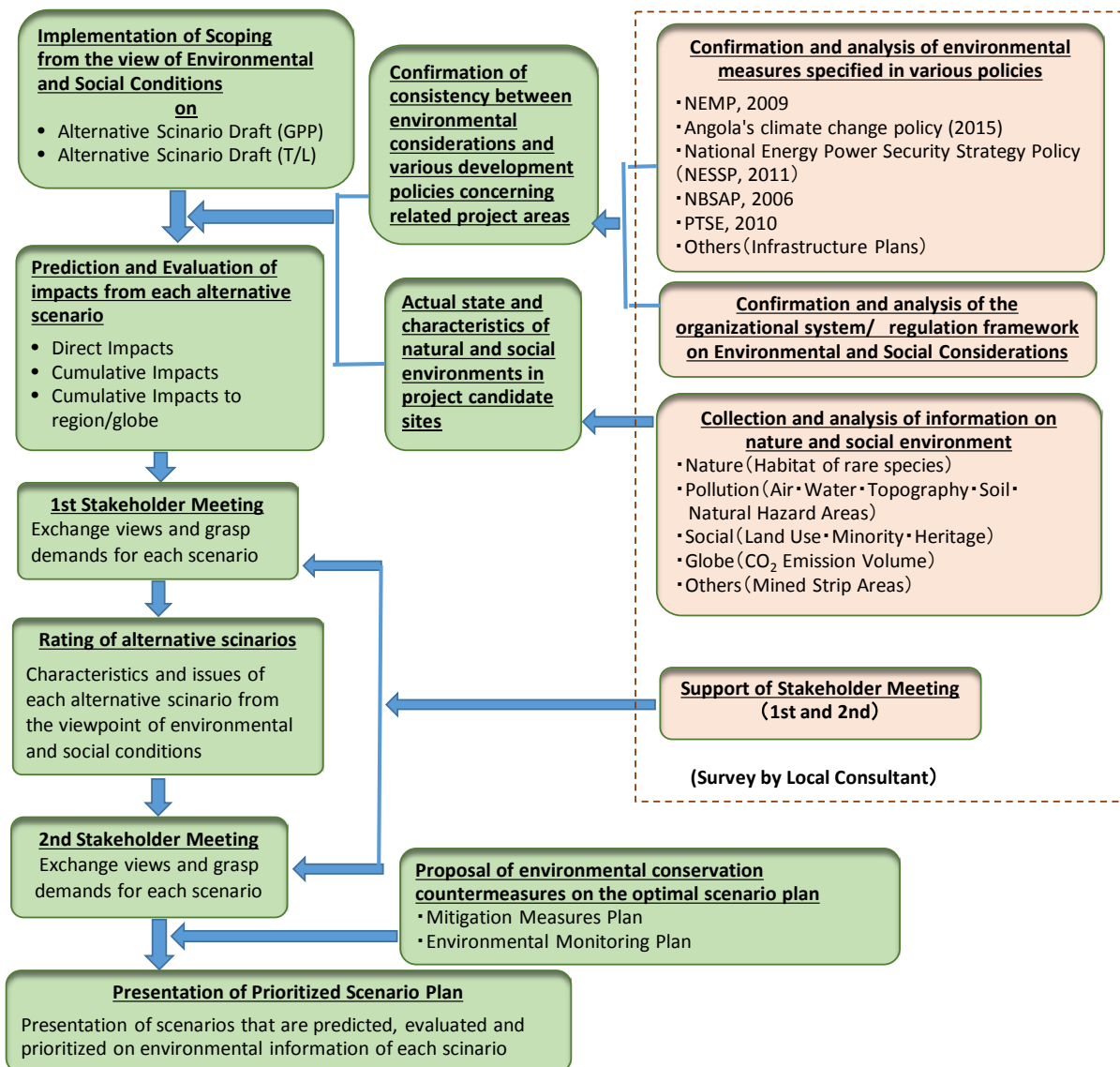


Chapter 11 Environmental and Social Considerations

11.1 Outline of the Strategic Environmental Assessment (SEA) Approach for the Power Development Master Plan

An SEA focused on environmental and social aspects is to be conducted on the development of various power sources projected in the development scenarios from the "Power development plan / transmission system expansion plan." The assessment will be performed using the method shown in Figure 11-1. That is, we will quantitatively assess the environmental load from the development of each type of generation, prioritize the alternative development scenarios, and propose the most desirable scenario from the viewpoints of environmental and social conservation.



(Source: JICA Survey Team)

Figure 11-1 Workflow for the SEA

(a) Selection of scoping items and indicators

In order to analyze and evaluate each power development plan from environmental and social viewpoints, the plans are to be scoped based on evaluation items focused on the natural, social, and global environments.

(b) Evaluation of scoping items

Quantitative evaluations are to be carried out based on a four-point score (from 0 to -3) quantifying the degree of impact on the above scoping items by project.

(c) Matrix Evaluation of each power generation development plan

A matrix evaluation of each alternative development scenario is to be carried out to quantitatively assess each scenario's impact on the environment.

11.2 Overview of the present state of the proposed project area

Angola consists of a land area of 1,246,700 km² situated on the Atlantic Coast of the western region of southern Africa. The country is bordered in the north by the Republic of Congo (201 km) and the Democratic Republic of Congo (2,511 km), in the east by Zambia (1,110 km), and in the south by Namibia (1,376 km). The physical characteristics of the 1,600 km Angolan coastline are extremely variable.

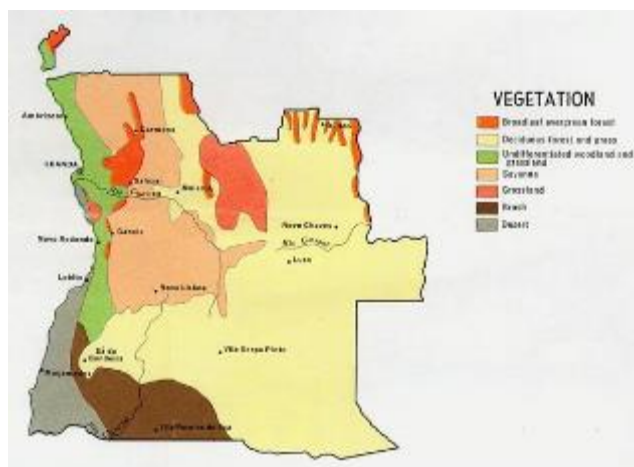
Angola can be divided into six geomorphological areas: coastal, marginal mountain chain (cadeia marginal de montanhas), the old tableland (planalto central), the Zaire Basin, and the Basins of the Zambezi and the Cubango.

The highest point is Moco Hill (2,620 m) in the central part of the country, where the major Angolan rivers have their origins.

Temperatures range from between 25 and 33 °C in the rainy season (September to April) and between 18 and 22 °C in the dry season (May to August). The climate in the north is tropical and humid, with an annual average rainfall of 1,200-2,000 mm. The coastal region has an average annual rainfall of less than 600 mm, decreasing from north to south. The inland climate ranges from high temperatures and high rainfall to semi-desert conditions.

The country can be divided into five ecozones (SARDC, SADC & IUCN 1994):

1. Lowland Tropical Forest (rainforest) in the northeast characterized by high rainfall all year round, high evaporation, and low soil fertility
2. Moist Savanna occupying around 70% of the country area, characterized by rainfall between 500 and 1,400 mm a year and broad-ranging soil types that are generally poor in nutrients
3. Dry Savanna in southern Angola characterized by unpredictable summer rainfall of 250-500 mm a year, with generally fertile soils but sparse vegetation
4. Nama-Karoo in the southwest characterized by an average rainfall of 100-400 mm a year
5. Desert along the narrow coastal strip in southwest Angola characterized by very low average rainfall of 10-85 mm a year.



(Source: Website Angola vegetation Map 1970)

Figure 11-2 Status of Vegetation

(1) Natural Environment

(a) Current status of biodiversity

The palanca preta gigante (giant sable antelope) and the *Welwitschia mirabilis* ((Source: ERM)

Figure 11-3) have been world-renowned emblems of the Angolan identity for a long time. They are just two of many examples of the rich biological diversity of the Republic of Angola and how living beings can be emblematic of a nation.

Angola has a wealth of unique biological diversity. Scientists believe that Angolan biodiversity is one of the most important in the African continent. Over 5,000 plant species are inferred to exist in Angola (after excluding the vast flora wealth of Cabinda Province), and 1,260 of the species are endemic (Angola is the second richest country in Africa in endemic plants).

In total, 275 species of mammals have been recorded, many more than in most other countries on the continent. Meanwhile, the 872 species of bird recorded in Angola make up 92% of the avifauna in southern Africa.

The exceptional biodiversity in Angola can be attributed to a number of factors in combination: the vast size of the country, its inter-tropical geography, the altitude variation, and the biome types. The climate diversity, coupled with equal geographical and soil variability, contributes to the formation of bioclimatic zones that vary from dense tropical forest to poor vegetation in the desert. These different habitats are favorable for a high level biological diversity.

Chimpanzees, gorillas, and a diversity of other mammals also live in the forests. There is a consensus that special protection measures should be taken to protect the region and its biodiversity. Uncontrolled bush-burning, poaching, and anarchical logging have adversely affected the conservation of this and other important ecosystems in Angola.

Preliminary studies indicate that about 120 species of plant are listed as endangered plants. Many of them can be found protected areas. Trees such as the *Avicenia* and *Combretum* are important for the vegetation that protects the Angolan coast and are also listed as highly endangered species.

Animal species such as the cheetah, brown hyena, African wild dog, black rhinoceros, mountain and plain zebras, giraffe, and oryx are assigned extinct and/or very vulnerable status in some areas of the Angolan territory where they were hitherto abundant. Various other species also face extinction due to pressure from anthropogenic activities. To give a faint idea of the precarious conditions the mammals face, 50 out of the 275 species that inhabit Angola are listed as extinct and threatened species according to the IUCN.

Another threat to biological diversity is illegal trade of animals smuggled outside the country. There are unconfirmed signs that some of the bird species are smuggled in quantities large enough to endanger their survival. Approximately 34 Angolan birds are listed as endangered species.

According to the National Biodiversity Strategy and Action Plan (2007-2012), Angola has over 8,000 species of plant, out of which 1,260 are endemic. Concerning the fauna, 275 mammal species and 872 bird species are confirmed so far, of which 13 mammal, 11 bird, 22 reptile, 23 amphibian, and 72 fresh water fish species are reported to be endemic.



(Source: ERM)

Figure 11-3 Welwitschia mirabilis

Table 11-1 Number of Endangered Species in Angola

Category		Critical (CR)	Endanger (EN)	Vulnerable (VU)
Number				
Fauna	108 Sp.	10	32	66
Flora	34 Sp.	-	3	31

(Source: Angola Government)

(b) Designation and management status of protected areas

Angola also has a number of protected areas established during the colonial period of the 1930s mainly for tourism, controlled hunting, protection, and scientific research. These areas were primarily considered to have low agricultural and economic potential but high value for hunters.

The protected areas in Angola include national parks, strict reserves, partial reserves, regional nature parks, and special reserves. As of 2011, Angola had 13 conservation areas, each governed by its own system of legislation. In total, they covered around 12.98% of the country's surface (82,832 km²).

There were nine national parks (6.3%), four strict reserves (4%), two natural reserves, and one regional natural park (0.4%). Five public hunting reserves and a private hunting reserve were also established.

The current protected areas in Angola are listed in Table 11-2 below.

Table 11-2 List of Protected Area

No.	Name	Area (km ²)	Year
National Parks			
1	Quiçama National Park	9,960	1957
2	Mupa National Park	6,600	1964
3	Bicuar National Park	7,900	1964
4	Cangandala National Park	630	1970
5	Cameia National Park	14,450	1957
6	Iona National Park	15,150	1957
7	Mayombe National Park	1,930	2011
8	Luengue-Luiana National Park	45,818	2011
9	Mavinga National Park	46,072	2011
Total		148,510	
Regional Park			
1	Chimalavera Nature Park	150	1974
Total		150	
Nature Reserves			
1	Ilhéu dos Pássaros Integral Nature Reserve	2	1973
2	Luando Integral Nature Reserve	8,280	1957
Total		8,282	
Strict Reserves			
1	Buffalo Partial Reserve	400	1974
2	Mavinga Partial Reserve	5,950	1973
3	Luando Integral Nature Reserve	8,280	1957
4	Namibe Partial Reserve	4,450	1973
Total		19,080	

(Source: Angola Government)

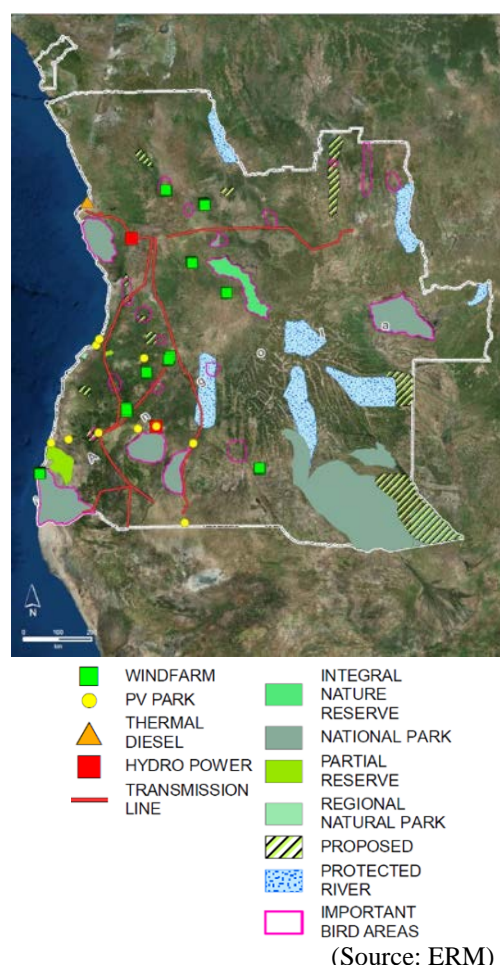


Figure 11-4 Distribution of Protected Areas

(Source: ERM)

(2) Social Environment

The total area of Angola is 1,246,700 km². Angola's 2014 national census reports a national population of 25.8 million and population density of 21.8 head/km². (INE, 2014).

Infrastructures such as transport, electricity, water supply, waste disposal, healthcare and telecommunication have all deteriorated due to the civil war (much infrastructure has been destroyed; much has become untenable). Unexplored ordinance (UXO) still exists in vast areas of the country, which renders much of Angola unusable by inhabitants.

(a) Language and ethnic groups

The official and predominant language of use in Angola is Portuguese. Approximately 40% of the population speaks a Bantu dialect as their mother tongue.

Roughly 37% of Angolans are Ovimbundu, 25% are Ambundu, 13% are Bakongo, 2% are Mestizo, 1-2% are white Africans, and 22% are people from other African ethnicities.

(b) Type of Land Use

By land use, 47% of the country consists of non-agricultural land. Of the remainder, approximately 4% consists of cultivated agricultural land, approximately 46% consists of forests, and the remaining 3% consists of wheat/barley fields, pastures, and urban areas. Details of the land use are as shown in the table below.

Table 11-3 General Land Balance Sheet

Type of land use	Area (ha, %)
Arable land, permanent crop land, permanent pasture land	59,190,000 (47.47)
Forest	57,856,000 (46.41)
Other (wheat/barley/urban land)	7,624,000 (6.12)
Total	124,670,000 (100.00)

(Source: Trading Economics World Bank 2015)

11.3 Structure and regime for environmental and social considerations in Angola

11.3.1 Legal and regulatory frameworks for environmental and social considerations

(1) Regulatory framework for strategic environmental assessment

Strategic Environmental Assessment (SEA) is not a mandatory requirement under the Environmental Framework Law (EFL) enacted in 1998.

(2) Related laws and regulations on strategic environmental assessment (SEA)

The table below lists the key laws and regulations to be considered for SEA implementation.

Table 11-4 Legal and Regulatory Frameworks for Environmental and Social Considerations

Policy, Law, Regulation	Main Contents
Environmental Framework Law (Law No. 5/98, 19 June 1998)	The Environmental Framework Law (LBA – Lei de Base do Ambiente) defines the basic concepts and principles for the protection, preservation, and conservation of the environment, promotion of quality of life, and the rational use of natural resources. Article 16 of this law stipulates that an Environmental Impact Study should be mandatory for every undertaking that has an impact on the environmental balance and the population's quality of life.
Environmental Impact Assessment (Decree 51/04, July 2004)	The EIA Decree specifies the activities required during the EIA process (Articles 6 and 7), as well as the contents of the EIA report (Article 9).
Land Law (Law No. 9/04, 09/11/2004)	The Land Law declares land to be the property of the State and proposes the following multiple uses: ① To provide shelter and homes for inhabitants of Angola; ② A source of natural resources that can be used for mining, agriculture, forestry, and land planning; and ③ A support for economic, agricultural and industrial activities.
Cultural Heritage Law (Law No. 14/05, 07 October 2005)	This Law defines cultural heritages as material and immaterial assets that, in light of their value, must be protected.
Environmental Licensing (Decree 59/07, 13 July 2007)	This Decree lays down the rules that regulate the environmental licensing of activities that are judged to be potential sources of significant environmental impacts in light of their nature, location, or scale.
Environmental Auditing Decree (Decree 1/10, January 2010)	This Decree is a tool to be used after the environmental impact assessment process to make it possible to check whether the planned minimization measures and Monitoring Plan have been implemented once a project is installed. It also requires other checks, such as whether the minimization measures have had a positive performance, whether and how the anticipated impacts have occurred, and whether there have been other unanticipated impacts.
Water Quality (Decree 261/11, 06 October 2011)	This Decree specifies the National Environmental Standard on Water Quality.
Terms of Reference for Environmental Impact Studies (Decree 92/12, 01 March 2012)	This Decree establishes the guidelines and procedures to be followed during the development of Environmental Impact Studies.

Public Consultation for Projects Subject to Environmental Impact Assessment (Decree 87/12, 24 February 2012)	This Decree describes the opinions of residents concerning environmental impact assessment and the method used to reflect those opinions in the reports.
Regulation on Resettlement (Decree 117/16, 30 May 2016)	This Regulation aims to define the rules and procedures to govern the actions of the organs of the central administration and autonomous state in the resettlement and rehousing process for groups of people living in given territories and for households and residents affected by redevelopment and urban areas conversion, in accordance with the principles governing public administration. The Regulation cautions against the pursuit of the public interest and protects the rights and interests of citizens.

(Source: JICA Survey Team organized based on Angola Government materials)

(3) International treaties/conventions concerning SEA

The following table summarizes international treaties ratified by Angola with regard to environmental conservation.

Table 11-5 International Treaties/Conventions Concerning SEA

Name of convention	Date of Ratify
Convention concerning the Protection of the World Cultural and Natural Heritage (1972)	1992
Convention of Migratory Species of Wild Animals or Bonn Convention (1979)	2006
Convention on Biological Diversity (1992)	1997
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973)	2007
Convention on Wetlands of International Importance especially Waterfowl Habitat (Ramsar Convention, 1971)	2016
Convention to Combat Desertification (1994)	2000

(Source: JICA Survey Team organized based on Angola Government materials)

(4) INDC (Intended Nationally Determined Contribution) and Contribution of Master Plan 2040

At the United Nations Climate Change Conference, COP21, in Paris, France, the Paris agreement was adopted as a climate agreement by all the nations of the world. While the Paris agreement includes no obligations for CO₂ reduction, all countries are to submit national goals, updates, reports, and reviews every five years. In consideration of the worldwide movements regarding global warming and the environment, the introduction of renewable energy has been discussed positively in Angola.

In 2016 Angola submitted an Intended Nationally Determined Contribution (INDC) that encompasses, for Mitigation purposes, both unconditional and conditional measures for the reduction of GHG, to the United Nations Framework Convention on Climate Change (UNFCCC).

In achieving unconditional and conditional goals, Angola promised to reduce GHG emissions by approximately 20% below its 2005 emissions (66.8 million tons) in the BAU (Business As Usual) scenario by 2030. GHG emissions in 2005 were 66.8 million tons, of which more than 95% was attributable to fossil fuel consumption.

In response to this situation, Angola takes the promotion of renewable energy projects as a top priority issue of national strategy.

1. Repowering of the Cambambe Central I Hydropower Plant:

It will increase the installation capacity from 180 MW to 260 MW and aim to reduce emissions by 1,529,311 tCO₂e per year.

2. Cambambe II Hydropower Plant:

It will secure 700 MW capacity and aim to reduce emissions by 3,282,000 tCO₂e per year.

3. Tombwa Wind Farm Plant

It will secure a capacity of 100 MW and reduce emissions by 157,258 tCO₂e per year.

4. The promotion of the biomass business

Along with the promotion of the biomass business, it plans to reduce emissions by 750,000 tCO₂e per year.

Based on the CO₂ emissions per 1 MW for each power development developed by the Angola government, the CO₂ reduction volumes by the renewable energy project proposed in the Master Plan are estimated as follows. The total reduction volume will be 5.64 million CO₂-tons.

Table 11-6 Reduction of CO₂ emissions by project proposed by M/P

	Hydro PP	Wind PP	Solar PP	Bio. PP	Total
Install Capacity* (MW)	1,000	488	100	3	1,591
CO ₂ Reduction (ton/y)	4,700,000	767,000	157,000	14,000	5,638,000

(Source: JICA Survey Team organized based on INDC of Angola)

11.3.2 Differences between the JICA guidelines and Angolan regulations

Regarding the environmental and social considerations, the following table show key differences between the main items under the domestic law of Angola (Regulation on Environmental Impact Assessment) and the JICA Environmental and Social Considerations Guideline (2010).

Note, however, that the environmental and social considerations for Donor-supported projects in Angola are to be handled according to the requirements of the Donors.

Table 11-7 Differences between JICA Guidelines and Angolan regulations on SEA

Items	JICA Guidelines	Angola Regulations	Key differences
Implementation of SEA	JICA applies an SEA when conducting a Master Plan or Feasibility Study.	SEA is still not a mandatory requirement in Environmental Impact Assessment Regulation (EIAR).	A gap exists. No articles on SEA implementation in the Environmental Framework Law, and no Guideline for SEA implementation
EIA Report	EIA reports are requested for projects expected to have serious adverse environmental impact.	Based on Environmental Impact Assessment Regulation, projects requiring EIA/IEE reports are specified.	No gaps.
Alternative examination	Examination of available alternatives is mandated.	Examination of available alternatives is mandated by	No gaps.
Environmental checklist	An environmental checklist specific to an EIA is provided.	No.	A gap exists. No Article on formulating a Checklist is

Items	JICA Guidelines	Angola Regulations	Key differences
			provided in the Environmental Impact Assessment Regulation
Resettlement Action Plan (RAP)	The project proponent is obligated to prepare a RAP. If the number of resettled households is small (e.g., one household), the RAP can be simplified. The RAP is initially prepared as a part of the EIA Report.	No Article on formulating a RAP is provided in the Environmental Impact Assessment Regulation.	A gap exists. While no Article on formulating a RAP is provided in the Environmental Impact Assessment Regulation, a RAP is to be formulated based on the WB Guideline if donors ask for its implementation.
Land compensation	Land is compensated by replacement cost as much as possible.	While no descriptions on how to estimate or pay compensation are provided, the compensation cost is likely to be estimated based on the market price.	A gap exists. The full replacement cost is unlikely to be considered.
Monitoring/Mitigation measures	Implementation of monitoring and mitigation is required.	Implementation of monitoring and mitigation is required by EIAR.	No gaps.
Disclosure information	The EIA report is to be disclosed 120 days before the agreement documents are to be concluded.	Based on EIAR, the EIA is to be disclosed to the public.	No gaps.

(Source: JICA Survey Team)

11.3.3 Organizations and their roles for Environmental and Social considerations

(1) Organizations for Environmental and Social Considerations (Role of central government and its executing agency)

The administrative organization on environmental and social considerations in Angola is under the control of the National Environmental Impact Prevention and Evaluation Bureau under the Ministry of the Environment. The main tasks of the Ministry of Environment in the field are as follows:

- Coordinate sustainable management strategies and policies for natural resources, such as the assurance of environmental sustainability;
- Coordinate national response actions to address global environmental problems, notably through the implementation of international conventions and agreements;
- Require environmental licensing for activities likely to cause significant environmental and social impacts;
- Develop and coordinate national programs focused on the conservation of natural ecosystems;
- Promote programs run by and for nature conservation areas, natural parks, areas of the biosphere, and landscape protection and preservation;
- Promote necessary measures to ensure biosafety and biodiversity in order to better ensure protection of the environment and quality of life;

The National Directorate for Prevention and Environmental Impact Assessment (DNPAIA) is accountable for evaluating environmental impact studies, while the National Directorate of

Environment (DNA) is accountable for the conception and implementation of urban management policies and urban strategies.

(2) Key items implemented through environmental and social considerations

(a) Implementation of Environmental Impact Assessment

The EIA procedures are set out in the Decree on Environmental Impact Assessment.

The activities listed in the Annex to the EIA Decree are categorized in the following sectors:

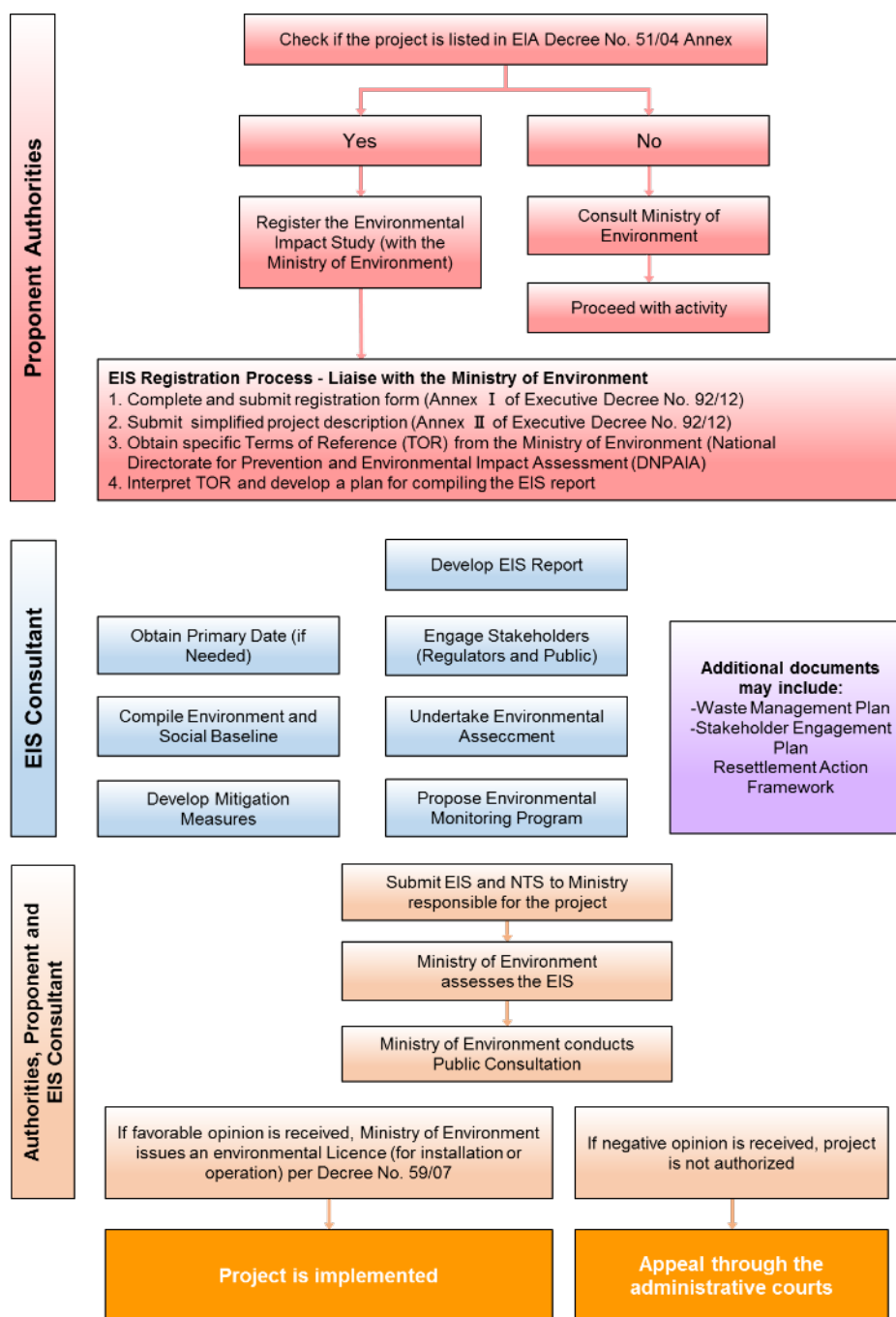
- Agriculture, fisheries and forestry;
- Extractive industries, such as petroleum, mining and dredging;
- Energy industry;
- Glass industry;
- Chemical industry;
- Infrastructure projects; and
- Other projects.

The energy industry projects that EIA implementation will be required for the following activities:

- a) Industrial installations for carrying gas, steam, and hot water, and transmission of electrical energy by overhead cables;
- b) Surface storage of natural gas;
- c) Underground storage of combustible gases;
- d) Surface storage of fossil fuels;
- e) Industrial briquetting of coal and lignite;
- f) Installations for the production and enrichment of nuclear fuels;
- g) Installations for the reprocessing of irradiated nuclear fuels;
- h) Installations for the collection and processing of radioactive waste;
- i) Installations for hydroelectric energy plants with capacities of greater than 1,000 kW;
- j) Power transmission lines with capacities above 230 kV;
- k) Hydraulic works for the exploitation of water resources, such as dams for hydroelectric purposes, sanitation or irrigation, the creation of navigable canals, irrigation, the straightening of watercourses, the opening of bars and river mouths, bay crossings, and dykes;
- l) Nuclear power stations with capacities of greater than 500 kW; and
- m) Nuclear power stations generating electricity through fission of isotopes;

(b) EIA Implementation Process

Figure 11-5 shows the screening and appraisal process for environmental permit issuance. At first, the developer carries out a screening to determine whether EIA is necessary according to the EIA Decree. When EIA is judged to be necessary, the process for environmental permit issuance is implemented.



(Source: JICA Survey Team)

Figure 11-5 Screening and Appraisal for Environmental Permit Issuance

(c) Environmental monitoring

According to Article 22 of the EIA Decree, the competent environmental authority (in this case the Ministry of Environment) is responsible for monitoring the implementation of the EIA in specific projects. In practice, however, the Ministry or its Directorate often neglects to follow up the monitoring due to a lack of available resources and professional capacity.

(d) Public consultation

All projects listed in the Annex to the EIA Decree (see above (2) a) must be a subject to a public consultation programme organized by the Ministry of Environment, as prescribed in Article 10 of the EIA Decree.

The public consultation process, to be undertaken by the responsible ministry, comprises the following steps:

- Release of the non-technical summary of the EIA report to the interested and affected parties (as defined in Article 3 of the Decree);
- Consideration and appraisal of all presentations and comments related to the proposed project;

Compilation of a brief report within eight days of the completion of the consultation period, specifying the measures taken, the level of public participation, and the conclusions that may be drawn;

The consultation process must take place over a period from five to ten days, and the costs must be borne by the developer.

(e) Land acquisition and resettlement

There are two type of regulation for land acquisition and resettlement in Angola: the “Land Law, No.9/04, 09/11/2004” and the “Regulation on Resettlement, No.117/16, 30/05/2016.”

Article 12 of the Land Law stipulates that in cases of land acquisition for public works, the Nation or state governor shall pay appropriate compensation to landowners who have land use rights. Landowners receive compensation under this law.

Moreover, based on the Regulation on Resettlement enforced in 2016, compensation related to relocation is to be negotiated among the state, the affected people, and the business operator.

Compensation is provided in cash or as real estate equivalent to the land and house(s) lost.

11.4 Comparison of Alternatives (including Zero Options)

The zero option in this master plan is to be left out from this study, since it would be unrealistic to prepare measures and plans that enable a power development master plan to meet the power demand up to 2040 without implementing various power developments.

The draft scenario for power development is shown in chapter "11.8 Scenario analysis from ."

11.5 Scoping

In accordance with the following procedure, the SEA is to be conducted on power source development plans in the several alternative development scenarios from environmental and social viewpoints.

(1) Selection of scoping items and indicators

In order to analyze and evaluate each alternative development scenario (power development) from environmental and social viewpoints, evaluation items related to various power development projects are selected with reference to the JICA guidelines (checklist).

Table 11-8 Scoping Item Selection for SEA

Sort	Impact Items		Conventional			Renewable Energy		
			Hydro	Coal	LNG, Oil	Wind	Solar	Biomass
Pollution Control	1	Air Quality	C	A	B	D	D	C
	2	Water Quality	B	B	B	C	B	B
	3	Soil Quality	D	B	C	D	D	B
	4	Sediment	D	D	D	D	C	D
	5	Noise and Vibration	B	B	B	A	B	B
	6	Odor	D	C	C	D	D	C
	7	Waste	C	A	C	D	A	A
	8	Subsidence	B	B	B	D	D	B
Natural Environment	9	Protected areas	A	D	D	A	A	A
	10	Ecosystem	A	D	D	A	A	A
	11	Topography and Geology	A	C	C	B	B	C
	12	Hydrology	C	D	D	D	D	D
Social Environment	13	Land acquisition	A	A	B	D	D	C
	14	Disturbance of Poor People	C	D	D	D	D	D
	15	Disturbance of Ethnic Minority Groups and Indigenous People	A	C	D	D	D	D
	16	Deterioration of Local Economy such as Loss of Employment and Livelihood Means	C	C	C	C	C	C
	17	Land Use and Utilization of Local Resources	A	B	B	B	B	B
	18	Disturbance of Water Usage, Water Rights, etc.	A	A	A	D	D	D
	19	Disturbance of Existing Social Infrastructure and Services	C	C	C	C	C	C
	20	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	C	C	C	C	C	C
	21	Misdistribution of Benefits and Compensation	C	C	C	C	C	C
	22	Local Conflicts of Interest	C	C	C	C	C	C
	23	Cultural Heritage	B	D	D	D	D	D
	24	Landscape	B	C	C	A	B	D
	25	Gender	D	D	D	D	D	D
	26	Children's Rights	D	D	D	D	D	D
	27	Infectious Diseases such as HIV/AIDS	C	C	C	C	C	C
	28	Work Environment (including Work Safety)	C	C	C	C	C	C
	Other	29	Accidents	C	C	C	C	C
30		Cross-boundary Impact and Climate Change	C	A	B	D	D	D

- Note;** A: Significant negative impact is expected
 B: Negative impact is expected to some extent
 C: Negative impact is unknown (further examination is needed and the impact may be clarified as the study progresses), and no evaluation is to be done in the SEA
 D: No impact is expected, and no evaluation is to be done in the SEA

Based on the aforementioned screening, the scoping objects to be implemented in the SEA were narrowed down to the 17 items shown in Table 11-9 (natural environment, 10 items; social environment, 6 items; global environment, 1 item) for evaluation according to the evaluation criteria mentioned below.

Table 11-9 Selected scoping items and impact evaluation indicators

Category	Items	Indicators
Natural (10)	Topography & Geology	Destruction of ground
	Soil	Erosion, disposal, leakage of toxic substances; peeling off of top soil
	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances
	Quality of Air	Emission of pollutants from facilities
	Noise/Vibration	Noise/vibration from facilities or operation activities
	Waste	Domestic or industrial waste from facilities
	Subsidence	Use of underground water by facilities
	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem
	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse impact on migratory fish or birds
	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks
Social (6)	Resettlement / Land acquisition	Involuntary resettlement / Land requirement
	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people
	Land Use	Land use conflict
	Water Use	Water use conflict
	Landscape	Destruction of landscape
	Historical Heritage	Loss of local heritage
Global (1)	CO ₂ Emission	Adverse impacts on global warming

(Source: JICA Survey Team)

(2) Method for evaluating the scoping items

Each project listed in the alternative development scenario is to be quantitatively evaluated based on impact evaluation criteria scored on a four-point scale (from 0 to -3), as shown in Table 11-10.

The scores (degrees of impact) for each alternative development scenario are totaled, and each scenario is prioritized based on the total score from environmental and social viewpoints.

Table 11-10 Impact Evaluation Criteria

Score (E.C.I)*	Evaluation Criteria
- 3	Significant direct-negative impact is expected, and mitigation cannot be expected.
-2	Significant direct-negative impact is expected, and mitigation is expected.
-1	Minor direct-negative impact is expected, and mitigation is expected.
0	Minor indirect-negative impact is expected, and mitigation is not needed.

*: Environmental Contribution Indicator

(Source: JICA Survey Team)

11.6 Results of SEA

(1) Power development candidate sites selected for evaluation of environmental impacts through SEA

Studies on environmental and social considerations were carried out in consultation with MINEA

using the above scoping and evaluation method for a total of 22 potential development candidates, as shown in the table below.

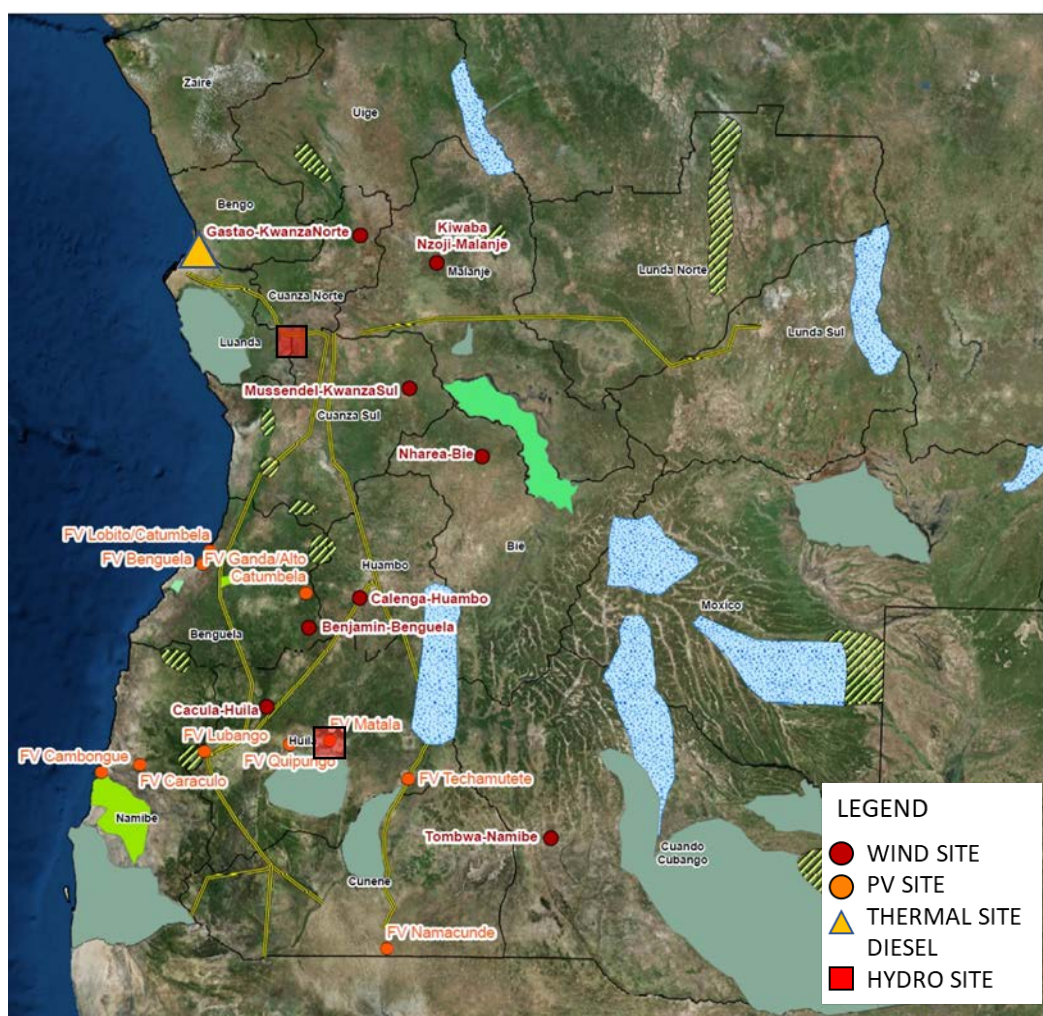
As no candidate sites for hydropower projects were nominated by MINEA, the environmental evaluation (scoring) for hydropower was done by evaluating the impacts of existing hydropower plants on nature, society, and the global environment, in lieu of conducting SEA evaluations on candidate sites. The environmental impacts when implementing hydropower development projects in Angola were assumed accordingly.

Table 11-11 Power Development Candidate Sites for SEA

Type of Generation	Name of Project	Location	Capacity (MW)
Hydropower	CAMBAMBE	Kwanza Norte	960
	MATALA	Huila	40.8
Sub total	2		1000.8
Thermal Power (LNG / Heavy-Oil)	CIMANGOLA	Luanda	212
Sub total	1		212
Wind Power	BENJAMIN	Benguela	52
	CACULA	Huila	88
	CALENGA	Huambo	84
	GASTAO	Kwanza Norte	30
	KIWABANZOJI I	Malanje	62
	MUSSENDE I	Kwanza Sul	36
	NHAREA	Bie	36
	TOMBWA	Namibe	100
Sub total	8		488
Solar Power	BENGUELA	Benguela	10
	CARACULO	Namibe	10
	CAMBONGUE	Namibe	10
	GANDA/ALTOCATUMBELA	Benguela	10
	LOBITO/CATUMBELA	Benguela	10
	LUBANGO	Huila	10
	MATALA	Huila	10
	QUIPUNGO	Huila	10
	NAMACUNDE	Cunene	10
	TECHAMUTETE	Huila	10
Sub total	9		90
Biomass	1 Biomass Project, (No Project Name as of 2018)	Huila	3
Sub total	1		3
Total	22		

(2) Locations of the candidate power development sites

The map below shows the locations of the candidate sites.



(Source: ERM Report)

Figure 11-6 Locations of the Generation Power Site

(3) Evaluation of each project from social and environmental viewpoints

(a) Hydropower Plant

(a)-1. CAMBAMBE Hydropower Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment

- There are 4 types of vegetation zone in the site area: (1) Dry savannah with more or less scattered shrubs and trees; (2) Forests of tall, semi-deciduous trees with many climbing plants; (3) Communities of aquatic plants, and (4) plant communities from the cliff margins. Some of the floral species in these zones have low abundance, so any small change could potentially lead to species extinct around the site area.
- The vegetation is expected to change near the river banks due to the change of the river flow downstream of the dam.

- A change in the migratory patterns of the mammals is expected due to the scarcity of existing habitats.
- There is some concern that excavation and construction for access roads and transmission lines will lead to soil erosion.
- Social Environment
 - There are only a few number of resettlements of rural people.
 - The area is characterized by the presence of well-developed industrial facilities and residential areas.
 - No heritage resources are expected to be affected by the project.



Figure 11-7 Site for CAMBAMBE Hydropower Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-12 Evaluation Results on the CAMBAMBE HPP

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	-1.0	Drilling and construction of access roads may cause erosion, but mitigation measures are possible.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil erosion is assumed, but mitigation measures (embankment, planting on the cut surface) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-1.0	There is concern about the influence on wetlands etc in the downstream area, but mitigation measures are possible.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Dust flight is assumed, but it is temporary, there is no emission of pollutants at the time of operation phase.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	0.0	Waste is properly processed through 3R (Reduce, Reuse, Recycle) rule.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-2.0	Lost of some species of plant is assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-1.0	There is concern about the influence on wetlands etc in the downstream area, but mitigation measures are possible. The flight route of birds has not been confirmed.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.60	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-1.0	Resettlement of some houses is assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	-1.0	Competition of water use due to intake from rivers in the downstream area is assumed, but mitigation measures (maintenance release) are possible.
	5	Landscape	Destruction of landscape	0.0	Impacts that require mitigation measures are not assumed.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.33	
Global	1	Green House Gas	Emission of CO ₂	0.0	CO ₂ will be produced from construction work although the emission is limited and negligible on climate change.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.31	

(Source: JICA Survey Team)

(a)-2. MATALA Hydropower Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site is located in the proximity of an urban area with lots of human activities. Aquatic plants, scattered shrubs and trees, and tall and dense trees close to river banks are expected to be found in certain areas where no human activities take place (e.g.: crops).
 - No substantial change is expected in the migratory patterns of the mammals due to small effects on the existing habitats.
 - Hydropower activity could potentially affect species vulnerability by changing the ecosystem.
 - No significant noise impacts on the social environment are expected.
- Social Environment
 - There are some rural resettlements in the area.

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-13 Evaluation Results on the MATALA HPP

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-1.0	There is concern about the influence on aquatic plants etc in the downstream area, but mitigation measures are possible.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Dust might be assumed, but it is temporary, there is no emission of pollutants at the time of construction.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	0.0	Waste is properly processed through 3R (Reduce, Reuse, Recycle) rule.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-1.0	Lost of some species of plant is assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	0.0	There is concern about the influence on wetlands etc in the downstream area, but mitigation measures are possible. The flight route of birds has not been confirmed.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.20	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-1.0	Resettlement of some houses is assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	-1.0	Competition of water use due to intake from rivers in the downstream area is assumed, but mitigation measures (maintenance release) are possible.
	5	Landscape	Destruction of landscape	0.0	Impacts that require mitigation measures are not assumed.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.33	
Global	1	Green House Gas	Emission of CO ₂	0.0	CO ₂ will be produced from construction work although the emission is limited and negligible on climate change.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.17	

(Source: JICA Survey Team)

(b) Thermal Power

(b)-1. CIMANGOLA Thermal Power Plant

CIMANGOLA thermal power plant was only selected as a thermal power plant candidate site for SEA from MINEA.

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The project site is located in a highly populated area with intense traffic from a combination of industrial-use and specified-use vehicles of nearby roads. Accordingly, there are no significant natural resources to be protected.
 - The predominant soil type in the area is silt soil (0-10% clay), so dry cracks form during dry season. The soil contains a brown expansive clay of silky sand, so soil erosion is a concern during wet season.
 - There is a risk of contamination of air quality by emissions of SO₂, NO₂ and PM₁₀.
 - Negative impact from the generation of noise above the recommended standards is expected around the border between the living quarter and proposed site area.
- Social Environment
 - There is concern that water resources may be contaminated if groundwater is pumped up and used as cooling water.
 - There are some rural resettlements.
- Global Environment
 - Carbon dioxide emissions are expected even after introduction of mitigation measures.



Figure 11-8 Site for CIMANGOLA Thermal Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-14 Evaluation Results on the CIMANGOLA Thermal Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-2.0	Soil contamination due to the loss of oil from treatment facilities and pipeline installation is expected, but mitigation measures are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-2.0	Rising in the water temperature is expected due to a large amount of thermal effluent to the ocean or river, and in the case of large capacity, mitigation measures are impossible.
	4	Quality of Air	Emission of pollutants from facilities	-2.0	Pollution of air quality (NO ₂ , SO ₂ , PM 10, etc.) due to smoke is expected; mitigation measures (introduction of high combustion efficiency boiler, installation of denitration/desulfur, dustproof devices) are possible.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	-1.0	Noise is assumed, but mitigation measures (construction in remote areas) are possible.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-2.0	Rising in the water temperature is expected due to a large amount of thermal effluent to the ocean or river, and the influence on plants (mangrove, marine plants) is assumed. In the case of large capacity, mitigation measures are impossible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-2.0	Rising in the water temperature is expected due to a large amount of thermal effluent to the ocean or river, and in the case of large capacity, mitigation measures are impossible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-1.10	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-1.0	Resettlement of some houses is assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	-1.0	Competition for water use due to intake from peripheral rivers as cooling water is assumed, but mitigation measures (introduction of air cooling system) are possible.
	5	Landscape	Destruction of landscape	0.0	Impacts that require mitigation measures are not assumed.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.33	
Global	1	Green House Gas	Emission of CO ₂	-2.0	CO ₂ emissions is expected.
Impact Indicator to Global Environment				-2.00	
Comprehensive Impact Indicator				-1.14	

(Source: JICA Survey Team)

(c) Wind Power

(c)-1. BENJAMIN Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is characterized mainly by Savannah and bare land.
 - There is concern about a cliff area with a probable concentration of migratory birds.
 - Operational noise may negatively impact agricultural houses nearby.
- Social Environment
 - A farm is located within the buffer area at a distance of around 1 km. Compensation might be required, considering the current land use.

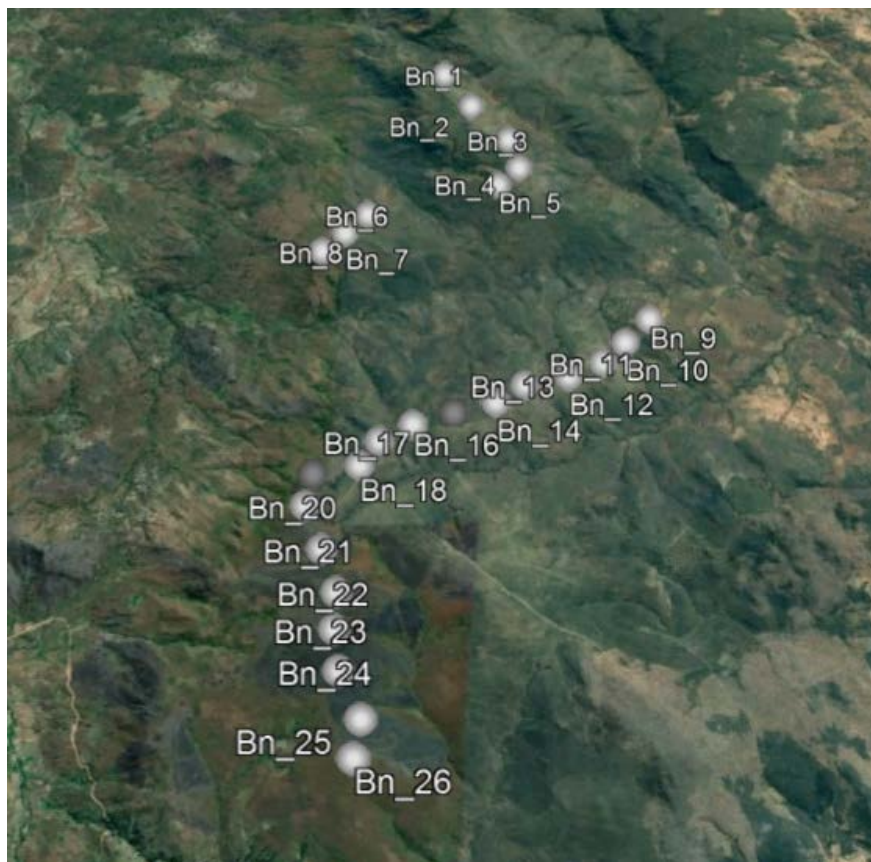


Figure 11-9 Site for BENJAMIN Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-15 Evaluation Results on the BENJAMIN Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	-1.0	Noise is assumed, but mitigation measures (construction in remote areas) are possible.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.40	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	-1.0	Land competition is assumed, but mitigation (securing of substitute) is possible.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.66	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.35	

(Source: JICA Survey Team)

(c)-2. CACULA Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is characterized mainly by forests and agricultural patches. Construction yards and access roads will alter the landscape settings.
 - There is concern about a cliff area with a probable concentration of migratory birds.
 - Reptiles, rodents and other species may be found in the area and could be affected during the installation of the turbines and associated infrastructure.
 - Operational noise may negatively impact agricultural houses nearby.
- Social Environment
 - A farm is located within the buffer area within a range of about 1 km. Compensation might be required, considering the current land use.

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-16 Evaluation Results on the CACULA Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	-1.0	Noise is assumed, but mitigation measures (construction in remote areas) are possible.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.40	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-1.0	resettlement might be required within 1Km.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	-1.0	Land competition is assumed, but mitigation (securing of substitute) is possible.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.83	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.41	

(Source: JICA Survey Team)

(c)-3. CALENGA Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

● Natural Environment

- The area is characterized by savannah and agricultural patches in the north, while the south is mostly covered by forest.
- The site area is situated in Serra do Uendelongo. There is concern about a cliff area with a probable concentration of migratory birds.
- There are expected to be corridors for birds of prey in the site area.

● Social Environment

- There is no agricultural land to be compensated in the buffer area within an approximately 1 km range.

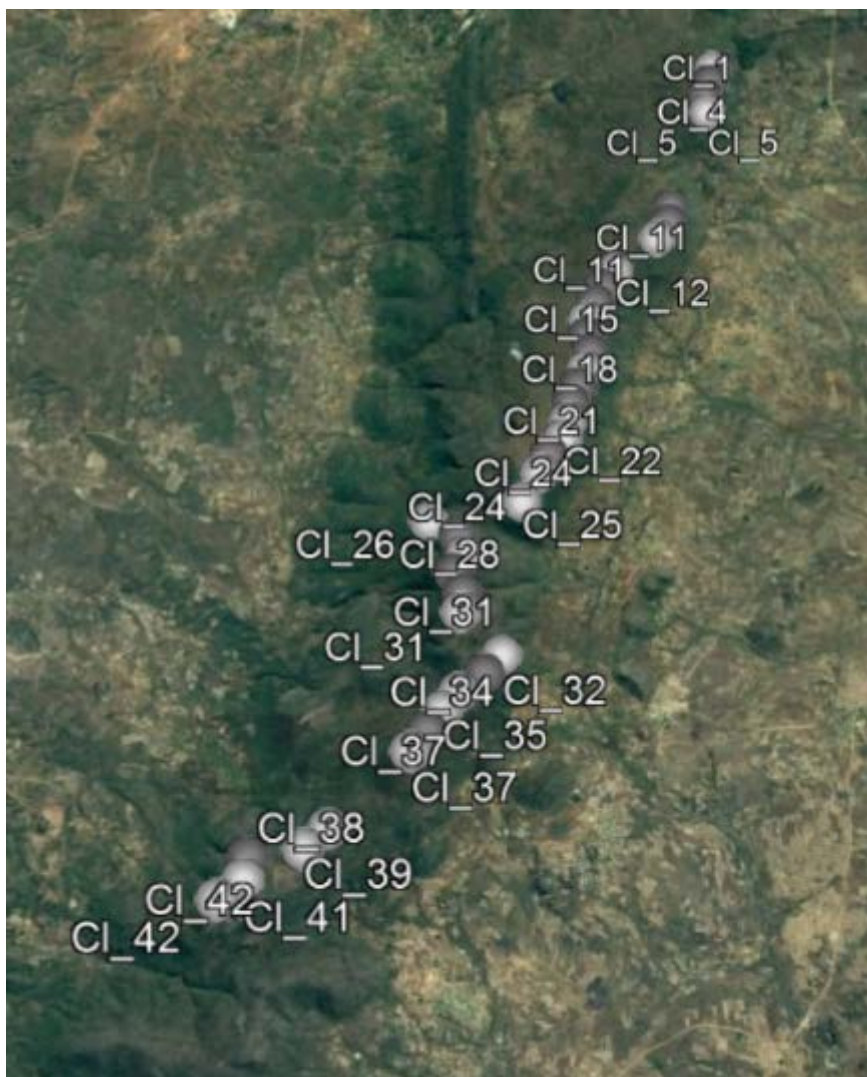


Figure 11-10 Site for CALENGA Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-17 Evaluation Results on the CALENGA Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.30	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	-1.0	Land competition is assumed, but mitigation (securing of substitute) is possible.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.66	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.32	

(Source: JICA Survey Team)

(c)-4. GASTAO Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is characterized by savannah and agricultural patches in the north, while the south is mostly covered by forest.
 - There is concern about a site area with a probable concentration of migratory birds.
- Social Environment
 - There are no agricultural lands or houses to be compensated in the buffer area within an approximately 1 km range.

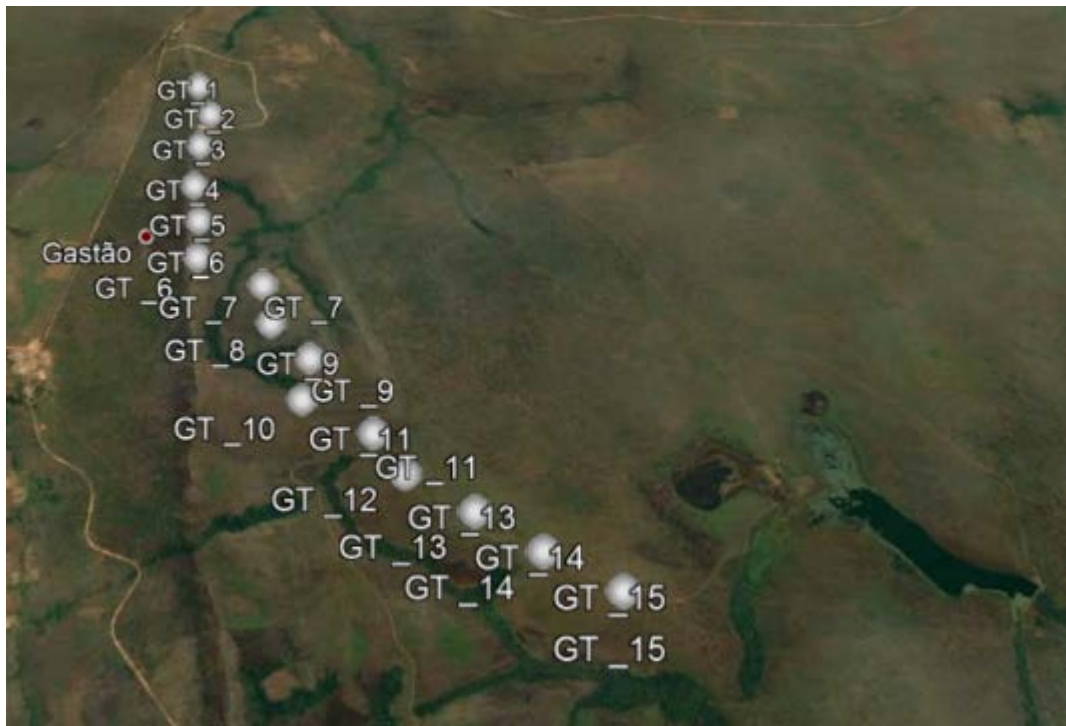


Figure 11-11 Site for GASTAO Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-18 Evaluation Results on the GASTAO Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.30	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.26	

(Source: JICA Survey Team)

(c)-5. KIWABANZOJI I Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is characterized mainly by savannah, with some part covered by forests.
 - The nearest protected area is located 40 km east of the site (Milando Special Reserve). No project impacts on the reserve are expected.
- Social Environment
 - There are 118 dwellings in the area.
 - Agricultural lands are located in the buffer area within a range of around 1 km. Compensation might be required, considering the current land use. Influences of the project on the agricultural lands can be avoided by modifying certain design aspects (place of installation, etc.)



Figure 11-12 Site for KIWABANZOJI I Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-19 Evaluation Results on the KIWABANZOJI I Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	-2.0	Windmill noise is assumed, but mitigation measures (construction in remote areas) are possible.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.50	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-2.0	A serious negative direct impact due to resettlement of residents is assumed, but mitigation measures (recovery of living base after relocation, securing alternative place etc.) are possible.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.83	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.44	

(Source: JICA Survey Team)

(c)-6. MUSSENDE I Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - There are mosaic agriculture lands located within 500 m from the site.
 - The nearest protected area (Luanda Integral Nature Reserve) is located 40 km east from the site. No project impacts on the reserve are expected.
- Social Environment
 - There are villages in the south part of the site area. Negative impact from noise is expected.
 - Agricultural lands are located within the 500 m buffer zone of the site area. Resettlement and compensation may be required.



Figure 11-13 Site for MUSSENDE I Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-20 Evaluation Results on the MUSSENDE I Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	-2.0	Windmill noise is assumed, but mitigation measures (construction in remote areas) are possible.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.50	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-2.0	A serious negative direct impact due to resettlement of residents is assumed, but mitigation measures (recovery of living base after relocation, securing alternative place etc.) are possible.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.83	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.44	

(Source: JICA Survey Team)

(c)-7. NHAREA Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site area is covered by dense forest with a high potential for rich biodiversity.
 - The nearest protected area (Luanda Integral Nature Reserve) is located 40 km east of the site. No project impacts on the reserve are expected.
- Social Environment
 - There are no houses near the project site.
 - Agricultural lands are located within the 500 m buffer zone of the site area. Resettlement and compensation may be required.

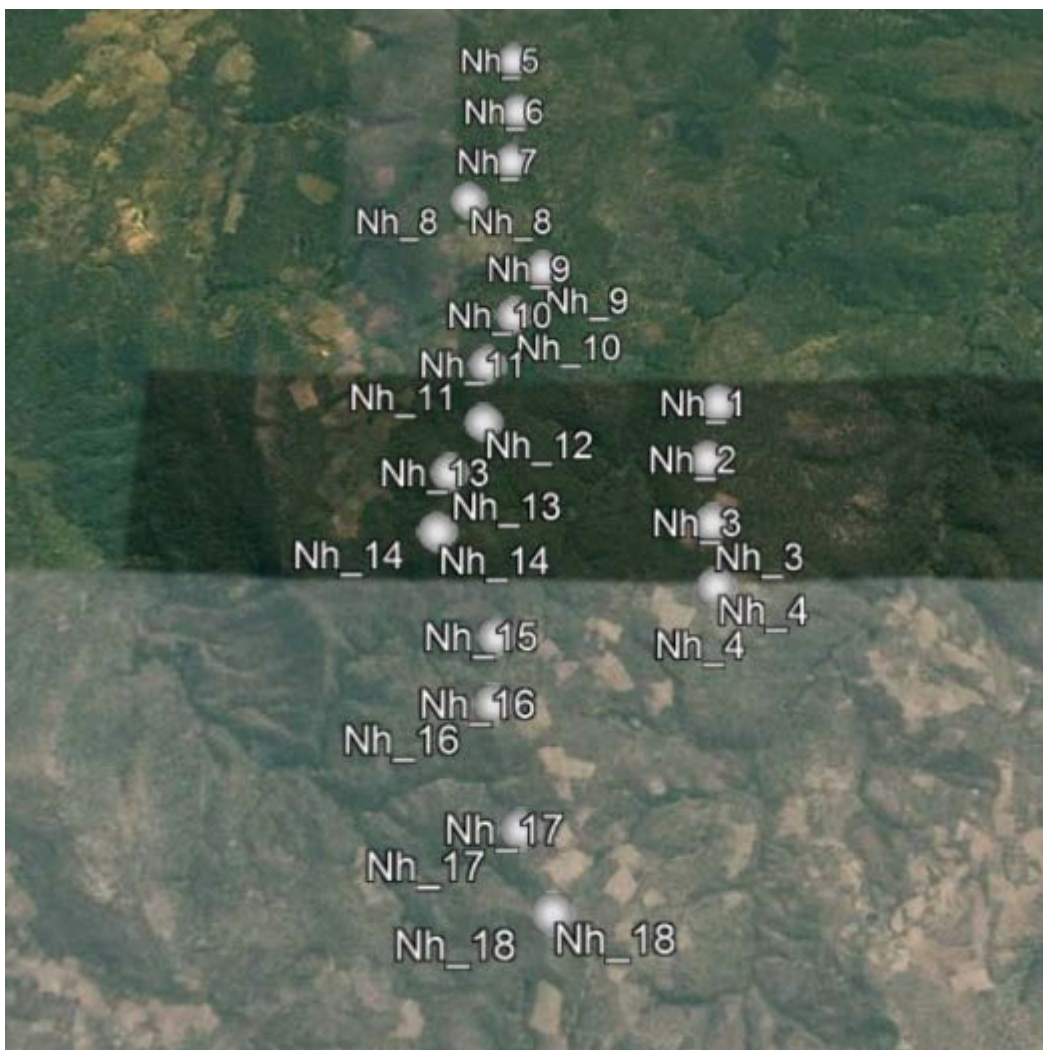


Figure 11-14 Site for NHAREA Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-21 Evaluation Results on the NHAREA Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-1.0	Impacts to the forest near project site is assumed, but mitigation measures will be possible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.40	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	-1.0	Competition for land use of agriculture is assumed, but mitigation measures (securing alternative site) are possible.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.66	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.35	

(Source: JICA Survey Team)

(c)-8. TOMBWA Wind Power

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The project area is located in the Namibe Desert near the coast. Migratory birds and some birds of prey (e.g.: Circaetus pectoral) live there.
 - Typical flora species in the site area include Stoebe cinerea and several sparse grasses common among the dry areas of the desert.
 - The project is located inside the Iona National Park.
- Social Environment
 - There are no houses or land for agriculture near the project site.



Figure 11-15 Site for TOMBWA Wind Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-22 Evaluation Results on the TOMBWA Wind Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	0.0	Impacts that require mitigation measures are not assumed.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-1.0	Impacts to the forest near project site is assumed, but mitigation measures will be possible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-3.0	The occurrence of bird strike accident is assumed. Even adopting mitigation measures to avoid migratory birds' flight routes, it is difficult to eradicate such an accident.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	-3.0	Influence on the flight and ecology of bird species' habitats in protected areas is assumed.
Impact Indicator to Natural Resources				-0.70	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear in the wilderness, etc., so there is concern about serious influence on the surrounding environment, and mitigation measures are difficult.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.40	

(Source: JICA Survey Team)

(d) Solar Power Plant

(d)-1. BENGUELA Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site area is covered with grass, small shrubs, and meadows.
 - There is low possibility of soil erosion, since the terrain of the site is flat.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - There are several houses around the site.



Figure 11-16 Site for BENGUELA Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-23 Evaluation Results on the BENGUELA Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Impacts that require mitigation measures are not assumed.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-2.0	There is a concern about serious impacts on vegetation due to the bare ground under the panels, but mitigation measures (planting of shade-tolerant plants under the panels) are possible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-1.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.50	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	-1.0	A negative direct impact due to resettlement of residents is assumed, but mitigation measures (securing alternative place etc.) are possible.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.66	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.38	

(Source: JICA Survey Team)

(d)-2. CARACULO Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site area is a suitable habitat for important reptiles and small rodents.
 - There is a possibility of soil erosion due to excavation and construction for access roads and transmission lines.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - There are no houses around the site.



Figure 11-17 Site for CARACULO Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-24 Evaluation Results on the CARACULO Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-2.0	There is a concern about serious impacts on vegetation due to the bare ground under the panels, but mitigation measures (planting of shade-tolerant plants under the panels) are possible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-1.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.60	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.36	

(Source: JICA Survey Team)

(d)-3. CAMBOUNGUE Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site is located in a desert area devoid of natural vegetation.
 - There is a possibility of soil erosion due to excavation and construction for access roads and transmission lines.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - A port city (Sacomar) is located about 3 km west of the site, but no project impacts are expected.



Figure 11-18 Site for CAMBOUNGUE Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-25 Evaluation Results on the CAMBOUNGUE Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-2.0	There is a concern about serious impacts on vegetation due to the bare ground under the panels, but mitigation measures (planting of shade-tolerant plants under the panels) are possible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-2.0	There is a concern about the influence of large-scale facilities on the flight route of migratory birds.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.70	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.40	

(Source: JICA Survey Team)

(d)-4. GANDA/ALTOCATUMBELA Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site area is suitable for habitats of important reptiles and small rodents.
 - The site is a savanna zone with agricultural land patches mixed in.
 - There is a possibility of soil erosion due to excavation and construction for access roads and transmission lines.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - Some of the agricultural lands may be affected. The land use may change and compensation may be required. Some of the possible influences during project implementation can be avoided by modifying design aspects (place of installation, etc.)

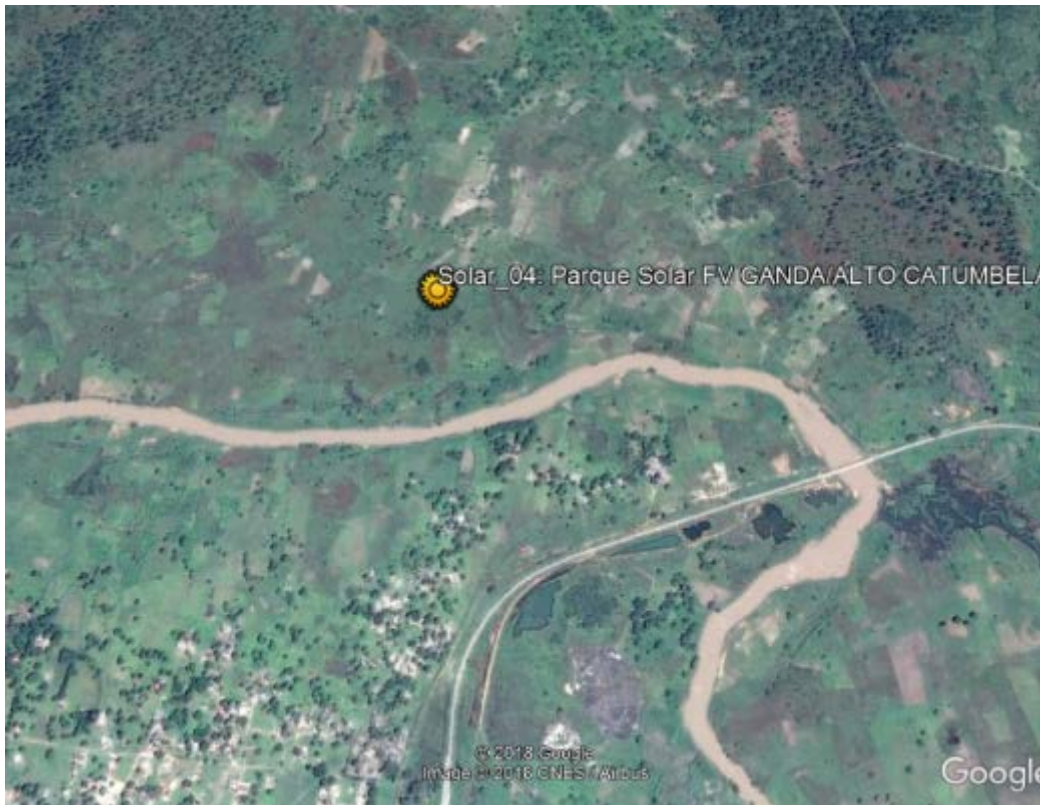


Figure 11-19 Site for GANDA/ALTOCATUMBELA Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-26 Evaluation Results on the GANDA/ALTOCATUMBELA Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	-2.0	There is a concern about serious impacts on vegetation due to the bare ground under the panels, but mitigation measures (planting of shade-tolerant plants under the panels) are possible.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-1.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.60	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.36	

(Source: JICA Survey Team)

(d)-5. LOBITO/CATUMBELA Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site is located in a desert area, but there are residential areas around the site.
 - There is a possibility of soil erosion due to excavation and construction for access roads and transmission lines.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - Some of the grass fields may be affected, possibly necessitating a change in land use and compensation. Some of the influences during project implementation can be avoided by modifying design aspects (place of installation, etc.)



Figure 11-20 Site for Solar LOBITO/CATUMBELA Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-27 Evaluation Results on the LOBITO/CATUMBELA Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	0.0	Impacts that require mitigation measures are not assumed.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.30	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.26	

(Source: JICA Survey Team)

(d)-6. LUBANGO Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site area is suitable for habitats of important reptiles and small rodents.
 - The site is located in a desert area, with no residential areas situated nearby.
 - There is a possibility of soil erosion due to excavation and construction for access roads and transmission lines.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - Some of agricultural lands may be affected, possibly necessitating a change in the land use and compensation. Some of the influences during project implementation can be avoided by modifying design aspects (place of installation, etc.)

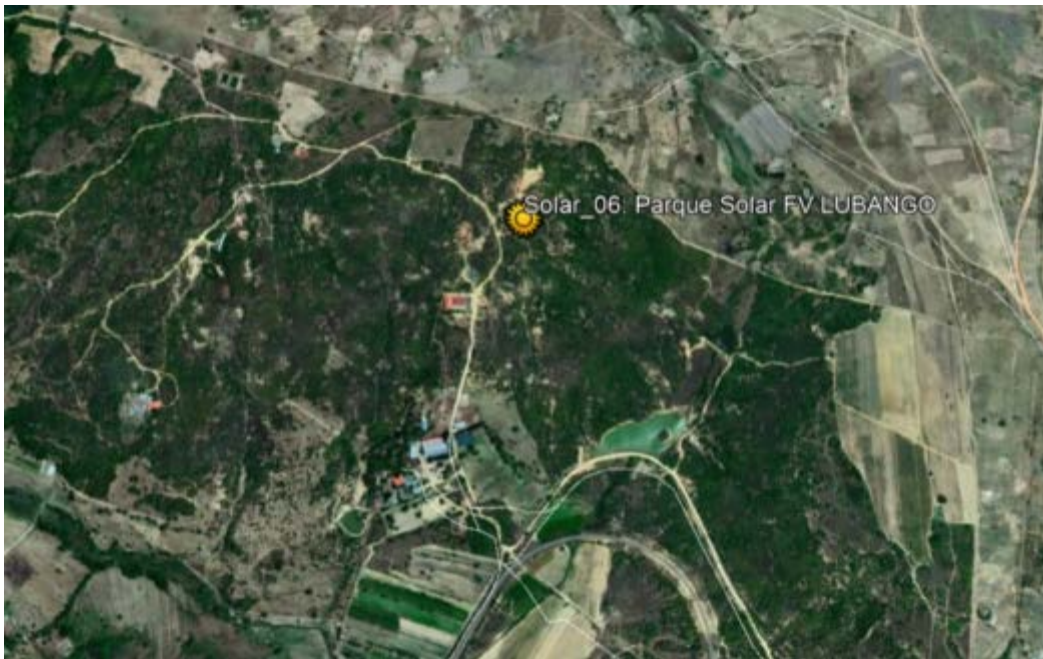


Figure 11-21 Site for LUBANGO Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-28 Evaluation Results on the LUBANGO Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-1.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.40	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are assumed, but mitigation measures are possible.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.30	

(Source: JICA Survey Team)

(d)-7. MATALA Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The site area is suitable for habitats of important reptiles and small rodents.
 - There is a possibility of soil erosion due to excavation and construction for access roads and transmission lines.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - Some of the agricultural lands may be affected, possibly necessitating a change in the land use and compensation. Some of the influences during project implementation can be avoided by modifying design aspects (place of installation, etc.).



Figure 11-22 Site for MATALA Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-29 Evaluation Results on the MATALA Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	-1.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	0.0	Impacts that require mitigation measures are not assumed.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	-1.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.40	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.30	

(Source: JICA Survey Team)

(d)-8. QUIPUNGO Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is an agricultural land cultivated in a mosaic pattern, with 84 residences situated in the 1 km buffer area around the site.
 - A water resource (Cuanhama pond) is located nearby.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - The 84 houses in the surrounding area may be affected by the installation of panels.
 - Some of agricultural lands may be affected, possibly necessitating a change in the land use and compensation.

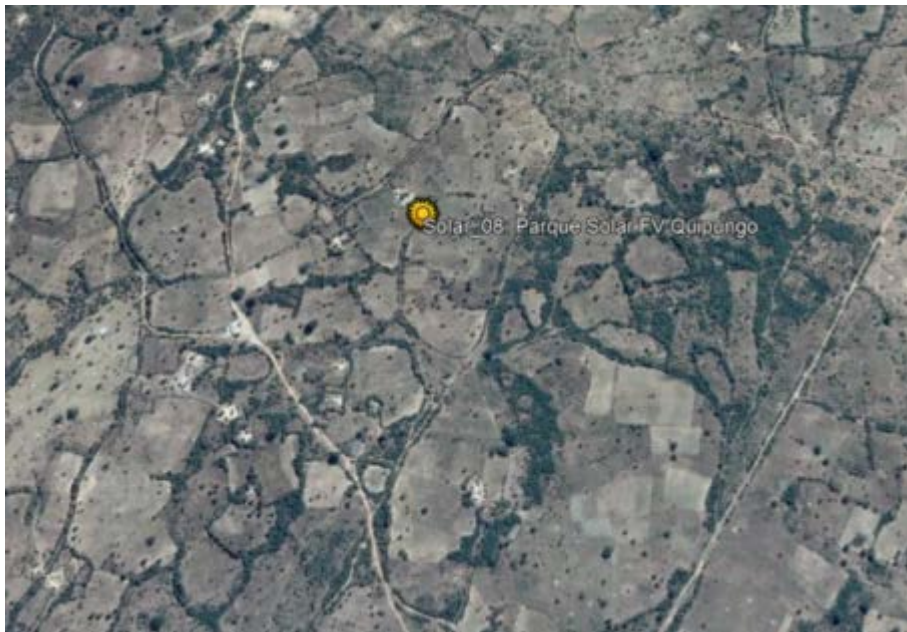


Figure 11-23 Site for QUIPUNGO Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-30 Evaluation Results on the QUIPUNGO Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-1.0	Occurrence of muddy flow due to soil erosion is assumed, but mitigation measures (construction of adjustment reservoirs and installation of drainage channels) are possible.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	0.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.30	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	-1.0	The use of agricultural land may be restricted.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.66	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.32	

(d)-9. NAMACUNDE Solar Power Plant

(Source: JICA Survey Team)

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is primarily forested and some parts are covered with savanna.
 - A water source (Cuanhama pond) is located nearby.
 - The site area is suitable for habitats of important reptiles and small rodents.
 - Storage batteries will be installed for use during operations, so industrial waste is expected.
- Social Environment
 - Agricultural lands are located in the surrounding area, and impacts are assumed. Some of the influences during project implementation can be avoided by modifying design aspects (place of installation, etc.).

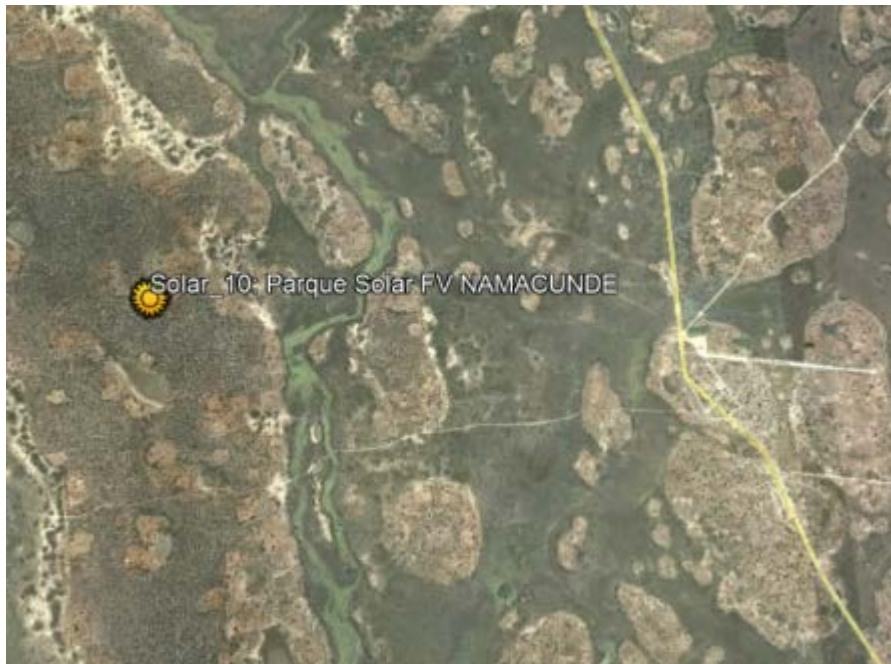


Figure 11-24 Site for NAMACUNDE Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-31 Evaluation Results on the NAMACUNDE Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-1.0	Occurrence of muddy flow due to soil erosion is assumed, but mitigation measures (construction of adjustment reservoirs and installation of drainage channels) are possible.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	0.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.30	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.26	

(Source: JICA Survey Team)

(d)-10. TECHAMUTETE Solar Power Plant

i) Following is a summary of the main features of the natural and social environments identified through the SEA survey.

- Natural Environment
 - The area is mainly characterized by savanna and bare land, with a national park located nearby.
 - The site is surrounded by an area of bare fields, with an iron man located nearby.
 - A water source (Cuanhama pond) is located nearby.
 - Batteries will also be installed for use during operations, so industrial waste is expected.
- Social Environment
 - There are no residences or agricultural lands in the surrounding area.

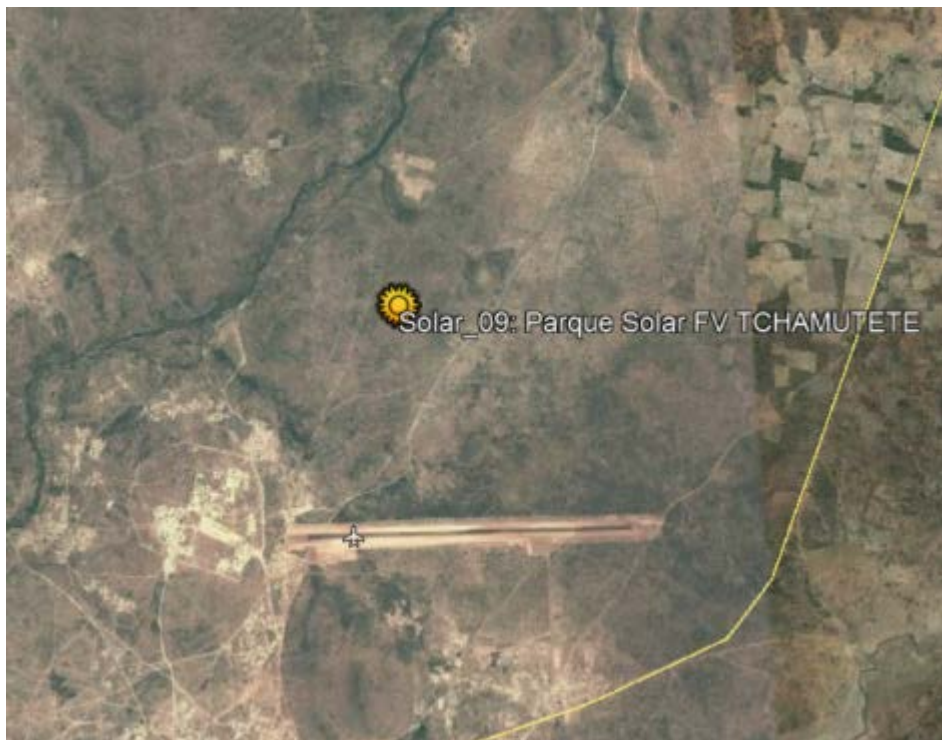


Figure 11-25 Site for TECHAMUTETE Solar Power Plant

ii) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

Table 11-32 Evaluation Results on the TECHAMUTETE Solar Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-1.0	Occurrence of muddy flow due to soil erosion is assumed, but mitigation measures (construction of adjustment reservoirs and installation of drainage channels) are possible.
	4	Quality of Air	Emission of pollutants from facilities	0.0	Impacts that require mitigation measures are not assumed.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	0.0	Impacts that require mitigation measures are not assumed.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A large amount of waste (solar cell modules, storage batteries, power conditioners, etc.) is assumed after reaching the end of its life, but mitigation measures (promotion of 3R) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	0.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.30	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	0.0	Impacts that require mitigation measures are not assumed.
	5	Landscape	Destruction of landscape	-3.0	Huge artificial structures appear at the foot of mountains, in the wilderness, etc., and there is concern about serious impact on the surrounding environment, but mitigation measures (tree planting around the facility) are possible.
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.50	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.26	

(Source: JICA Survey Team)

(e) Biomass Power Plant

(e)-1. Huila Biomass Power Plant

MINEA nominated only one biomass power plant, with a 3 MW capacity plant. The plant is to be located somewhere within the Huila District, but the exact location is uncertain.

Referring examples from other countries, the JICA Study Team evaluated an assumed case where the plant is to be constructed in “Some Area” of Huila District, from environmental and social viewpoints.

i) Evaluation from environmental and social viewpoints

Following is a summary of the evaluation results on the expected influences of this project on the natural, social, and global environments.

ii) Evaluation from environmental and social viewpoints

Table 11-33 Evaluation Results on the Huila Biomass Power Plant Power Plant

Group	No.	Item	Indicator	Score	Basis of Score
Natural	1	Topography & Geology	Destruction of ground	0.0	Impacts that require mitigation measures are not assumed.
	2	Soil	Erosion, Disposal, Leakage of toxic substances, Peeling off of top soil	0.0	Soil collapse, top soil release, and soil erosion is assumed, but mitigation measures (paving, stabilization of foundation soil by gravel bed) are possible.
	3	Quality of Water	Pollution due to water-diversion / sedimentation of toxic substances	-1.0	Leakage of polluted water from the collection materials is expected, but mitigation measures (drainage canals, construction of purification ponds) are possible.
	4	Quality of Air	Emission of pollutants from facilities	-1.0	Contamination of air quality (NO ₂ , SO ₂ , PM 10, etc.) is assumed, but mitigation measures (introduction of high efficiency boilers, installation of denitrification/sulfur, dustproof device) are possible.
	5	Noise/Vibration	Noise/vibration from facilities or operation activities	-1.0	Noise due to vehicles and heavy machinery used for loading materials, discharging waste, etc. are assumed, but mitigation measures (low noise vehicles, maintenance of vehicles at regular intervals, etc.) are possible.
	6	Waste	Domestic or industrial waste from facilities	-2.0	A serious negative direct impact is assumed when securing the disposal site for waste (combustion residues, etc.), but mitigation measures (promotion of 3R etc.) are possible.
	7	Subsidence	Use of underground water by facilities	0.0	Impacts that require mitigation measures are not assumed.
	8	Flora	Deforestation (including mangroves), peeling of vegetation, changing of the flora ecosystem	0.0	Impacts that require mitigation measures are not assumed.
	9	Fauna/Fish/Coral	Destruction of animal habitats/ecosystems, adverse on migratory fish or birds	0.0	There is a concern about the influence of large-scale facilities on the movement route of animals, but mitigation measures are possible.
	10	Natural Protected Areas	Impacts on strict natural protected areas such as National Parks	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Natural Resources				-0.50	
Social	1	Resettlement	Involuntary resettlement / loss of means of livelihood	0.0	Impacts that require mitigation measures are not assumed.
	2	Ethnic minorities / Indigenous people	Adverse impacts on vulnerable people	0.0	Impacts that require mitigation measures are not assumed.
	3	Land Use	Land use conflict	0.0	Impacts that require mitigation measures are not assumed.
	4	Water Use	Water use conflict	-1.0	Competition for water use due to intake from peripheral rivers as cooling water is assumed, but mitigation measures (introduction of air cooling system) are possible.
	5	Landscape	Destruction of landscape	0.0	Impacts that require mitigation measures are not assumed
	6	Historical Heritage	Loss of local heritage	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Social Resources				-0.15	
Global	1	Green House Gas	Emission of CO ₂	0.0	Impacts that require mitigation measures are not assumed.
Impact Indicator to Global Environment				0.00	
Comprehensive Impact Indicator				-0.21	

(Source: JICA Survey Team)

11.7 Environmental Evaluation

The table below presents the results of the SEA evaluation on power development from environmental and social viewpoints by indicator (degree of environmental impact).

The power source ranking by negative impact on the natural and social environments, in ascending order (from lowest to highest), was as follows: (i). Biomass, (ii). Hydropower, (iii). Solar, (iv). Wind, (v). Thermal (LNG/Heavy Oil).

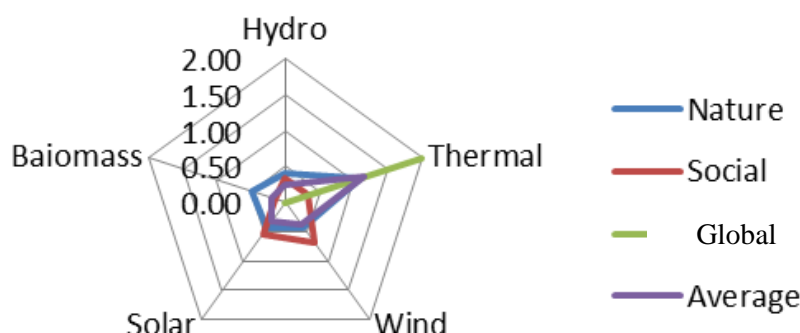
The relatively high total environmental impact of wind power and solar power generation stems from the large negative impact on the local landscape caused by the appearance of huge artificial structures in the vast plains of the continent of Africa (mainly savanna, shrub vegetation).

Table 11-34 Environmental indicator on each power generation plant

Type	Name	HYPP		THPP	Wind PP										Solar PP										Bio. PP
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
MW		960	40.8	212	52	88	84	30	62	36	36	100	10	10	10	15	16	10	10	10	10	10	22		
Topography & Geology		-1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Soil		-1.0	0.0	-2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0	-1.0	-1.0	0.0	0.0		
Quality of Water		-1.0	-1.0	-2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0	-1.0		
Quality of Air		0.0	0.0	-2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Noise/Vibration		0.0	0.0	-1.0	-1.0	-1.0	0.0	-2.0	-2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0		
Waste		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0		
Subsidence		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Flora		-2.0	-1.0	-2.0	0.0	0.0	0.0	0.0	0.0	-1.0	-1.0	-2.0	-2.0	-2.0	-2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Fauna/Fish/Coral		-1.0	0.0	-2.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-1.0	-1.0	-2.0	-1.0	0.0	-1.0	-1.0	0.0	0.0	0.0	0.0		
Nature Protected Areas		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
(Natural Environment)		-0.80	-0.20	-1.10	-0.40	-0.40	-0.30	-0.30	-0.50	-0.50	-0.40	-0.70	0.50	-0.60	-0.70	-0.60	-0.30	-0.40	-0.40	-0.30	-0.30	-0.30	-0.50		
(Average)		-0.40	-1.10					-0.43									-0.44						-0.50		
Resettlement		-1.0	-1.0	-1.0	0.0	-1.0	-1.0	0.0	-2.0	-2.0	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Ethnic/Indigenous pec		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Land use		0.0	0.0	0.0	-1.0	-1.0	-1.0	0.0	0.0	0.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0	0.0	0.0		
Water Use		-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.0		
Landscape		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0		
Historical Heritage		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
(Social Environment)		-0.33	-0.33	-0.33	-0.66	-0.83	-0.66	-0.50	-0.83	-0.83	-0.66	-0.50	-0.66	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.50	-0.66	-0.50	-0.50		
(Average)		-0.33	-0.33					-0.68									-0.53						-0.15		
Renewable House Gas		0.0	0.0	-2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
(Global Environment)		0.00	0.00	-2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
(Average)		0.00	-2.00					0.00									0.00						0.00		
Comprehensive Environmental Indexes		-0.31	-0.17	-1.14	-0.35	-0.41	-0.32	-0.26	-0.44	-0.44	-0.35	-0.40	-0.38	-0.36	-0.40	-0.36	-0.26	-0.30	-0.30	-0.32	-0.26	-0.26	-0.21		
Comprehensive Environmental Indexes (Average)		-0.24	-1.14					-0.31									-0.32						-0.21		
Comprehensive Environmental Indexes/per MW (each Plant) *		-0.32	-4.16	-5.37	-6.73	-4.65	-3.80	-8.66	-7.08	-12.22	-9.72	-4.00	-38.00	-36.00	-40.00	-36.00	-26.00	-36.00	-30.00	-32.00	-26.00	-26.00	-70.00		
Comprehensive Environmental Indexes/per MW (Type of Generation)		-2.24	-5.37					-7.11									-32.00						-70.00		

*: For convenience sake, it is 1,000 times for comparison.

(Source: JICA Survey)



(0: means the lowest impact)

(Source: JICA Survey Team)

Figure 11-26 Environmental Impact Analysis Diagram of Power Generation Type (Overall)

11.8 Scenario analysis from environmental and social viewpoints

The following (A) scenario plan is analyzed as a draft scenario

Meanwhile, the JICA Survey Team formulated a draft scenario (B) to develop more renewable energy, as a reference plan with lower burdens on the global environment and regional environment.

● Scenario (A)

Only hydropower plants and thermal power plants (LNG / heavy oil fired) will be developed in this scenario. Hence, hydropower will be the only renewable energy developed.

[Reference plan]

● Scenario (B)

In this scenario, all types of renewable energy will be developed except hydropower.

Both scenarios were evaluated through the following steps.

From environmental and social viewpoints, the global environment was assessed based on the CO₂ emissions volume and the regional environment was evaluated by the negative impact (environmental index) on the surrounding environment (see 11.5(2)).

(a) Evaluation from the viewpoint of the global environment (CO₂ emissions)

Section 11.7 summarizes the evaluation of global environmental aspects in the project area of each power source.

The numerical values are re-listed in the table below.

Table 11-35 Evaluation Points on the Global Environment for Each Power Source

Type of Generation	Hydro	Thermal (LNG/Oil)	Wind	Solar	Biomass
Environmental Indicator	0.00	-2.00	0.00	0.00	0.00

(Source: JICA Survey Team)

(b) Evaluation from the viewpoint of the regional environment

Section 11.7 summarizes the evaluation of regional environmental aspects in the project area of each power source.

The numerical values are re-listed in the table below.

Table 11-36 Evaluation Points on the Regional Environment for Each Power Source

Type of Generation	Hydro	Thermal (LNG/Oil)	Wind	Solar	Biomass
Environmental Indicator	-0.36	-0.71	-0.55	-0.48	-0.32
Average	-0.535		-0.45		

(Source: JICA Survey Team)

【Analysis result on Scenario (A)】

(c) Global environment

A thermal power generation project with a capacity of 212 MW (CIMANGOLA) using LNG / heavy oil as fuel was indicated by MINEA.

Carbon dioxide of 0.392 kg-CO₂/kWh (EIA statistic data 2011) will be emitted with the implementation of this project.

However, if hydropower projects such as CAMBAMBE, MATALA (total capacity of about 1,000 MW) are operated, CO₂ emission of 4.7 million tons-CO₂ will be reduced annually in comparison with fossil fuel power generation (see Section 11.3.1(4)).

(d) Regional environment

The average value of the natural and social environmental load index (environmental indicator) of hydropower plants and thermal power plants (LNG / heavy oil) is -0.535.

This figure is about 20% higher than the average value of the natural and social environmental load index of renewable energy (wind power, sunlight, biomass), namely, -0.45 (see Table 11-36).

Accordingly, from environmental and social viewpoints, replacing some hydropower and thermal power projects with renewable energy power plants will help improve the local environment.

The analysis of reference Scenario (B), where renewable energy power plants are incorporated into the power development master plan, showed the following results.

【Analysis result on Scenario (B)】

(e) Global environment

By implementing the renewable energy plans indicated by MINEA, wind power plants (total: 488 MW), solar power plants (total: 100 MW), and biomass power plant (total: 3 MW) will reduce 938 thousand tons of CO₂ emission annually in comparison with fossil-fuel-fired thermal power plants (see Section 11.3.1(4)). This contribution to global environment improvement exceeds the contribution by the diesel-dependent power supply development configuration (2005) by more than 95%.

(f) Regional environment

The average value of the natural and social environmental load index (environmental indicator) of Renewable Energy projects (wind power, solar power, biomass) is about 20% lower than that of hydraulic power generation and thermal power generation (LNG / heavy oil).

The replacement with renewable energy power plants helps to improve the regional environment in the project area.

The following issues are to be taken into account, however, in the case of development of renewable energy power plants instead of hydropower/thermal power plants.

Power system operators have great difficulty in controlling power system stability, as the output of wind power and/or solar power depends on climate conditions. And as the configuration rate of wind power and solar increases, it becomes harder to keep power system stable without sufficient ancillary service such as frequency control.

Therefore, the stability aspect must be considered along with the environmental aspect when introducing renewable energy.

Meanwhile, since biomass power plants can supply stable power less subject to the influences of climate, positive efforts to introduce them would be advantageous.

11.9 Expected mitigation measures

This survey excludes any coverage of the detailed development plans (scale, design etc.) of the respective projects embodied in the various power developments.

Accordingly, since concrete mitigation measures against the environmental impacts caused by the respective power development projects are impossible to quantify at this survey stage (SEA level), the table below describes only the general mitigation measures to be considered for each power development project.

Table 11-37 Expected Mitigation Measures for Each Power Source

	Expected mitigation measures (avoidance, reduction, compensation)
Hydropower	<ul style="list-style-type: none"> • Prioritize the adoption of “Run-of River Type” and reduce the impact on the natural and social environments (resettlement of residents). • Preferentially select an alternative that can avoid resettling residents. • Release river maintenance flow to avoid influences on the natural and social environments (drinking water supply, irrigation, tourism use) downstream due to water reduction. • Install fish passes to avoid influences on migratory fish due to the installation of dams / intake weirs. • Use nets, barriers or screens to prevent fish from passing into the turbines. • Discharge at various elevations of the dam to avoid outflow of anoxic or cold water. • In principle, adopt an “embedded type” for a penstock. If inevitable, adopt an “open type.” • In the case of the “ground surface type” or “semi-underground type” power house, design the building harmoniously with the surrounding landscape.
Thermal (LNG, Oil)	<ul style="list-style-type: none"> • Avoid new land alterations by locating the plant where existing infrastructure can be used. • Adopt the cooling tower system to avoid influence from heated effluent. • Set any equipment that generates noise/vibration as far as possible apart from the residences. • Offset CO₂ emission from the power plant by energy-saving measures throughout the whole factory or by introducing renewable energy power plants.
Wind	<ul style="list-style-type: none"> • Use blades to suppress the generation of noise and very-low-frequency sound. • Avoid flight routes of migratory birds and avoid bird strikes. • Avoid shadow flicker by locating the plant as far as possible apart from residential areas. • Avoid the influence of electromagnetic waves on fish, in the case of offshore wind power generation. • Design the facilities in harmony with the surrounding landscape
Solar	<ul style="list-style-type: none"> • Develop a battery that can be disposed of simply, as waste. • Design the facilities harmoniously with the surrounding landscape by planting around the site.
Biomass	<ul style="list-style-type: none"> • Avoid new land alterations by locating the plant where existing infrastructure can be used. • Adopt a cooling tower system to avoid the influence of heated effluent. • Set any equipment that generates noise/vibration as far apart as possible from residences. • Promote the effective use of combustion residue.

(Source: JICA Survey Team)

11.10 Implementation of the monitoring plan

For the same reason described in Section 11.9 Mitigation Measures, the preparation and implementation of the monitoring plan is to be considered in the EIA at the project implementation stage.

The table below describes the general monitoring items to be considered when monitoring in time-series the appropriate implementation of mitigation measures proposed in the power development project.

Table 11-38 Common Monitoring Items for Power Development Project

	Main Monitoring Items		
Power Development Project	Anti-Pollution measures	Air Quality	SO ₂ , NO ₂ , CO, O ₃ , Soot, Dust, Suspended Particulate Matter (PM10, PM2.5), Coarse Particulate
		Water Quality (Surface) (Ground)	pH, Suspended Solids (SS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Total Nitrogen, Total Phosphorus, Heavy Metals, etc.
		Waste (Industrial) (Domestic)	Types, Volume, Implementation of 3R
		Noise Vibration	Level of noise (dB) and vibration
		Odors	Specific bad smell material
		Soil	Presence of heavy metals
		Sedimentation	Sedimentation volume
	Natural Environment	Ecosystem	Threatened species, Endemic species
		Topography Geology	Erosion, landslide or collapse
	Social Environment	Resettlement	Impacts due to resettlement Adequate payment of compensation cost
		Living Livelihood	Adverse impacts on the livelihood of inhabitants
	Global Environment	Air Quality	GHG (CO ₂) emission

(Source: JICA Survey Team)

11.11 Stakeholder Meeting

Two stakeholder meetings (SHMs) were scheduled to be held at MINEA in Luanda. The first SHM was held at the scoping implementation stage and the second will be held at the draft final stage of the SEA.

Relevant government agencies, environment-related NGOs, international development support organizations, etc. are invited to participate.

(1) The first stakeholder meeting

MINEA held the first SHM in Luanda with the support of the JICA Survey Team on October 17, 2017.

There were 40 participants, including the JICA Survey Team.



The SHM was held to explain the following matters to MINEA's counterparts and related organizations and exchange opinions on the SEA to be implemented in the master plan.

- What SEA is conducted in the Master Plan?
- How is the SEA for the power generation projects to be implemented?
- What is the “Best Scenario from an environmental viewpoint” for power development?
- How is the SEA for transmission lines to be implemented?
- What points should be considered regarding the “best route from an environmental viewpoint”?

In addition, a local consultant entrusted by JICA explained how to collect and analyze information on environmental and social considerations necessary for the SEA.

The main opinions or questions are as follows.

- The potential candidate sites for hydroelectric power have already been submitted to RNT (GAMEK).
- For hydroelectric power candidate sites, adjust to RNT and compile as soon as possible (MINEA).
- The international connecting line (Route No.4, Xangongo - Baynes) passes through a national park, which creates a problem when applying the JICA guidelines (INRH).

	
<p>Discussion by SHM participants</p>	<p>Explanations by the JICA study Team</p>



LISTA DE PRESENCAS DO PRIMEIRO ENCONTRO SOBRE A AVALIAÇÃO AMBIENTAL
ESTRATÉGICA (AAE) DO PLANO DE DESENVOLVIMENTO ELÉCTRICO DE ANGOLA


LUANDA, AOS 17 DE OUTUBRO DE 2017.



NOME	INSTITUIÇÃO	FUNÇÃO	CONTACTOS (TELEMÓVEL OU EMAIL)
Eduardo Ferdinand	Holisticos	Eng Ambienta	
Adub Naito	IRSEA	Chf de Op	
Miriam Balansa	EXIDE	Director	
Eudes Louzo	RNT	Chefe de Depto	
Manuel Domingos	RNT	Eng Dominga	
Paulino Diniz	JICA	Tradutor	
VASTER MINDANDA	FREE-LANCER	TRADUTOR	
Masayuki ITO	JICA Team		
Aoumano Vidal	ENDE	DIRECTOR	
Kimori Nakamata	JICA		
Hitoshi FURUKOSHI	JICA Team		

* Encontro realizado nas instalações do Ministério da Energia e Águas.



Participants List of 1st Stake Holder Meeting (1/4)



MINISTÉRIOS
DO ENERGIAS E ÁGUAS

LISTA DE PRESENCAS DO PRIMEIRO ENCONTRO SOBRE A AVALIAÇÃO AMBIENTAL
ESTRATÉGICA (AAE) DO PLANO DE DESENVOLVIMENTO ELÉCTRICO DE ANGOLA




LUANDA, AOS 17 DE OUTUBRO DE 2017.

NOME	INSTITUIÇÃO	FUNÇÃO	CONTACTOS (TELEMÓVEL OU EMAIL)
ANGOLA VUANGA	MINEA	CHEFE DE DPTO	[Redacted Contact Information]
LEONEX LUCALA	MINGA	CHEFE DE DPTO	
António Furtado	MINEA	CHEFE DPTO	
Carlos Fergentus	ENDE	Precedor	
Manuel Fozzo	PRODEL	Director	
Manuel Quintino	INRH	Director	
ARLINDO CARLOS	GATIER	Técnico	
Shigehi MADA	JICA	Expert	
Paulo Francisco	GAMCK	Técnico	
REGÍDIO BUAKELA	GAMCK	TECNICO	
José Luis	GAMCK	TECNICO	

* Encontro realizado nas instalações do Ministério da Energia e Águas.

Participants List of 1st Stake Holder Meeting (2/4)






**LISTA DE PRESENCAS DO PRIMEIRO ENCONTRO SOBRE A AVALIAÇÃO AMBIENTAL
ESTRATÉGICA (AAE) DO PLANO DE DESENVOLVIMENTO ELÉCTRICO DE ANGOLA**
LUANDA, AOS 17 DE OUTUBRO DE 2017.

NOME	INSTITUIÇÃO	FUNÇÃO	CONTACTOS (TELEMOVEL OU EMAIL)
ALBANO GASPAR	GATER	TÉCNICO	[REDACTED]
Morris Jimba	"	"	
ALFONSO SANTO	"	"	
NUNO LOPES	"	"	
JOÃO NICOLAO	GNMBS	TÉCNICO	
ALBERTO FERNANDES	IRSEA	TÉCNICO	
Alfredo J. Dypop	PRODEL	"	
EDUARDO M. F. dos Santos	PRODEL	Defectamento	
Isabelias Ferreira	Prodel	Defortamento	
Sandra Gustave	DNER	Director	
LARDA JOÃO	DNER	C. Defectamento	


*Encontro realizado nas instalações do Ministério da Energia e Águas.

Participants List of 1st Stake Holder Meeting (3/4)



**LISTA DE PRESENCAS DO PRIMEIRO ENCONTRO SOBRE A AVALIAÇÃO AMBIENTAL
ESTRATÉGICA (AAE) DO PLANO DE DESENVOLVIMENTO ELÉCTRICO DE ANGOLA**

LUANDA, AOS 17 DE OUTUBRO DE 2017.



NOME	INSTITUIÇÃO	FUNÇÃO	CONTACTOS (TELEMÓVEL OU EMAIL)
Erédia Marina	MINERA/DNER	Técnica	[REDACTED CONTACT INFORMATION]
Dionil Mithonga	MINERA/DNER	TÉCNICO	
Vladimir Nuro	HOUSTON	DIRETOR TÉCNICO	
Escolides de Ponte	GAMÉK	Director Admin	
António Beirão Costa	MINERA	SEE	
Osvaldo Manuel Jubbé Loupato	MINERA	TÉCNICO	
Raafael Miguel Henri	GAMÉK	CHEFE DE SERVIÇOS	

* Encontro realizado nas instalações do Ministério da Energia e Águas.

Página 2 | 2

Participants List of 1st Stake Holder Meeting (4/4)

(2) The second stakeholder meeting

MINEA held the second SHM in Luanda with the support of the JICA Survey Team on June 12, 2018.

There were 61 participants, participating from RNT (22 persons), PRODEL (9), MINEA (7), ENDE (4), GAMEK (3) and others (16).





The SHM was held, following the opening remarks of Mr. João Baptista Borges, Minister of Energy and Water, to explain the main contents of Draft Final Report to MINEA's counterparts and related organizations and exchange opinions on the SEA results which are the main them of the DFR and to be implemented in the master plan.

After both presentations, participants were required to provide comments and questions:

The main question is as follows;

(Q): Mr. Euclides de Brito, Deputy Director of GAMEK, indicated that Strategic Environmental Assessment is an important step towards clarifying the country's strategic options. He asked for additional information on the Cimangola Thermal Project particularly with regards to the required mitigation measures due to the existence of communities and sensitive receptors in the vicinity of the project. Mr. Brito asked if the project investment amount would increase if strict mitigation measures would be proposed;

(A): all sites were assessed at SEA level and no specific details were provided for each project to allow for Environmental Impact Assessment. However, in case strict mitigation measures are imposed to meet international guidelines it is likely that the project investment amount would be increased.

	
<p>Photo 1: Opening ceremony of the Stakeholder Meeting.</p>	<p>Photo 2: Opening speech by Honourable Minister of Water and Energy, Eng.º João Baptista Borges</p>
	
<p>Photo 3: Participants of the stakeholder meeting.</p>	<p>Photo 4: Presentation by JICA Team</p>



REPÚBLICA DE ANGOLA
MINISTÉRIO DA ENERGIA E ÁGUAS
DIRECÇÃO NACIONAL DE ENERGIA ELÉCTRICA

LISTA DE PRESENÇA

DATA: 12 DE JUNHO 2018

HORA: 08:30 – 13:00

LOCAL: ANFITEATRO DA ENDE NO EDIFÍCIO SEDE

ASSUNTO: PROJECTO DE ELABORAÇÃO DO PLANO DIRECTOR DE DESENVOLVIMENTO DO SISTEMA ELÉCTRICO

Nº	NOME	ORGANISMO	TELEMOVEL	E-MAIL
01	Osvaldo Menezes Julião Gonçalves	MINEA		
02	Rosa Maria Afonso Miguel	PRODEL		
03	Manuel de Sousa Ramos	PRODEL		
04	Fernando Alberto Pinto Pereira	GAMER		
05	Gaspar Emmanuel Naves Moreira	PRODEL		
06	Luís Augusto Garcia de Barros	RNT		

Avenida Cónego Manuel das Neves 234, 1º andar, CP 2229, Luanda

Participants List of 2nd Stake Holder Meeting (1/4)

07	Paulo Bemudo	RNT
08	Nelson Quicalongo	RNT-EP
09	Rui Oliveira	RNT-EP
10	Adalberto Nambo	IRSEA
11	CRISTÓVÃO MAGALHÃES	MINEA
12	Rafael Oliveira	RNT-EP
13	Pedro Neto	RNT-EP
14	Albino Julio Domingos	ENDE-EP
15	Alexandre Demary Vaz	PRODEL-EP
16	Alfonsinho dos Santos Jompo	PRODEL-EP
17	Euclydes Lanto	RNT-EP
18	Nelson Neto	RNT-EP
19	Delso Domingos Cruz da Fonseca	RNT-EP
20	José Rafael da Silva	PRODEL-EP
21	MAITIN DUSO	Huisticas
22	Hiroyuki SHIMAZAKI	JICA TEAM
23	Hitoshi FURUKOSHI	JICA TEAM
24	Hitoshi NAKAUCHI	JICA TEAM
25	Masayuki TADA	"
	Dr. José António Almeida	MAISA-DNEG

27

Participants List of 2nd Stake Holder Meeting (2/4)

26	Masachito Sado	TZCA
27	Shipehi WADA	
28	João Gonçalves da Gama	ENDE-EP
29	Miguel José Victoria	ENDE-EP
30	Raul Noñez	ENDE-EP
31	Luís Henrique Afonso	ENDE-EP
32	Manuel Ericson Dominga	RNT-EP
33	Melchior Gomes	RNT-EP
34	João Maria Garcia Sulala	RNT-EP
35	YUZO KITAHOTO	JICA
36	AUTOALÍO EDGAR F. FURTADO	MINEA
37	LEONEL LUCENA	MINEA
38	Marcelo Paulo Vidal Boças Alves	ENDE
39	Helosáudio Santos	ENDE
40	Aldina G. A. Joo	PRODEL
41	Enéida Martins	MINEA/DNEP
42	Ricardinho Mubongo	MINEA/DNEP
	Dr. Xavier Afonso Januário	PRODEL/DPH

37

Participants List of 2nd Stake Holder Meeting (3/4)

43	Eusebio de Brito	GAMEL
44	NEGÍDIO BUAKELA	GAMEK
45	ANTÓNIO MONTE	RNTEP
46	Domingas Lúcia Adriano	PRODEL
47	Dorivaldo F. Manuel	RNT
48	Domingo Brito de Sá	RNT
49	Isabel Laimamba	hJT
50	Miguel JAKHAMPONA Quiala	RNT
51	FRANCISCO MEIRELES	PRODEL
52	Luis Mourão Silva	IRSEA
53	Victoria Vinze	GCIT
54	Wesley Zol	RNT
55	Murphy CHAMALIS	EASAGE
56	Antonio Inglês Pinto	RNT-É.P.
57	Abelair Amador M. Paes	RNT
58	Paulino Ernesto	JICA TEAM
59	Hisanobu Kuraki	JICA TEAM
60	Helena Múcio Cassiano Ntambi	JICA TEAM

417

Participants List of 2nd Stake Holder Meeting (4/4)

11.12 SEA concerning transmission expansion plans

(1) Outlines of Projects

An SEA has been conducted on the following transmission lines shown in the "Angola Energy Long-term Vision (Angola Energia 2025)" aiming at appropriate power development up to 2025.

Table 11-39 List of T/Ls to be evaluated by SEA

	Interval	Length (km)		Route	
		Section	Total		
Dom.	1	Capanda PS – Saurimo	550	2,290	See the Below Figure
	2	Cambambe PS – Lubango	600		
	3	Belem do Dango – Lubango SS	330		
	4	Lubango SS – Cahama SS – Baynes SS	330		
	5	Belem do Dango – Ondjiva	480		
Int.	1	Cahama SS – Ruacana PS	120	280	

(Source: JICA Survey Team)



(Source: JICA Survey Team)

Figure 11-27 Transmission Lines to be evaluated by SEA (5+1 Routes)

(2) Comparative analysis of alternatives (including Zero Option)

The transmission lines listed in Table 11-39 are bulk transmission lines proposed in Angola Energia 2025 to interconnect among the northern, central, and southern regions and neighboring countries.

An SEA is therefore to be implemented for the above T/L expansion plan. Noteworthy environmental and social issues when implementing the T/L expansion projects are indicated based on the results of this SEA.

In concrete terms, scoping will be carried out on each planned transmission line route to determine which of the environmental items to be evaluated quantitatively (from 0 to -3) have negative impacts on the surrounding environment. Environmental items evaluated with low numerical values (high negative impact) will be identified as items to address when planning alternative routes.

However, since the methods for quantitatively evaluating environmental impacts have not yet been scientifically proven, each evaluation item is to be scored on a four-point scale (from 0 to -3) focused on the qualitative differences of each route.

- 0: No impact
- 1: Small but not serious impact
- 2: Serious but not irreversible impact
- 3: Huge, serious, irreversible impact

The table below shows the results of a quantitative comparison of the impact of each transmission line on the environment, from environmental and social viewpoints.

The examination of the zero option is not considered at the SEA stage, since no practical or concrete project plan to transmit electricity other than the construction of transmission lines can be seen.

The zero option would be considered at the F/S stage or EIA, where various investigations on the natural and social environments will be conducted.

Table 11-40 Items to watch when implementing or selecting the T/L routes and weighing the impacts of each route

Name Items	①	②	③	④	⑤	①
	Capanda PS - Saurm	Cambambe PS - Lubango	Belem do Dango - Lubango SS	Lubango SS - Cahama SS - Baynes SS	Belem do Dango - Ondjiva SS	Cahama SS - Ruacana PS
Protected Area ⁱ	-2	-3	-3	-2	0	0
Topography ⁱⁱ	0	-1	-1	-1	-1	-1
Resettlement ⁱⁱⁱ	-1	-2	-2	-2	-2	-1

(Source: JICA Survey Team)

- Note)
- i: National Parks and Bird Sanctuary (for migratory birds) evaluated as (-3)
 - ii: Average slope of the whole route evaluated as 0%~5% (0), 5%~10% (-1), 10%~20% (-2), >20% (-3)
 - iii: No house (0), 100~400 houses (-1), 401~1,000 houses (-2), >1,000 houses (-3)

(3) **Scoping on every transmission line route**

The scoping on every Transmission Line is shown in the following tables.

(3)-1. **CapanSaurimoda PS – Saurimo Route**

Table 11-41 Scoping for Capanda PS – Saurimo Transmission Line

Item	Impact	Rating	Results	
Pollution Control	1	Air Quality	D	No specific negative impact is expected.
	2	Water Quality	D	No specific negative impact is expected.
	3	Soil Quality	D	No specific negative impact is expected.
	4	Sediment (bottom of dam)	D	No specific negative impact is expected.
	5	Noise and Vibration	D	No specific negative impact is expected.
	6	Odor	D	No specific negative impact is expected.
	7	Waste	D	No specific negative impact is expected.
	8	Subsidence	D	No specific negative impact is expected.
Natural Environment	9	Protected Areas	B	Specific negative impact on protected area(s) is expected.
	10	Ecosystem	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	11	Topography and Geology	C	Depending on the geology, there is a possibility of soil erosion around the towers.
Social Environment	12	Land acquisition and Resettlement	B	Confirm the existence of private land on the transmission line land (ROW) and the usage situation. The actual condition of the settlements and other residences on the route is also unconfirmed, but no need for involuntary resettlement relating to the construction of transmission lines is assumed.
	13	Poor People	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	14	Ethnic Minority Groups and Indigenous People	D	No specific negative impact is expected.
	15	Local Economy such as Loss of Employment and Livelihood Means	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	16	Land Use and Utilization of Local Resources	C	The impact is unknown from the existing documents. This item will be evaluated after collecting and analyzing information through social surveys in the field.
	17	Water Usage, Water Rights, etc.	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	18	Existing Social Infrastructure and Services	D	No specific negative impact is expected.
	19	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	No specific negative impact is expected.
	20	Misdistribution of Benefits and Loss	D	No specific negative impact is expected.
	21	Local Conflicts of Interest	D	No specific negative impact is expected.

Item	Impact	Rating	Results	
	22	Cultural Heritage	D	No specific negative impact is expected.
	23	Landscape	D	There are no scenic spots in or around the site.
	24	Gender	D	No specific negative impact is expected.
	25	Children's Rights	D	No specific negative impact is expected.
	26	Infectious Diseases such as HIV/AIDS	C-	The extent of the influence associated with the construction of the transmission line is unknown at present.
	27	Work Environment (including Work Safety)	B-	Accidents may occur at the construction site. Accidents involving workers may occur during maintenance work
Other	28	Accidents	B-	Accidents may occur at the construction site. Increased traffic volume may cause traffic accidents.
	29	Cross-boundary Impact and Climate Change	D	No specific negative impact is expected.

Note: A+/-: Significant positive/negative impact is expected

B+/-: Positive/negative impact is expected to some extent

C+/-: Extent of positive/negative impact is unknown (further examination is needed; the impact may be clarified as the study progresses)

D: No impact is expected

(Source: JICA Survey Team)

(3)-2. Cambambe PS – Lubango Route

Table 11-42 Scoping for Cambambe PS – Lubango Transmission Line

Item	Impact	Rating	Results	
Pollution Control	1	Air Quality	D	No specific negative impact is expected.
	2	Water Quality	D	No specific negative impact is expected.
	3	Soil Quality	D	No specific negative impact is expected.
	4	Sediment (bottom of dam)	D	No specific negative impact is expected.
	5	Noise and Vibration	D	No specific negative impact is expected.
	6	Odor	D	No specific negative impact is expected.
	7	Waste	D	No specific negative impact is expected.
	8	Subsidence	D	No specific negative impact is expected.
Natural Environment	9	Protected Areas	A-	Specific negative impact on protected area(s) is expected.
	10	Ecosystem	A-	Bird strikes on power transmission lines are assumed.
Social Environment	11	Topography and Geology	C	Depending on the geology, there is a possibility of soil erosion around the towers.
	12	Land acquisition and Resettlement	B	Confirm the existence of private land on the transmission line land (ROW) and the usage situation. The actual condition of the settlements and other residences on the route is also unconfirmed, but no need for involuntary resettlement relating to the construction of transmission lines is assumed.
	13	Poor People	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	14	Ethnic Minority Groups and Indigenous People	D	No specific negative impact is expected.
	15	Local Economy such as Loss of Employment and	C	The extent of the influence associated with the construction of the transmission line is unknown at present.

Item	Impact	Rating	Results	
	Livelihood Means			
16	Land Use and Utilization of Local Resources	C	The impact is unknown from the existing documents. This item will be evaluated after collecting and analyzing information through social surveys in the field.	
17	Water Usage, Water Rights, etc.	C	The extent of the influence associated with the construction of the transmission line is unknown at present.	
18	Existing Social Infrastructure and Services	D	No specific negative impact is expected.	
19	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	No specific negative impact is expected.	
20	Misdistribution of Benefits and Loss	D	No specific negative impact is expected.	
21	Local Conflicts of Interest	D	No specific negative impact is expected.	
22	Cultural Heritage	D	No specific negative impact is expected.	
23	Landscape	D	There are no scenic spots in or around the site.	
24	Gender	D	No specific negative impact is expected.	
25	Children's Rights	D	No specific negative impact is expected.	
26	Infectious Diseases such as HIV/AIDS	C-	The extent of the influence associated with the construction of the transmission line is unknown at present.	
27	Work Environment (including Work Safety)	B-	Accidents may occur at the construction site. Accidents involving workers may occur during maintenance work	
Other	28	Accidents	B-	Accidents may occur at the construction site. Increased traffic volume may cause traffic accidents.
	29	Cross-boundary Impact and Climate Change	D	No specific negative impact is expected.

(Source: JICA Survey Team)

(3)-3. Belem do Dango – Lubango SS Route

Table 11-43 Scoping for Belem do Dango – Lubango SS Transmission Line

Item	Impact	Rating	Results	
Pollution Control	1	Air Quality	D	No specific negative impact is expected.
	2	Water Quality	D	No specific negative impact is expected.
	3	Soil Quality	D	No specific negative impact is expected.
	4	Sediment (bottom of dam)	D	No specific negative impact is expected.
	5	Noise and Vibration	D	No specific negative impact is expected.
	6	Odor	D	No specific negative impact is expected.
	7	Waste	D	No specific negative impact is expected.
	8	Subsidence	D	No specific negative impact is expected.
Natural Environment	9	Protected Areas	A-	Specific negative impact on protected area(s) is expected.
	10	Ecosystem	A-	Bird strikes on power transmission lines are assumed.
	11	Topography and Geology	C	Depending on the geology, there is a possibility of soil erosion around the towers.
	12	Land acquisition and	B-	Confirm the existence of private land on the transmission line

Item	Impact	Rating	Results
	Resettlement		land (ROW) and the usage situation. The actual condition of the settlements and other residences on the route is also unconfirmed, but no need for involuntary resettlement relating to the construction of transmission lines is assumed.
13	Poor People	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
14	Ethnic Minority Groups and Indigenous People	D	No specific negative impact is expected.
15	Local Economy such as Loss of Employment and Livelihood Means	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
16	Land Use and Utilization of Local Resources	C	The impact is unknown from the existing documents. This item will be evaluated after collecting and analyzing information through social surveys in the field.
17	Water Usage, Water Rights, etc.	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
18	Existing Social Infrastructure and Services	D	No specific negative impact is expected.
19	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	No specific negative impact is expected.
20	Misdistribution of Benefits and Loss	D	No specific negative impact is expected.
21	Local Conflicts of Interest	D	No specific negative impact is expected.
22	Cultural Heritage	D	No specific negative impact is expected.
23	Landscape	D	There are no scenic spots in or around the site.
24	Gender	D	No specific negative impact is expected.
25	Children's Rights	D	No specific negative impact is expected.
26	Infectious Diseases such as HIV/AIDS	C-	The extent of the influence associated with the construction of the transmission line is unknown at present.
27	Work Environment (including Work Safety)	B-	Accidents may occur at the construction site. Accidents involving workers may occur during maintenance work
Other	28	B-	Accidents may occur at the construction site. Increased traffic volume may cause traffic accidents.
	29	D	No specific negative impact is expected.

(Source: JICA Survey Team)

(3)-4. Lubango SS – Cahama SS – Baynes SS Route

Table 11-44 Scoping for Lubango SS – Cahama SS – Baynes SS Transmission Line

Item	Impact	Rating	Results	
Pollution Control	1	Air Quality	D	No specific negative impact is expected.
	2	Water Quality	D	No specific negative impact is expected.
	3	Soil Quality	D	No specific negative impact is expected.
	4	Sediment (bottom of dam)	D	No specific negative impact is expected.
	5	Noise and Vibration	D	No specific negative impact is expected.
	6	Odor	D	No specific negative impact is expected.
	7	Waste	D	No specific negative impact is expected.
	8	Subsidence	D	No specific negative impact is expected.
Natural Environment	9	Protected Areas	A-	Specific negative impact on protected area(s) is expected.
	10	Ecosystem	A-	Bird strikes on power transmission lines are assumed.
	11	Topography and Geology	C	Depending on the geology, there is a possibility of soil erosion around the towers.
Social Environment	12	Land acquisition and Resettlement	B-	Confirm the existence of private land on the transmission line land (ROW) and the usage situation. The actual condition of the settlements and other residences on the route is also unconfirmed, but no need for involuntary resettlement relating to the construction of transmission lines is assumed.
	13	Poor People	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	14	Ethnic Minority Groups and Indigenous People	D	No specific negative impact is expected.
	15	Local Economy such as Loss of Employment and Livelihood Means	C	The extent of the influence associated with the construction of the transmission line is unknown at present
	16	Land Use and Utilization of Local Resources	C	The impact is unknown from the existing documents. This item will be evaluated after collecting and analyzing information through social surveys in the field.
	17	Water Usage, Water Rights, etc.	C	The extent of the influence associated with the construction of the transmission line is unknown at present
	18	Existing Social Infrastructure and Services	D	No specific negative impact is expected.
	19	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	No specific negative impact is expected.
	20	Misdistribution of Benefits and Loss	D	No specific negative impact is expected.
	21	Local Conflicts of Interest	D	No specific negative impact is expected.
	22	Cultural Heritage	D	No specific negative impact is expected.
	23	Landscape	D	There are no scenic spots in or around the site.
	24	Gender	D	No specific negative impact is expected.
	25	Children's Rights	D	No specific negative impact is expected.
	26	Infectious Diseases such as HIV/AIDS	C-	The extent of the influence associated with the construction of the transmission line is unknown at present

Item	Impact	Rating	Results
	27 Work Environment (including Work Safety)	B-	Accidents may occur at the construction site. Accidents involving workers may occur during maintenance work.
Other	28 Accidents	B-	Accidents may occur at the construction site. Increased traffic volume may cause traffic accidents.
	29 Cross-boundary Impact and Climate Change	D	No specific negative impact is expected.

(Source: JICA Survey Team)

(3)-5 Belem do Dango – Ondjiva SS Route

Table 11-45 Scoping for Belem do Dango – Ondjiva SS Transmission Line

Item	Impact	Rating	Results
Pollution Control	1 Air Quality	D	No specific negative impact is expected.
	2 Water Quality	D	No specific negative impact is expected.
	3 Soil Quality	D	No specific negative impact is expected.
	4 Sediment (bottom of dam)	D	No specific negative impact is expected.
	5 Noise and Vibration	D	No specific negative impact is expected.
	6 Odor	D	No specific negative impact is expected.
	7 Waste	D	No specific negative impact is expected.
	8 Subsidence	D	No specific negative impact is expected.
Natural Environment	9 Protected Areas	D	No specific negative impact is expected.
	10 Ecosystem	D	No specific negative impact is anticipated.
Social Environment	11 Topography and Geology	C	Depending on the geology, there is a possibility of soil erosion around the towers.
	12 Land acquisition and Resettlement	B-	Confirm the existence of private land on the transmission line land (ROW) and the usage situation. The actual condition of the settlements and other residences on the route is also unconfirmed, but no need for involuntary resettlement relating to the construction of transmission lines is assumed.
	13 Poor People	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	14 Ethnic Minority Groups and Indigenous People	D	No specific negative impact is expected.
	15 Local Economy such as Loss of Employment and Livelihood Means	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	16 Land Use and Utilization of Local Resources	C	The impact is unknown from the existing documents. This item will be evaluated after collecting and analyzing information through social surveys in the field.
	17 Water Usage, Water Rights, etc.	C	The extent of the influence associated with the construction of the transmission line is unknown at present.
	18 Existing Social Infrastructure and Services	D	No specific negative impact is expected.
	19 Social Institutions such as Social Infrastructure and	D	No specific negative impact is expected.

Item	Impact	Rating	Results
			Local Decision-making Institutions
	20	D	Misdistribution of Benefits and Loss No specific negative impact is expected.
	21	D	Local Conflicts of Interest No specific negative impact is expected.
	22	D	Cultural Heritage No specific negative impact is expected.
	23	D	Landscape There are no scenic spots in or around the site.
	24	D	Gender No specific negative impact is expected.
	25	D	Children's Rights No specific negative impact is expected.
	26	C-	Infectious Diseases such as HIV/AIDS The extent of the influence associated with the construction of the transmission line is unknown at present
	27	B-	Work Environment (including Work Safety) Accidents may occur at the construction site. Accidents involving workers may occur during maintenance work
Other	28	B-	Accidents Accidents may occur at the construction site. Increased traffic volume may cause traffic accidents.
	29	D	Cross-boundary Impact and Climate Change No specific negative impact is expected.

(Source: JICA Survey Team)

(3)-6 Cahama SS – Ruacana PS Route

Table 11-46 Scoping for Cahama SS – Ruacana PS Transmission Line

Item	Impact	Rating	Results
Pollution Control	1	D	Air Quality No specific negative impact is expected.
	2	D	Water Quality No specific negative impact is expected.
	3	D	Soil Quality No specific negative impact is expected.
	4	D	Sediment (bottom of dam) No specific negative impact is expected.
	5	D	Noise and Vibration No specific negative impact is expected.
	6	D	Odor No specific negative impact is expected.
	7	D	Waste No specific negative impact is expected.
	8	D	Subsidence No specific negative impact is expected.
Natural Environment	9	D	Protected Areas No specific negative impact is expected.
	10	D	Ecosystem No specific negative impact is expected.
	11	C	Topography and Geology Depending on the geology, there is a possibility of soil erosion around the towers.
Social Environment	12	B-	Land acquisition and Resettlement Confirm the existence of private land on the transmission line land (ROW) and the usage situation. The actual condition of the settlements and other residences on the route is also unconfirmed, but no need for involuntary resettlement relating to the construction of transmission lines is assumed.
	13	C	Poor People The extent of the influence associated with the construction of the transmission line is unknown at present.
	14	D	Ethnic Minority Groups and Indigenous People No specific negative impact is expected.
	15	C	Local Economy such The extent of the influence associated with the construction of

Item	Impact	Rating	Results
	as Loss of Employment and Livelihood Means		the transmission line is unknown at present
16	Land Use and Utilization of Local Resources	C	The impact is unknown from the existing documents. This item will be evaluated after collecting and analyzing information through social surveys in the field.
17	Water Usage, Water Rights, etc.	C	The extent of the influence associated with the construction of the transmission line is unknown at present
18	Existing Social Infrastructure and Services	D	No specific negative impact is expected.
19	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	D	No specific negative impact is expected.
20	Misdistribution of Benefits and Loss	D	No specific negative impact is expected.
21	Local Conflicts of Interest	D	No specific negative impact is expected.
22	Cultural Heritage	D	No specific negative impact is expected.
23	Landscape	D	There are no scenic spots in or around the site.
24	Gender	D	No specific negative impact is expected.
25	Children's Rights	D	No specific negative impact is expected.
26	Infectious Diseases such as HIV/AIDS	C-	The extent of the influence associated with the construction of the transmission line is unknown at present
27	Work Environment (including Work Safety)	B-	Accidents may occur at the construction site. Accidents involving workers may occur during maintenance work
Other	28	Accidents	B- Accidents may occur at the construction site. Increase of traffic volume may cause traffic accidents
	29	Cross-boundary Impact and Climate Change	D No specific negative impact is expected.

(Source: JICA Survey Team)

(4) Proposed TOR on survey to collect data

The table below summarizes the surveys on major environmental and social aspects to be carried out at the implementation stage of the project, based on the above evaluations.

Table 11-47 Survey Items and Methods

Environmental Items	Survey Items	Survey Method
Air Quality	<ul style="list-style-type: none"> - Relevant environmental standards - Meteorological information - Current status of ambient atmosphere 	<ul style="list-style-type: none"> - Obtain ambient air quality standards, - Measure the air pollutants (TSP), SO₂, NO₂, CO, O₃, PM₁₀, PM_{2.5}.
Water Quality	<ul style="list-style-type: none"> - Relevant environmental standards - Current status of water quality 	<ul style="list-style-type: none"> - Obtain water quality standards and effluent standards. - Measure the existing reservoir and river water quality (temperatures, salinity, COD, nutrients, etc.)
Soil Quality	<ul style="list-style-type: none"> - Relevant environmental 	<ul style="list-style-type: none"> - Measure the soil quality and screen

Environmental Items	Survey Items	Survey Method
	standards	for any contamination.
Noise and Vibration	<ul style="list-style-type: none"> - Relevant environmental standards - Current status of noise and vibration 	<ul style="list-style-type: none"> - Obtain noise level standards - Measure the noise levels (background)
Waste	<ul style="list-style-type: none"> - Relevant environmental standards 	<ul style="list-style-type: none"> - Obtain waste handling standards / manuals / guidelines.
Subsidence	<ul style="list-style-type: none"> - Current status of soil conditions 	<ul style="list-style-type: none"> - Geological survey
Protected Areas	<ul style="list-style-type: none"> - Current status of Protected Areas 	<ul style="list-style-type: none"> - Collect relevant laws and regulations, information on Protected Areas
Ecosystem	<ul style="list-style-type: none"> - Current habitat status of flora, mammal, birds, reptiles, amphibians, fish, precious species (migrant birds) 	<ul style="list-style-type: none"> - Survey the distribution of flora and fauna.
Topography and Geology	<ul style="list-style-type: none"> - Geological conditions 	<ul style="list-style-type: none"> - Obtain geological information
Land acquisition / Resettlement	<ul style="list-style-type: none"> - Confirm who the affected people are and the negative impacts caused by the project. - Confirm the assets of the affected people - Identify the livelihoods of the affected people 	<ul style="list-style-type: none"> - Collect relevant laws and regulations, information on relevant cases - Conduct a population census - Conduct an asset inventory survey - Conduct a household socioeconomic survey
Disturbances to Ethnic Minority Groups and Indigenous People	<ul style="list-style-type: none"> - Identify ethnic minority groups and indigenous people among the affected people 	<ul style="list-style-type: none"> - Collect information on relevant laws and regulations, information on relevant cases - Conduct a population census - Conduct an asset inventory survey - Conduct a household socioeconomic survey
Land Use and Utilization of Local Resources	<ul style="list-style-type: none"> - Identify the present land use - Identify the jobs and livelihoods of the affected people 	<ul style="list-style-type: none"> - Collect information on the employment and income in the affected area - Interviews with the households
Disturbance of Water Usage, Water Rights, etc.	<ul style="list-style-type: none"> - Identify the present water use for day-to-day life and agricultural activities. 	<ul style="list-style-type: none"> - Household socioeconomic survey - Interviews with the households
Cultural Heritage	<ul style="list-style-type: none"> - Current status of Cultural Heritage Areas 	<ul style="list-style-type: none"> - Collect information on relevant laws and regulations and information on Heritage Areas
Landscape	<ul style="list-style-type: none"> - Current status of outstanding scenery 	<ul style="list-style-type: none"> - Collect information on relevant laws and regulations and information on outstanding scenery
Cross-boundary Impact and Climate Change	<ul style="list-style-type: none"> - Identify the present air quality 	<ul style="list-style-type: none"> - Measure CO₂ emitted from construction vehicles and heavy machines

(Source: JICA Survey Team)

(5) Environment Impact Assessment

The following table summarizes environmental items that should be considered from environmental and social viewpoints when preparing concrete plans for each transmission line route (5 +1 routes), based on the evaluation results from the scoping on the planned routes.

Table 11-48 Environmental Items to be considered for Determination of the T/L Route

No.	Name of Route	➤ Environmental Items
①	Capanda PS – Saurimo	<ul style="list-style-type: none"> ➤ An Important Bird Area (CUANGO) is located nearby, so considerations for ecological conservation will be necessary. ➤ There are three villages, each with about 50 households, nearby. These villages should preferably be avoided when deciding the routes. ➤ The terrain is generally flat, but about 20% of the total area is sloped at gradients of 5 to 10%, entailing a risk of soil erosion.
②	Cambambe PS - Lubango	<ul style="list-style-type: none"> ➤ A protected area (BUFFALO) and Important Bird Area (GABELA) are located in and around the planned area, so considerations for ecological conservation will be necessary. ➤ There are 13 villages, each with about 50 households. It will be preferable to avoid these villages when deciding the routes. ➤ The terrain is generally flat, but about 25% of the total area is sloped at gradients of 5 to 10%, entailing a risk of soil erosion.
③	Belem do Dango – Lubango SS	<ul style="list-style-type: none"> ➤ A protected area (BUFFALO) and Important Bird Area (CACONDA) are located in and around the planned area, so considerations for ecological conservation will be necessary. ➤ There are 11 villages, each with about 50 households. These villages should preferably be avoided when deciding the routes. ➤ The terrain is generally flat, but about 30% of the total area is sloped at gradients of 5 to 10%, entailing a risk of soil erosion.
④	Lubango SS – Cahama SS – Baynes SS	<ul style="list-style-type: none"> ➤ A National Park (IONA) is located in the planned area, so considerations for ecological conservation will be necessary. ➤ There are 4 villages, each with about 50 households. These villages should preferably be avoided when deciding the routes. ➤ The terrain is generally flat, but about 10% of the total area is sloped at gradients of 5 to 10%, entailing a risk of soil erosion.
⑤	Belem do Dango – Ondjiva SS	<ul style="list-style-type: none"> ➤ There are 14 villages, each with about 50 households. These villages should preferably be avoided when deciding the routes.

⑥	Cahama SS –Ruacana PS	➤ There are 2 villages, each with about 50 households. These villages should preferably be avoided when deciding the routes.
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(Source: JICA Survey Team)

(6) Expected Mitigation Measures

No detailed determination of transmission line routes is covered in this survey.

As concrete mitigation measures against the environmental impacts caused by each transmission line expansion project are impossible to quantify at this survey stage (SEA level), the table below presents only general mitigation measures to be considered.

Table 11-49 Expected Mitigation Measures for Transmission Lines

	Expected mitigation measures (avoidance, reduction, compensation)
Transmission line	<p>(Countermeasure on Environment)</p> <ul style="list-style-type: none"> • Optimization of transmission line route with respect to avian migration corridors. • Installation of anti-perching devices or platforms specially designed to encourage birds to perch or nest in safer places. • Placement of fluttering banners and brightly-colored (orange, yellow, white) spirals on transmission lines. • Use of plant screens or other types of screens close to the transmission lines to force birds to fly at a higher altitude. • Avoidance of conservation units in habitats that have good wildlife potential. <p>(Work Environment and Accidents)</p> <ul style="list-style-type: none"> • Confirmation of landmine laying areas and a thorough ban on entry into dangerous areas. • Establishment of safety management plans and enforcement of compliance. • Thorough use of basic safety equipment such as safety shoes, gloves, and helmets. • Thorough use of safety belts when working high above the ground.

(Source: JICA Survey Team)

(7) Implementation of Monitoring Plan

For the same background reasons described in the above section on Mitigation Measures, the preparation and implementation of the monitoring plan is to be considered in the EIA at the project implementation stage.

The table below describes the general monitoring items to be considered when monitoring in time-series the appropriate implementation of mitigation measures proposed in a transmission expansion project.

Table 11-50 Common Monitoring Items for Transmission Line Expansion Projects

	Main Monitoring Items		
Transmission Line	Anti-Pollution measures	Air Quality	SO ₂ , NO ₂ , CO, O ₃ , Soot, Dust, Suspended particulate Matter (MP ₁₀ , PM _{2.5}), Coarse particulate
		Water Quality Surface (Ground)	pH, Suspended solids (SS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Total Nitrogen, Total Phosphorus, Heavy Metals, etc.
		Waste (Industrial)	Types, Volume, Implementation of 3R

		(Domestic)	
		Noise Vibration	Level of noise (dB) and vibration
		Odors	Specific bad smell materials
		Soil	Presence of heavy metals
	Natural Environment	Ecosystem	Threatened species, Endemic species Grasping of bird strike accidents
		Topography Geology	Erosion, Landslide
	Social Environment	Resettlement	Impacts of Resettlement Adequate explanation on compensation
		Living Livelihood	Adverse impacts on the living conditions of inhabitants
	Global Environment	Air Quality	Emission of GHG (CO ₂)

(Source: JICA Survey Team)

Chapter 12 Drafting the Master Plan

12.1 To Draft Comprehensive Power Master Plans toward the Year 2040

12.1.1 Generation Development Project List Formulation Policy

Based on the results examined in Chapter 6 and the results of the study on environmental and social considerations in Chapter 11, we will formulate a generation development project list according to the following policy

(1) To Reflect the Results of the study on Environmental and Social Considerations, Including SEA

- Since renewable energy has less impact on the natural environment than large hydropower and thermal power generation, we will introduce feasible projects to the maximum extent possible.
- The examinations so far performed indicate that large hydropower and thermal power generation do not have a huge influence on the natural environment and social environment in Angola. We will therefore introduce them appropriately according to their characteristics.
- The CO₂ emissions from the thermal power plants planned under this Master Plan will stand at around 3,000 kton-CO₂ / year in 2030, or about 3% of the INDC estimate (Conditional scenario). The impact, therefore, is not considered significant.

(2) Planned Introduction of Large Hydropower

- Based on the latest project cost, large hydropower is the most advantageous from the viewpoint of economy, as discussed in terms of power generation expenses. For this reason, hydropower development is planned as the first priority.
- Large hydropower is also important for the mitigation of CO₂ emissions, so positive adoption has significance. There will, however, be possible impacts on the social environment (e.g., resident resettlement) and impacts on the natural environment inside dam reservoirs. It will therefore be essential to consider these points when planning the future stages of development.
- As a development pattern, multiple projects should not overlap in the same river in a scheduled manner. If project schedules overlap, a schedule change in one project is very likely to affect the schedules of other projects, impeding the planning overall.

(3) Listing of Renewable Generation Projects as Much as Possible

- From the viewpoint of reducing CO₂ emissions, we will actively introduce renewable power generation.
- Many of the plans, however, remain at the theoretical reserves study level and still appear to have low feasibility. Among the projects listed in the plans, feasibility will only be confirmed for those that have been given project names.

(4) Introduction of CCGT as a Middle Demand Power Supply

- As study on the power generation expenses, CCGT is advantageous in terms of cost as a middle demand power supply and is economical next to hydropower as a base demand power supply.
- The fuel to be used in the CCGT is assumed to be natural gas in the future. Earlier, however, the fuel will be switched from LPG at the initial stage to LNG at the second stage.

(5) Introduction of GT as a Peak Demand Power Supply

- GT has cost advantages as a peak demand power supply, according to our examinations of power generation expenses. Because GT is economical as a reserve power, we also introduce it as capacity for the reserve margin.
- It will be essential, however, to operate the peak demand power supply in response to sudden changes in demand. SCADA and other controllable systems will therefore have to be introduced.
- According to the experiences of the Survey Team, peak demand often shifts to middle demand as the load factor changes. An effective approach to this is to combine single cycle GT with steam turbine to make CCGT. Hence, the new GT plant will be connected to the 400 kV backbone to the maximum extent possible, on the premise of large capacity. To ensure high heat efficiency, GT will be placed where cooling water on rivers or coastlines is easily available. One possibility would be to place a GT plant in Lobito Port.
- Although we assume natural gas in the future, LPG is the assumed fuel in the early stages.

12.1.2 Policy for Formulating the Transmission Development Project List

Based on the results examined in Chapter 7, we formulated the electric power transmission development list in accordance with the following policy.

(1) Expansion of the 400 kV Backbone from the Northern Part to the Central Part, Southern Part, and Western part

- To promote the electrification of the whole country of Angola, we expand the 400 kV main system to realize the supply of grid electricity nationwide by the target year of 2025.
- To prioritize development of the backbone project from the middle part to Lubango in the southern part on the extension line of the 400 kV transmission development already started among Lauca ~ Waco Kungo ~ Belem do Huambo.
- In parallel, we recommend new backbone line projects from Cambutasu ~ Gabela ~ Nova Biopio to Lubango, the development we newly planned in this study.
- To coordinate the timing with the completion of the international interconnection line with Namibia, from Lubango to Cahama, we will extend the 400 kV backbone line toward 2027 of the target year.

(2) Development of 220 kV Lines for Reinforcement of Regional Power System Substations to Respond to Increased Demand

- To enhance the regional supply system in Luanda in the capital and Benguela in the central region, etc.

(3) Construction of Transmission Lines for Newly Developed Power Sources

- We will link the newly developed hydropower supply and gas thermal power plants to be installed in the central and southern parts to the backbone lines.

(4) Adoption of a Two-Circuit-type Main Transmission Line to Satisfy the N-1 Criteria.

- We plan to install one more transmission line circuit for formation of two parallel circuits, in order to avoid overload during accidents of the existing one-circuit main line, eliminate operational restrictions, and improve reliability.

12.1.3 Project Lists

(1) Generation Development Plan

Table 12-1 List of Generation Development Plan Projects

	Plant name	Province	Installed capacity (MW)	Project costs (MUSD)	Commissioning year	Note
Hydropower	Lauca	Malanje	2,070	4,300	2018	
	Lomaúim (extension)	Benguela	65	385	2018	
	Luachimo (extension)	Lunda Norte	34	N/A	2020	
	Caculo Cabaça	Kwanza Norte	2,100	4,500	2024	
	Baynes	Namibe	300	660	2026	
	Quilengue	Kwanza Sul	210	N/A	2028	
	Zenzo	Kwanza Norte	950	N/A	2032	
	Genga	Kwanza Sul	900	N/A	2035	
	Tumulo do Cacador	Kwanza Norte	453	1,041	2038	
	Biopio (Repower)	Benguela	29	N/A	N/A	
	Matala(Repower)	Lubango	15	N/A	N/A	
Thermal power	Soyo 1 CCGT	Zaire	750	900	2017-2018	
	Soyo 2 CCGT	Zaire	Apprx.750	N/A	2021-2022	
	Lobito 1 CCGT	Benguela	Apprx.750	900	2027-2029	
	Lobito 2 CCGT	Benguela	Apprx.750	900	2031-2034	
	Namibe 1 CCGT	Namibe	Apprx.750	900	2036-2038	
	Lobito 3 CCGT	Benguela	Apprx.375	450	2040	
	Cacuaco GT	Luanda	125 x 6	81 x 6	2022-2037	
	Sambizanga GT	Luanda	125 x 3	81 x 3	2025-2037	
	Quileva GT	Benguela	125 x 6	81 x 6	2027-2035	
	Soyo-SS GT	Zaire	125 x 3	81 x 3	2030-2037	
Renewable	Benjamin Wind	Benguela	52	N/A	2028	
	Benguela Solar	Benguela	10	N/A	2028	
	Cacula Wind	Huila	88	N/A	2029	
	Cambongue Solar	Namibe	10	N/A	2029	
	Chibia Wind	Huila	78	N/A	2030	
	Caraculo Solar	Namibe	10	N/A	2030	
	Calenga Wind	Huambo	84	N/A	2031	
	Catumbela Solar	Benguela	10	N/A	2031	
	Gasto Wind	Kwanza Norte	30	N/A	2032	
	Lobito Solar	Benguela	10	N/A	2032	
	Kiwaba Nzoji I Wind	Malanje	62	N/A	2033	
	Lubango Solar	Huila	10	N/A	2033	
	Kiwaba Nzoji II Wind	Malanje	42	N/A	2034	
	Matala Solar	Huila	10	N/A	2034	
	Mussede I Wind	Kwanza Sul	36	N/A	2035	
	Quipungo Solar	Huila	10	N/A	2035	
	Mussede II Wind	Kwanza Sul	44	N/A	2036	
	Nharea Wind	Bie	36	N/A	2036	
	Techamutete Solar	Huila	10	N/A	2036	
	Tombwa Wind	Namibe	100	N/A	2037	
Namacunde Solar	Cunene	10	N/A	2037		

(2) Transmission Development Plan

Table 12-2 List of 400 kV Substation Projects

Project#	Year of operation	Area	Voltage (kV)	Substation Name	Capacity (MVA)	Cost (MUS\$)	Remarks
1	2020	Cuanza Sul	400	Waco kungo	450	40.5	450 x 1, under construction(China)
2	2020	Huambo	400	Belem do Huambo	900	51.3	450 x 2, under construction(China)
3	2022	Luanda	400	Bitá	900	51.3	450 x 2, under construction(Brazil)
4	2025	Cuanza Sul	400	Waco kungo	450	40.5	upgrade 450 x 1
5	2025	Luanda	400	Bitá	450	40.5	upgrade 450 x 1
6	2025	Zaire	400	N'Zeto	450	40.5	upgrade 450 x 1
7	2025	Luanda	400	Viana	2,790	96.6	upgrade 930 x 3
8	2025	Bengo	400	Kapary	450	40.5	upgrade 450 x 1
9	2025	Huíla	400	Lubango2	900	51.3	450 x 2, Pre-FS implemented*
10	2025	Huíla	400	Capelongo	900	51.3	450 x 2
11	2025	Huíla	400	Calukembe	120	32.6	60 x 2
12	2025	Benguela	400	Nova Biopio	900	51.3	450 x 2
13	2025	Southern	400	Cahama	900	51.3	450 x 2
14	2025	Eastern	400	Saurimo	900	51.3	450 x 2, under Pre-FS
15	2025	Lunda Norte	400	Xa-Muteba	360	38.3	180 x 2, under Pre-FS
16	2025	Huíla	400	Quilengues	120	32.6	60 x 2
17	2025	Cuanza Sul	400	Gabela	900	51.3	450 x 2
18	2025	Luanda	400	Sambizanga	2,790	96.6	930 x 3
19	2025	Malanje	400	Lucala	900	51.3	450 x 2
20	2025	Chipindo	400	Chipindo	360	38.3	180 x 2
21	2030	Bengo	400	Kapary	450	40.5	upgrade 450 x 1
22	2030	Luanda	400	Catete	450	40.5	upgrade 450 x 1
23	2035	Cunene	400	Ondjiva	900	51.3	450 x 2, Pre-FS implemented*
24	2035	Luanda	400	Bitá	450	40.5	upgrade 450 x 1
25	2035	Malanje	400	Lucala	450	40.5	upgrade 450 x 1
Total					19,590	1,171.4	

Pre-FS implemented*:Candidate site were selected by USTDA and DBSA.

Table 12-3 List of 220 kV Substation Projects (1)

Project#	Year of operation	Area	Voltage (kV)	Substation Name	Capacity (MVA)	Cost (MUSS)	Remarks
1	2018	Benguela	220	Benguela Sul	240	24.5	120 x 2, under construction(China)
2	2020	Luanda	220	Bitá	240	24.5	120 x 2, under construction(Brazil)
3	2020	Zaire	220	Tomboco	40	13.7	20 x 2
4	2020	Malanje	220	Capanda Elevadora	130	18.6	65 x 2, upgrade
5	2021	Luanda	220	Cacuaco	480	37.5	240 x 2, upgrade
6	2022	Luanda	220	Zango	360	31.0	120 x 3
7	2022	Malanje	220	Malanje 2	240	24.5	120 x 2
8	2022	Cuanza Sul	220	Waco Kungo	60	14.8	60 x 1
9	2022	Cuanza Sul	220	Quibala	120	18.1	60 x 2
10	2022	Benguela	220	Cubal	120	18.1	60 x 2
11	2022	Huíla	220	Lubango	240	24.5	120 x 2, Pre-FS implemented*
12	2022	Huíla	220	Matala	120	18.1	60 x 2, Pre-FS implemented*
13	2022	Huíla	220	Capelongo	60	14.8	60 x 1
14	2022	Cuando-Cubango	220	Cuchi	60	14.8	60 x 1
15	2022	Cuando-Cubango	220	Menangue	240	24.5	120 x 2
16	2022	Namibe	220	Namibe	240	24.5	120 x 2, Pre-FS implemented*
17	2022	Namibe	220	Tombwa	120	18.1	60 x 2, Pre-FS implemented*
18	2022	Lunda Norte	220	Lucapa	60	14.8	60 x 1
19	2022	Lunda Norte	220	Dundo	120	18.1	60 x 2, under Pre-FS
20	2022	Lunda Sur	220	Saurimo	120	18.1	60 x 2, under Pre-FS
21	2022	Uíge	220	Uíge	240	24.5	120 x 2, upgrade
22	2025	Luanda	220	Golfe	360	31.0	120 x 3
23	2025	Luanda	220	Chicara	480	37.5	240 x 2
24	2025	Bengo	220	Caxito	60	14.8	60 x 1
25	2025	Bengo	220	Maria Teresa	60	14.8	60 x 1
26	2025	Cuanza Sul	220	Porto Amboim	120	18.1	60 x 2
27	2025	Cuanza Sul	220	Cuacra	60	14.8	60 x 1
28	2025	Benguela	220	Catumbela	120	18.1	60 x 2
29	2025	Benguela	220	Bocoio	120	18.1	60 x 2
30	2025	Huambo	220	Ukuma	60	14.8	60x 1, Pre-FS implemented*
31	2025	Huambo	220	Catchiungo	120	18.1	60 x 2, Pre-FS implemented*
32	2025	Bié	220	Andulo	60	14.8	60 x 1
33	2025	Huíla	220	Nova Lubango	120	18.1	60 x 2
34	2025	Huíla	220	Caluquembe	60	14.8	60 x 1
35	2025	Huíla	220	Quilengues	60	14.8	60 x 1
36	2025	Huíla	220	Tchamutete	120	18.1	60 x 2, Pre-FS implemented*
37	2025	Cunene	220	Ondjiva	120	18.1	60 x 2, Pre-FS implemented*
38	2025	Cunene	220	Cahama	60	14.8	60 x 1, Pre-FS implemented*
39	2025	Cunene	220	Xangongo	60	14.8	60 x 1, Pre-FS implemented*
40	2025	Moxico	220	Luena	240	24.5	120 x 2, under Pre-FS
41	2025	Lunda Norte	220	Xa-Muteba	120	18.1	60 x 2
42	2025	Luanda	220	Viana	600	44.0	300 x 2, upgrade
43	2025	Luanda	220	Camama	120	18.1	120 x 1, upgrade
44	2025	Luanda	220	Sambizanga	240	24.5	240 x 1, upgrade
45	2025	Kuanza Norte	220	N' Dalatando	80	15.9	40 x 2, upgrade
46	2027	Moxico	220	Cazombo	60	14.8	60 x 1
47	2027	Moxico	220	Luau	60	14.8	60 x 1
48	2027	Lunda Sur	220	Muconda	60	14.8	60 x 1
49	2027	Bié	220	Kuito	120	18.1	120 x 1, upgrade
50	2030	Luanda	220	Futungo de Belas	120	18.1	120 x 1, upgrade

Pre-FS implemented*:Candidate site were selected by USTDA and DBSA.

Table 12-4 List of 220 kV Substation Projects (2)

Project#	Year of operation	Area	Voltage (kV)	Substation Name	Capacity (MVA)	Cost (MUSS)	Remarks
51	2030	Uíge	220	Negage	180	21.3	60 x 3
52	2030	Cabinda	220	Cabinda	240	24.5	120x 2
53	2030	Cabinda	220	Cacongo	120	18.1	60 x 2
54	2030	Benguela	220	Alto Catumbela	120	18.1	60 x 2
55	2030	Benguela	220	Baria Farta	120	18.1	60 x 2
56	2030	Huambo	220	Bailundo	120	18.1	60 x 2
57	2030	Huíla	220	Chipindo	60	14.8	60 x 1
58	2031	Zaire	220	M'Banza Congo	180	21.3	60 x 3, upgrade
59	2032	Cunene	220	Ondjiva	120	18.1	120 x 1, upgrade
60	2032	Lunda Sur	220	Saurimo	120	18.1	120 x 1, upgrade
61	2034	Luanda	220	Cacuaco	240	24.5	240 x 1, upgrade
62	2035	Luanda	220	PIV	480	37.5	240 x 2
63	2035	Kuanza Norte	220	Lucala	120	18.1	60 x 2
64	2035	Uíge	220	Sanza Pombo	120	18.1	60 x 2
65	2035	Bié	220	Camacupa	60	14.8	60 x 1
66	2035	Cuando-Cubango	220	Cuito Cuanavale	60	14.8	60 x 1
67	2035	Luanda	220	Cazenga	120	18.1	120 x 1, upgrade
68	2035	Bengo	220	Kapary	120	18.1	120 x 1, upgrade
69	2035	Benguela	220	Catumbela	240	24.5	120 x 2, upgrade
70	2036	Luanda	220	Sambizanga	240	24.5	240 x 1, upgrade
71	2036	Uíge	220	Maquela do Zombo	40	13.7	40 x 1, upgrade
72	2036	Huambo	220	Belém do Dango	240	24.5	240 x 1, upgrade
73	2036	Lunda Norte	220	Dundo	120	18.1	120 x1, upgrade
74	2037	Cuanza Sul	220	Gabela	60	14.8	60 x 1, upgrade
75	2038	Benguela	220	Cubal	240	24.5	120 x 2, upgrade
76	2040	Cuando-Cubango	220	Mavinga	60	14.8	60 x 1
77	2040	Malanje	220	Malanje 2	120	18.1	120 x 1, upgrade
78	2040	Huíla	220	Caluque mbe	60	14.8	60 x 1, upgrade
Total					11,810	772.4	

Table 12-5 List of 400 kV Transmission Line Projects

Project#	Year of operation	Area	Voltage (kV)	Starting point	End point	number of circuit	Power Flow (MVA)	Line Length (km)	Cost (MUSS)	Remarks
1	2020	Central	400	Lauca	Waco kungo	1	307	177	138.1	under construction(China)
2	2020	Central	400	Waco kungo	Belem do Huambo	1	242	174	135.7	under construction(China)
3	2020	Northern	400	Cambutas	Bitá	1	580	172	134.2	under construction(Brazil)
4	2022	Northern	400	Catete	Bitá	2	504	54	52.9	under construction(Brazil)
5	2025	Northern	400	Cambutas	Catete	1	791	123	95.9	Dualization
6	2025	Northern	400	Catete	Viana	1	579	36	28.1	Dualization
7	2025	Northern	400	Lauca	Capanda elev.	1	518	41	32.0	Dualization
8	2025	Northern	400	Kapary	Sambizanga	2	1130	45	44.1	For New Substation
9	2025	Northern	400	Lauca	Catete	2	868	190	186.2	Changing Connection Plan
10	2025	Central	400	Lauca	Waco kungo	1	307	177	138.1	Dualization
11	2025	Central	400	Waco kungo	Belem do Huambo	1	242	174	135.7	Dualization
12	2025	Central	400	Cambutas	Gabela	2	484	131	128.4	Pre-FS implemented*
13	2025	Central	400	Gabela	Benga	2	848	25	24.5	Pre-FS implemented*
14	2025	Central	400	Benga	Nova Biopio	2	550	200	196.0	Pre-FS implemented*
15	2025	Southern	400	Belem do Huambo	Caluquembe	2	606	175	171.5	Pre-FS implemented*
16	2025	Southern	400	Caluquembe	Lubango2	2	666	168	164.6	Pre-FS implemented*
17	2025	Southern	400	Belem do Huambo	Chipindo	2	264	114	111.7	
18	2025	Southern	400	Chipindo	Capelongo	2	190	109	106.8	
19	2025	Southern	400	Nova Biopio	Quilengues	2	840	117	114.7	Pre-FS implemented*
20	2025	Southern	400	Quilengues	Lubango2	2	772	143	140.1	Pre-FS implemented*
21	2025	Southern	400	Lubango2	Cahama	2	450	190	186.2	Pre-FS implemented*
22	2025	Eastern	400	Capanda elev	Xa-Muteba	2	590	266	260.7	
23	2025	Eastern	400	Xa-Muteba	Saurimo	2	510	335	328.3	under Pre-FS
24	2027	Southern	400	Capelongo	Ondjiva	2	292	312	305.8	
25	2027	Southern	400	Cahama	Ondjiva	2	442	175	171.5	
26	2027	Southern	400	Cahama	Ruacana	2	409	125	122.5	International Interconnection
Total								3,948	3,654.2	

Pre-FS implemented*:Candidate route were selected by USTDA and DBSA.

Table 12-6 List of 220 kV Transmission Line Projects

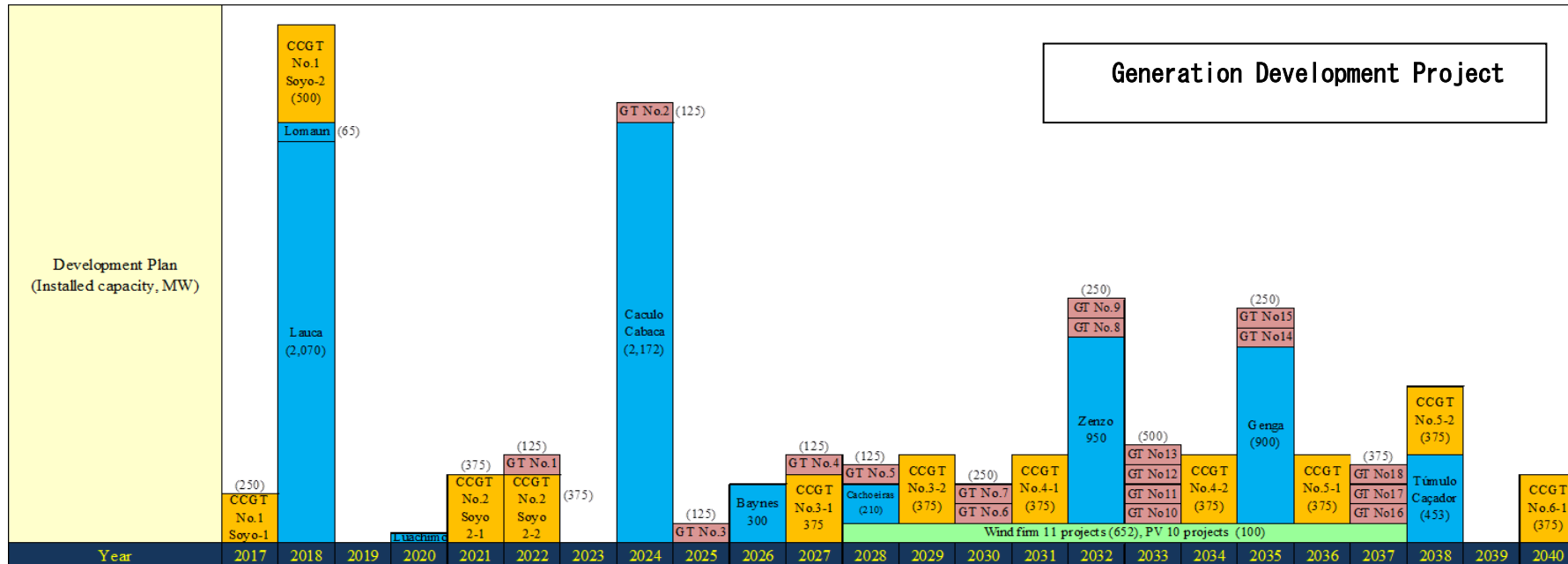
Project#	Year of operation	Area	Voltage (kV)	Starting point	End point	number of circuit	Required Capacity (MVA)	Line Length (km)	Cost (MUSS)	Remarks
1	2020	Southern	220	Lubango2	Lubango	2	360	30	13.5	Pre-FS implemented*
2	2020	Southern	220	Lubango2	Namibe	2	360	162	72.9	Pre-FS implemented*
3	2020	Southern	220	Namibe	Tombwa	2	120	97	43.7	Pre-FS implemented*
4	2020	Eastern	220	Saurimo	Lucapa	2	300	157	70.7	Pre-FS implemented*
5	2020	Eastern	220	Lucapa	Dundo	2	240	135	60.8	Pre-FS implemented*
6	2022	Northern	220	Bitá	Camama	2	840	21	9.5	
7	2022	Northern	220	Catete	Zango	2	360	40	18.0	
8	2022	Northern	220	Capanda elev.	Maranje	2	360	110	49.5	
9	2022	Central	220	Gabela	Alto Chingo	1	300	81	29.2	Dualization
10	2022	Central	220	Quibala	Waco Kungo	2	120	92	41.4	
11	2022	Central	220	Lomaum	Cubal	2	360	2	0.9	
12	2022	Southern	220	Lubango	Matala	2	120	168	75.6	Pre-FS implemented*
13	2022	Southern	220	Matala HPS	Matala	1	41	5	1.8	upgarade
14	2022	Southern	220	Capelongo	Cuchi	2	420	91	41.0	
15	2022	Southern	220	Cuchi	Menongue	2	360	94	42.3	
16	2025	Northern	220	Sambizanga	Golle	2	360	7	3.2	
17	2025	Northern	220	Kapary	Caxito	2	60	26	11.7	
18	2025	Northern	220	N'Zeto	Tomboco	2	220	5	2.3	For Substation inserted
19	2025	Northern	220	M'banza Congo	Tomboco	2	220	5	2.3	For Substation inserted
20	2025	Northern	220	Sambizanga	Chicala	2	480	7	3.2	
21	2025	Northern	220	Catete	Maria Teresa	2	60	51	23.0	
22	2025	Central	220	Alto Chingo	Cuacra	2	60	25	11.3	
23	2025	Central	220	Alto Chingo	Port Amboim	2	120	60	27.0	
24	2025	Central	220	Quileva	Nova Biopio	1	550	18	6.5	Dualization
25	2025	Central	220	Quileva	Catumbela	2	240	8	3.6	
26	2025	Central	220	Nova Biopio	Bocoio	2	120	5	2.3	For Substation inserted
27	2025	Central	220	Lomaum	Bocoio	2	120	5	2.3	For Substation inserted
28	2025	Central	220	Belem do Huambo	Ukuma	2	60	66	29.7	
29	2025	Central	220	Belem do Huambo	Catchiungo	2	720	76	34.2	Strengthen
30	2025	Central	220	Catchiungo	Kuito	2	480	85	38.3	Strengthen
31	2025	Central	220	Kuito	Andulo	2	60	110	49.5	
32	2025	Southern	220	Cahama	Xangongo	2	180	97	43.7	Pre-FS implemented*
33	2025	Southern	220	Ondjiva	Xangongo	1	120	97	34.9	Pre-FS implemented*
34	2025	Southern	220	Capelongo	Tchamutete	2	120	98	44.1	
35	2025	Eastern	220	Saurimo	Luena	2	240	265	119.3	Pre-FS implemented*
36	2027	Eastern	220	Saurimo	Muconda	2	180	187	84.2	
37	2027	Eastern	220	Muconda	Luau	2	120	115	51.8	
38	2027	Eastern	220	Luau	Cazombo	2	60	264	118.8	
39	2030	Central	220	Cubal	Alto Catumbela	2	120	47	21.2	
40	2030	Central	220	Catchiungo	Bailundo	2	120	66	29.7	
41	2030	Central	220	Benguela Sul	Baia Farta	2	120	30	13.5	
42	2030	Northern	220	Uige	Negage	2	620	5	2.3	For Substation inserted
43	2030	Northern	220	Pambos de Sonhe	Negage	2	620	5	2.3	For Substation inserted
44	2035	Northern	220	Viana	PIV	2	480	7	3.2	
45	2035	Northern	220	Negage	Sanza Pombo	2	120	109	49.1	
46	2035	Central	220	Kuito	Camacupa	2	60	145	65.3	
47	2035	Southern	220	Menongue	Cuito Cuanavale	2	120	189	85.1	
48	2035	Southern	220	Cuito Cuanavale	mavinga	2	60	176	79.2	
Total								3,746	1,667.6	

Pre-FS implemented*:Candidate route were selected by USTDA and DBSA.

Table 12-7 List of Transmission Line Projects for Newly Developed Power Sources

Project#	Year of operation	Area	Voltage (kV)	Starting point	End point	number of circuit	Generation Capacity (MVA)	Line Length (km)	Cost (MUS\$)	Remarks
1	2025	Northern	400	HPP Caculo Cabaça	Cambutas	2	496	54	52.9	under construction(China)
2	2025	Northern	400	HPP Caculo Cabaça	Lauca	2	1326	25	24.5	
3	2025	Northern	400	TPP Soyo 2	Soyo	2	750	5	4.9	
4	2025	Central	400	TPP Lobito CCGT #1	Nova Biopio	2	750	23	22.5	
5	2025	Northern	220	TPP Cacuoac GT #1	Cacuaco	2	375	5	2.3	
6	2025	Northern	220	TPP Cacuoac GT #2	Cacuaco	2	375	5	2.3	
7	2025	Northern	220	TPP Boavista GT #3	Sambizanga	2	375	5	2.3	
8	2030	Northern	220	HPP Quilengue ⑤	Gabera	2	210	37	16.7	
9	2030	Southern	400	HPP Baynes	Cahama	2	300	195	191.1	
10	2030	Central	220	TPP Quileva GT #4	Quileva	2	250	1	0.5	
11	2030	Central	220	TPP Quileva GT #5	Quileva	2	250	1	0.5	
12	2030	Central	220	TPP Quileva GT #6	Quileva	2	250	1	0.5	
13	2030	Northern	400	TPP Soyo GT #7	Soyo	2	375	5	4.9	
14	2035	Northern	400	HPP Zenzo	Cambutas	2	950	41	40.2	
15	2035	Northern	400	HPP Genga	Benga Switch-yard	2	900	30	29.4	
16	2035	Central	400	TPP Lobito CCGT #2	Nova Biopio	2	720	23	22.5	
17	2035	Southern	220	HPP Jamba Ya Mina	Matala	1	205	86	31.0	
18	2035	Southern	220	HPP Jamba Ya Oma	HPP Jamba Ya Mina	1	79	37	13.3	
19	2040	Northern	220	HPP Túmulo Caçador	Cambutas	2	453	16	7.2	
20	2040	Southern	220	TPP Namibe CCGT #3	Namibe	2	750	17	7.7	
21	2040	Central	400	TPP Lobito CCGT #4	Nova Biopio	2	375	23	22.5	
Total								635	499.4	

The generation development plan and transmission development plan are summarized in the table below.



Transmission Dev. Plan	Year 2018-20	Year 2021-25	Year 2026-30	Year 2031-35	Year 2036-40
Trans. For Power Plant	Implementation of projects to connect the new hydropower plants and the new gas-fired thermal power plants in the central and south to the main & regional system.				
Construction of 400 kV Main System	Lauca – Waco Kungo – Belem do Huambo	- Lubango			
	Cambutasu - Gabela – Nova Biopio – Lubango				
		Lubango – Cahama			
Enhancement of 220 kV System	to enhance the 220 kV regional system, mainly in Luanda, Benguela region				
Two circuit of the backbone line to secure N-1 criteria	To avoid overload during accidents of an existing circuit of the transmission line, eliminate operational restrictions, and improve the reliability, one circuit has to be added in parallel to make the backbone line a two-circuit type.				

Figure 12-1 Summary of Generation Development Plan & Transmission Development Plan

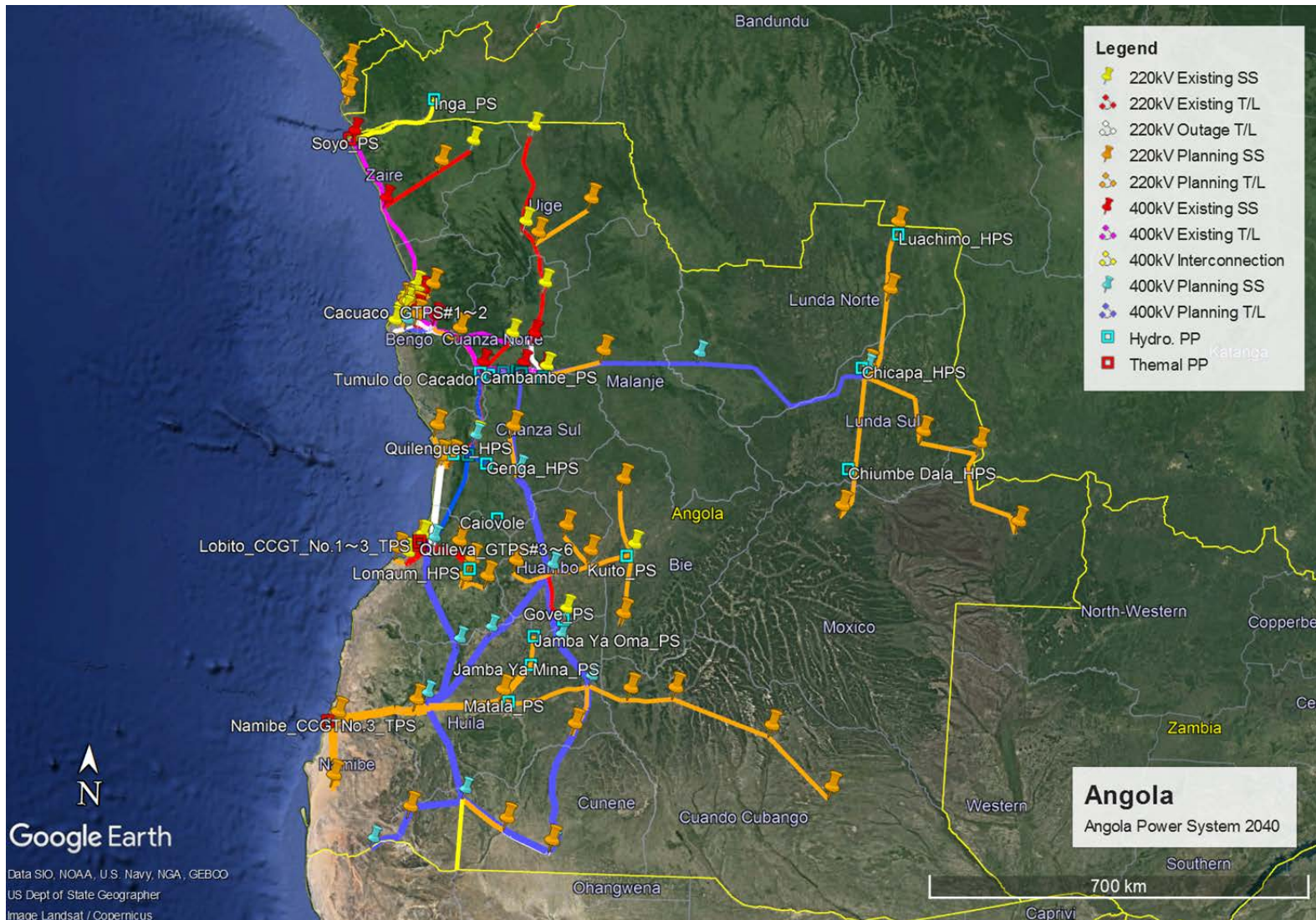


Figure 12-2 Project Map toward 2040

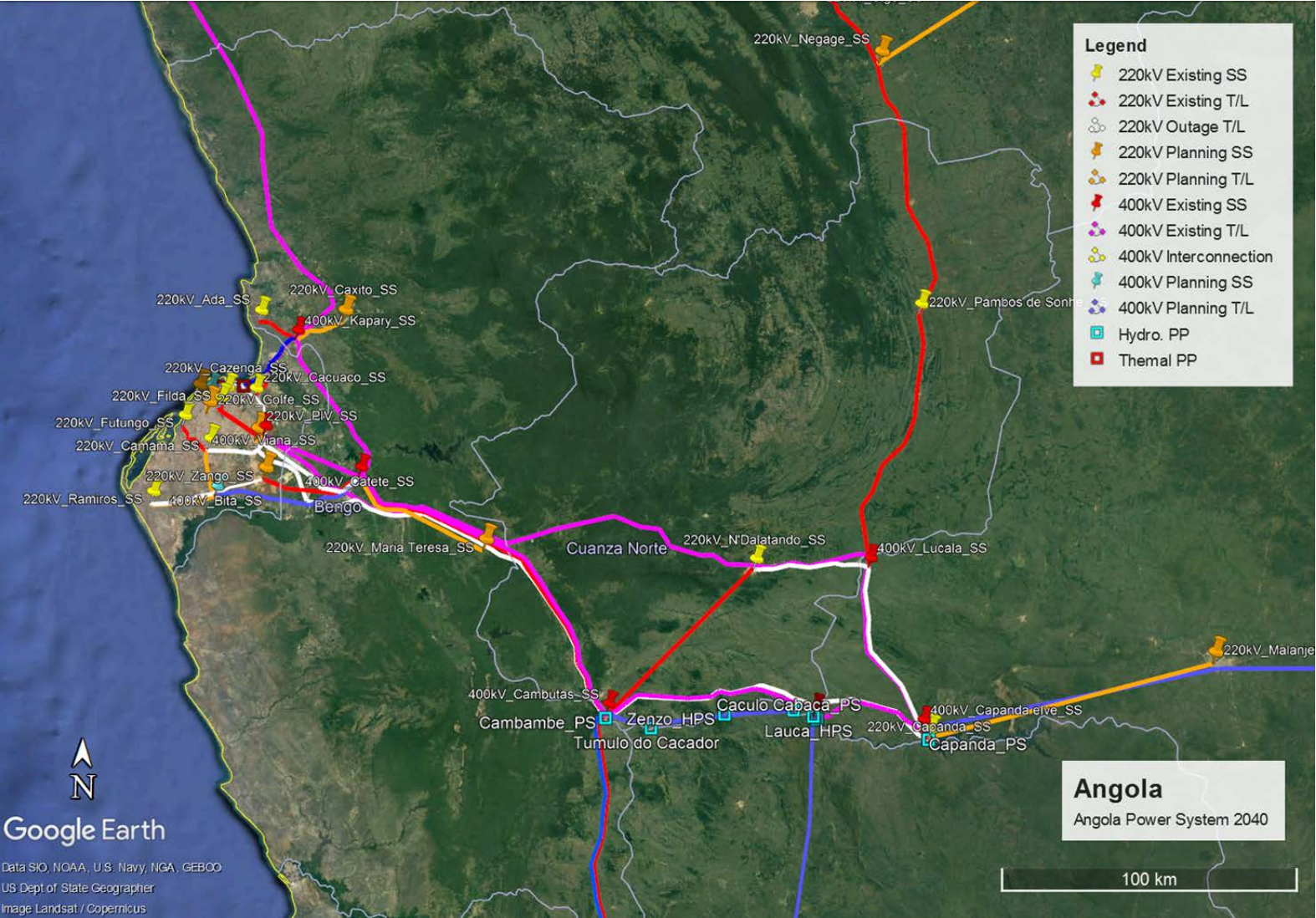


Figure 12-3 Project Map toward 2040 (nearby Luanda)

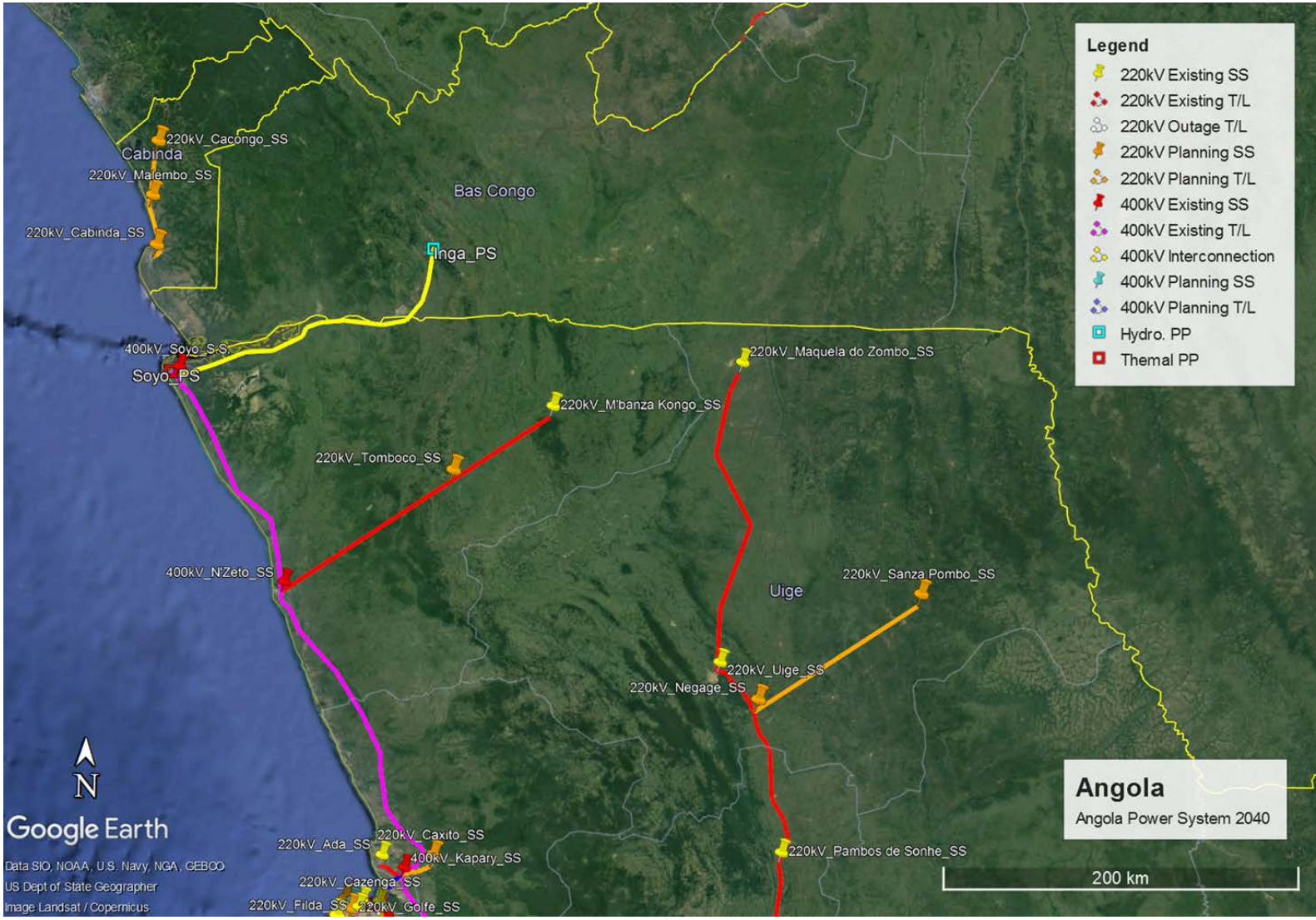


Figure 12-4 Project Map toward 2040 (Northern Region from Luanda)

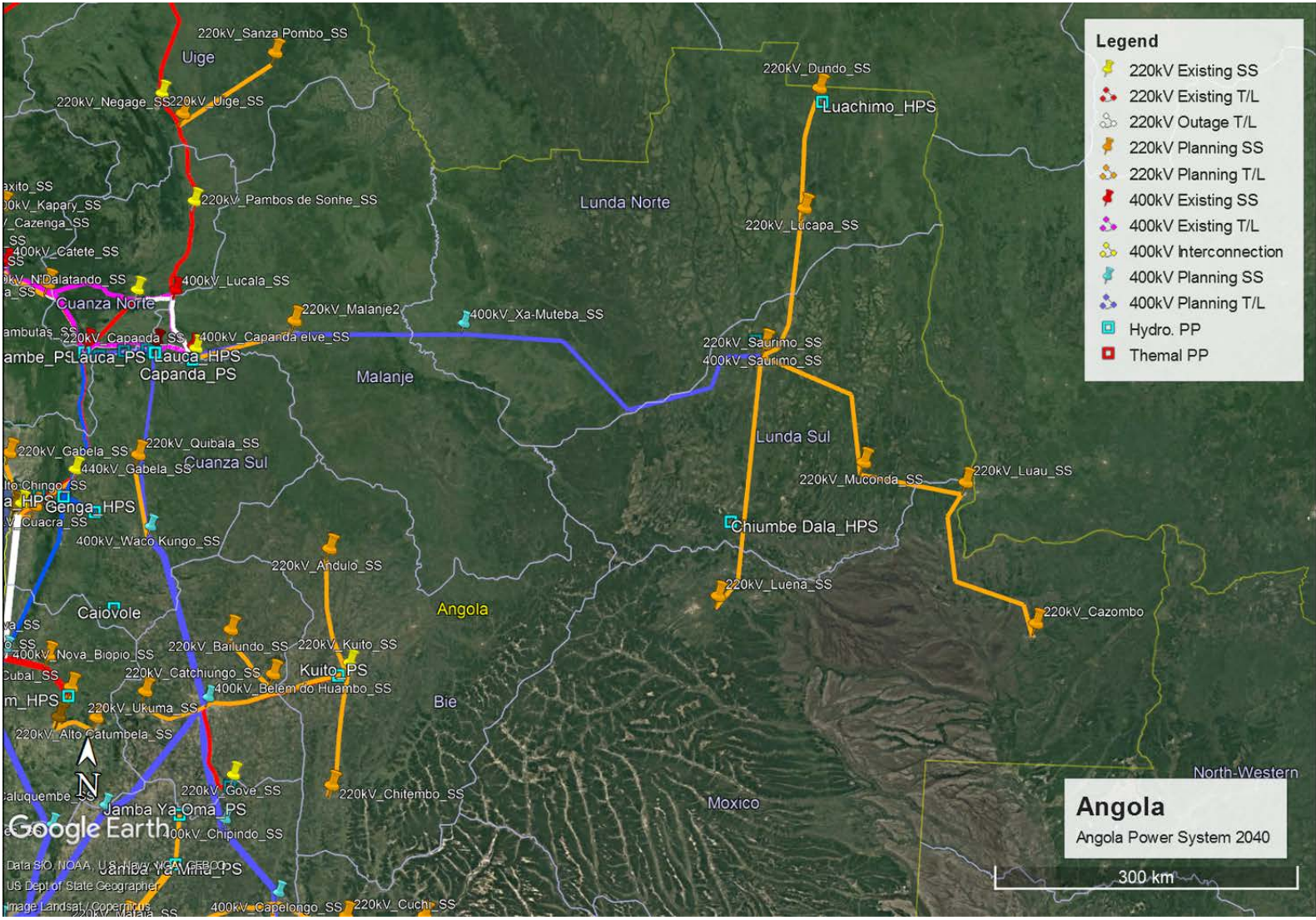


Figure 12-5 Project Map toward 2040 (Western Region from Luanda)

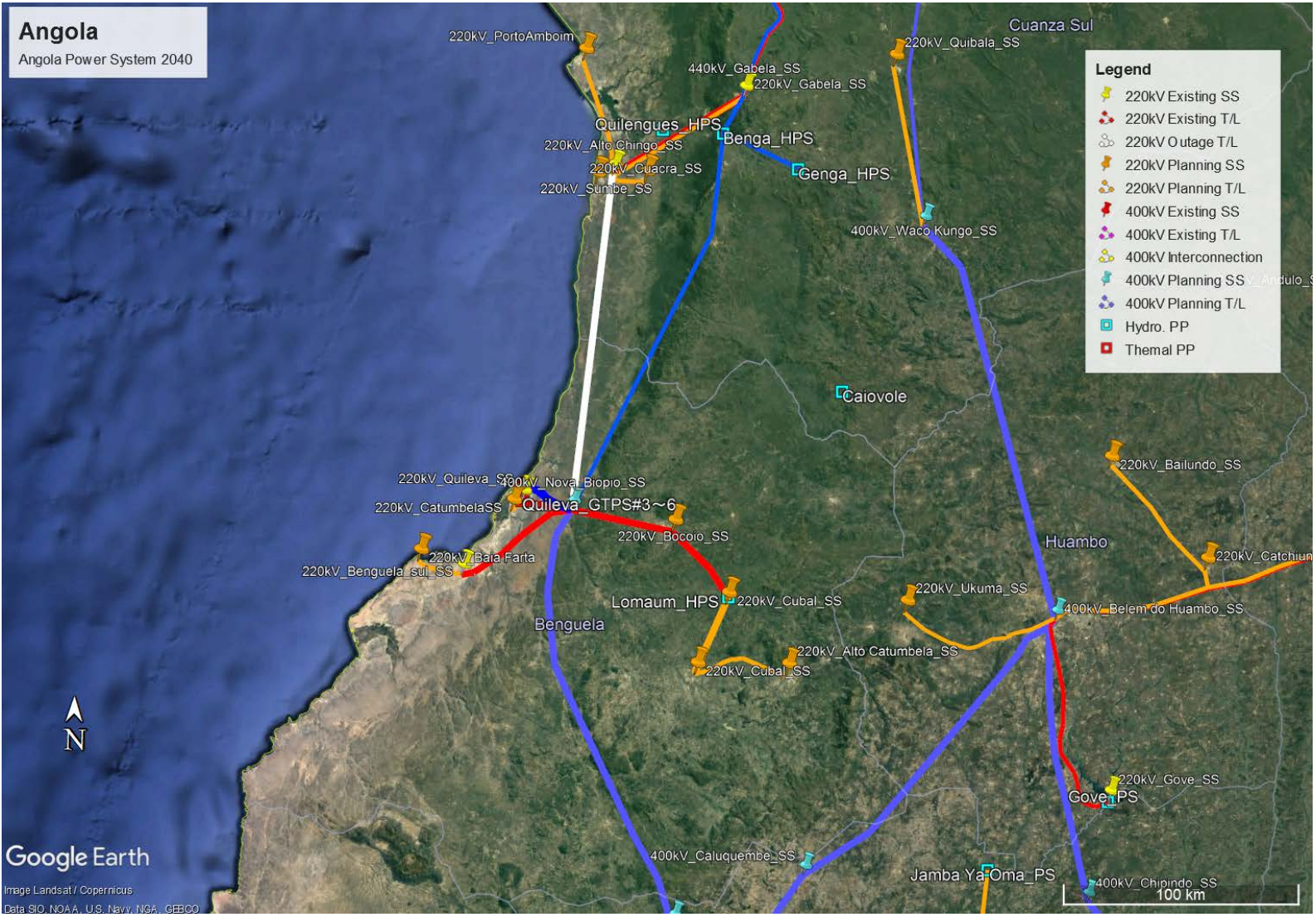


Figure 12-6 Project Map toward 2040 (Central Region)

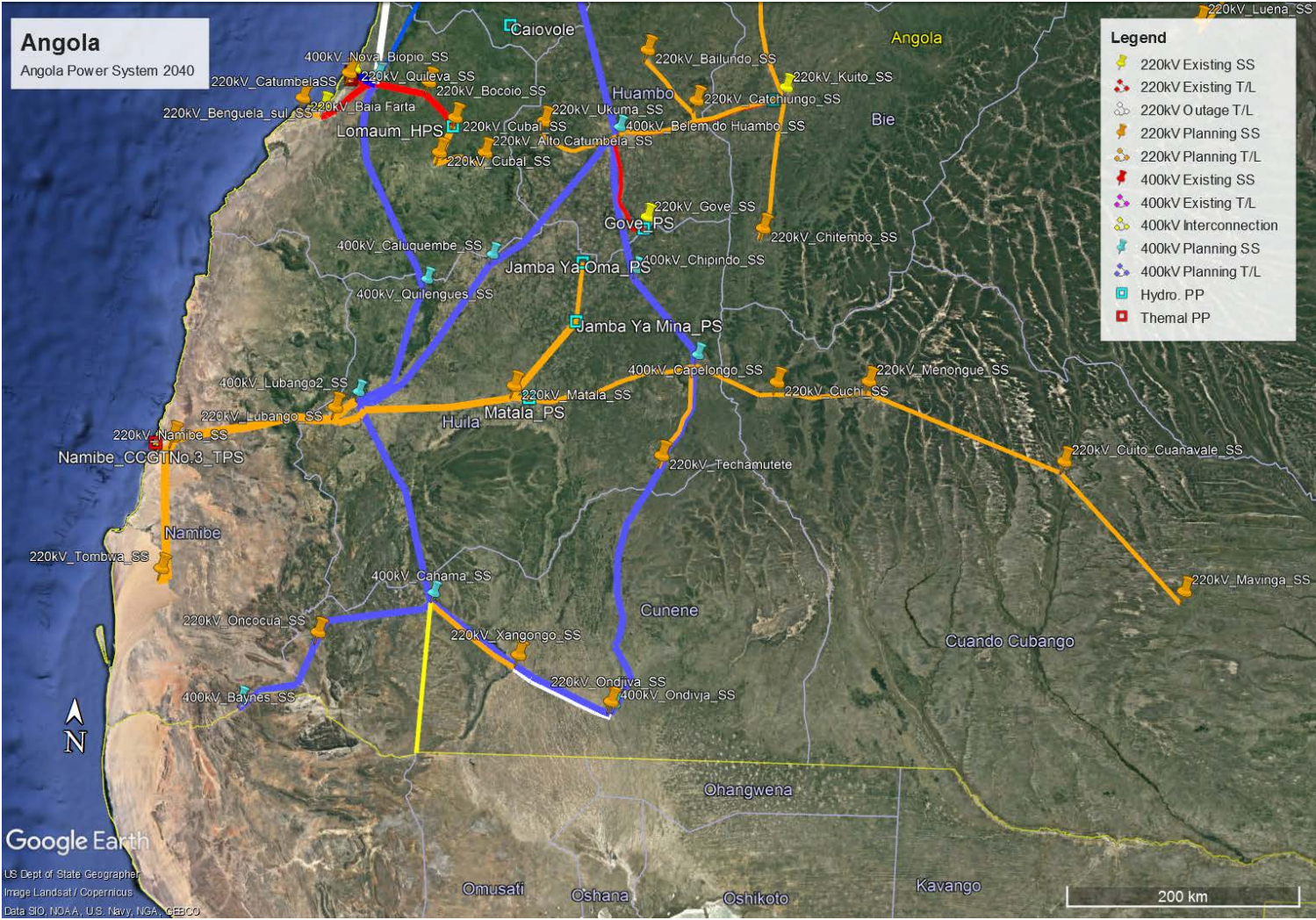


Figure 12-7 Project Map toward 2040 (South Region)

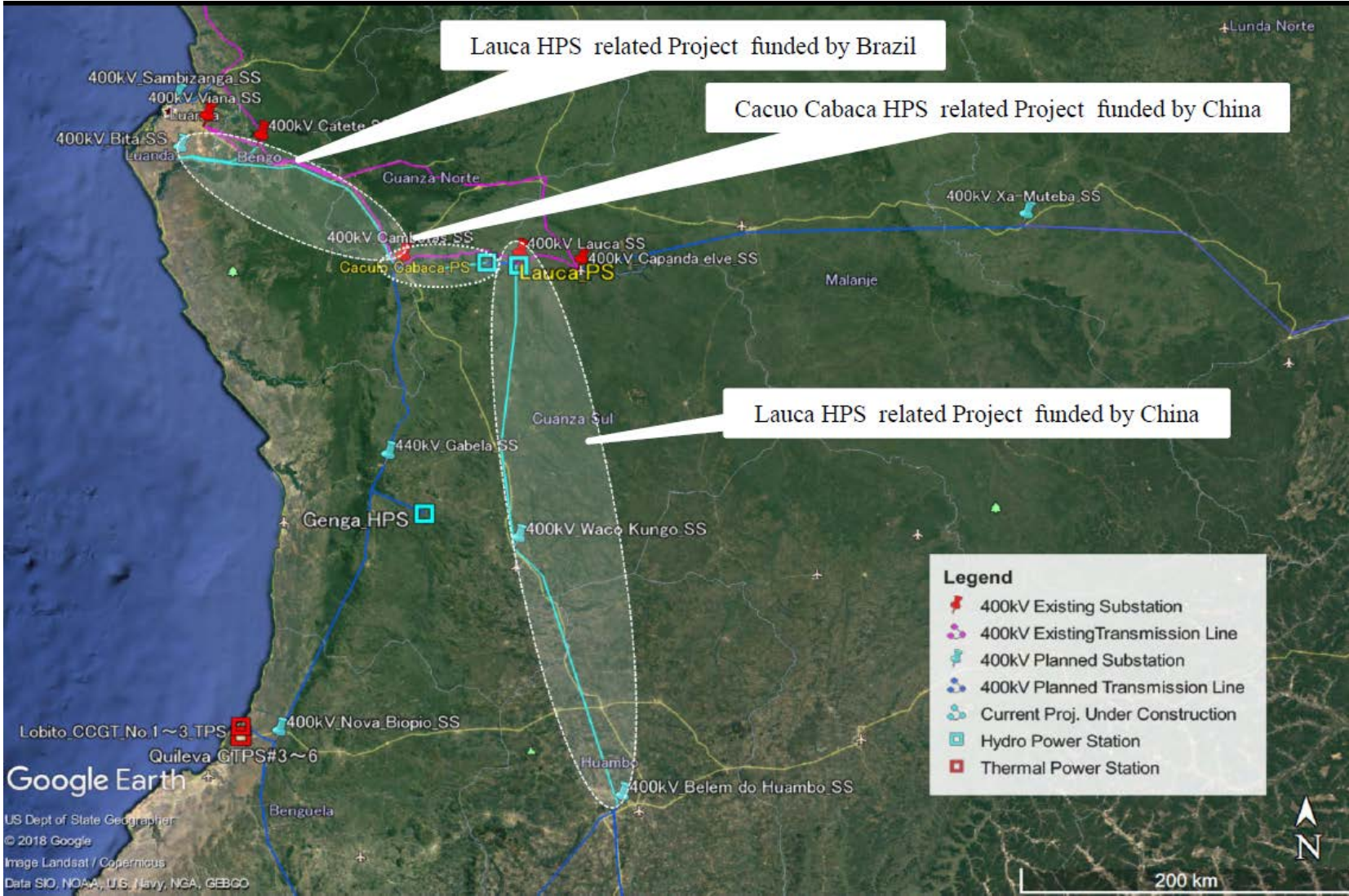


Figure 12-8 Current Project under Construction

12.2 Projects to which Japan can contribute from a technical standpoint

12.2.1 South Transmission System Enhancement Project

Because the power transmission system enhancement project in the northern system is already underway with China and Brazilian funds, Japan can cooperate more meaningfully by assisting other power transmission enhancement projects in the central and southern regions. In this region, JICA currently supports renovation of the port of Namibe by grant aid. Therefore, JICA can contribute to the economic growth of this region by improving power access along with logistics. When Japan provides financial cooperation, however, the participation of Japanese companies should be considered, which in turn raises the issue of safety.

Figure 12-8 shows the transmission system enhancement plan superimposed on an Angolan risk map obtained from the Ministry of Foreign Affairs Overseas Safety Website.

Two possibilities can be found from this figure. The first is the development of the CCGT power near Lobito Port in Benguela Province and the development of a 400 kV power line spanning a short 23 km distance to the 400 kV Nova BioPio substation.

We had already confirmed, however, during our second regional survey of Benguela and Huambo, that the Chinese side was beginning to work on power transmission system enhancements in that area.

The second possibility is the development of a 220 kV transmission line connecting a CCGT plant near Namibe Port to the 220 kV Namibe substation and the 400 kV Lubango 2 substation. We investigated the route of the transmission lines along the national roads in this area in our 3rd regional survey and confirmed that there were no big problems in terms of safety. We therefore think this second possibility would be preferable for scale, and would like to recommend it. We also considered an optional inclusion of a 220 kV Tombwa substation.

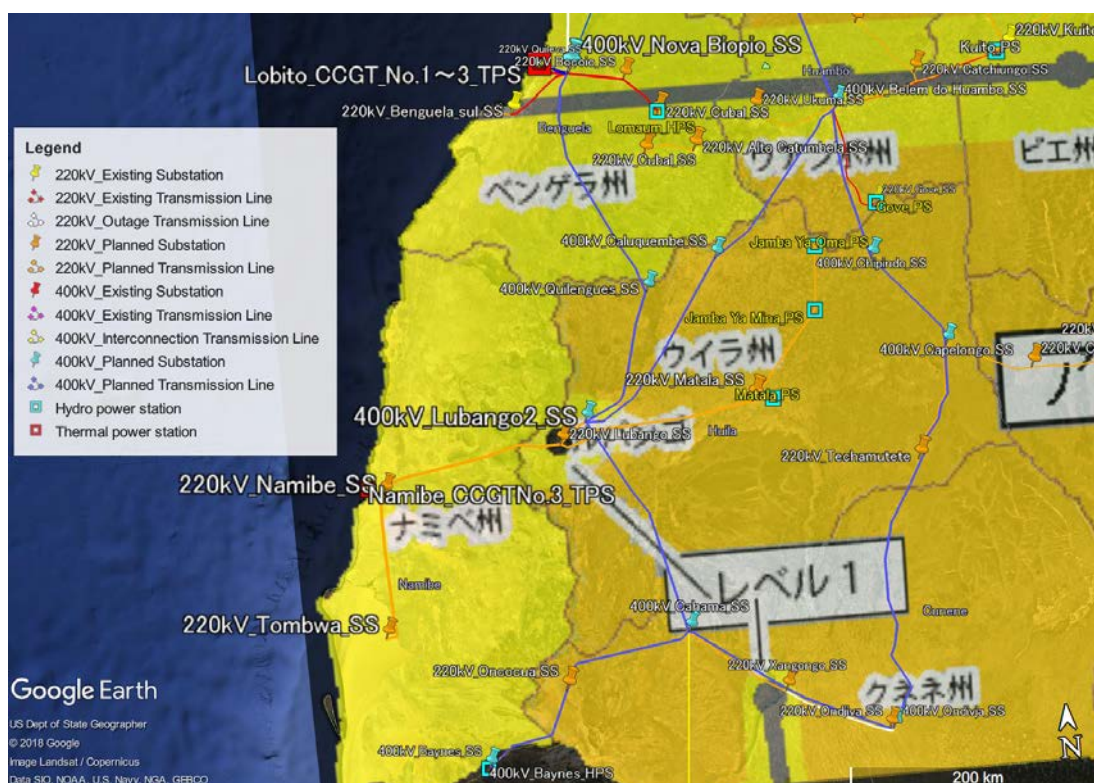


Figure 12-9 South Transmission System Enhancement Project Map

Table 12-8 List of South Transmission System Enhancement Projects

Item	Voltage	Name of Facilities	Overview	Cost (MUS\$)
Substation	400kV	Lubango2	900MVA	51.3
	220kV	Namibe	240MVA	24.5
	220kV	Tombwa	120MVA	18.1
Transmission Line	220kV	Lubango2-Namibe	2cct,154km	68.0
	220kV	Namibe-Tombwa	2cct,110km	49.5
			Project Total	211.4

12.2.2 New CCGT Project

As mentioned in Chapter 6, it will be necessary to introduce CCGT as a middle demand power supply in Angola in order to realize the optimal generation mix. Japanese manufacturers have the world's top-class technology in CCGT and are ideally positioned to contribute through technical cooperation. A typical CCGT project is shown in Table 12-9.

Table 12-9 CCGT Project (example)

Item	Contents
Project	New CCGT Construction
Installed Capacity	Approx. 750 MW/plant
Project Costs*	Approx. 900 millUSD
Project Boundary	CCGT main machine, auxiliaries (chiller, condenser, fuel receiving tank, etc.), civil work, architectural work, etc.
Project Type	EPC, BOT, IPP

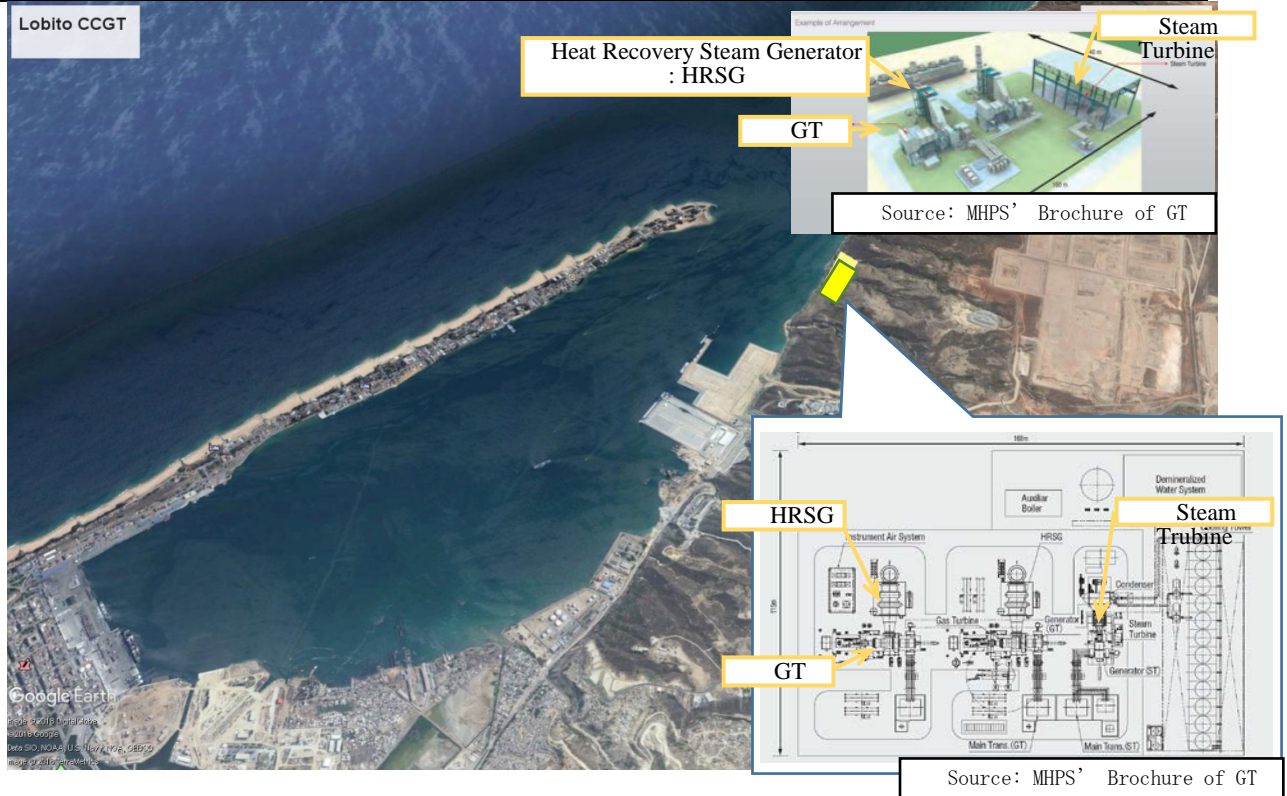
* The above construction cost is CCGT project only. Considering fuel consumption, it is necessary to construct the following fuel supply facilities.

Note (Costs based on investigation in Japan)	Construction Costs for LNG Tank: 100-150 millUSD/unit Construction Costs for Gas Pipeline: 4-13 millUSD/km FSRU (Floating Storage Regasification Unit): 250 - 330 millUSD (Capacity 140,000 m3) Construction Costs for LPG Tank: 10-30 millUSD/unit (Capacity 20,000 m3)
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<Tank matter>

An approximately 750-MW-class CCGT requires about 50,000 m3 of LNG per month. One 125,000 m3 LNG tank can therefore store more than two months of fuel. For backup purposes, a system should ideally have 2 tanks. With 2 tanks, fuel can be supplied to up to about 4 CCGT power plants.

When LPG is used as a fuel, about 30,000 tons of LPG is required per month. Unlike LNG, LPG is procured through diversified routes and accordingly can be stored in smaller quantities. The maintenance of total tank capacities of 20,000 tons is thought to be sufficient, with backups included.



12.2.3 New GT Construction as a Peak Demand Power Supply & Introduction of SCADA for GT Control

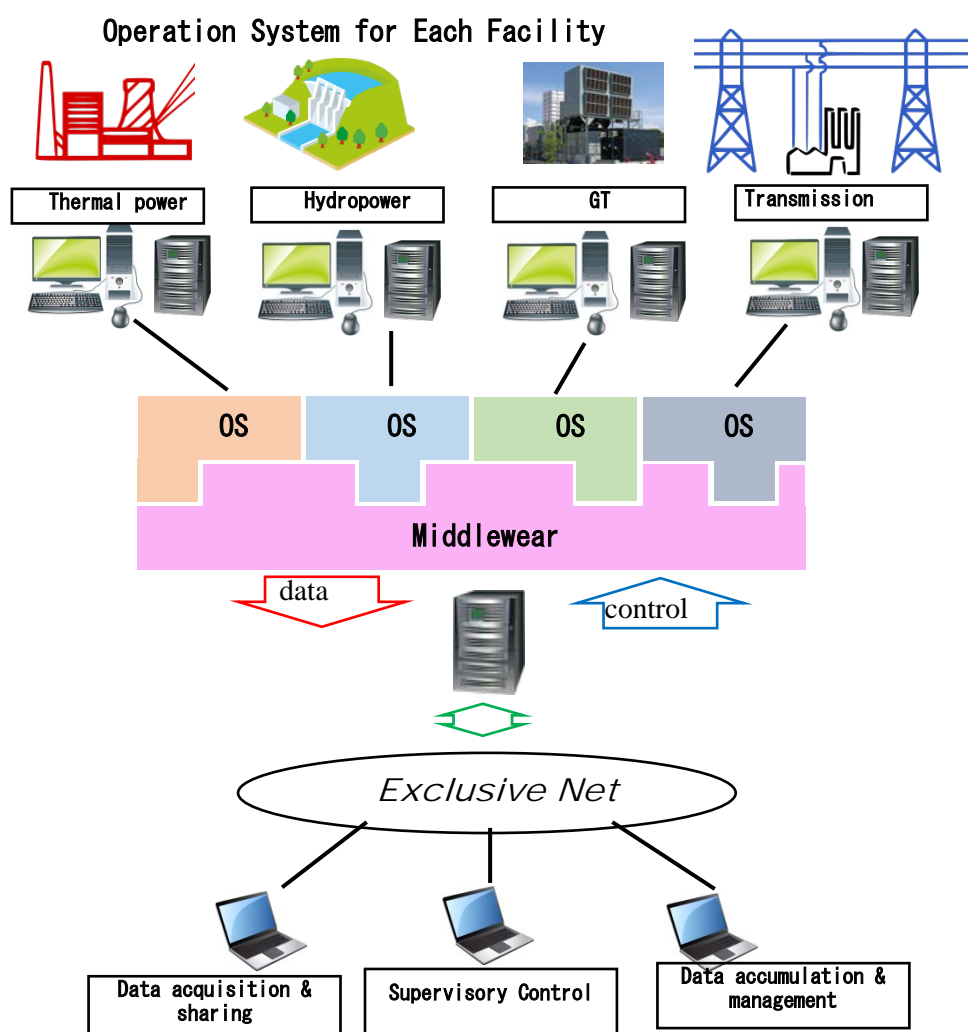
An examination of the optimal generation mix clearly showed that it will be necessary to introduce GT to some extent as a peak demand power supply. Japanese manufacturers are ideally suited to introduce the technology, as they are the world's most technologically advanced entities in this field.

Peak demand power supply must incur a low power generation cost at times of low utilization and requires a function to allow rapid load fluctuation when peak demand occurs. This latter function can be realized by introducing a control system such as SCADA for dispatching the power supply. As a system enabling the easy collection of data on power generation and demand, SCADA also leads to more efficient system operation and ensures system stability.

Japan's example experience in this field makes Japan an ideal source of technical cooperation.

Table 12-10 Construction of Peak Demand Power Supply & Introduction of SCADA

New GT Construction Project		SCADA Introduction Project	
Project	New GT Construction	Project	SCADA development & introduction
Installed Capacity	Approx. 100 MW/plant	Project Costs	Depends on the project scale
Project Costs	Approx. 60-80 millUSD/plant		
Project Type	EPC, BOT	Project Type	Technical Assistance Project



12.2.4 Project to Repower Old Hydropower Plants

The Biópio hydropower plant and Matala hydropower plant in Angola are medium-sized plants that supply the core power for each region. Both, however, were developed as far back as the 1950s and suffer from problems such as equipment damage and efficiency reductions due to aging and other causes. Given these background conditions, we believe that the regional power supply could be strengthened by diagnosing the equipment at these hydropower plants and rehabilitating them based on the results.

Japan's ample experience in repowering aged hydropower plants makes Japan as an ideal source of technical cooperation.

Table 12-11 Current Status of the HPP

Name	Province	Municipality	Installed capacity (MW)	Available capacity (MW)	Commissioning Year	Status
Biópio	Benguela	Lobito	14.58 (4x 3.645)	12.0	1955	The penstock is damaged and no water can be supplied to the turbine. Operations at the power plant are therefore completely stopped .
Matala	Huíla	Matala	40.8 (3x 13.6)	27.2	1959	There were plans to install three generators, but one of the three has not been installed. The efficiency of the remaining two units is thought to be declining as a result.

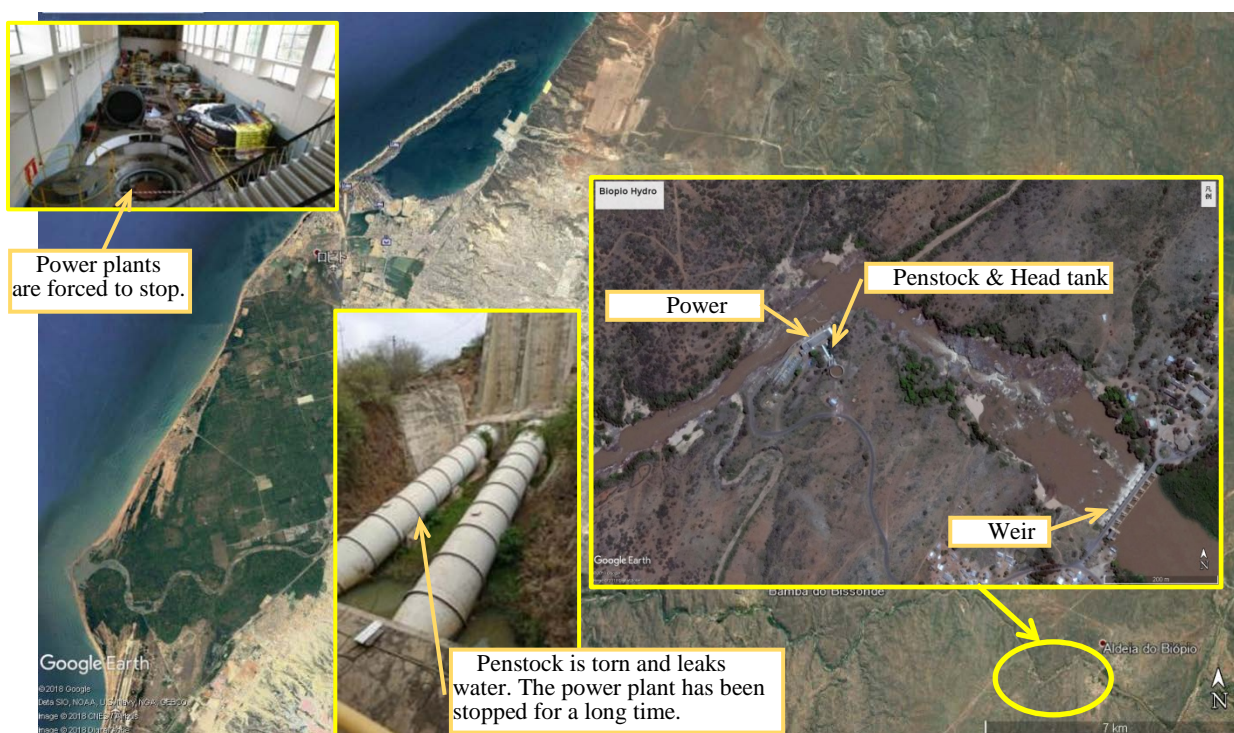


Figure 12-10 Biópio HPP's Current Status

12.3 Advice to MINEA, RNT, PRODEL, ENDE and IRSEA's Action Plan on the Power Development Master Plan

12.3.1 Action Plan for the Power Development Master Plan

The Angolan action Plans on the Power Development Master Plan are summarized in the following table.

Table 12-12 Action Plans for the Power Development Master Plan

Target	Item	Action Plan in Detail
Action plans related to maintenance of the Power Master Plan	Establishment of an organization to formulate PDMP	➤ Establishment of the Institute of Power Development Planning (IPDP) <tentative name>
	Continuing to revise PDMP	Ongoing revisions to the Power Demand Forecast <ul style="list-style-type: none"> ➤ To collect necessary data such as economic indicators ➤ To collect demand data and improve accumulation method ➤ Hearing customers
		Ongoing revisions to the Generation Development Plan <ul style="list-style-type: none"> ➤ Review of fuel procurement plans ➤ Collection of the latest technical information on hydropower & thermal power ➤ Ongoing study on the occupancy hydropower potential ➤ Maintaining the Best Generation Mix
		Ongoing revisions of the Transmission Development Plan <ul style="list-style-type: none"> ➤ Ongoing analysis of the supply-demand imbalance by region ➤ Review of transmission facility specifications ➤ Review of power flow analysis
Action plans related to execution of development projects	Company Operation & Project management	➤ PDMP deployment and reflection of PDMP in the medium-term plans of the respective entities
	Management and reform of fund procurement	<ul style="list-style-type: none"> ➤ Improvement of the tariff system ➤ Study on utilizing the foreign loan ➤ Study on introducing private sector funds
Others	Reform of dispatching organizations	<ul style="list-style-type: none"> ➤ Introduction of SCADA ➤ Reform of central and regional dispatching organizations

The action plans will be described in detail from the next section.

12.3.2 Establishment of an Organization to Formulate and Continuously Revise the PDMP

The preconditions for the formulation of Power Development Master Plan such as the power demand, power generation situation, project schedule, and electric power technology in general all evolve and change every day. Given the ever-changing nature of these preconditions, the master plan must be reviewed at least every three to five years. A dedicated department will be required to accomplish this.

At present, Angola has individually arranged an electricity planning department in each public corporation, and MINEA consolidates the examination results within the departments. This regime is not necessarily efficient or effective. In the near future we should establish a department with motivated staff within MINEA to oversee the power planning function (demand forecast, power development plan, transmission and distribution development plan), revise the master plan consistently, and develop human resources. We need to proceed with the preparations for the establishment such a department immediately.

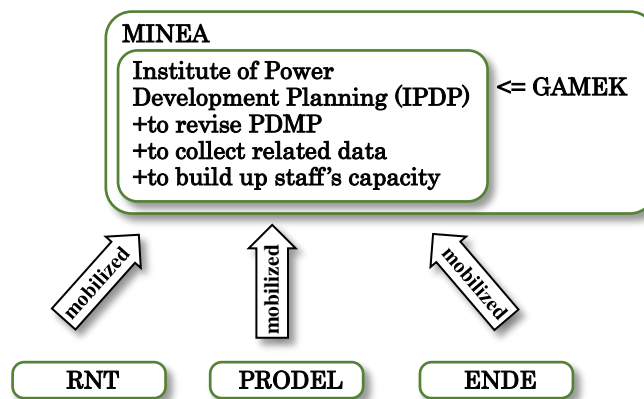


Figure 12-11 Example of Organization to Formulate PDPM

12.3.3 Improvement Activities to Establish a Method for Accurate Power Demand Forecasts

Angola currently lacks the accumulated data needed to formulate power demand forecasts. To improve the Power Development Master Plan in the future, it will be necessary to prepare a system for collecting these data and forecasting power demand more accurately. And to predict and grasp special demand for industrial/commercial use, ENDE will have to grasp customer contract requests, information on factory construction, information on commercial facility development, etc. on the basis of the supply areas of distribution S/S. A hearing system will have to be developed for this purpose.

The following shows an example of a power demand forecasting system.

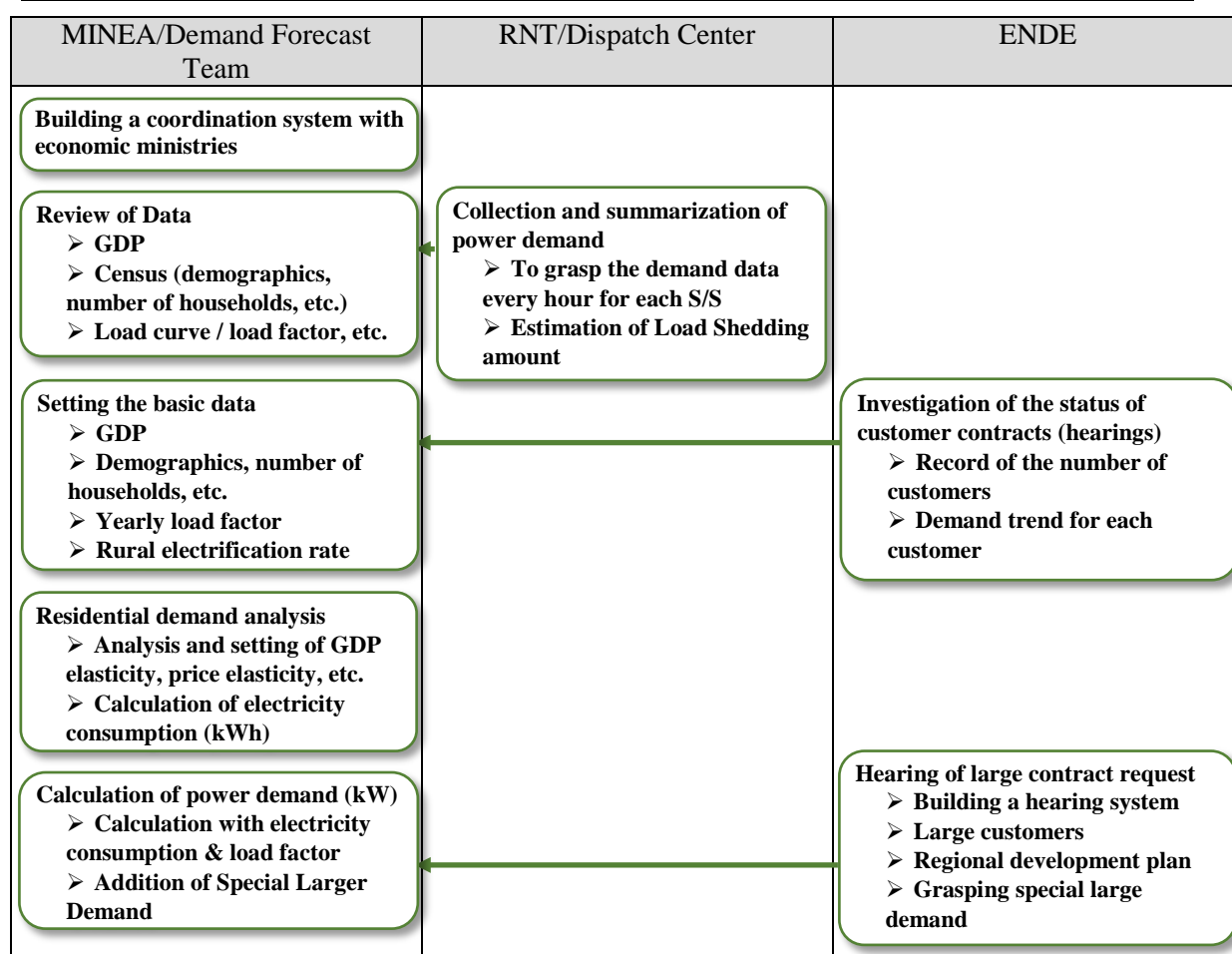


Figure 12-12 Action Plan and Structure for Power Demand Forecast

12.3.4 Ongoing study on the occupancy hydropower potential

The hydropower development plan is an important item to consider when formulating generation development plans, especially in a country with a high ratio of hydropower power supply, like Angola. The most basic data to review when considering a hydropower development plan is focused on the occupancy hydropower potential. Surveys on hydropower potential must be periodically reviewed to keep track of how it has been affected by changes in the natural environment (e.g., weather), social environment, economic conditions, etc. While some hydropower potential has been described in Enagia, we have no clear information on if and how often the surveys have been periodically revised. The Survey Team therefore recommends periodic revisions.

12.3.5 Management and Improvement of Fund Procurement

As mentioned in Chapter 9, the total investment in the power sector amounts to 31,548 MUSD. It would be impossible to cover the entire investment in the power sector with national funds. The following are therefore considered as the most feasible options for enabling fund procurement.

- Introduction of private funds
- Utilization of diverse ODA
- Improvement of electricity tariff structures

(1) Establishment of Framework for Introducing Private Funds

One way to reduce the national fiscal burden is to introduce private funds such as IPP. Angola has also enforced a PPP Law from April 2011 with a view of introducing IPP from 2021, but the method for awarding entrance licenses (bidding method), the method for selling contracts, the tariff structure etc. have not yet been made clear. It will therefore be necessary to advance a concrete system design.

(2) Establishing a Method and Scheme to Borrow from Foreign Funds

While Angola has borrowed from European countries and China, support from other aid organizations should henceforth be considered with a view to diversifying fund procurement.

Note, however, that loans provided by OECD member countries and loans provided by aid organizations will entail ideas and financing conditions divergent from those associated with financial assistance from China.

- The projects developed with foreign funds in Angola are initially constructed by GAMEK. Later, after the operation is started, the equipment is handed over to PRODEL, RNT, and ENDE. Borrowed funds are repaid by the Angolan government, and the implementing agency, the borrower of the funds, and the repayer of the funds all seem to be separate in that sense. Considering the financial burden accompanying borrowing and the availability of government guarantees, etc., it will be necessary to reconsider whether the implementing agency, the borrower of the funds, and the repayer of the funds can be separated in this way.
- The entities will have to familiarize themselves with the project formation cycle of each donor organization, to know what will be required for the loan reviews, and to have an accurate idea of how long the project will take to implement. With this information, we can decide which projects to request and which ones to develop by ourselves.
- Government guarantees are necessary for loans from JICA and AfDB. Note, also, that JICA will only implement ODA loans that the partner country officially requests. Therefore, the government of Angola and the agency implementing the project must both establish procedures for approval by the competent authorities and the formal request for the ODA loan.
- The Angolan government, meanwhile, should pay attention to external debt and additionally consider the risk that it will be unable to issue government guarantees. If no government guarantees can be issued, there is a risk that an unavailability of borrowing from outside will bring the development to halt. In such an event, the implementing agency would have to raise the tariff rate and endeavor to enrich its financial content.
- A donor agency wishing to review the case requires an Implementation Report (I/P) report examining the content of the project over a reasonable amount of time and the expense required. JICA, for example, has a system (*) to promote necessary surveys in the project cycle. In order to make use of these, we should be familiar with the project formation cycle of donor agencies.

* Specifically, a Special Assistance Facility Survey (SAF) in line with JICA's project cycle. Three types are available: Special Assistance for Project Formation (SAPROF), Special Assistance for Project Implementation (SAPI), and Special Assistance for Project Sustainability (SAPS).

Table 12-13 shows an example of a project schedule for arranging a JICA ODA loan for a thermal power plant.

Table 12-13 Flow of Implementation of ODA Loan

Timetable	Item	Duration
1. Project Preparation	Fact-finding mission, F/S etc.	1-2 years
2. Official Loan Request	Follow the official procedures of the financial institutions
3. Project formation	Follow the project cycle and make use of an official project formation support system such as SAPROF (※) .	1-2 years
4. Appraisal of the project	If necessary, exchange an E/S loan agreement	
5. Exchange of Notes and Loan Agreement	Sometimes including E/S loans	
6. Project Implementation		4-7 years

(3) Improvement of Tariff Structure

In order to achieve stable power supply and systematic reinforcement of equipment, it is essential that the equipment at each facility be financed with the public power company's own funds. A tariff rate enabling capital recovery must be established to enable this. It will be important, in this regard, to consider action plans by which to realize the tariff rate level examined in Chapter 9.

- The income and expenses related to the project must be considered when examining the tariff rate. The analysis of LRMC in Section 9.3 and the costs per kWh (including financial costs) are examples. The examination of the tariff rate will require ready access to the accounting data at all times.
- On the political level, the actual costs to be incurred tend to be forgotten when a deficit is supplemented with a subsidy to curb the electricity tariff rate of distribution. The extent to which subsidies are to be introduced should be decided after calculating the original income and expenses involved in the project.
- We recommend that the IRSEA evaluate the power generation, power transmission, and distribution costs with reference to the results of this survey and revise the electricity tariff in the future.

12.3.6 Deploying the PDMP and reflecting it in the medium-term plan of each entity

The Power Development Master Plan is a super-long-term plan with a target period of longer than 20 years. As such, the assumptions on which it is based may sharply diverge from the realities over time. Power companies usually deploy and reflect a super-long-term plan into their mid-term plans and prepare annual management plans and implementation plans for individual projects. These plans typically include the following components.

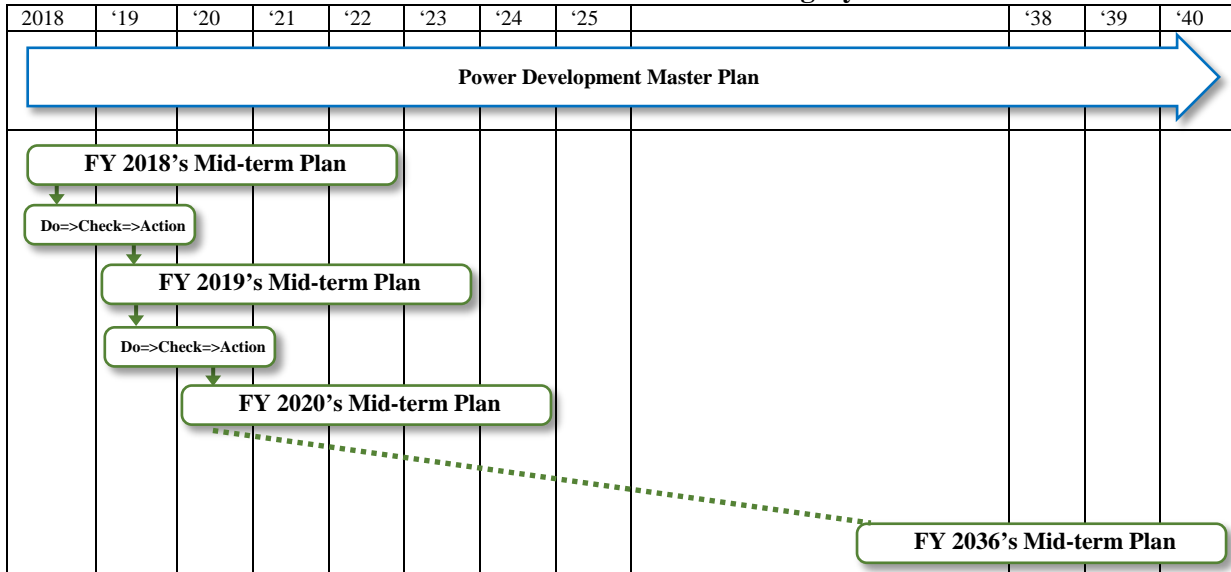
- Power demand forecast
- Generation development plan
- Transmission development plan
- Capital investment plan (based on the generation & transmission development plan)
- Fuel Procurement Plan
- Toll collection plan
- Fund procurement plan
- O&M plan
- Toll collection plan

- Organization & Human Resources Development Plan
- Other

An annual budget is formulated based on these plans.

Even in Angola, RNT, PRODEL and ENDE each formulate a mid-term plan to realize the aforesaid based on the Power Development Master Plan revised by MINEA. These mid-term plans are often revised every year through a Plan-Do-Check-Action (PDCA) cycle.

Table 12-14 Medium-Term Planning Cycle



12.3.7 Improvement of Power Operation System / Introduction of SCADA

As mentioned earlier, Angola is currently unable to accumulate or consolidate various types of operational data. One of the reasons for this is thought to be the practice of entering most of the data into handwritten datasheets and then digitizing later at the head office.

In several S/Ss and power plants we visited during the survey, the operational data was written out by hand and transferred to the headquarters in hard copy form. Computerized operating systems were introduced but unused for the data-keeping purpose.

The use of the computer systems is likely to be discouraged by the poor uniformity of operating systems from project to project and development to development. Smooth data transmission from system to system appears not to have been adequately considered during system installation.

In order to make effective use of these existing systems, it will be necessary to develop middleware and integrate each system to enable data browsing and transmission.

If this approach is applied, remote control of the machines will become possible, enabling use of the machines for SCADA system construction.

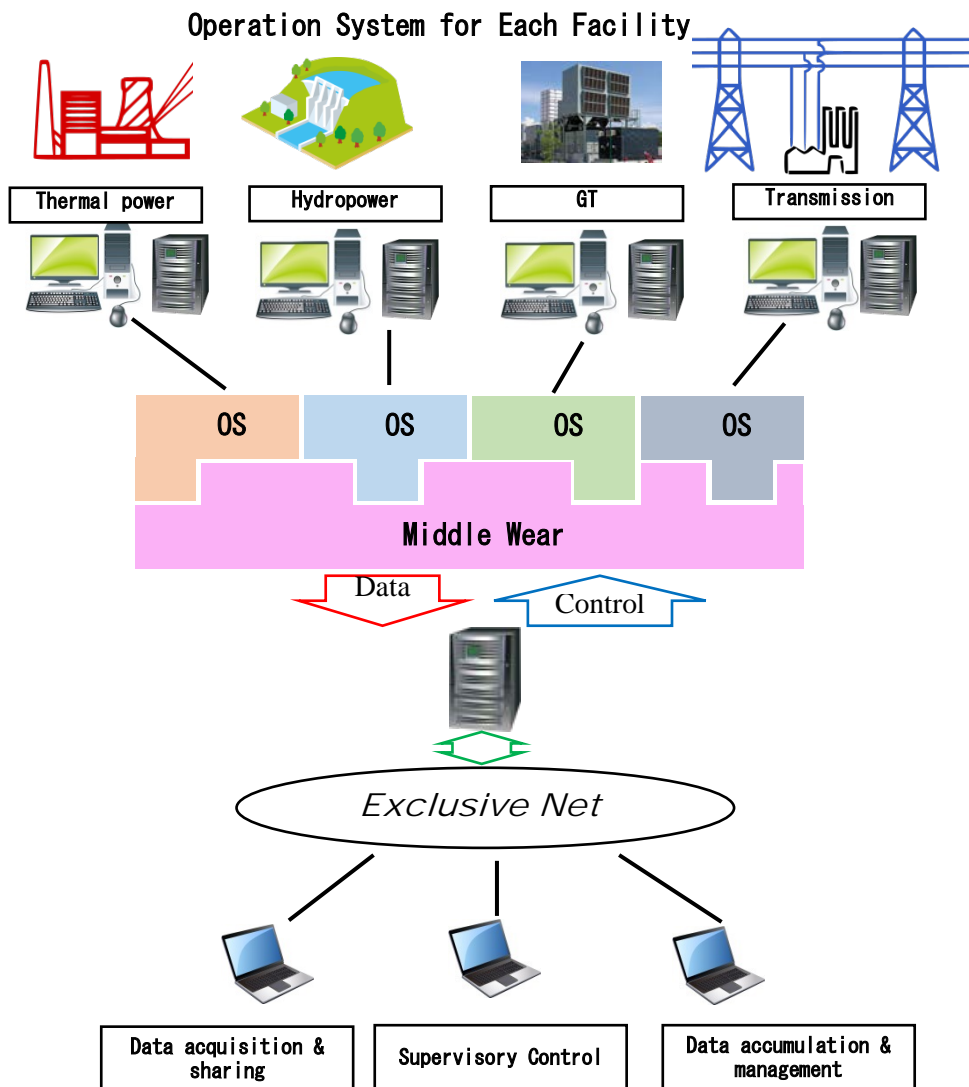


Figure 12-13 Example of SCADA

12.3.8 Improvement of Operation System to Make Use of Power Generation Characteristics

The optimal generation mix is obtained by considering and combining power generation methods with the lowest power generation cost at utilization rates set according to the facility utilization ratios. The cost is cheapest if the GT corresponds to the peak demand area, that is, the low utilization rate area. Meanwhile, it is advantageous to respond to base demand, that is, the large utilization rate area, by hydropower. Conversely, if GT is to be used as a power source capable of responding to peak demand, it will be necessary cease generating electricity by GT over many hours and dispatch a base demand power supply such as hydropower to operate as long as possible. Given that the peak demand is also rapidly changing, the stable supply of electric power will hinge on close and effective control of the time zones in operation. The establishment of the control system will be an extremely important step in making this possible.

Figure 12-13 and Figure 12-14 show TEPCO's load dispatching system. The organization of the whole load dispatching system consists of local load dispatching offices established under a central load dispatching office. Orders to adjust operations, power generation commands, and operation record management procedures are all under the control of the central and local load dispatching offices. Only after establishing such an organization will it be possible to operate a power system according to the characteristics of the power plants. Hence, such an organization will have to be prepared even in Angola.

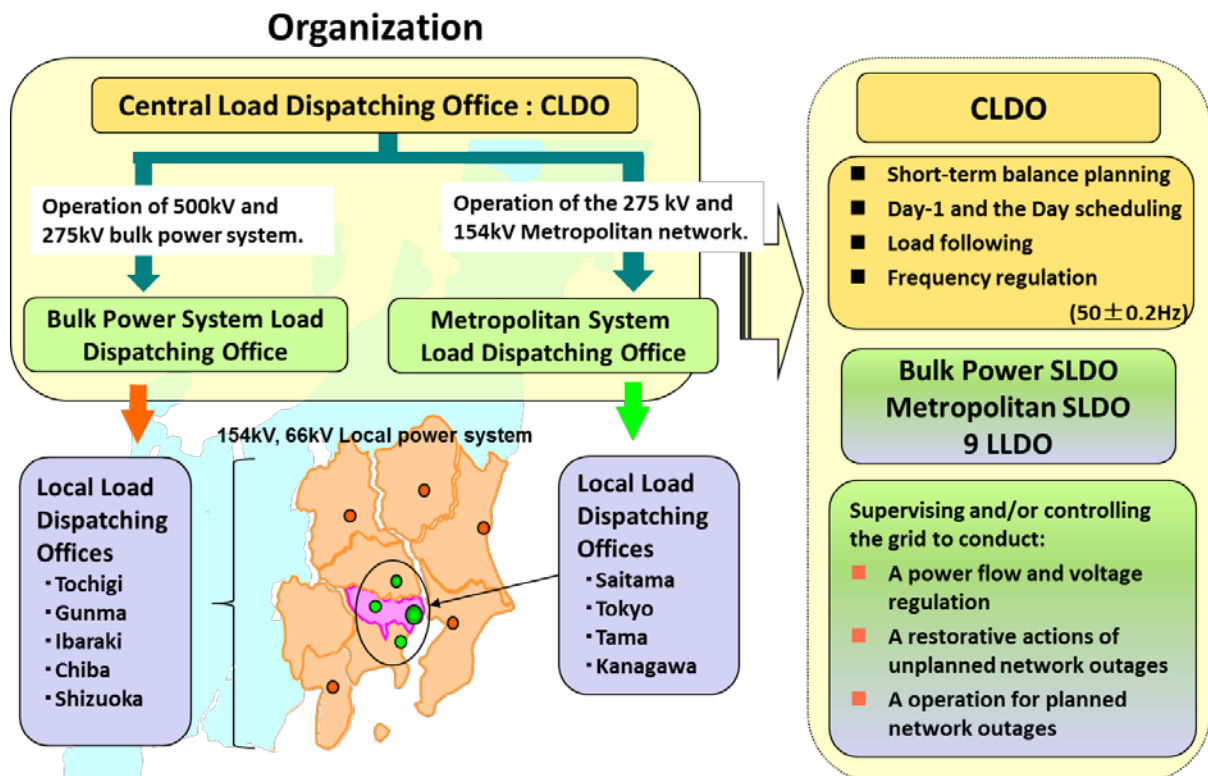


Figure 12-14 TEPCO's Load Dispatching Offices

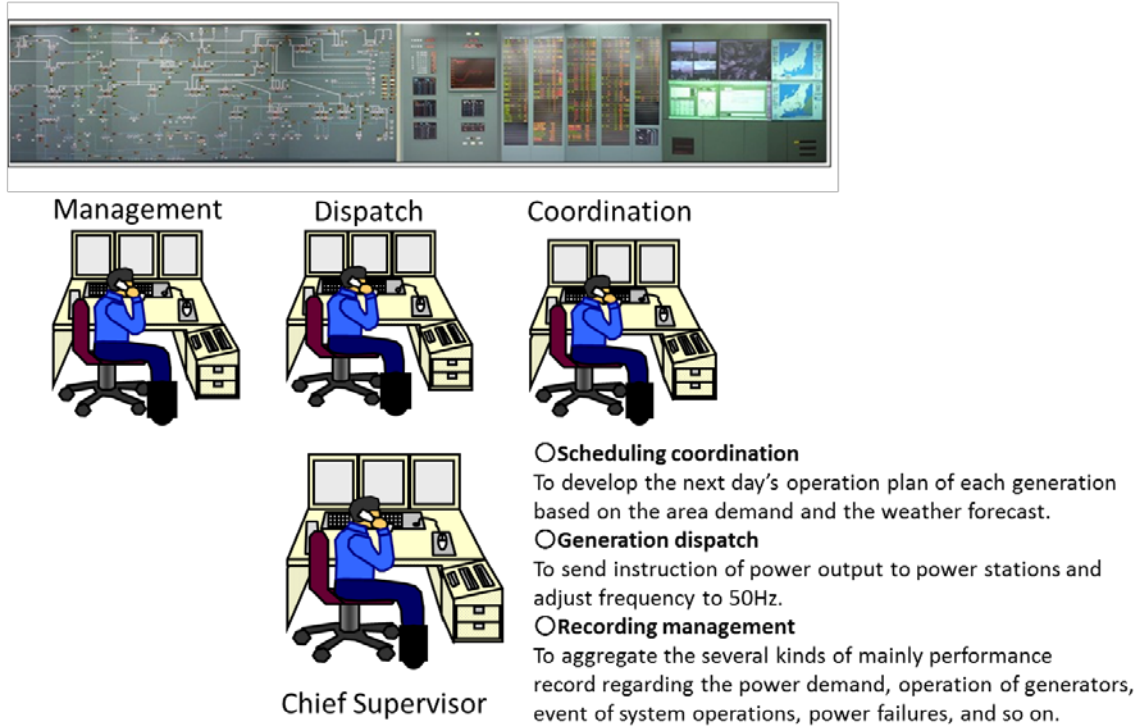


Figure 12-15 Staffing of Load Dispatching Office

12.3.9 Establishment of standards for transmission and substation facilities

Since we have not clearly set up facility planning criteria in Angola at this time, we have set standards for transmission line type / size, transformer capacity, number of units. However in the future, the standard for transmission facilities taking account of regional environmental characteristics is necessary to be established.

The provisional transmission and substation planning standards for this time are shown in Table 12 15 and Table 12 16.

(Each conductor thermal capacity was calculated by Cigre formula according to allowable current calculation condition of conductors in Angola.)

Table 12-15 The standard for Substation facilities

Voltage (Primary/Secondary)	Maximum Number per Substation	Transformer Capacity (MVA)	Remarks
400/220	3	450	usual
		930	heavy load
220/60	3	60	rural
		120	usual
		240	heavy load

(Source: JICA Survey Team)

Table 12-16 The standard for Transmission line facilities

Voltage (kV)	Conductor Type	Number of Conductor per Phase	Transmission Line Thermal Capacity per Circuit (MVA)	Remarks
400	AAAC Sorbus (659mm ²)	2	1519	usual
	''	3	2278	heavy load
220	ACSR Crow (409mm ²)	1	305	rural
	AAAC Yew (479mm ²)	1	343	rural
	''	2	686	usual
	AAAC Sorbus (659mm ²)	2	835	heavy load

(Source: JICA Survey Team)

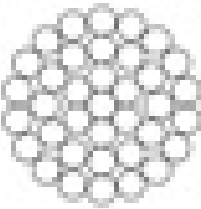
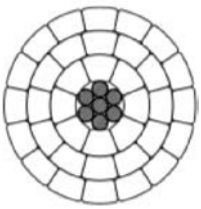
Particularly in the above table, since AAAC (all aluminum alloy stranded wire) is weak against breeze vibration fatigue and has a weak point that the creep amount is large, and its application to a place where the load becomes large (strong wind, icing, large difference in height, etc.), you should be aware of its application.. In addition, fretting corrosion phenomenon (friction corrosion due to vibration) is known to occur, and attention must also be paid to use in coastal areas and desert areas.

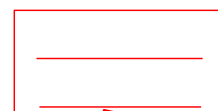
Also, since AAAC is made of aluminum alloy, the power transmission loss is larger than that of pure aluminum type electric conductors. Compared to AAAC Yew which is approximately the same size as LL-ACSR 500 mm which is a low-loss conductor (Low-Loss ACSR: abbreviated as LL-ACSR) developed in Japan, the resistance of LL-ACSR is about 16.7% smaller as Table 12 17 , The initial investment amount due to the high electric conductor price of LL-ACSR can be collected in

10 to 20 years at the place where tidal current is large, and it becomes economical in consideration of the life of electric conductor 40 years.

In the future, planning of transmission lines with large currents should be done, planning criteria should be determined considering power transmission loss well enough.

Table 12-17 Compare of AAAC and LL-ACSR

Description		Unit	Conventional	Recent
			AAAC Yew	LL-ACSR 500mm ²
Cross sectional view		—		
Nominal diameter		mm	28.4	27.00
Cross sectional area	AL	mm ²	479	500.2
	Core			21.99
	Total		479	522.2
Nominal weight		kg/km	1,319	1,546
DC resistance at 20 deg. C		ohm/km	0,069	0.05750
Unit price		USD/km	5,000*	7,420



(Source: JICA Survey Team)

Table 12-18 Schedule for Action Plan on PDMP

		2018-'20	2021-'25	2026-'30	2031-'35	2036-'40
Establishment of Organization to Formulate PDPM	MINEA RNT PRODEL ENDE	Establishment of IPDP				
Revision of PDPM	MINEA/IPDP		▼	▼	▼	▼
<ul style="list-style-type: none"> ➤ Actions to improve the accuracy of the Power Demand Forecasting ✧ Organizing and accumulating information ✧ Hearings with customers 	RNT ENDE	Design & introduction of SCADA		Efficient accumulation and analysis of data		
		Enhancement of customer hearing system; Continuation of hearings				
<ul style="list-style-type: none"> ➤ Revision of study on occupancy hydropower potential 			▼	▼	▼	▼
Formulation of mid-term plan	RNT PRODEL ENDE	Review of the mid-term plan year by year				
Design of electricity tariff structure	IRSEA	Tariff structure design		until the start of liberalization at the latest		
Institution design for IPP entry <ul style="list-style-type: none"> ➤ Concession system, PPA system, etc. 	IRSEA	Institution design for IPP entry		until the start of liberalization at the latest		
Renovation of load dispatching organization <ul style="list-style-type: none"> ➤ Reform of load dispatching offices ➤ Introduction of SCADA 	RNT PRODEL	Reform of load dispatching offices				
		Introduction of				