

Overview of Microgrids with Renewable Energy in ASEAN

CEFIA Flagship Project - Microgrids

 **Mitsubishi Research Institute**

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Energy and Sustainability Division

Gota Seto

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CEFIA (Cleaner Energy Future Initiative for ASEAN)

About CEFIA

- **CEFIA** (Cleaner Energy Future Initiative for ASEAN) is a public-private initiative proposed by the Government of Japan to advance the dissemination of decarbonization technologies and establishment of related policies and systems under the leadership of businesses with the aim of promoting decarbonization and energy transition in the ASEAN region. It began its initiatives in September 2019.

Key Components of CEFIA

Finance

Linking projects with the Sustainable Development Goals, and attracting ESG investments



Decarbonization Technology

Utilizing cleaner energy technology and decarbonization technology



Institutions

Developing and improving policy and institutional framework required for introduction and deployment of cleaner energy technology and decarbonization technology

CEFIA (Cleaner Energy Future Initiative for ASEAN)

CEFIA flagship projects

- Within the framework of CEFIA, there are the so-called **CEFIA flagship projects**. CEFIA flagship projects serve to **share and showcase good practices** of cooperation in introducing decarbonization technology. The flagship projects could be effectively used to develop appropriate policy and institutional framework, as well as mobilize public and private finance (governments, private sectors, and academia).

CEFIA Flagship Projects

Title	Purpose	Activities
ZEB	Promoting and developing the Net-Zero Energy Building (ZEB) to contribute to the acceleration of energy efficiency in the demand side in ASEAN.	<ul style="list-style-type: none"> ➤ International Standardization ➤ Seminar and workshop
RENKEI	Disseminating control optimization (RENKEI) to reduce energy consumption throughout utility plants and manufacturing plants through IoT.	<ul style="list-style-type: none"> ➤ Feasibility Study for Thailand Industry ➤ Workshop
Microgrid	Introducing Microgrid system combining Magnus wind turbines, solar power, and energy storage functions into remote islands, to realize decarbonized energy and improving resilience.	<ul style="list-style-type: none"> ➤ Feasibility Study ➤ Demonstration project
SteelEcosol	Diagnosing and introducing the best available energy-saving technologies (BAT) to the steel industries.	<ul style="list-style-type: none"> ➤ Capacity Building ➤ Public-Private Dialogue

Source: Ministry of Economy, Trade and Industry, “Cleaner Energy Future Initiative for ASEAN (CEFIA)”, https://8620884.fs1.hubspotusercontent-na1.net/hubfs/8620884/240123_CEFIA_Overview_EN.pdf, (Accessed: 6 January 2025)

CEFIA (Cleaner Energy Future Initiative for ASEAN)

CEFIA flagship projects: microgrids

- **An initiative to introduce a microgrid system** that integrates multiple renewable energy sources, such as wind and solar power, along with storage batteries.

◆ Activity Structure

Introducing case studies with the participation of companies aiming to expand into ASEAN.

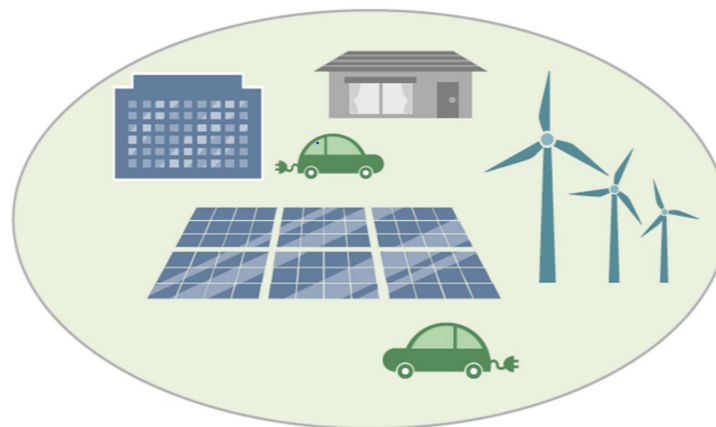
◆ Expected effects

By spreading the technology to highly vulnerable areas such as islands, it will be possible to ensure a stable supply of electricity in the event of a disaster, thereby simultaneously achieving a carbon-free power supply and strengthening resilience.

◆ Main Activity

Sharing good practices

Visualization of GHG reduction effects



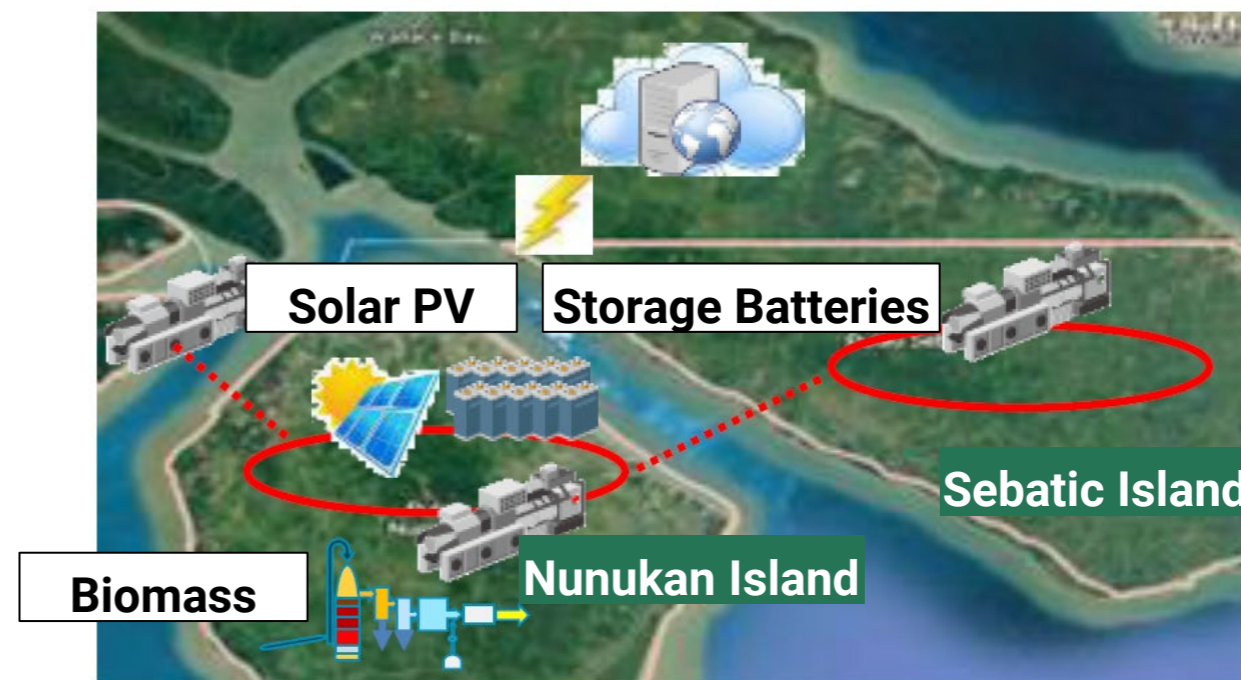
Sharing feasibility studies, demonstration projects, etc.

Discussions towards disseminating technology

About microgrids

- **Microgrid** is a system in which small-scale power generation facilities are built in a certain area, and energy is produced and consumed locally without relying on large-scale power plants and grids (known as macro-grids). It efficiently uses renewable energy, and in emergencies, it supplies electricity generated within the area independently of the traditional large-scale power transmission and distribution network.
- Applications range from rural electrification and industrial energy efficiency to military bases and urban infrastructure.
- Kyudenko is currently engaged in a demonstration project of microgrid in remote island areas in North Kalimantan, Indonesia. This microgrid is composed of solar PV, biomass, and storage batteries.

Demonstration Project in Indonesia by Kyudenko



Pros and cons of microgrid

- There is an emerging focus on microgrid since it could have numerous benefits, including GHG emission reduction, enhanced reliability, greater resilience, local economic development, and less dependence on conventional power grids.
- However, while microgrid is a novel technology, it holds a number of disadvantages that need to be carefully considered before implementation. Upsides and downsides of microgrids are summarized in the table below.

Pros		Cons	
Environmental benefits	<ul style="list-style-type: none"> • By integrating clean energy sources, such as solar and wind, it contributes to the GHG emission reduction 	Technical complications	<ul style="list-style-type: none"> • There are technical barriers for the introduction due to a lack of experience, technical expertise, and assistance for operation and management
Enhanced reliability	<ul style="list-style-type: none"> • Outages occur in conventional power systems due to overloads or device failures whereas it provides reliable source of power independently 	High initial capital costs	<ul style="list-style-type: none"> • The initial startup investment could be high, discouraging private sectors and communities • Subsidies or grants from governments are required to encourage more investors
Greater resilience	<ul style="list-style-type: none"> • It can enhance resilience during cyber-attacks, natural disasters, and other unexpected incidents as power is generated and distributed by the different parts of the macro-grid 	Regulatory issues	<ul style="list-style-type: none"> • Current regulations focus more on the conventional power gridding models. • Enacting regulations oriented towards microgrids is essential for their dissemination
Local economic development	<ul style="list-style-type: none"> • Microgrids that utilize locally available energy sources can create economic activities and employment, leading to the local economic development 		

Source: P&S Intelligence, "What are the Advantages and Challenges of Microgrids?", <https://www.psmarketresearch.com/blogs/microgrid-analysis#>, (Accessed: 9 January 2025)

About Microgrids

Important technology - EMS

- Microgrids must be able to manage the load on the system and ensure that energy demand is balanced with supply. The introduction of storage batteries can mitigate fluctuations in renewable energy output, and an **Energy management system (EMS) can be used to make generator operation more efficient**, making it possible to actively introduce renewable energy while maximizing the use of generated electricity.

	On-site environment (before introduction)	After introduction of EMS
Stand-alone type [Stable power supply for remote islands and remote areas]	Electricity supply by diesel power sources with high CO2 emission and high-cost structure due to fuel transportation	Fluctuating renewable energy can be stably supplied through remote monitoring to match demand. Thus, CO2 emission will be reduced
Grid-connected type: Grid supply [Increase in renewable energy ratio]	Increasing proportion of renewable energy sources is creating constraints on the output that can be connected to the grid	Even in regional grids where the ratio of renewable energy is rapidly increasing, it will be possible to flexibly supply renewable energy sources and ensure a stable power supply
Self-consumption type [Resilience improvement]	In the event of a grid accident, long-term power outage may occur. Emergency power supply is only possible by in-house power generation	Seamless stand-alone operation will be possible in the event of a grid accident.

Source: Mitsubishi Research Institute

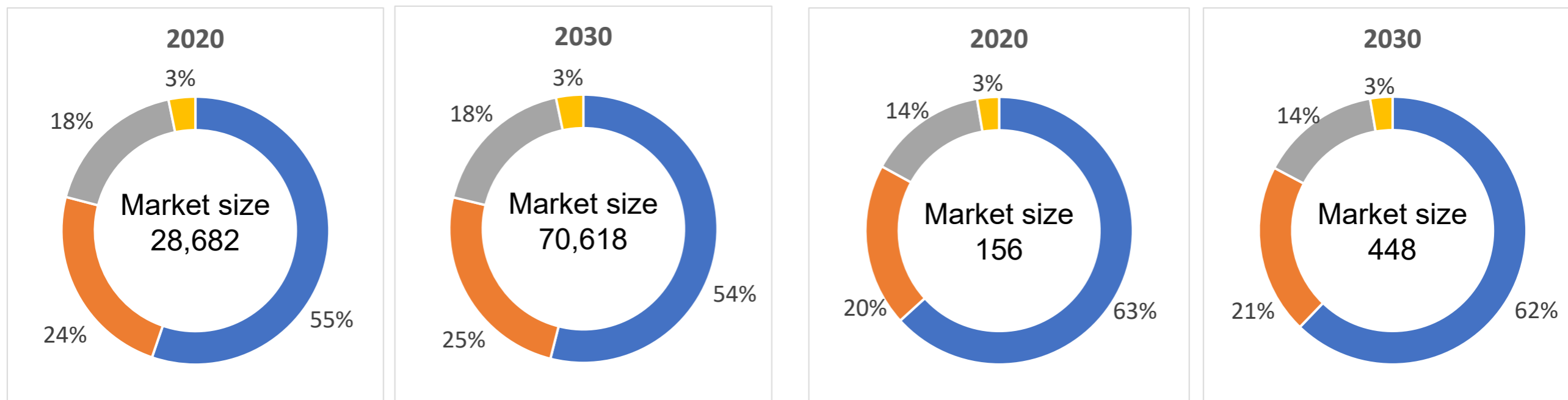
Market of microgrids in the Philippines

- The market size will more than double both globally and in the Philippines from 2020 to 2030. So, it can be said that microgrid has a large potential to grow in the future.

Microgrid market size globally and in the Philippines in 2020 and 2030, and the proportion by technology type (USD million)

【Global】

【The Philippines】



■ Grid connected Microgrids ■ Hybrid Microgrids ■ Remote Microgrids ■ Others

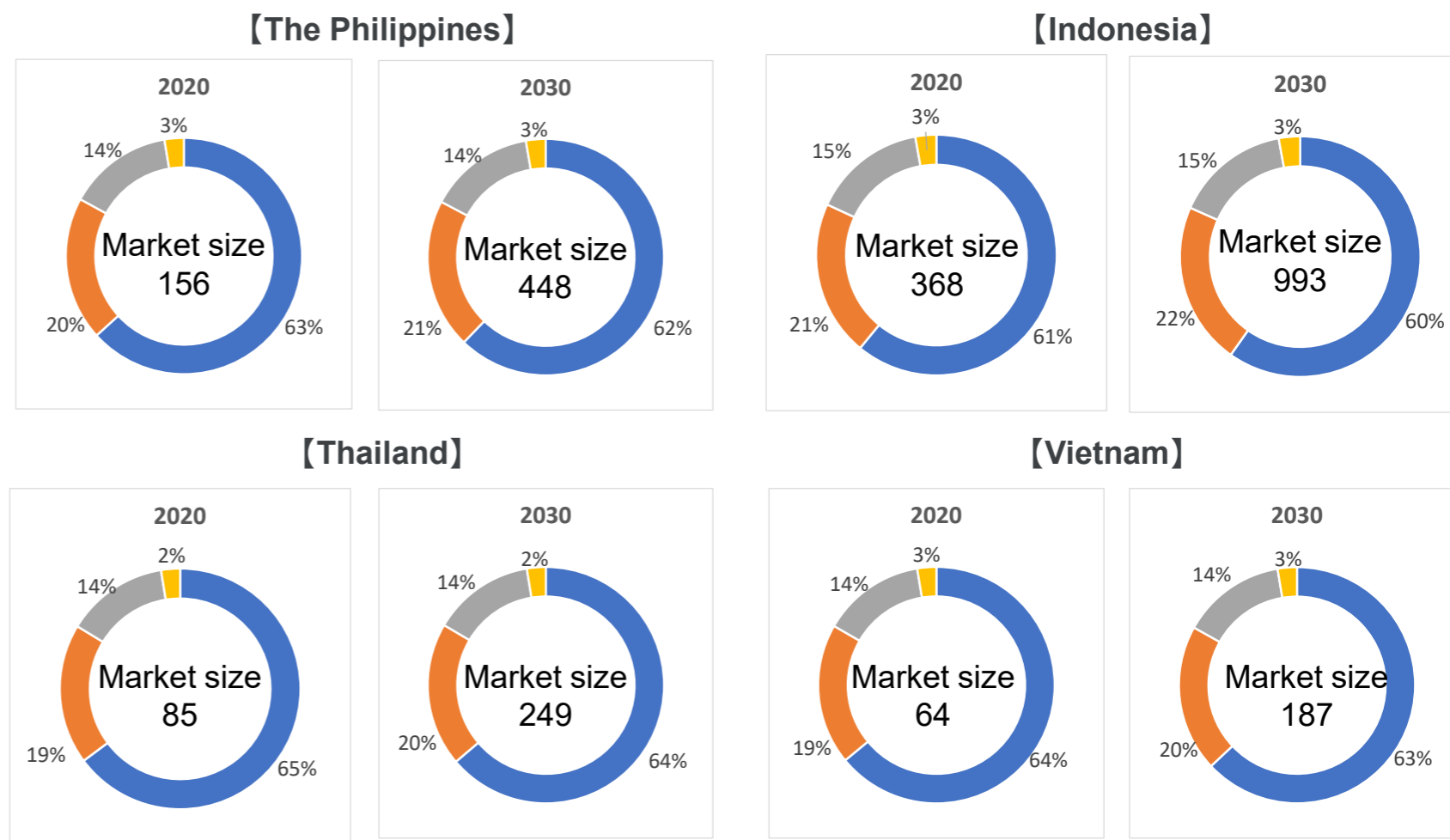
Source: Mitsubishi Research Institute

※ Hybrid is a combination of multiple types of power sources

Market of microgrids in ASEAN countries

- The market size in the Philippines and Indonesia is relatively larger than other ASEAN countries.
- This seems to be because both countries have numerous remote and isolated areas, reflecting their geographical features. In addition, both countries have specific policies and plans to promote microgrids.

Microgrid market size in ASEAN in 2020 and 2030 by technology type (USD million)

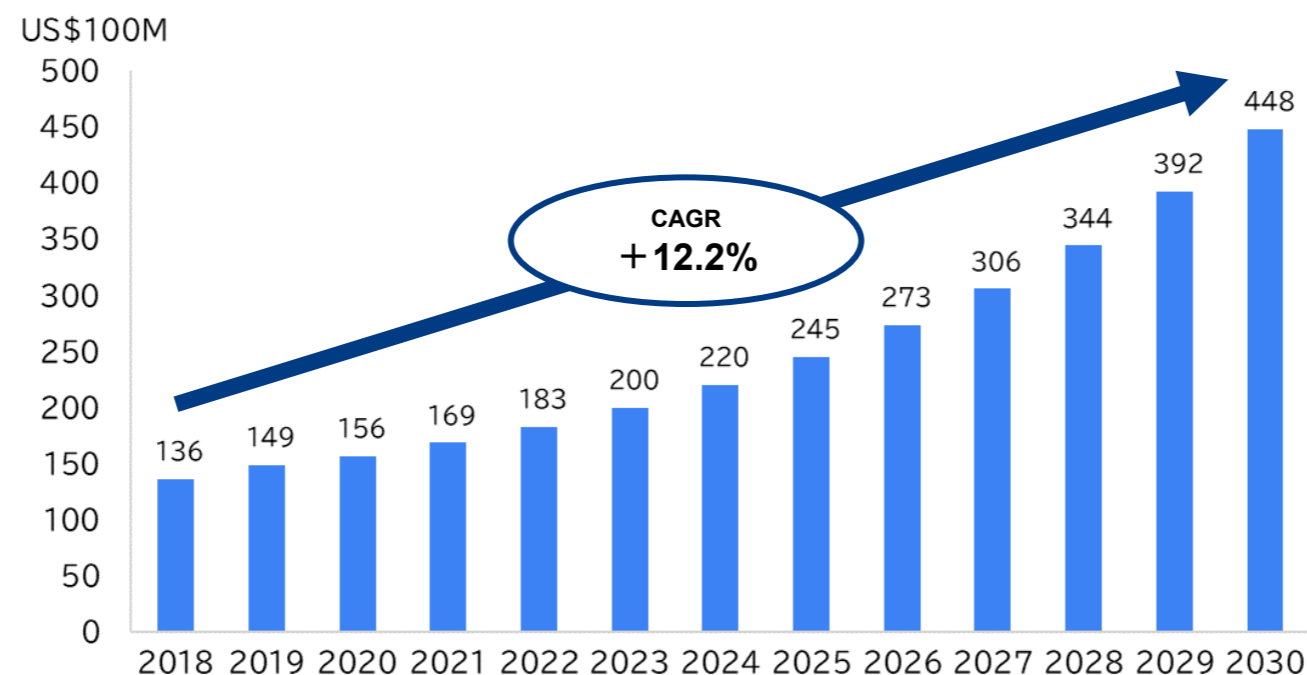


■ Grid connected Microgrids ■ Hybrid Microgrids ■ Remote Microgrids ■ Others

Market of microgrids in the Philippines

- Government of the Philippines has set goals such as increasing renewable energy capacity to more than 30,000 MW by 2030.
- The market size of microgrids in the Philippines is expected to grow at a CAGR (compound average growth rate) of 12.2% from 2018 to 2030, reaching 448 million USD in 2030.

Growth prospect of microgrids market in the Philippines

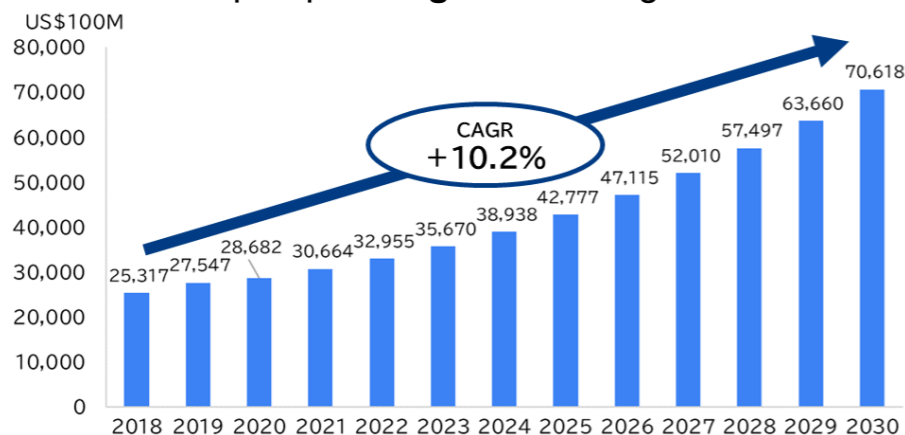


Market of Microgrids

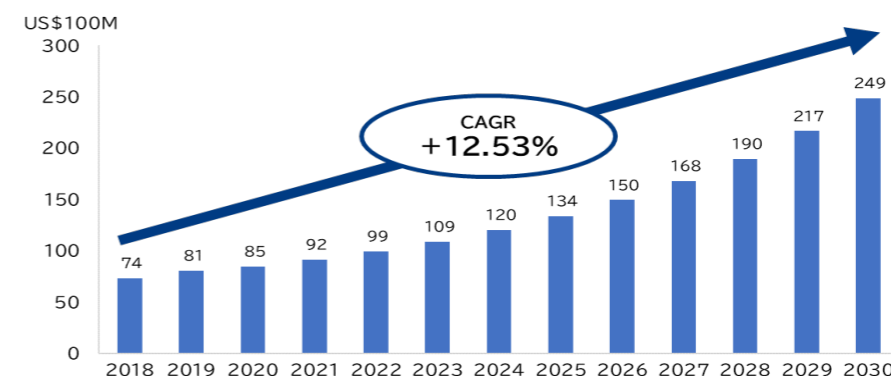
Market of microgrids in ASEAN countries

- Growth prospect of microgrid markets is higher in ASEAN countries than the global market. Adding to this, the growth prospects in Thailand and Vietnam are higher. This seems to be because the foundation of microgrid market in the two countries are relatively underdeveloped.

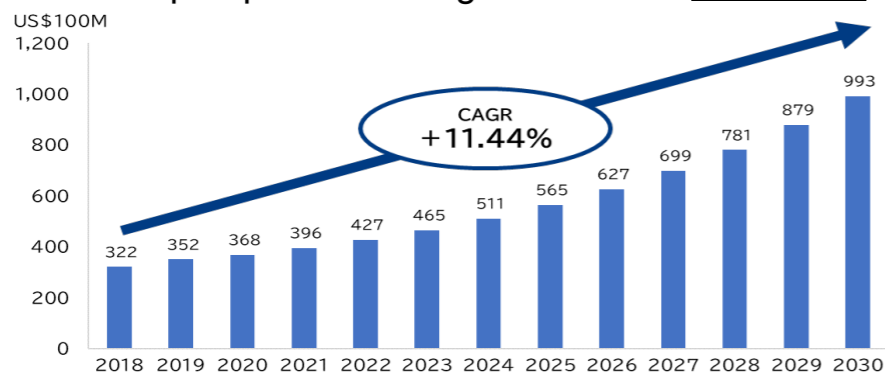
Growth prospect of **global** microgrid Market



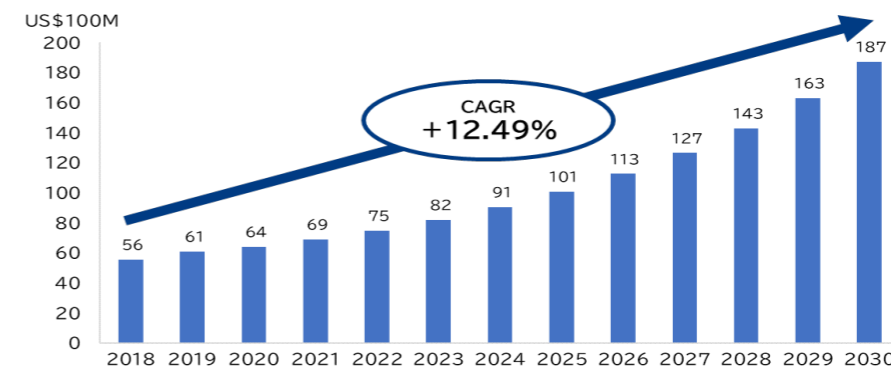
Growth prospect of microgrid market in **Thailand**



Growth prospect of microgrid market in **Indonesia**



Growth prospect of microgrid market in **Vietnam**

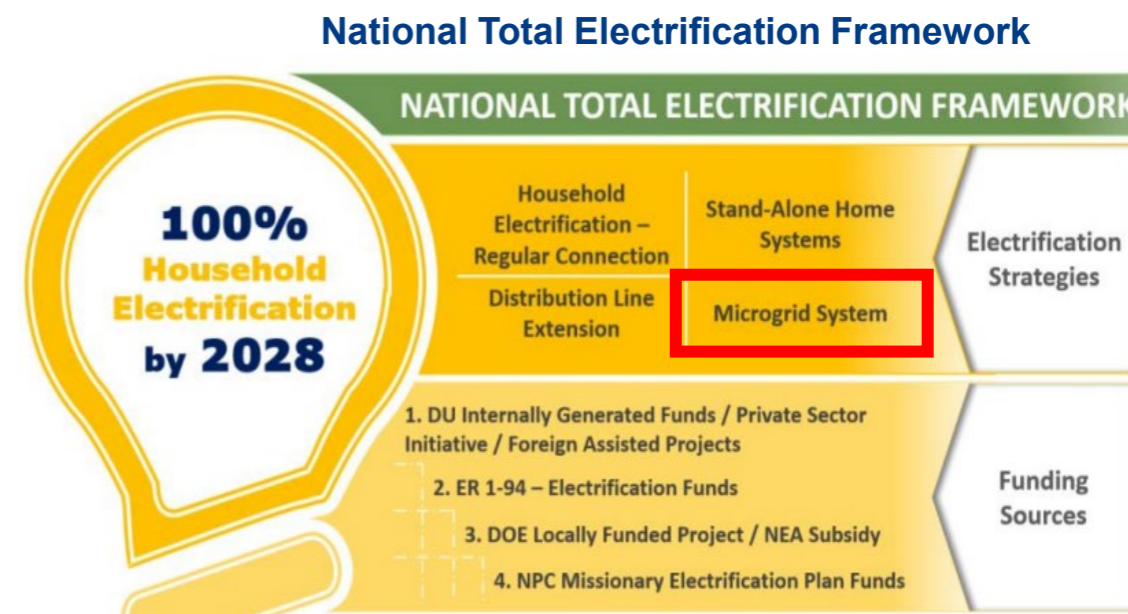


Source: Mitsubishi Research Institute

Philippines | National Total Electrification Roadmap

- The Philippine Energy Plan (PEP) 2023-2040 stressed the goal of total electrification in the country, especially in remote rural areas, often located far from urban infrastructure.
- Furthermore, President Ferdinand R. Marcos Jr. said, **“We will spare no effort to achieve full household-electrification by the end of my term (June 2028). 100% is within our reach.”**
- To achieve the goal, National Total Electrification Roadmap (NTER) 2023-2032, has been published by the Department of Energy (DOE) with the four electrification strategies as below, and one of them is **Microgrid system**. Thus, it can be said that microgrid is a key component of Philippine energy policy and significant investments may occur in the near future.

Strategies	Details
1. Household Electrification - Regular Connection	• Connecting individual households to existing grid or power supply system
2. Distribution Line Extension	• Some distribution utilities undertaking line extension
3. Stand-Alone Home Systems	• Most appropriate solution to last-mile areas that are not feasible for microgrid systems
4. Microgrid System	• In areas with clusters of households and potential for economic activities, microgrid systems are seen as viable option when these areas cannot be immediately or very difficult to be connected to the grid.



Source: Republic of the Philippines Department of Energy, “National Total Electrification Roadmap”, <https://doe.gov.ph/sites/default/files/pdf/electric.power/2023-2032-NTER-2023-2032-Annexes.pdf>, (Accessed: 6 January 2025)

Indonesia | RUPTL and LTS-LCCR

- The “**RUPTL 2021-2030**”, which is national electricity supply plan of Indonesia, states that a local and independent electricity supply for residents on the island or isolated area can be achieved through **smart microgrid**.
- The development of microgrid, established with solar PVs, wind, biomass, and micro-hydro, is increasingly needed in order to maintain electricity availability and reliability and to electrify villages 24 hours a day.
- Furthermore, in the “**Long-Term Strategy for Low Carbon and Climate Resilience 2050 (LTS-LCCR)**” published in 2021, Government of Indonesia demonstrated the direction of national policy towards net-zero emission in 2060. In “Power” section of LTS-LCCR, the increasing development of ‘off-grid’ and ‘**microgrid**’ is clearly mentioned, indicating the growing awareness of microgrid’s role to play for the energy objective of Indonesia.



The importance of developing microgrids has been recognized in island countries, such as the Philippines and Indonesia, aiming to supply stable electricity to remote island and isolated areas.

Source: PLN, "RUPTL2021-2030", <https://web.pln.co.id/statics/uploads/2021/10/ruptl-2021-2030.pdf>, (Accessed: 6 January 2025)

Indonesia, "Long-Term Strategy for Low Carbon and Climate Resilience 2050", https://unfccc.int/sites/default/files/resource/Indonesia_LTS-LCCR_2021.pdf, (Accessed: 6 January 2025)

GIZ support programs

- There are a number of governmental or not-for-profit organizations that provide support programs to promote microgrids as part of rural electrification planning of developing and emerging countries.
- **GIZ**, German development agency established by German government, is one of them and works with national governments, private sectors, and civil society to facilitate necessary capacity development.
- It is implementing bilateral technical assistance programs on the development of microgrids in countries including Afghanistan, India, **Indonesia**, **Myanmar**, Nigeria, Pakistan, **the Philippines**, and Pacific island states.

Microgrid with solar power in Indonesia



Overview	
Agency	<ul style="list-style-type: none"> • For over 40 years, GIZ has worked with governments in over 40 countries in Africa, Asia and Latin America to provide rural electricity. • In developing microgrids, GIZ works in a practical and results-oriented manner at global, regional, national and local levels.
Activities in ASEAN	<ul style="list-style-type: none"> • In the Philippines, GIZ developed an investor checklist for the project developers of hybrid systems that provides guidance on preparing financing proposals and business plans and helps them in their negotiations with banks.

Source: GIZ, "GIZ PORTFOLIO: RENEWABLE ENERGY AND HYBRID MINI-GRID SYSTEMS", [https://energypedia.info/images/f/ff/GIZ_\(2017\)_Mini-grid_Portfolio_Overview.pdf](https://energypedia.info/images/f/ff/GIZ_(2017)_Mini-grid_Portfolio_Overview.pdf), (Accessed: 7 January 2025)
 GIZ, "Energising Development (EnDev) Indonesia", <https://www.giz.de/en/worldwide/24209.html>, (Accessed: 7 January 2025)

GEAPP support programs

- Global Energy Alliance for People and Planet (GEAPP), established by several foundations, including the Rockefeller Foundation, is an organization which works to develop innovative green energy solutions in developing and emerging countries.
- It provides country-level support to seven foundation countries, namely Congo, Ethiopia, India, **Indonesia**, Nigeria, South Africa and **Vietnam**. While these countries have been prioritized based on potential impact and government commitments, other ASEAN countries could receive the support.
- For example, GEAPP provides funding to energy developers in **Myanmar** that supply distributed solar microgrid and offers rooftop solar solutions to small and medium enterprises (SMEs) and agriculture.

A solar farm powering a rubber factory in Myanmar



Overview	
Agency	<ul style="list-style-type: none"> • A US-based organization founded by the IKEA Foundation, the Rockefeller Foundation and the Bezos Earth Fund. • Since its creation, it has been joined by global institutions and dozens of partners who share the common belief that access to green energy in emerging markets is fundamental to tackling the climate change crisis and ending inequality.
Activities in ASEAN	<ul style="list-style-type: none"> • In March 2022, it launched the Diesel Replacement Programme (DRP) in cooperation with the Government of Indonesia, PLN and affiliated partners, aiming to convert approximately 5,200 diesel power plants to renewable energy and integrate them into the grid • It also demonstrates the pilot project of sustainable microgrid with renewable energies and batteries for un-electrified communities in specific regions of Indonesia.

Source: GEAPP, "Who We Are", <https://energyalliance.org/who-we-are/>, (Accessed: 7 January 2025)

GEAPP, "Staying the course in Myanmar", <https://energyalliance.org/wp-content/uploads/2024/07/Myanmar-Breakthrough-Story.pdf>, (Accessed: 7 January 2025)

Support programs of Japanese government

Support programs	Agency	Project scale	Overview
Global South Future-Oriented Co-Creation Project (Large-scale Demonstration Project)	METI JETRO	Between 500 million yen and 4 billion yen	The project aims to utilize the market growth potential of the so-called Global South countries (the target countries of this project are ASEAN member states) by solving the problems they face, to strengthen economic partnerships with these countries, and to bring benefits to the countries where this project is implemented.
Global South Future-Oriented Co-Creation Project (FS Project/Small-scale Demonstration Project)	METI	FS project: up to 100 million yen Small-scale demonstration project: up to 500 million yen	The project aims to utilize the growth potential of the market in the Global South by solving the issues faced by these countries, and to revitalize domestic industries through innovation in Japan.
International Demonstration Project on Japan's Technologies for Decarbonization and Energy Transition	NEDO	Budget: 4.5 billion yen (FY2024)	In this project, efforts are made to promote the use of Japan's advanced technologies that contribute to safety, energy security, economic efficiency, and the environment (S+3E) by demonstrating such technologies overseas. The demonstrations are carried out in international energy markets that have more advanced energy policies in place in order for Japan to gain meaningful results.
Program to Facilitate Overseas Promotion of Low Carbon Technology Through the Joint Crediting Mechanism (JCM)	NEDO	Up to 1 billion yen	The program aims to reduce greenhouse gas emissions on a global scale while spreading Japan's advanced technology. Demonstration projects will be carried out in partner countries using the JCM framework to measure Japan's contributions to the emission reductions and removals achieved by the projects. This will allow Japan to appropriately obtain JCM credits based on the results.
Joint Crediting Mechanism (JCM) funded project: JCM equipment subsidy project	MOE	Total amount: approximately 12.8 billion yen (over 3 years)	The Joint Crediting Mechanism (JCM) quantitatively evaluates Japan's contribution to greenhouse gas (GHG) emission reductions achieved through the dissemination of advanced decarbonization technologies and the implementation of measures, and it is utilized to achieve Japan's emission reduction target (NDC). To promote the JCM, the project provide financial support of part of the initial investment cost for projects introducing decarbonization equipment under the JCM.

Individual case | Indonesia and Philippines

- WEnergy is a renewable energy solution company headquartered in Singapore. It provides clean, affordable electricity through renewable energy technologies, advanced energy storage systems, financing, etc. It is developing and operating microgrids in **Indonesia** and **the Philippines**.
- In Nusa Tenggara, **Indonesia**, a feasibility study was conducted to investigate the potential of solar power generation with storage batteries to lower dependency on diesel power generation.
- In Sabang, Palawan island, **the Philippines**, it has signed a contract with electrical solution providers to energize over 7,100 households and 300 small local businesses through 16 microgrids.

Nusa Tenggara, Indonesia



Philippines Sabang Project



Overview	
Area	<ul style="list-style-type: none"> • Nusa Tenggara, Indonesia • Sabang, Palawan, Philippines
System component	<ul style="list-style-type: none"> • (Indonesia) Solar PV with storage battery • (Philippine) 3,800 kWp solar PV, 2,000 kW diesel generators, and batteries with a total capacity of 4,200 kWh
Developers	WEnergy (Singapore)
Details	<ul style="list-style-type: none"> • A total of eight archaeological sites and 45 villages in Nusa Tenggara Timur were selected and surveyed. • WEnergy Global is to energize over 7,100 households and 300 small local businesses through 16 microgrids spread over 14 barangays in seven municipalities.

Source: WEnergy, "What we do: Microgrids", <https://www.wenergyglobal.com/microgrids#indonesia>, (Accessed: 7 January 2025)

Oasis Media Group Corp, "PARAWAN NEWS", <https://palawan-news.com/wenergy-global-partners-set-to-power-over-30000-people-in-palawan/>, (Accessed: 8 January 2025)

Individual case | Indonesia

- Microgrid project was implemented in a village of East Kalimantan, Indonesia by French renewable energy producer, Akuo. The company has more than 80 renewable energy production plants around the world and obtains subsidiary in Indonesia.
- Regarding the project, originally, electricity was generated solely by a diesel generator, allowing for only 4 hours of electricity usage per day. But with the installation of the microgrid, electricity is now available 24 hours a day.

East Kalimantan, Indonesia



Overview	
Area	East Kalimantan, Indonesia
System component	Solar PV: 1MW Battery: 2MWh
Developers	Akuo
Details	<ul style="list-style-type: none"> • Introduced Indonesia's largest off-grid hybrid solution (solar power, batteries and micro-hydropower generators) to three villages. • The project, which was the largest hybrid project in Indonesia at the time of construction (2018), was realized with the support of MCC (Millenium Challenges Corporation) • Previously, they used shared diesel generators and only had access to electricity for 4 hours a day, but thanks to this project they now have access to electricity 24 hours a day, and the cost has also decreased by 2.5 time.

Source: Akuo, "MCA", <https://www.akuoenergy.com/en/akuo-in-the-world/all-our-projects/mca>, (Accessed: 8 January 2025)

Individual case | Malaysia

- Small-scale microgrid project was implemented in a remote area, namely Tapah in Malaysia by a Malaysian electrical power technology company listed on the market of Bursa Malaysia, POSTECH. Until now, POSTECH has expanded its business into other ASEAN countries, such as **Cambodia, Philippines, Thailand, and Myanmar.**
- Before the project, villagers who live in the surrounding area in Tapah did not have the access to electricity due to its remote location. But, with installation of this microgrid system, the living condition of the community was improved since they can now illuminate their house and use electrical appliances with newly generated electricity.

Tapah, Malaysia



	Overview
Area	Tapah, Malaysia
System component	Solar PV, energy storage banks
Developers	PESTECH
Details	<ul style="list-style-type: none"> • The system consists of 3.4kW solar panels, energy server and supercapacitor-based energy storage banks. This is a long term and cost-saving solution as the maintenance cost is low and a storage life cycle is 45 years • This project benefited 15 houses and brought positive impacts to over 100 villagers living in houses that have no access to electricity for 20 years due to its remote location. The living condition of the community has been significantly improved.

Source: POSTECH, “Renewable-Based Microgrid Solution at Tapah”, <https://pestech-international.com/sustainability-development-project/renewable-based-microgrid-solution-at-tapah>, (Accessed: 8 January 2025)

Individual case | Thailand

- The wave-powered microgrid, which is made up of onshore wave energy converters, a wireless distributed energy management system, and AI-based technologies, will be developed by a consortium of tech companies and universities. This microgrid is created to energize the remote Thai island of Koh Tao, with a low levelized cost of energy compared to solar and diesel generators.
- Eco Wave Power, one of the companies in the consortium, will provide onshore wave energy converters, which convert sea or ocean waves into clean energy in an environmentally friendly and cost-effective way.

Eco Wave Power's converters



Overview	
Area	Koh Tao Island, Thailand
System component	onshore wave energy converters, wireless distributed energy management system, AI-based technologies
Developers	The Provincial Electricity Authority (PEA)
Details	<ul style="list-style-type: none"> • Eco Wave Power, an onshore wave energy company, will provide onshore wave energy converters (WEC), which convert sea or ocean waves into clean energy in an environmentally friendly and cost-effective manner. • The pilot project develops and deploy a wave energy microgrid that includes a predictive control system, a radar system that forecasts wave heights and optimizes energy generation as well as load and generation prediction tools powered by artificial intelligence (AI).

Source: MICROGRID KNOWLEDGE, "Wave-Powered Microgrid to be Developed on Remote Thai Island", <https://www.microgridknowledge.com/remote-and-island-microgrids/article/33036694/wave-powered-microgrid-to-be-developed-on-remote-thai-island>, (Accessed: 9 January 2025)

Summary and future prospect

Summary

- Microgrid has big potentials environmentally and economically in ASEAN region, bringing us numerous benefits, including GHG emission reduction, enhanced reliability, greater resilience, local economic development, etc.
- With these benefits, microgrid market is more likely to develop significantly in the next decades. Especially, the countries which have lots of remote areas, such as the Philippines and Indonesia, have greater potential for the market development.
- It would be also better to make the most of some support programs that I have introduced.

CEFIA flagship project

- The flagship project of microgrids contribute to accumulating experiences and knowledge in introducing the microgrid technologies and to making recommendations on policy-making of microgrids from the economic and environmental perspective.
- The CEFIA flagship project will continuously promote horizontal expansion of similar projects through the active sharing of good practices.

Envisioning the future, leading change

