunan Semesta Berencana menuju Bali Era Baru;
b. bahwa dalam mewujudkan Bali yang bersih, hijau, dan indah, sesuai ketentuan Pasal 29 ayat (3) Peraturan Gubernur Bali Nomor 47 Tahun 2019 tentang Pengelolaan Sampah Berbasis Sumber di Desa/Kelurahan dan Desa Adat, mengatur pengelolaan sampah berbasis sumber dapat dilaksanakan atas kerja sama dan sinergitas Desa/Kelurahan dan Desa Adat;
c. bahwa untuk kepastian dan kelancaran pelaksanaan kerjasama dan sinergitas Desa/Kelurahan dan Desa Adat dalam pengelolaan sampah berbasis sumber, diperlukan pedoman pelaksanaannya;
d. bahwa berdasarkan pertimbangan sebagaimana dimaksud dalam huruf a, huruf b, dan huruf c, perlu menetapkan Keputusan Gubernur tentang Pedoman Pengelolaan Sampah Berbasis Sumber di Desa/Kelurahan dan Desa Adat;

Mengingat :
1. Undang-Undang Nomor 64 Tahun 1958 tentang Pembentukan Daerah-daerah Tingkat I Bali, Nusa Tenggara Barat dan Nusa Tenggara Timur (Lembaran Negara Republik Indonesia Tahun 1958 Nomor 115, Tambahan Lembaran Negara Republik Indonesia Nomor 1649);

Figure 2-45 Scene of a meeting with the environmental bureau of Bali (Aug. 2022) (left) and the order No. 381 of the governor of Bali in 2021 (right)

This order of the governor specifies the process of waste management in each village as shown in the figure below, and requests that waste should be segregated into organic waste, inorganic waste, and other waste at home, the waste should be transported to the first sorting site (Tempat Pengolahan Sampah 3R: TPS 3R), which collects and sorts waste, and organic waste should be composted, other waste should be recycled, and the remaining waste should be incinerated with a compact incinerator.

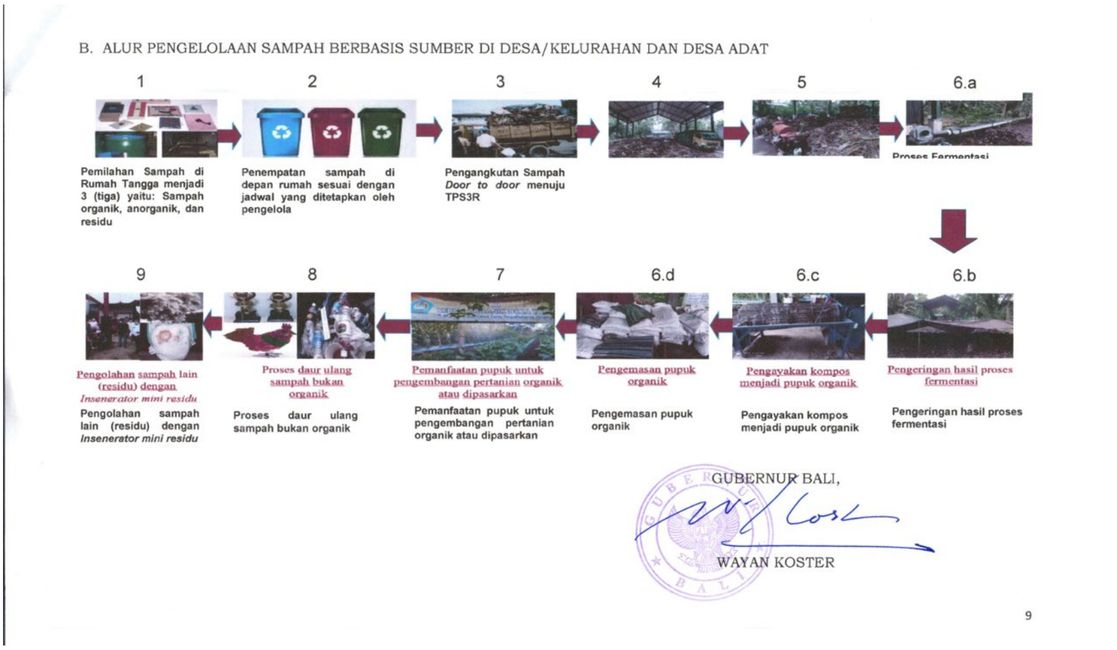


Figure 2-46 Flowchart of waste management in each village requested by the order No. 381 of the governor of Bali in 2021

According to the interview with the environmental bureau of Bali, TPS 3R is operated by each village, and the public works bureau of Bali distributes about 3 million yen per year for operation costs to each village, but the funds are not used for waste management, and waste treatment does not progress in each village. In the village we actually visited, waste was collected at a single spot, but TPS 3R was not in operation, and the waste was burned there in the open air. In Bali, there are 214 facilities of TPS 3R, but 30% of them are not operated.

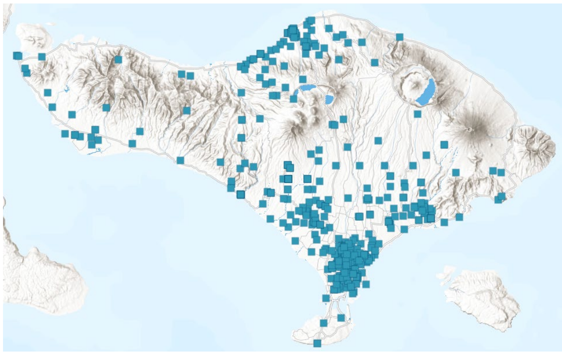
Figure 2-47 Waste burned in the open air

Village-level projects are not functioning well, but about 90% of residents in Bali are Hindu, and communities called banjar centered around temples are active. Accordingly, the activities based on banjar are easily accepted by residents. For example, “waste banks” are used actively in some regions.

In Indonesia, waste banks through which residents can sell waste as resources and deposit revenues from the sale are operated in each region. Such waste banks exist also in Bali. For example, when we visited Bank Sampah Bali Bersih, we found waste being collected once a month from 150 units, which are composed of banjar, schools, and enterprises, covering almost all southern and western areas of Bali. On the other hand, the residents using waste banks in banjar account for 30-60%, and the waste from other residents is handled by garbage collectors of villages (municipalities).

Figure 2-48　Visit to a waste bank for study (Aug. 2022) (left) and sorting of plastic waste

Education for popularizing this activity is conducted. In Banjar, instructions for sorting waste are given and the utilization of waste banks is promoted by radio, so the amount of waste bought via Bank Sampah Bali Bersih is increasing, partially thanks to residents' cooperation. In Bali, there are a lot of waste banks as shown below, but the amount of waste collected by waste banks accounts for only 7% of the total amount of waste.



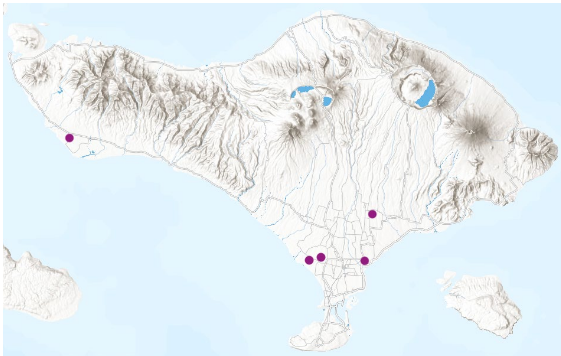


Figure 2-49　Distribution of waste banks (left) and recycling enterprises (which mainly collect waste) (right) in Bali

The waste segregated at such waste banks is transported to Surabaya by intermediate agencies, which collect, wash, crush, and pelletize waste, for recycling. The shortage of recycling enterprises is another problem with waste treatment in Bali. The flow of waste via waste banks is as shown below.

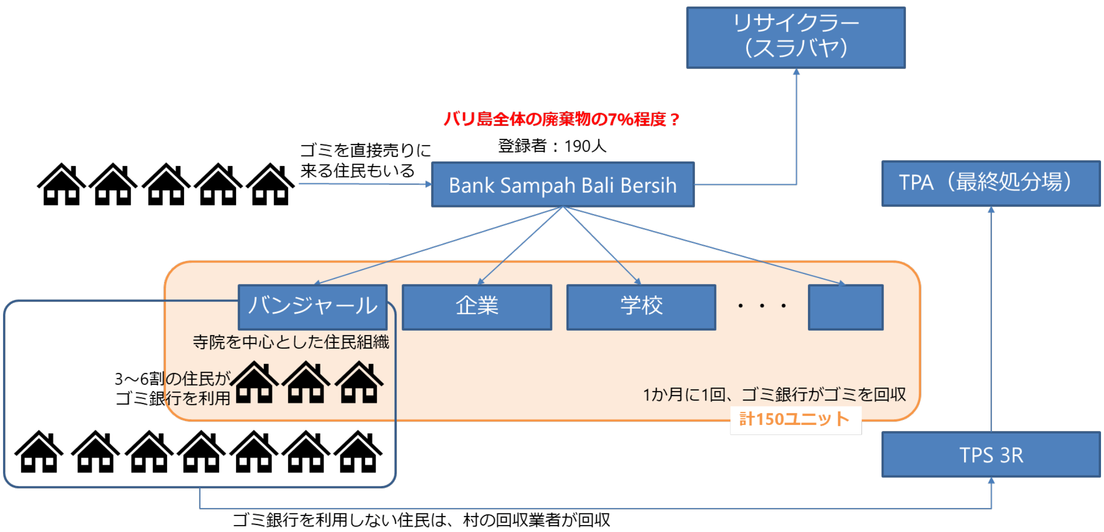


Figure 2-50　Flow of waste via waste banks

Waste is collected also by municipalities. In Denpasar, residents carry waste to TPS in the neighborhood between 17:00 and 19:00 every day, and it is transported via a waste transfer station (DEPO) to TPA. The government of Bali is responsible for transportation of waste from TPS to TPA or from DEPO to TPA. In Denpasar, there are 127 facilities of TPS/DEPO, where waste is loaded onto 121 vehicles for waste collection owned by the city (as of 2019) [20], and waste is transported to TPA three or four times a day [21]. The following

shows the flowchart of waste collection in Denpasar.

[20] STATISTICS INDONESIA, "Environment Statistics of Indonesia 2020," https://www.bps.go.id/publication/download.html?nrbvfeve=NWE3OThiNmI4YTg2MDc5Njk2NTQwNDUy&xzmn=aHR0cHM6Ly93d3cuYnBzLmdvLmlkL3B1YmxpY2F0aW9uLzIwMjAvMTEvMjcvNWE3OThiNmI4YTg2MDc5Njk2NTQwNDUyL3N0YXRpc3Rpay1saW5na3VuZ2FuLWhpZHVwLWluZG9uZXNpYS0yMDIwLmh0bWw%3D&twoadfnoarfeauf=MjAyMS0wMi0yNyAxMTozNjo0NQ%3D%3D, obtained in Jan. 2021

[21] Midori Industry Co., Ltd. and NTT Data Institute of Management Consulting, Inc., Project for overseas economic cooperation based on ODA in 2013 "Survey for designing a project for treating organic waste to produce biogas and compost in Denpasar, Bali, Indonesia," https://www.mofa.go.jp/mofaj/gaiko/oda/seisaku/kanmin/chusho_h25/pdfs/5a11-1.pdf, obtained in Jan. 2021

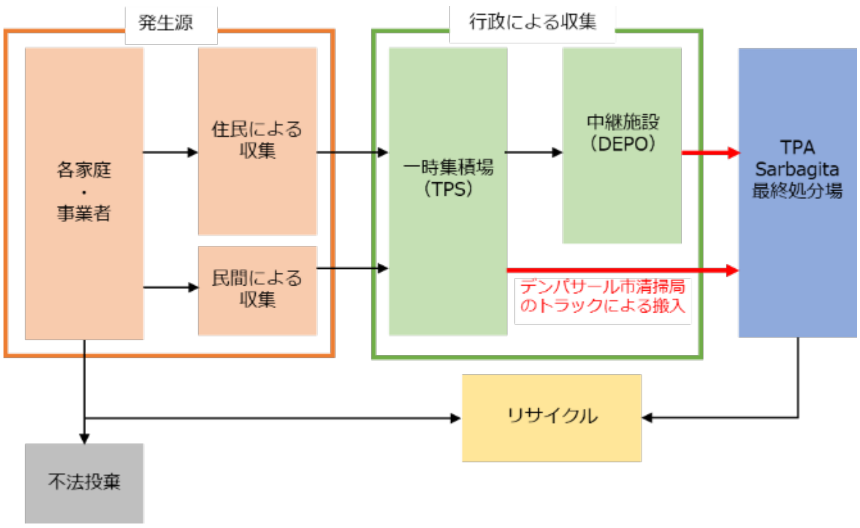


Figure 2-51　Flowchart of waste collection in Denpasar

Source: Produced by JANUS with reference to "Report on the waste-based power generation project in Bali, Indonesia" of the intercity collaboration project of JFE Engineering Corporation: https://www.env.go.jp/earth/coop/lowcarbon-asia/project/data/JP_IDN_H28_01.pdf

As mentioned above, we found that Bali promotes the treatment of waste in each municipality to cope with theshortage of final disposal sites, but the processes for collecting and sorting waste do not work. For developing a system for recycling resources in a designated area, we can refer to the ecotown project of Toyama City and municipal waste collection systems in Japan, but in order to educate residents, who are essential for waste treatment in each region, it is necessary to take some measures, such as the linkage with communities centered around banjar in Bali.

2） Discussion on the applicability of the ecotown project of Toyama City

Since 2002, Toyama City has engaged in the "ecotown project" for developing towns that function in harmony with the environment while vitalizing the region under the "zero-emission concept" aimed at eliminating all kinds of waste by utilizing them as raw materials in other fields. Through this project, an industrial complex of about 18 ha was built and is serving as a hub for resources-recycling facilities in the city.

In the first phase of the project, they built a facility for recycling raw garbage and pruned branches, a hybrid facility for recycling waste plastics, a facility for recycling wooden waste, and a facility for recycling automobiles, to proceed with activities for recycling resources, mainly materials. In the second phase, they constructed a facility for recycling difficult-to-process fibers and mixed waste plastics, a facility for recycling waste food oil, and a facility for recovering waste energy, and opened Toyama City Ecotown Exchange Promotion Center.

Among them, the facility for recycling difficult-to-process fibers and mixed waste plastics is operated by "Eco-mind Co., Ltd." It collects waste plastics, waste fiber, used paper, etc., produces recycle plastic fuel (RPF), and ships it to factories requiring fuel, such as paper manufacturers in the prefecture, to contribute to the recycling of waste in the region.

Eco-Mind develops and upgrades equipment, and combines them, to recycle a variety of waste, including fiber waste and mixed waste plastics, which have been difficult to recycle due to the adhesion of and contamination by dirt or foreign matter or difficulty in crushing.

The process flow is shown below.

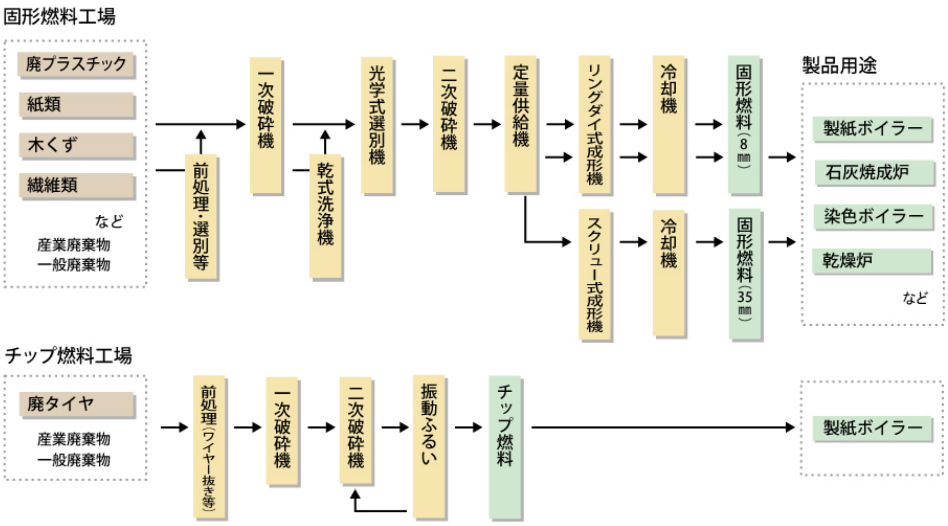


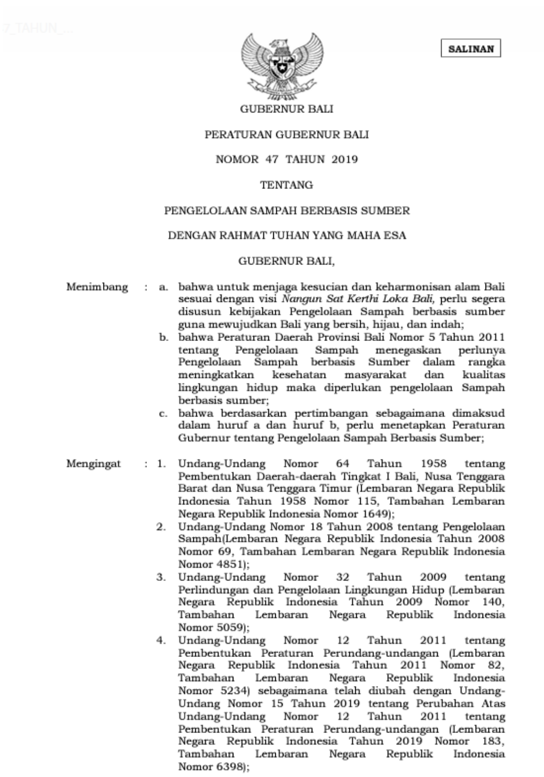
Figure 2-52 Process flow in Eco-mind Co., Ltd.

The RPF producing technology of Eco-mind Co., Ltd. is considered as suitable for Bali, where it is difficult to sort and wash waste before collection. The ecotown in Toyama City is characterized by a recycling system in which the residue discharged from the hybrid plastic recycling facility is transported to a facility of Eco-mind, where RPF is produced and then used as fuel. This scheme for recycling resources in the ecotown is in line with the policy of Bali, which aims to promote waste treatment in the region, so it can be used as reference.

(2) Discussion on the possibility of adopting a technology for producing hydrogen from mixed waste through a pyrolysis gas technology

1) Situation of collection and segregation of plastic waste in Bali

In November 2019, Bali enacted the regulations No. 47 of the governor of Bali regarding waste management in each waste-generating area (Peraturan Gubernur Bali Nomor 47 Tahun 2019), to demand sorting in each waste-generating area. This is aimed at promoting the sorting of waste into naturally decomposable waste (organic waste), recyclable waste (plastic waste, etc.), B3, waste including B3 waste, and residues in each home or TPS 3R in the vicinity of waste-generating sites to reduce the amount of waste transported to final disposal sites.



SALINAN

GUBERNUR BALI

PERATURAN GUBERNUR BALI

NOMOR 47 TAHUN 2019

TENTANG

PENGELOLAAN SAMPAH BERBASIS SUMBER

DENGAN RAHMAT TUHAN YANG MAHA ESA

GUBERNUR BALI,

Menimbang :
a. bahwa untuk menjaga kesucian dan keharmonisan alam Bali sesuai dengan visi *Nangun Sat Kerthi Loka Bali,* perlu segera disusun kebijakan Pengelolaan Sampah berbasis sumber guna mewujudkan Bali yang bersih, hijau, dan indah;
b. bahwa Peraturan Daerah Provinsi Bali Nomor 5 Tahun 2011 tentang Pengelolaan Sampah menegaskan perlunya Pengelolaan Sampah berbasis Sumber dalam rangka meningkatkan kesehatan masyarakat dan kualitas lingkungan hidup maka diperlukan pengelolaan Sampah berbasis sumber;
c. bahwa berdasarkan pertimbangan sebagaimana dimaksud dalam huruf a dan huruf b, perlu menetapkan Peraturan Gubernur tentang Pengelolaan Sampah Berbasis Sumber;

Mengingat :
1. Undang-Undang Nomor 64 Tahun 1958 tentang Pembentukan Daerah-daerah Tingkat I Bali, Nusa Tenggara Barat dan Nusa Tenggara Timur (Lembaran Negara Republik Indonesia Tahun 1958 Nomor 115, Tambahan Lembaran Negara Republik Indonesia Nomor 1649);
2. Undang-Undang Nomor 18 Tahun 2008 tentang Pengelolaan Sampah(Lembaran Negara Republik Indonesia Tahun 2008 Nomor 69, Tambahan Lembaran Negara Republik Indonesia Nomor 4851);
3. Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup (Lembaran Negara Republik Indonesia Tahun 2009 Nomor 140, Tambahan Lembaran Negara Republik Indonesia Nomor 5059);
4. Undang-Undang Nomor 12 Tahun 2011 tentang Pembentukan Peraturan Perundang-undangan (Lembaran Negara Republik Indonesia Tahun 2011 Nomor 82, Tambahan Lembaran Negara Republik Indonesia Nomor 5234) sebagaimana telah diubah dengan Undang-Undang Nomor 15 Tahun 2019 tentang Perubahan Atas Undang-Undang Nomor 12 Tahun 2011 tentang Pembentukan Peraturan Perundang-undangan (Lembaran Negara Republik Indonesia Tahun 2019 Nomor 183, Tambahan Lembaran Negara Republik Indonesia Nomor 6398);

Figure 2-53 Waste boxes for segregation (left) and the regulations No. 47 of the governor of Bali regarding waste management in each waste-generating area

Waste banks sort plastic waste further. Plastic bottles and bags are sorted by color, and sachets are sorted by brand.

Figure 2-54　Examples of waste segregated at waste banks

As mentioned above, there exist regulations that obligate residents to segregate waste in each waste-generating area and systems for collecting and recycling waste via waste banks or the like. However, according to the environmental bureau of Bali and the managers of waste banks, budgets are not used and TPS 3R does not function, and it is necessary to educate residents further in order to popularize the sorting of waste in each household.

The actual situation of plastic waste in Bali has been summarized in Bali Partnership Platform[22], in which data are collected and analyzed by the governor and the environmental bureau of Bali, Udayana University, University of Leeds, SYSTEMIQ, etc. In Bali, 1.6 million tons of waste is generated per year, and plastic waste accounts for about 20% (303,000 tons). It is estimated that only 7% of the plastic waste is recycled.

2） Dicussion on the possibility of adopting a pyrolysis gas technology in Bali

As mentioned above, 7% of plastic waste is recycled, as most of plastic waste includes a lot of impurities so it is not suited to recycling. A suitable technology for treating such plastic waste is the chemical recycling technology, which combusts plastic waste to gasify it (pyrolysis) and obtains hydrogen from synthesis gas, and JGC Holdings offers this technology.

[22] Bali Partnership Platform, https://www.balipartnership.org/en_gb/

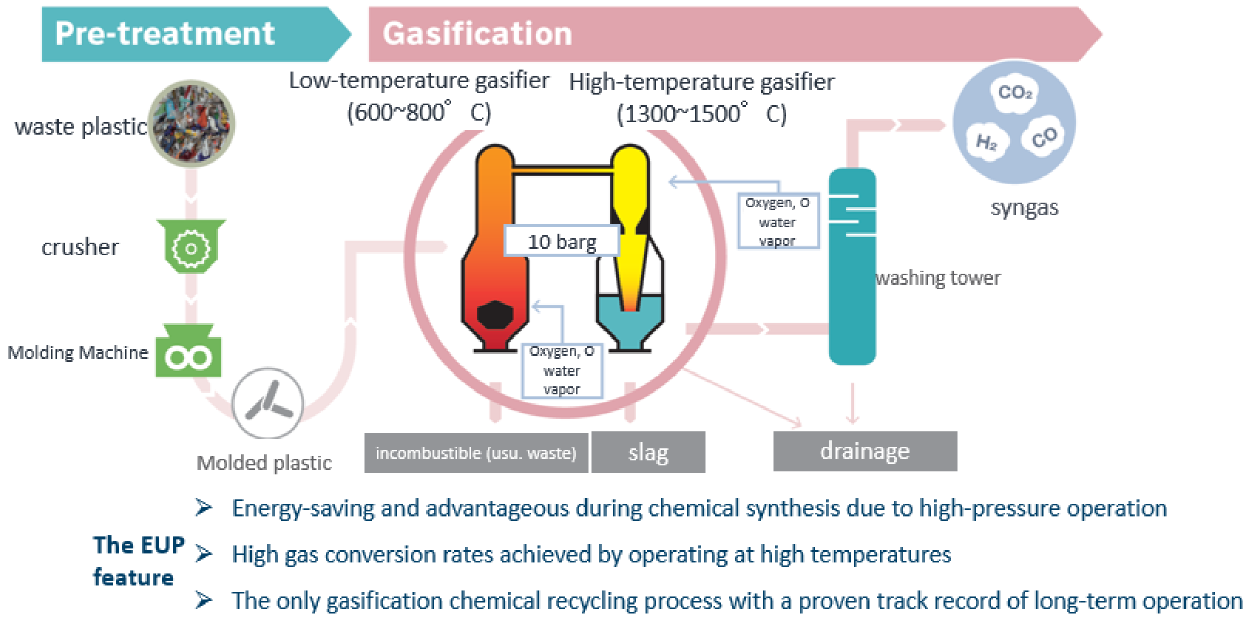


Figure 2-55 Outline of JGC Holdings' plant for gasification through pyrolysis

According to Bali Partnership Platform, Denpasar and Badung generate waste the most in Bali, and it amounts to about 1,600 tons per day. Plastic waste accounts for about 40% or 640 tons.

According to the interview with the environmental bureau of Bali, Denpasar has established 3 facilities called TRST 3R, which can treat 450 tons of waste per day with a larger scale than TPS, in addition to the construction of TPA[23]. We estimated the reduction amount of CO_2 emissions, under the assumption that TPS, TPST, waste banks, and the waste collectors of Denpasar are coordinated, 50% of waste is collected, and about 800 tons of waste is supplied to the above-mentioned gasification plant per day.

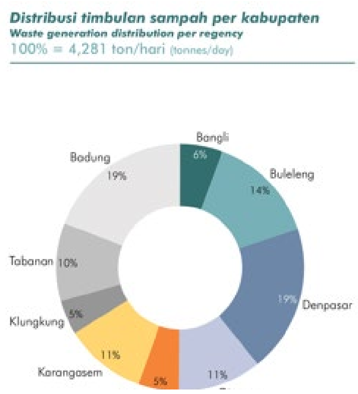


Figure 2-56 Ratio of waste from each municipality in Bali

According to JGC Corporation, the hydrogen yield through pyrolysis of waste plastics depends on the properties of the plastics. In the case of good-quality waste plastics, it is possible to obtain 1,300-1,500 tons of hydrogen from 10,000 tons of waste plastics. Namely, it is possible to obtain 104 tons of hydrogen from 800 tons of waste plastics per day. Here, let us suppose that the obtained hydrogen is supplied to industrial fuel cells.

1 kg of hydrogen has a high heating value of 142 MJ and an electric power of 1 kWh equals 3.6 MJ, so 1 kg of hydrogen can generate an electric power of 39.44 kWh. 37,960 tons/year of hydrogen could generate 149,714,240 kWh/year. According to a report of the Ministry of Economy, Trade and Industry, the power generation efficiency of industrial storage batteries was 48% as of 2019, so

[23] ANTARA KANTOR BERITA INDONESIA, "Tiga TPST di Denpasar ditargetkan olah 450 ton sampah per hari" https://www.antaranews.com/berita/3373515/tiga-tpst-di-denpasar-ditargetkan-olah-450-ton-sampah-per-hari?utm_source=antaranews&utm_medium=desktop&utm_campaign=related_news (Jan. 31, 2023)

available electric power would be 71,862,835 kWh.

Assuming that this power is supplied to grids, we can obtain 44,051 tCO_2 by multiplying it by the grid emission factor with renewable energy in Bali: 0.613 tCO_2/MWh. The cost for the equipment varies considerably according to location and the necessity of pretreatment equipment, so it is difficult to assume its scale, etc. Accordingly, in this discussion, too, we will estimate the subsidy amount from the standard cost-effectiveness value (4,000 yen/t-CO_2) of the JCM equipment subsidy program. As for the statutory service life, it is necessary to confirm it with the National Tax Agency, but considering it as equipment for gas business because the equipment gasifies waste through pyrolysis and produces hydrogen, we assume that it is 10 years. Since the total reduction amount of CO_2 emissions in 10 years is about 440,000 tons, we can obtain 1.7 billion yen by multiplying it by the standard cost-effectiveness value: 4,000 yen. This equipment is the first subject of the JCM equipment subsidy program, so 50% of the cost would be subsidized. By specifying equipment that would cost 3.4 billion yen, whose 50% would be subsidized, it is possible to make it subject to the JCM subsidy program.

3. Intercity collaboration to realize a low-carbon society (discussions with local stakeholders)

In the intercity collaboration project in this fiscal year, we were able to conduct an on-site survey and other activities as COVID-19 has subsided. We gained the understanding of local staff by explaining the details of our surveys and the status of our activities through remote meetings, etc., fostered relationships with the government of Bali Province, Pertamina, and related enterprises, and had discussions based on gathered information.

Major activities are as tabulated below.

Table 3-1 Activities in this project

Date	Activities	Participating institutions
Aug. 14, 2022	Discussion with the bureau of energy and mineral resources of Bali Province	Udayana University, JANUS
Aug. 15, 2022	Visit to waste banks in Denpasar	Udayana University, JANUS
Aug. 16, 2022	Discussion with the environmental bureau of Bali Province	Udayana University, JANUS
Aug. 16, 2022	Visit to the waste disposal site of BUDUK Village	JANUS
Aug. 29, 2022	Discussion with Toyama City and Hokusan	Toyama City, Hokusan, JANUS
Sep. 26, 2022	Discussion with Nihonkucho Hokuriku	Nihonkucho Hokuriku, JANUS
Oct. 11, 2022	Meeting with PT, Pertamina	Toyama City, Hokusan, JANUS
Dec. 14, 2022	Meeting with PT.Senergi Kidul Konsulindo	PT.SKK, JANUS
Dec. 23, 2022	Discussion with Hokusan	JANUS
Jan. 6, 2023	Discussion with JGC	JANUS
Jan. 20, 2023	Meeting with PT. Taeyang Group	PT.SKK, JANUS
Jan. 23, 2023	Meeting with PT. Gowi Karya Lestari	PT.SKK, JANUS
Jan. 25, 2023	Meeting with Bali Province	Udayana University, PT.SKK、JANUS
Jan. 26, 2023	Meeting with PT. Bintang Terbarukan	PT.SKK, JANUS
Jan. 26, 2023	Meeting with PT. Nusa Mata Terbit	PT.SKK, JANUS
Jan. 26, 2023	Meeting with PT. Solar Power	PT.SKK, JANUS
Jan. 27, 2023	Meeting with PT. Ineco	PT.SKK, JANUS
Jan. 27, 2023	Meeting with PT. Fuji Home	PT.SKK, JANUS
Jan. 27, 2023	Meeting with Bali Mandara Hospital	PT.SKK, JANUS
Jan. 27, 2023	Meeting with Bali Solar Association	PT.SKK, JANUS

Source: Produced by JANUS

3.1. Items discussed with Bali Province

Through two meetings with Bali, we discussed the policy for our intercity collaboration project, exchanged opinions, and considered measures, etc.

Through the G20, Bali got motivated to pursue decarbonization for making their society greener. In particular, solar power generation has great potential, and they would welcome proposals for promotion. On the other hand, they informed us that standards and regulations for power connections are unclear due to the capacity of PLN, so many products are pending.

Regarding EVs, an action plan is scheduled to be announced in the near future. They plan to start to build 200 EV stations in April 2023. They hope that solar power will be adopted for these facilities, too.

Regarding hydrogen, they recognized that it is a future technology, but they are keenly interested in the demonstration and distribution of it for alleviating the impact on grids through power storage and solving the problem of intermittency of solar power generation.

As mentioned above, hospitals are proactively adopting solar power generation, and they commented that they hope that we will cooperate with them.

Furthermore, they commented that they hope that not only business, but also environmental friendliness will be advertised as a matter of top priority. There is also a request for installation in a place where education could be conducted. In the intercity collaboration project, they requested that the project should increase the employment of local residents.

Figure 3-1 Exchange of opinions with Bali (Aug. 2022 [left], Jan. 2023 [right])

4. Summary of outcomes and future plans

The following shows future plans based on the results of the surveys in the intercity collaboration project in this fiscal year.

4.1 Application for the JCM equipment subsidy

This fiscal year, we researched and discussed mainly local needs and the suitability and feasibility of installation. We plan to cement relationships with the staff related to candidate sites clarified through the above activities, and discuss detailed installation plans (designs, cost estimation, and division of roles) from the next fiscal year.

4.2 Intercity collaboration activities

After seeing the outcomes of G20 and getting motivated, the Bali government expressed considerable interest in green and decarbonized society, and is promoting measures for distributing solar power and EVs. In this situation, they are keenly interested in the activities of Toyama City, which pioneered in declaring itself a zero-carbon city in Japan.

Accordingly, the bureau of energy and mineral resources of Bali Province, Pertamina Gas, which is involved in this project, and others are planning to visit Toyama City, as COVID-19 has subsided. We would like to prepare invitation opportunities, introduce successful cases of political measures of Toyama City and support for the activities of enterprises in the city, and facilitate the activities in Bali.

Future plans based on these activities are shown below.

survey item	FY2022				FY2023				FY2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. efforts to commercialize the submitted project												
1.1 Survey of Hydrogen Production and Utilization Projects												
1) Hydrogen production and grid-connected projects using fuel cells												
(i) Target site identification												
a. conformance point survey			━	━	━	━	━					
b. Geographic Information Gathering					━	━	━	━	━			
c. systematization						━	━	━	━	━		
(2) effectiveness verification												
a. CO2 Emission Reduction Effect							━	━	━	━	━	
b. cost estimation							━	━	━	━	━	
c. Economic feasibility and return on investment analysis								━	━	━	━	━
2) FCV and EV Mobility Utilization Projects												
(i) Target site identification												
a. conformance point survey			━	━	━	━	━					
b. Geographic Information Gathering					━	━	━	━	━			
c. systematization						━	━	━	━	━		
(2) effectiveness verification												
a. CO2 Emission Reduction Effect							━	━	━	━	━	
b. cost estimation							━	━	━	━	━	
c. Economic feasibility and return on investment analysis							━	━	━	━	━	━
3) Support for appropriate decarbonized waste disposal												
(i) feasibility study												
a. Survey of Waste Properties			━	━	━	━	━					
b. Collection and pretreatment method study				━	━	━	━	━				
c. systematization					━	━	━	━	━			
(2) effectiveness verification												
a. CO2 Emission Reduction Effect							━	━	━	━	━	
b. cost estimation							━	━	━	━	━	━
c. Economic feasibility and return on investment analysis							━	━	━	━	━	━
1.2 Policy advocacy												
1) Sharing of initiatives and transfer of decarbonization policies by Toyama Ci												
(i) Seminars held							▲					
(2) Policy dialogue and top-level meetings								▲				
2. site surveys and seminars												
1) Field survey (JGC Indonesia officials dispatched, online)			▲			▲			▲			
2) Workshop for local officials/Invited by Toyama City					▲		▲			▲		
3) Presentations at conferences designated by the Ministry of the Environmer								▲				▲
4) Presentation at a conference designated by the Ministry of the Environmen				▲				▲				▲
3. debriefing and report writing												
1) briefing				▲				▲				▲
2) Report preparation and submission				▲				▲				▲