The summary of the SEA regrading "Master Plan for Energy Transition Management Project in Indonesia "

This paper is made for the purpose of informing the overview of the first stakeholders meeting (SHM) held on 30 July 2024 and the second SHM held on 9 April 2026 in Jakarta, Indonesia.

[Introduction]

In October 2016, the Indonesian government ratified the Paris Agreement of the United Nations Framework Convention on Climate Change and announced a goal of zero greenhouse gas emissions by 2060 in the Conference of the Parties in 2021.

In January 2024, supported by the Japan International Cooperation Agency (JICA), "Master Plan for Energy Transition Management Project in Indonesia (hereinafter "the Project") " has started entrusted a consortium of experts (hereinafter "JICA Project Team") in Japan in order to study how to achieve stable, affordable, and sustainable electricity supply in Indonesia and achieve Net Zero Emission by 2060 collaborating closely with PT PLN and Indonesian Ministry of Energy and Mineral Resources (MEMR) as our main counterparts in the Project.

The Project consists of studying grid analysis, identification of issues related to power system planning, confirmation of development status and potential analysis of renewable energy, and strategic environmental assessment.

On 30 July 2024, the first SHM was held to introduce an overview of the Project and how to proceed with the Strategic Environmental Assessment (SEA) for the development of power sources to achieve decarbonization, attended by government agencies, donors, and research institutions.

On 9 April 2026, the second SHM was held to introduce an overview of the results of our study.

[Summary]

1. Indonesia's Future Electricity Supply

In 2021, at the Conference of the Parties to the United Nations Framework Convention on Climate Change, Indonesia announced an ambitious goal of zero greenhouse gas emissions by 2060. The Ministry of Energy and Natural Resources (MEMR), in collaboration with the International Energy Agency (IEA), examined scenarios in the energy sector to achieve this goal. The major trend is that coal-fired capacity will remain at about 50% until around 2030, after which it will move toward virtually zero capacity toward 2060. The electricity supply system will be based on renewable energy sources (hydro, solar, wind, geothermal, etc.), fuel conversion (utilization of low-carbon fuels), and thermal power plant with CCUS, aiming for zero greenhouse gas emissions. Comprehensive and rapid sustainable actions must be taken to advance decarbonization while achieving economic growth toward real zero in 2060. The current dependence on fossil fuels is over 70%. Therefore, it is necessary to replace renewable energy from fossil fuels as the main source of energy, and consumers will also need to strengthen energy conservation and electricity saving measures.

2. Potential Sites for Power Generation Projects

Solar and wind power have a lot of potential in Indonesia, will be widely distributed in suitable locations, and are promising renewable energies for achieving carbon neutrality. However, since output fluctuates with the seasons, day and night, weather conditions, and other factors, it is necessary to provide frequency adjustment equipment to prepare for output fluctuations when large amounts of renewable energy are introduced. Hydro and geothermal power are expected to have relatively stable output. Another key to achieving carbon neutrality is the development of power grids between power supply and demand areas, and the production and transportation of green hydrogen or ammonia from renewable energy sources to be used as fuel for thermal power plants.

3. The Study on Environmental and Social Considerations in Future Electricity Supply

Project owners are required to assess the environmental impacts of their development projects in accordance with the EIA (Environmental Impact Assessment) procedure. EIA procedure is subject to specific development projects. It does not cover master plans or forward-looking higher-level plans. The Study is about the master plan for the power sector, and the EIA for future plans will be analyzed through SEA procedure, not by the conventional EIA procedure. EIA is an excellent tool as a method of environmental impact assessment for individual projects. Project owners basically implement the EIA when they decide to develop certain power generation plants and so on. EIA procedure for a specific project does not consider the overall, cumulative, and synergistic impacts with other projects in a region-wide development plan. There are limitations in considering environmental considerations for the region as a whole in EIA. Leaving EIA until the project stage means it limits the opportunity to reach more sustainable outcomes, to mitigate risks to the environmental resource which growth and development are based on, and to identify further strategic options. Implementing environmental assessment at the early stages will lead to considering various development options. It is a process that can achieve development outcomes while maintaining environmental sustainability over the long term. It can help expedite EIA process for individual projects and rationalize its scope. This means that SEA can hand over important information to EIA. Characteristics of SEA are as follows.

- SEA is implemented Policy, Plan and Program (PPP) stage that contributes to supporting and improving PPP.
- SEA focuses on the search for best practices and development.
- SEA emphasizes sustainability goals and safeguards. It may integrate the three dimensions of sustainability (environmental, social, and economic).
- SEA can approach development proposals in a proactive manner.
- SEA may focus on broad analysis, between sectors linkages, etc.
- SEA can provide a variety and range of alternatives.
- SEA can provide early warning of cumulative impacts to a sector or region.
- SEA can be related to Poverty and social impact analysis, Conflict/post-conflict and disaster

assessment, Country environmental analysis, etc.

JICA Project Team briefly explains how SEA has been conducted in the Study. The objective of SEA is to avoid or reduce significant environmental impacts at an early planning stage. Significant environmental impact is the case that the loss or degradation of conservation targets cannot be avoided based on the project and regional characteristics.

(1) Case the impact can be avoided or reduced by taking environmental conservation measures.

(2) Case the impact is reversible, short-term, or limited.

Cases (1) and (2) are not considered to pose a risk of significant impact. Regarding these cases, impact items that can be mitigated or avoided should still be thoroughly examined in the EIA as per standard procedures. The work for SEA is composed of the following four steps.

Step-1: Gathering information based on desk research

Step-2: Screening

Step-3: Scoping

Step-4: Prediction and Evaluation

Step 1: Gathering information based on desk research

Regarding Gathering information, information and data are collected from publicly available materials, such as statistical data, EIA reports, and documents published by government and research institutions via the Internet.

Step-2: Screening

The impact on the natural and social environment varies depending on the characteristic, scale, and location of the project. One important consideration in the early planning stage is whether the project site extends to or is located near areas requiring special consideration. The screening process in SEA is to clarify and identify the relationship between the proposed project areas and the area (scope) to be considered, such as important natural environment. Screening work is examined from multiple levels to grasp matters related to environmental impact at an early stage.

For example,

- Areas subject to location restrictions under international treaties, laws, or regulations.
- Areas where development is restricted due to the presence of airports, military facilities, or other critical infrastructure.
- In case of the proposed project area overlaps with designated areas of special social value, such as ethnic minorities or indigenous peoples.

The feasibility of the project will be considerably low.

Step 3: Scoping

Scoping in SEA requires identifying matters that could significantly impact project implementation itself or project progress.

Project proponent must investigate and consider these matters, incorporating them into the project

plan in the early planning stage. This is what is called “Prioritization through Scoping”. Impact items that can be mitigated or avoided should still be thoroughly examined in the EIA as per standard procedures. In Indonesia, high efficiency, fuel conversion (utilization of low-carbon fuels), and the introduction of CCS in thermal power plants, the development of renewable power sources, such as hydroelectric, wind, solar, and geothermal power, will be promoted. In the development of power generation projects, the contents and degree of impact assumed differ depending on the power generation project and the scale of power generation. The project characteristics and environmental factors that will be affected by major power supply developments were organized in this study.

Step-4: Prediction and evaluation

In terms of “predicting,” because SEA study is conducted at an early planning stage, it will not involve analysis based on field survey data or detailed simulation studies but will attempt to evaluate certain projects as quantitatively as possible. Predictions will be made using a matrix, overlay, case study comparisons, and other methods based on literature sources. For example, the relationship between the critical natural environment, areas to be considered (scope), and the project area should be confirmed by overlay. The “evaluation” examines the environmental benefits and disadvantages of the project, including an estimate of the environmental impact of the project and the causal relationship between the projects. The avoidance or reduction of significant environmental impacts is considered based on comparisons with evaluation indicators and multiple (alternative) proposals. This study does not predict or evaluate environmental impacts for a specific location (the project site). For each power development project, factors were organized based on the perspective of “what will be done (Impact factors)” and consequently “what will change (Environmental elements)”. Consideration was given to whether Impact factors should be examined at the early planning stage or whether Impact factors can be addressed through conventional EIA processes.

4. Considerations about SEA study for the power developments

(1) Environmental and social Considerations and Power Supply Scenarios

The core of energy policy is based on 3E+S: Energy Security, Economic Efficiency, Environment, Safety. This policy becomes the principle of stable power supply. By referencing General National Electricity Plan (RUKN) and other relevant documents, JICA Project Team projected scenarios for future power sources based on economic growth trends, electricity demand, electricity costs, etc.

_ **Green scenario** (Aggressive renewable energy deployment scenario)：351GW

_ **Base scenario** (Scenario aligned with advancements in decarbonization technologies)：177GW

_ **RE Conservative scenario**：128GW

Green Scenario offers faster CO2 reduction; however, it requires extensive land use, which poses potential environmental risks. RE conservative scenario generates higher CO2 emissions than the base scenario. Therefore, Base Scenario, aligned with advancements in decarbonization technologies, is more appropriate.

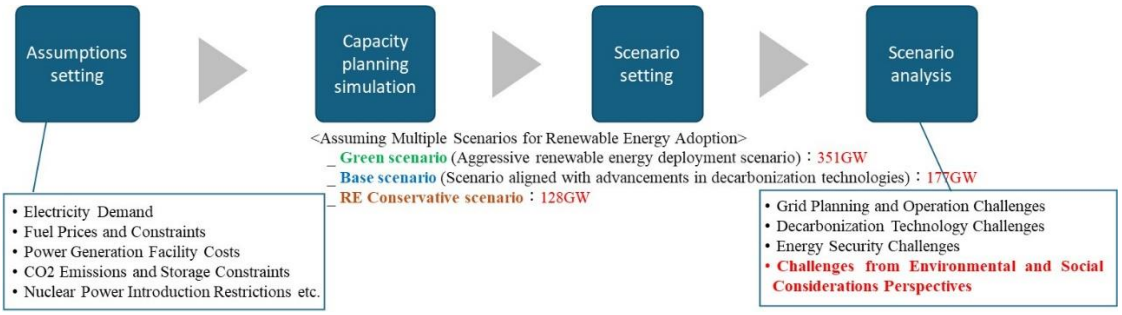

Figure 1 Scenario Planning Process

(Source: JICA Project Team)

Diversification of power sources will be introduced to achieve net-zero CO2 emissions, including fuel conversion (utilization of low-carbon fuels), co-located CCS/CCUS facilities in thermal power generation, and renewable energy sources such as solar and wind power.

Figure 2 shows Overview of Power Development based on Base scenario by 2060.

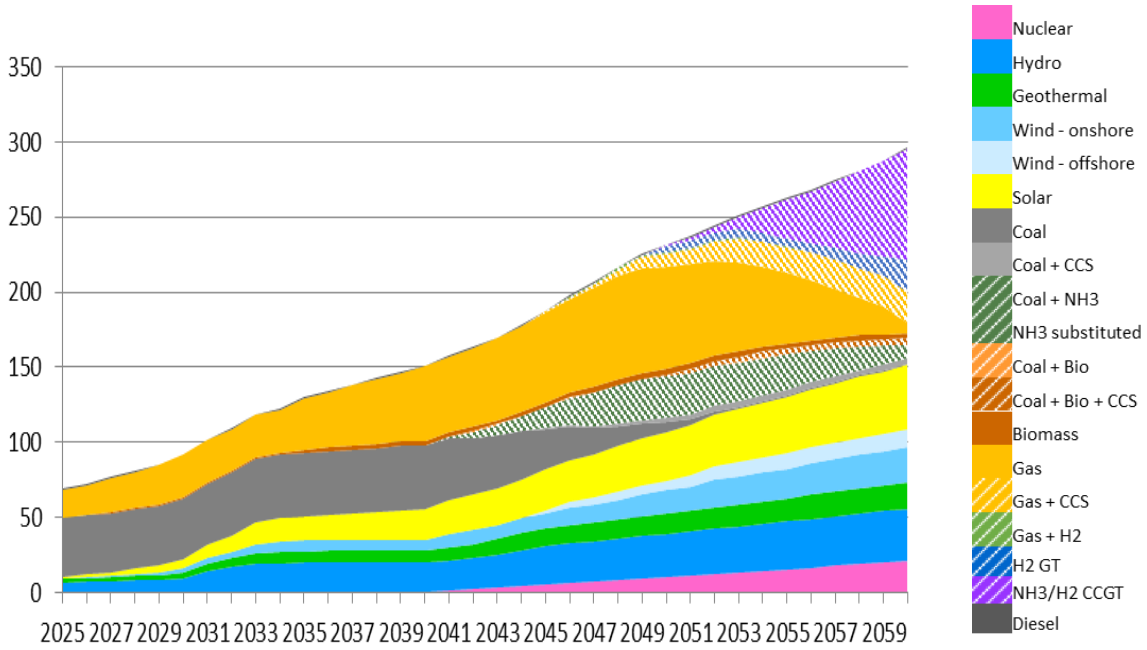

Figure 2 Overview of Power Development based on Base scenario by 2060

(Source: JICA Project Team)

(2) The result of SEA

A diverse range of power sources is being developed in Indonesia. Table 1 provides an overview of the main power sources.

Table 1 Key future power sources

Item	Characteristic
Thermal power plant	Indonesia can procure natural gas and coal domestically. Thermal power plants provide stable response to power demand but come with CO2 emissions. CO2 emissions are expected to be reduced through fuel substitutions to hydrogen and ammonia, which do not emit CO2, and through the introduction of CCS, but this is a relatively new technology and there are technical issues to be overcome.
Hydropower plant	Energy conversion efficiency is high, and management costs are low. On the other hand, the construction work will take a long time and there are concerns about environmental impacts.
Solar photovoltaic power plant	Indonesia consists of more than 15,000 islands. Indonesia is expected to respond to future increases in electricity demand and switch from existing thermal power plants. On the other hand, there are challenges such as land acquisition, ensuring stable supply, and the disposal of degraded solar panels etc.
Wind power plant	Indonesia consists of more than 15,000 islands. It has the potential for onshore and offshore installations and is expected to meet future increases in electricity demand. On the other hand, there are challenges such as land acquisition, impacts on ecosystems (e.g., bird strikes), and fishing rights etc.
Geothermal power plant	In general, the development of geothermal power plants is conducted in undeveloped areas near volcanoes, and it takes a long time from survey to operation. Indonesia is the world's second largest geothermal power country, and there are high expectations for the country's ability to meet future increases in electricity demand. However, attention must be paid to the environmental impact of development.
Nuclear power plant	Nuclear power plants do not emit CO2. However, careful consideration must be given to environmental impacts during construction and operation. According to RUPTL, 500 MW (2025–2034) is planned for introduction, with challenges including safety, legal/institutional frameworks, human resource development, and cost.

(Source: JICA Project Team)

The environmental social impacts vary depending on the characteristic, scale, and location of the project. Table 2 shows general environmental social impacts matrix (Scoping) for thermal power plant and renewable energy power plant (hydroelectric, wind, solar photovoltaic, and geothermal).

In addition, Indonesia has not yet finalized formal EIA for nuclear development. World Bank is only recently developing specific operational frameworks for nuclear-related environmental and social considerations. According to “Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes” (IAEA), types of expertise required for EIA are as follows.

Environmental science, Biology including human health, Meteorology,

Oceanography, Hydrology, Geology, Seismology, Volcanology

With reference to Scoping for Power Generation Project in Table 2, the scoping for nuclear power plant projects was proposed by JICA Project Team (Table 3).

From environmental and social perspectives, nuclear power plant does not emit exhaust gas, but impacts on other environmental items will be anticipated.

Regarding safety and accidents concerning radiation, they should be addressed under other laws due to their technical complexity and expertise in distinction from general environmental laws and regulations.

In order to go ahead promptly, the following items are identified as future directions for development of nuclear power plants.

Policy & Governance: Establish nuclear policies and legal/institutional frameworks

Sustainability: Conduct environmental and social impact assessments

Table 4 summarizes the main mitigation measures based on the project characteristics and impacts for each power development as organized in how to proceed with SEA. Some items can be specifically considered for mitigation measures during the EIA stage, but others must be addressed from the early planning stages, including project site selection. For these reasons, based on the regional situation in Indonesia organized in Baseline Study, it is necessary to focus on mitigation measures based on the assumption of significant impacts in actual situation. When protected areas or development-restricted zones overlap with candidate sites, or exist in close proximity in candidate sites, the impact area should be avoided or minimized by reviewing candidate sites through modification or downsizing, and by considering the location and layout of facilities. Furthermore, sufficient consideration is required when potential sites overlap with areas requiring resident relocation or areas constituting the living spheres of ethnic minorities and indigenous peoples. And the important things are explaining the project to stakeholders and building their understanding and acceptance. SEA identifies and extracts environmental elements that are difficult to avoid or mitigate in the project, examines them in the early stage and incorporates them into the plan. Significant Items Prioritized for power source development are as follows:

Natural environment: Protected Areas, Ecosystem and biodiversity

Social environment: Resettlement, socially vulnerable group, Heritage, Landscape

While Table 4 excludes nuclear power plants, they are essentially regarded as equivalent to other power plant development projects from environmental and social perspectives.

Table 2 Scoping for Power Generation Projects (Environmental Factors Affected by the Project)

Category		Environmental Item	Thermal (including Ammonia/Hydrogen、Biomass) *		Hydro		Wind		Solar photovoltaic		Geothermal	
			Before/ During construction	Operation	Before/ During construction	Operation	Before/ During construction	Operation	Before/ During construction	Operation	Before/ During construction	Operation
Anti-pollution Measures	1	Air Quality	○	○	○	—	○	—	○	—	○	○
	2	Water Quality	○	○	○	○	○	—	○	—	○	○
	3	Soil Contamination	○	○	○	—	○	—	○	—	○	○
	4	Sediment pollution (river bottom, seabed)	○	○	○	—	○	—	○	—	○	○
	5	Noise and Vibration	○	○	○	—	○	○	○	—	○	○
	6	Odor	○	○	○	—	○	—	○	—	○	○
	7	Waste	○	○	○	○	○	—	○	○	○	○
	8	Subsidence	○	○	○	—	○	—	—	—	○	○
Natural Environment	9	Protected Areas	○	○	○	○	○	○	○	○	○	○
	10	Ecosystem and Biota	○	○	○	○	○	○	○	○	○	○
Social Environment	11	Resettlement	○	○	○	○	○	○	○	○	○	○
	12	Poverty	○	○	○	○	○	○	○	○	○	○
	13	Ethnic Minorities and Indigenous Peoples	○	○	○	○	○	○	○	○	○	○
	14	Living and Livelihood	○	○	○	○	○	○	○	○	○	○
	15	Land use and local resource use	○	○	○	○	○	○	○	○	○	○
	16	Water use	○	○	○	○	○	—	○	—	○	○
	17	Existing social infrastructure and social services	○	○	○	—	○	—	○	—	○	○

Category		Environmental Item	Thermal (including Ammonia/Hydrogen、Biomass) *		Hydro		Wind		Solar photovoltaic		Geothermal	
			Before/ During construction	Operation	Before/ During construction	Operation	Before/ During construction	Operation	Before/ During construction	Operation	Before/ During construction	Operation
	18	Social organizations such as social relational capital and local decision-making bodies	○	○	○	○	○	○	○	○	○	○
	19	Uneven distribution of damage and benefits	○	○	○	○	○	○	○	○	○	○
	20	Conflicts of interest within the community	○	○	○	○	○	○	○	○	○	○
	21	Heritage	○	○	○	○	○	○	○	○	○	○
	22	Landscape	○	○	○	○	○	○	○	○	○	○
	23	Gender	○	○	○	○	○	○	○	○	○	○
	24	Right of children	○	○	○	○	○	○	○	○	○	○
	25	HIV/AIDS and other infectious diseases	○	○	○	○	○	○	○	○	○	○
	26	Labor environment (including occupational safety)	○	○	○	○	○	○	○	○	○	○
Other	27	Accident	○	○	○	○	○	○	○	○	○	○
	28	Transboundary Impacts, and Climate Change	○	○	○	—	○	—	○	—	○	—

Note; ○: There is the relationship. —: Not relevant.

(Source: JICA Project Team)

Table 3 Scoping for Nuclear Power Generation Projects（In case of the proposal by JICA Project Team）

Category	Environmental Item	Nuclear	
		Construction	Operation
Anti-pollution Measures	Air Quality/ Odor	○	—
	Water Quality	○	○
	Soil Contamination/ Sediment pollution	○	○
	Noise and Vibration	○	○
	Waste	○	○
Natural Environment	Protected Areas/ Ecosystem and Biota	○	○
Social Environment	Resettlement, Living and Livelihood, Landscape etc.	○	○
Other	Accident	○	○
	Transboundary Impacts, and Climate Change	○	○

Note; ○: There is the relationship. —: Not relevant.

(Source: JICA Project Team)

Table 4 Impacts, project characteristics, and mitigation measures by power development

Item	Major Environmental Impacts [1)]			Project Characteristics (Sources of Impact/Activity)[2)]	Major Mitigation Measures	Remarks
Thermal Power Plant Project	During construction	pollution-related	● Emission of air pollutants (SOx, NOx, etc.) ● Water turbidity, generation of construction wastewater ● Soil pollution due to lubricating oil and fuel oil leaks, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Generation of general and hazardous waste, etc.	● Carrying in and out of materials for construction work ● Commuting of construction workers ● Removal of surplus soil, logged trees, and waste materials ● Dredging and harbor construction ● Excavation, ground improvement, embankment, etc. ● Construction of buildings, structures, etc.	● Selection of optimum site and construction plan ● Leveling of construction work and transportation of materials and equipment ● Introduction of low-noise, low-vibration equipment ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	CO_2 emissions are expected to be reduced through fuel substitution to hydrogen and ammonia, which do not emit CO_2, and through the introduction of CCS, but this is a relatively new technology and there are technical issues to be overcome.
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Land acquisition, resettlement, poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			
	Operation	pollution-related	● Emission of air pollutants (SOx, NOx, etc.) ● Generation of plant wastewater ● Noise and vibration from facility operations ● Generation of general and hazardous waste, etc.	● Existence of a power plant (generating facilities, condensers, offices, etc.) ● Marine transportation, land transportation or pipelines for fuel procurement ● Removal of waste materials ● Carrying in/out of materials, etc. during periodic inspections, employee commuting	● Air pollution prevention and drainage measures ● Sound insulation and soundproofing ● Greening ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			

Note: This project assumes biomass procurement for biomass power generation will come from the wood industry, paper industry, agriculture, and waste sources (New deforestation and land reclamation are not anticipated). Impacts, project characteristics, and mitigation measures by power development are the same as those of thermal power plants. Generation using low carbon fuels such as hydrogen and ammonia is also categorized as thermal power plants.
(Source: JICA Project Team)

Item	Major Environmental Impacts [1)]			Project Characteristics (Sources of Impact/Activity)[2)]	Major Mitigation Measures	Remarks
Hydro Power Plant Project	During construction	pollution-related	● Emission of air pollutants (SOx, NOx, etc.) ● Water turbidity, generation of construction wastewater ● Soil pollution due to lubricating oil and fuel oil leaks, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Generation of general and hazardous waste, etc.	● Carrying in and out of materials for construction work ● Commuting of construction workers ● Removal of surplus soil, logged trees, and waste materials ● Related construction work, such as boring, earth dumping sites, and construction roads ● Construction of structures such as upper and lower regulating reservoirs, intake weirs, intake and discharge outlets, waterways, power plants, etc.	● Selection of optimum site and construction plan ● Leveling of construction work and transportation of materials and equipment ● Introduction of low-noise, low-vibration equipment ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	Energy conversion efficiency is high and management costs are low. On the other hand, small- and medium-scale power source development is concerned about environmental impacts associated with large-scale development.
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Land acquisition, resettlement, poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			
	Operation	pollution-related	● Deterioration of water quality due to eutrophication and anoxia in reservoirs, etc. ● Noise from facilities	● Existence of power plants (upper and lower dams (regulating reservoirs, intake weirs, etc.), waterways, power generation facilities, switchyards, administrative roads, etc.)	● Reservoir water quality improvement measures ● Driftwood and sediment control measures ● Sound insulation and soundproofing measures ● Environmental monitoring, etc.	
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Poverty, indigenous people, ethnic minorities, land use and local resource use, water use, cultural heritage, landscape, working environment, accidents, etc.			

Item	Major Environmental Impacts [1)]			Project Characteristics (Sources of Impact/Activity)[2)]	Major Mitigation Measures	Remarks
Wind Power Plant Project	During construction	pollution-related	● Emission of air pollutants (SOx, NOx, etc.) ● Water turbidity, generation of construction wastewater ● Soil pollution due to lubricating oil and fuel oil leaks, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Generation of general and hazardous waste, etc.	● Carrying in and out of materials for construction work ● Commuting of construction workers ● Removal of surplus soil, logged trees, and waste materials ● Excavation, ground improvement, embankment, etc. ● Development and grading of the site, delivery road, and road for power plant management ● Construction of structures, etc.	● Selection of optimum site and construction plan ● Leveling of construction work and transportation of materials and equipment ● Introduction of low-noise, low-vibration equipment ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	Indonesia, which consists of more than 15,000 islands, has the potential for onshore and offshore installations, and is expected to respond to future increases in electricity demand.
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Land acquisition, resettlement, poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			
	Operation	pollution-related	● Noise from wind turbines	● Existence of power plant (power generation facilities, office, substation, battery system building, etc.)	● Bird strike countermeasures (feather color, sound, etc.) ● Noise control by windmill shape, etc.) ● Environmental monitoring, etc.	
		Natural environment	● Impact on ecosystems, including flora and fauna (birds, etc.)			
		Social environment	● Impacts on Life and Livelihoods* *Poverty, indigenous people, ethnic minorities, shadow flicker, land use and local resource use, cultural heritage, landscape, working environment, accidents, etc.			

Item	Major Environmental Impacts [1)]			Project Characteristics (Sources of Impact/Activity)[2)]	Major Mitigation Measures	Remarks
Solar photovoltaic Power Plant Project	During construction	pollution-related	● Emission of air pollutants (SOx, NOx, etc.) ● Water turbidity, generation of construction wastewater ● Soil pollution due to lubricating oil and fuel oil leaks, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Generation of general and hazardous waste, etc.	● Carrying in and out of materials for construction work ● Commuting of construction workers ● Removal of surplus soil, logged trees, and waste materials ● Excavation, ground improvement, fill, etc. ● Development and grading of the site, delivery road, and road for power plant management ● Construction of structures, etc.	● Selection of optimum site and construction plan ● Leveling of construction work and transportation of materials and equipment ● Introduction of low-noise, low-vibration equipment ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	Indonesia, which consists of more than 15,000 islands, is expected to meet future increases in electricity demand. Floating solar photovoltaic power generation using dam lakes has the advantage of not requiring the acquisition of new land.
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Land acquisition, resettlement, poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			
	Operation	pollution-related	● Noise from facilities ● Generation of waste due to solar panel deterioration	● Existence of power plant (power generation facilities, office, substation, battery system building, etc.)	● Sound insulation and soundproofing ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Poverty, indigenous people, ethnic minorities, land use (regional division, etc.) and local resource use, reflected light, cultural heritage, landscape, working environment, accidents, etc.			

Item	Major Environmental Impacts [1)]			Project Characteristics (Sources of Impact/Activity)[2)]	Major Mitigation Measures	Remarks
Geothermal Power Plant Project	During construction	pollution-related	● Emission of air pollutants (SOx, NOx, etc.) ● Water turbidity, generation of construction wastewater ● Soil pollution due to lubricating oil and fuel oil leaks, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Noise and vibration due to operation of construction machinery, etc. ● Generation of general and hazardous waste, etc.	● Carrying in and out of materials for construction work ● Commuting of construction workers ● Removal of surplus soil, logged trees, and waste materials (including excavation sludge, etc.) ● Excavation, ground improvement, embankment, etc. ● Development and grading of sites, dumping sites, well, etc. ● Excavation of wells, construction of structures, etc.	● Selection of optimum site and construction plan ● Leveling of construction work and transportation of materials and equipment ● Introduction of low-noise, low-vibration equipment ● Appropriate waste treatment and disposal ● Environmental monitoring, etc.	Indonesia is the world's second largest geothermal power country and is expected to increase demand for electricity in the future. However, it generally takes a long time from the survey to the start of operation.
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Land acquisition, resettlement, poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			
	Operation	pollution-related	● Release of air pollutants (hydrogen sulfide) ● Generation of plant effluent ● Noise and vibration due to facility operation ● Generation of general and hazardous waste, etc.	● Existence of a power plant (steam-powered generator, condenser (cooling tower), offices, etc.) ● Removal of waste materials ● Carrying in and out of materials, etc., and commuting of employees	● Diffusion countermeasures by dilution of hydrogen sulfide mixed with air ● Prevention of groundwater pumping ● Design that takes into account the surrounding environment ● Environmental monitoring, etc.	
		Natural environment	● Impact on ecosystems, including flora and fauna			
		Social environment	● Impacts on Life and Livelihoods* *Poverty, indigenous people, ethnic minorities, land use and local resource use, water use, infrastructure and social services, cultural heritage, landscape, working environment, accidents, etc.			

(Source: JICA Project Team)

5. Key Takeaways

- ✓ In development projects, SEA process is crucial. SEA prevents project implementation and progress from being hindered.
- ✓ SEA identifies and extracts environmental elements that are difficult to avoid or mitigate in the project, examines them in the early stage and incorporates them into the plan. This is what is called "Prioritization through Scoping".

  Significant Items Prioritized in This Survey.

  _ Natural environment: Protected Areas, Ecosystem and biodiversity

  _ Social environment: Resettlement, socially vulnerable group, Heritage, Landscape
- ✓ In SEA, explanation to local stakeholders is key, and it is also important to incorporate various opinions into the plan at an early stage.
- ✓ SEA is primarily based on desk research and existing data. Impacts are estimated using simple prediction methods such as overlay analysis based on existing literature (Field surveys, detailed simulations, and mitigation measures are addressed during the EIA process).
- ✓ To enable the introduction of nuclear power plant, **legal frameworks and SEA/EIA procedures** should be established.