Chapter 8 Review on Private Investment Environment

8.1 Report on private Investment

(1) 'Doing Business 2017' from the World Bank

First, the JICA Survey Team reviews the 'Doing Business 2017' Report to learn about the business environment of Angola.

The World Bank (WB) publishes a 'Doing Business' report on the ease of doing business based on indicator sets every year. The latest 'Doing Business 2017' report evaluates data such as the days necessary to complete the application process and the required fees. Out of 190 countries covered in a country ranking, Angola ranks 182nd (versus rankings of 25th for Portugal, 74th for South Africa, 137th for Mozambique, and 169 for Nigeria).

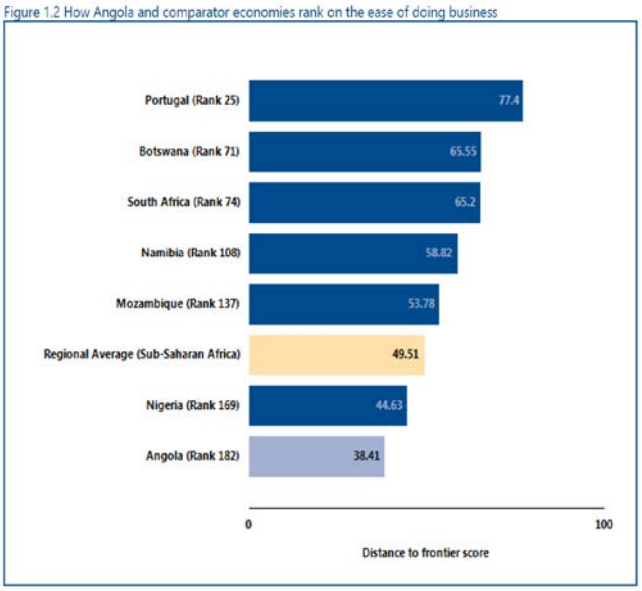


Figure 8-1 Ranking of Angola and other comparator countries

Item by item, Angola ranks 181st in 'Getting Credit,' 183rd in 'Trading across Borders,' 186th in 'Enforcing Contracts,' and 169th in 'Resolving Insolvency.' The rankings are based on the distance to the frontier score for each topic: i.e., the best country on the frontier is scored 100 and the other countries are scored from 0 to 100 according to their absolute distances to the frontier.

Figure 1.3 Rankings on *Doing Business* topics - Angola
(Scale: Rank 190 center, Rank 1 outer edge)

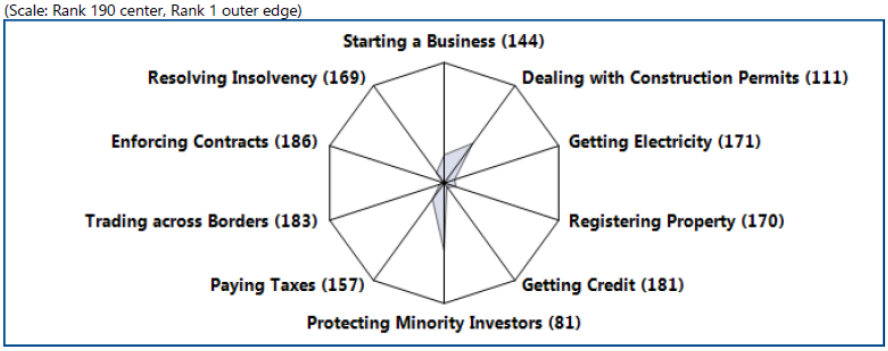
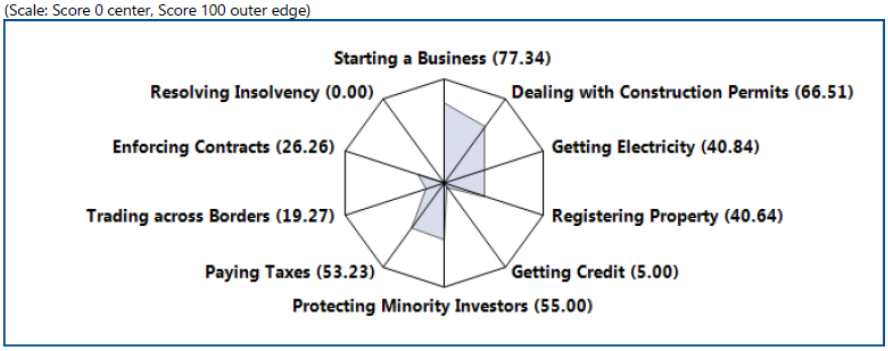


Figure 1.4 Distance to frontier scores on *Doing Business* topics - Angola
(Scale: Score 0 center, Score 100 outer edge)



Source: Doing Business database.
Note: The rankings are benchmarked to June 2016 and based on the average of each economy's distance to frontier (DTF) scores for the 10 topics included in this year's aggregate ranking. The distance to frontier score benchmarks economies with respect to regulatory practice, showing the absolute distance to the best performance in each *Doing Business* indicator. An economy's distance to frontier score is indicated on a scale from 0 to 100, where 0 represents the worst performance and 100 the frontier. For the economies for which the data cover 2 cities, scores are a population-weighted average for the 2 cities.

(Source: Doing Business database)

Figure 8-2 Ranks and scores for each topic

The JICA Survey Team understands that the problems of Angola concentrate around these low-scored items. The World Bank issued the following explanations in this regard.

- ✓ Credit information systems are not widely used. → Collateral laws or Bankrupcys law are not enacted. Borrower financial credit histories are not shared. Financial statements are not used effectively in providing credit.
- ✓ Contracts are not widely enforced. → no commercial dispute resolution system is established.
- ✓ Liquidation or insolvency systems are not well established. → Angola has not experienced any liquidation or insolvency.

8.2 Review of the Private Investment Environment Report

This section identifies bottlenecks in the private investment environment and summarizes plans to develop a private electric power project.

8.2.1 Private investment environment in Angola

(1) Private Sector Country Profile: Angola

The report describes problems in Angola's private investment environment broken down into three factors: the 'institutional factor,' 'economical factor,' and 'other factors.' The problems are summarized in the table below.

The JICA Survey Team reviewed the 'Private Sector Country Profile: Angola in 2012,' the first comprehensive business guidebook on Angola. The profile began with the geographical conditions of the country and then moved onto the recent political conditions, economic conditions, and finally the conditions of the investment environment. In 2015, the African Development Bank published its Portuguese edition. Unlike the 'Doing Business Report' from the World Bank, the contents of the Portuguese edition have not been updated.

The report describes problems in Angola's private investment environment organized into three factors: the 'institutional factor,' 'economical factor,' and 'other factors.' The problems are summarized in the table below.

Table 8-1 Problems in Angola's investment environment

	Problems in the private investment environment
institutional factor	・Laws and contracts tend not to observed. ・Infrastructures such as power and water supply are not properly established. ・It takes much time to obtain approvals for applications.
economical factor	・All daily products are imported by exporting oil. The official foreign currency reserves therefore depend on the oil price. ・No stock market exists. ・A monetary market exists, but is weak and vulnerable. ・Credit evaluations for borrowers are poorly executed. Accounting data that reflect financial conditions is insufficiently used.
other factors	・The labor market for skilled workers is immature.

(Sources: AfDB 'Private Sector Country Profile: Angola' in 2012')

8.2.2 Legal system in Angola

The legal system in Angola is principally based on Portuguese law. Laws, Decrees, and Acts restated to private investment, meanwhile, are being enacted apart from basic laws such as the Civil Law, Labor Law, etc.

The National Bank of Angola (BNA) has a statutory authority to adopt the accounting standards for financial institutions. Especially banks that meet at least one of the criteria in 2015 must adopt IFRS. Other banks also must adopt IFRS issued by IASB but may do so voluntarily from 2016. Many companies other than financial institutions mentioned above do not adopt IFRS. They are said to prepare the financial statements in conformity with the Angolan Accounting Law and the General Accounting Plan (PGC) that was adopted by the Presidential Decree as of 2001.

In this section the JICA Survey Team extracts the laws and regulations it considers important for private investment in Angola, out of those described in the report on the business environment. Note, however, that no laws intended for specific sectors other than the power sector are selected. The new Private Investment Law (newPIL), a law that will be important for private investment, will be reviewed in a later section.

Table 8-2 Names of laws related to the private investment environment

Name	year	contents
Anti money Laundering Law	2010	set up a penalty on Money Laundering
Countering Financial of Terrorism Law No.34/11	2010	Penalty on Public Probity
Public Asset Managing Law, with Presidential Decree	Aug. 2010	for inventory of State Petimnoy, in bidding process
President Decree 177/10	ditto	
New Private Investment Law	May, 2011	New PILwas enacted in 2015.
	→Aug. 2015	ANIPwas establishe in 2003
Exchange Law No.5/97	Jun. 1997	Trade activity : President Decree No.265/10 (Nov. 2010),
		specific rules: BNA's Notice No.19/2012 (Apr. 2012)
Commercial Societes Law Law 01/04	Feb. 2004	defines types of fims

(Sources: AfDB 'Private Sector Country Profile: Angola in 2012')

8.3 Interviews with Japanese companies

8.3.1 Interviews with Japanese Companies in Angola

In October 2017, the JICA Survey Team interviewed three Japanese companies doing business in Angola: Sumitomo Corporation (Sumitomo Syoji), Marubeni, and Toyota de Angola, S.A (Toyota Tusho). Sumitomo Corporation and Marubeni operate Representative Offices in the country, and Toyota de Angola, S.A. is a Joint Stock Company. Sumitomo Corporation is said to have concluded a Minutes of Understanding (MOU) with the Government of Angola for the construction of Japan-made diesel power plants, but the details of the plan are not known.

Issues

① What hardships are they going through in doing business in Angola?
② What bottlenecks are there in Angola's legal system?
③ Is the New Private Investment Law (new PIL) of help in developing new projects?
④ Other

（results）

① Hardships in doing business ・The low oil price binds the foreign reserves of Angola. Private companies are therefore unable to freely remit money outside of Angola. (Nacional Banco of Angola conducts a bid every week and only companies awarded bids are entitled to remit money.） ・ The laws are drafted in Portuguese, the official language, which makes them hard to read and understand.
② Legal bottlenecks ・New Presidential Decrees are being enacted. Actual business follows not the basic laws but the Decrees. ・Interpretation of law varies.
③ Request and opinions on the newPIL ・Laws are enacted, but direct negotiations will prevail.

④ Other
・The monetary market in Angola is weak and provides no good financial products
・Chinese companies doing business in Angola are said to settle their services not by cash but barter for oil. They are therefore immune to the influences of the strict regulations on bank remittance.

8.4 New Private Investment Law

8.4.1 New Private Investment Law (2015)

The New Private Investment Law, a law expected to have strong influence on private investment and project formation in Angola, was approved on August 11, 2015. It was entered into force on the same day that the former private investment law was repealed (Law No.20/11 of May 20, 2011).

A new agency called APITEX (Angolan Investment and Export Promotion Agency) was also formed to promote investments and exports.

An outline of the New Private Investment Law follows.

- ✓ The newPIL no longer includes minimum thresholds for investments. But to qualify for tax benefits and incentives, a foreign investor must invest at least $1 million and a domestic investor must invest at least $500,000.
- ✓ Decisions regarding private investments are in principle taken by the ministers responsible for the main sectors in which the investments are made, or by the Angolan executive (i.e., the President).
- ✓ The New Private Investment Law restricts indirect investment.
- ✓ An investor can be granted certain tax benefits and incentives, albeit no longer automatically.
- ✓ In the electricity and water sectors, the Angolan party should retain an interest of at least 35% in a joint venture.
- ✓ An investor can repatriate dividends, profits, and royalties. Any portion of a repatriated amount exceeding the funds of the company is subject to an additional tax.

8.4.2 Private power project in accordance with the New Private Investment Law

The details of a private electric power project are outlined below.

- ✓ In order to qualify for tax benefits and incentives, a foreign investor must invest at least $1 million and a domestic investor must invest at least $500,000. Negotiations are held directly with the Minister of Energie and Aqua (MINEA) or the Angolan executive (i.e., the President).
- ✓ Any tax incentives are decided and applied through negotiation.
- ✓ A foreign investor forms a joint venture with Angolan individuals or an Angolan company. The Angolan party retains an interest of at least 35% in the joint venture.
- ✓ After paying additional taxes, a foreign investor is eligible to repatriate dividends, profits, and royalties.

At present, the private investment environment in Angola is still underdeveloped. While every country and company recognizes the big potential of Angola, they are still reluctant to go ahead.

A power project by a private sector differs from an ODA project, in general, as no guarantees from the government are obtained. The private sector must therefore bear all of the risks such as the fluctuating prices of fuel and materials, foreign exchange, interest rates, etc. by itself.

Finally, the following are requested when private electric power projects are formed in Angola.

- Every party member observes and acts in accordance with the contract.
- The political system in Angola is stable and assets will not be nationalized.
- A reasonable long-term PPA (Power Purchase Agreement) is concluded. Tariffs are set to adequately secure a certain profit level over the long term.
- Profits earned are allocated in accordance with equity or the contract.
- A foreign investor is free to remit profit and dividends outside of Angola irrespective of the economy of Angola. (※)
- Funds from the monetary market of Angola are preferred: reasonable interest rates (not so high) and longer repayment periods.

※The auction system to settle payments for foreign countries re-started in 2018, with which the winner of the auction is entitled to receive foreign currencies for remittance. However this system seems to work only for a winner so that it does not meet requests from all import companies in Angola.

8.5 Summary and Bottlenecks

- Factors apart from the private investment issues tend to affect candidate projects. As a consequence, there seems to be little incentive to develop private investments overall. The Government needs to promote the observance of contracts and high transparency in appraising and approving projects.
- The lack of actual private investment projects to date leaves Angola with little experience in completing specific PPA agreements. As a result, negotiations and approvals may take longer.

Chapter 9 Long-term Investment Plan

9.1 Premise for fundraising

The progress of power development in Angola is mainly driven by PRODEL, RNT, and ENDE in an environment where private companies lack strong inclination to develop power projects by themselves. Under these circumstances, PRODEL will become a major implementing agency for generation, while ENDE will become the main implementing agency for transmission and distribution.

The JICA Survey Team reviews the financial statements for PRODEL, RNT, and ENDE. Given the apparent difficulty these companies would have in investing more with their own profits, they are likely to request funds from outside.

9.2 Fundraising for investment

First, the JICA Survey Team reviews whether it will be able to raise funds by issuing a bond or taking out a loan in a monetary market of Angola. As for the recent market condition, the official website of Banco Nacional de Angola (BNA) as of October 26, 2017 indicates a loan condition in terms of AOA, with an interest rate of 20.04% and repayment period of 1-3 years. The average interest rates for Treasury Bills with maturities of 91, 182, and 364 days, meanwhile, have been 16.12% (91 days), 23.19% (182 days), and 23.94% (364 days). In 2015 Angola raised $1.5 billion by selling its first Eurobond, offering a yield of 9.5% with a maturity of 10 years. Considering this information, conditions for a non-sovereign bond would be more difficult.

Note: Fitch assigned the bond a “highly speculative” rating of B+ in line with Angola’s sovereign ratings at the time. Angola was rated Ba2 by Moody’s and B+ by Standard & Poor’s and Fitch.

The issue of stock in Angola is improbable, as no stock market exists in the country. Actual fundraising must therefore depend on international monetary intermediaries such as the World Bank (WB), African Development Bank (AfDB), and Japan International Corporation Agency (JICA).

9.2.1 ODA loan

According to the definition of the Development of Co-operation Directorate (DAC), an ODA loan is a loan that includes a grant element of more than 25%. A loan with a greater grant element is advantageous to the borrower or borrowing country. International donor organizations such as the World Bank, AfDB, and JICA are eligible to extend such ODA loans.

Note: The grant element reflects the concessionary nature (i.e., softness) of a loan. The ratio of the grant element rises as the interest rate falls and the repayment period lengthens.

(1) Loan Conditions Extended by the International Financial Institutions

The World Bank (WB), European Bank for Reconstruction and Development (EBRD), and African Development Bank (AfDB) are all international financial institutions that provide ODA loans. Among them, however, the AfDB would be more familiar to Angola, a country located in the Sub-Saharan Region. The JICA Study Team visited the official website of AfDB to review the conditions of a Sovereign Guaranteed Loan (SGL) from the bank.

- Currency :USD, EUR, JPY, and others
- repayment period: maximum 20 years (grace: maximum 5 years)
- interest: 6MLIBOR（float）＋Funding Margin＋Lending Margin（60bp）
- principal: equal installments after the end of the grace period (other methods are acceptable)
- front end fee: none
- commission fee: charged
- other: other conditions added depend on the project

Characteristics of an SGL: ① a comparatively long maturity of up to 20 years, including a grace period; ② the borrower can choose a currency out of a few choices; ③ the interest rate is defined as 6MLIBOR (USD, JPY)+ funding margin + lending margin (currently 60bp); ④ a 5-year grace period is extended to the borrower.

According to the official website of AfDB on March 12, 2018, the 6MLIBOR (Fixed Spread Loan in USD), including the lending spread, was set at 1.85%, and the front-end fee was 25bp.

(2) ODA Loan by JICA

Japan International Corporation Agency (JICA) provides ODA loans, including Yen loans, under the frameworks of bilateral corporation between Japan and recipient countries. The JICA Study Team visited the official website of JICA on March 12, 2018 to review the loan conditions for Yen loans. According to the website, Angola is classified as an LDC country. The following conditions are applied to LDC countries.

- currency: JPY（Japanese Yen）
- repayment period: 30 year (grace: 10 year)
- interest: 1.0% (fixed), applied after October 17, 2017
- principal: equal installment of 20 years

Characteristics of a Yen Loan: ① long maturity of 30 years, including the grace period; ② JPY currency; ③ low interest rate (1%), ④ payment of principal not required during the grace period.

(3) Some Remarks on ODA Loan

Several points must be considered when receiving an ODA loan.

- AfDB can only extend an SGL loan to a regional member country (RMC).

- A guarantee from the Government of Angola is needed when AfDB provides a loan to a project in Angola.
- A certain procedure is required to conclude a JICA Yen Loan. First, the Government of Angola must send an official request for an ODA loan. Next, the Government of Japan appraises the candidate project. Next, the Government of Japan exchanges an E/N with the Government of Angola and finally concludes the L/A. It will actually take at least 2-3 years to conclude the L/A.
- A guarantee from the Government of Angola is needed when JICA provides a loan to a project in Angola.

In a case where the implementing agency does not expect the ODA loan or may not receive the ODA loan, it may request Export Credit from Export Credit Agencies (ECA) in foreign countries as an alternative option. When Angola plans to import plants from Japanese manufacturing companies, it requests export credit from the Japan Bank for International Corporation (JBIC), the ECA of Japan.

The provision of Export Credit needs a guarantee from the Government. An ECA loan is faster than an ordinary ODA loan when the implementation agency successfully obtains the Government's guarantee and commercial banks forming a syndicate with JBIC are ready to provide co-financing. Moreover all OECD member countries, including Japan, are to provide the Export Credit in accordance with '*the Arrangement on Officially Supported Export Credits.*' Consequently, the condition of Export Credit provided by each OECD member country shall be the same.

Meanwhile, historically Angola has been receiving loans or ECAs from the Chinese Export-Import Bank. As a country outside of the OECD, China can provide loans with different loan conditions. When the JICA Study Team visited the official website of the China Export-Import Bank to find the specific loan conditions, no specific loan conditions with figures were disclosed.

Here is the ECA condition JBIC provides as of March 12, 2018, based on information from the official website of JBIC. Commercial Interest Reference Rates (CIRR) is as follows.

- currency: USD ($)
- repayment period: over 8.5 years
- interest: 3.780%
- principal: equal installments or another method
- Beside the interest, the borrower needs to pay an up-front fee as a risk premium. As Angola is classified in Category 6 as of February 2, 2018, Angola needs to pay 12.88% of the up-front fee.
- Candidate borrower (i.e., the implementing agency in Angola) needs to be covered with the insurance issued by NEXI, the Export Insurance Company of Japan, when it requests export credit from JBIC. A visit to the official website of NEXI on March 9, 2018 confirmed that Angola is classified in Category G. The premium calculated with the attached calculation sheet from NEXI is 15.832%.

9.2.2 Typical Loan Conditions

The table below summarizes typical loan conditions for ① an AfDB Loan (AfDB), ② Yen Loan (JICA), ③ commercial loan in Angola, ④ ECA. Each of the foregoing types has its own procedures, appraisal system, and conditions. While it is difficult at this juncture to determine which of the above types is best, a loan with a longer repayment period and lower interest would impose a lighter financial burden.

Note also that the funds are provided with a sub-loan instead of an original loan the implementation agency may lose the merit of the latter.

Table 9-1 Typical Loan Conditions

	type	loan condition
1 AfDB loan (AfDB)	ODA	currency: USD, EURO, JPY and others interest rate: 2.16444% (estimated) (6MLIBOR +fund margin +lending margin(60bp)) maturity: up to 20 years (grace period up to 5 year) principal: equall installments other conditions: commitment fee etc.
2 Yen Loan (JICA)	ODA	currency: JPY interest rate: 1.0% maturity: 30 years (grace period: 10year) principal: equall installments others: -
3 Commercial Loan	commercial loan	currency: AoA interest rate: 20% (estimated) maturity: 3 years principal: - others: -
4 Export Credit	commercial loan	currency: JPY, USD, EURO etc. interest rate: 3.78% (USD, over 8.5 years) maturity: over 8.5 years principal: equall installments other conditions: pay the front-end fee, insurance may be needed.

9.3 Long-term Investment Plan

9.3.1 Summary of the Long-term Investment Plan

The JICA Study Team reviewed the long-term power development plan as of March, 2018. The development plan has two parts: the power development plan to meet the demand forecast and the development plan for the transmission lines and sub-stations.

The table below shows the unit prices necessary to construct power plants, transmission lines, and sub-stations. (The unit prices for hydro and thermal power plants are shown in section 6.3.)

The power development plan up to Year 2040 consists of hydropower projects, thermal power projects (CCGT and GT), transmission line projects (220 kV and 400 kV), and sub-station projects (220 kV and 400 kV). Meanwhile, construction of the renewable energy (wind and solar) facilities will be left to other developers, and power will be purchased from them.

Table 9-2 Unit Prices for Construction

Type		unit capital cost ($/kW)	Note
Hydro power	Large scale	2,700	Average in Angola
	Medium/Small	5,400	ditto
Thermal power	Combined Cycle	1,200	Construction cost of SoyoTPP
	Gas Turbine	650	International price
	Diesel	900	International price
Renewable	Wind	-	Considered in generation cost
	Solar	-	Considered in generation cost
Transmission	220 kV	0.36 mil/ km 0.45 mil/ km	1line 2nd line
	400 kV	0.78 mil./km 0.98 mil/ km	1 line 2nd line
Sub-station	200 kV	0.054*(MVA)+11.58mil	per station
	400 kV	0.024*(MVA)+29.67mil	per station

(1) **Investment in terms of the Commissioning Year**

Following are investment plans by the commissioning year. The total investment comes to 31,548 million USD: hydropower (19,083 million USD), thermal power (6,413 million USD), renewable energy (0 million USD), transmission lines (4,417 million USD) and sub-stations (1,636 million USD).

Table 9-3 Long-term Investment Plan up to 2040 (commissioning Year)

(unit: mil. $)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hydro	0	0	5,589	34	0	0	0	0	5,864	810	0	567	0	0
TPP	300	0	0	0	1,050	531	0	531	81	0	81	450	81	163
Renewable	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission	208	0	2	279	0	878	556	2	1,614	0	785	0	0	18
Sub-station	0	25	0	225	0	444	51	0	196	0	426	0	0	18
total	508	25	5,591	539	1,050	1,854	607	533	7,756	810	1,293	1,017	82	199

(unit: mil. $)

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	total
Hydro	0	2,565	0	0	2,430	0	0	1,223	0	0	**19,083**
TPP	450	163	325	450	163	450	244	450	0	450	**6,413**
Renewable	0	0	0	0	0	0	0	0	0	0	**0**
Transmission	34	0	0	8	6	0	6	0	18	2	**4,417**
Sub-station	129	0	0	0	103	0	0	0	18	0	**1,636**
total	613	2,728	325	458	2,701	450	250	1,673	36	452	**31,548**

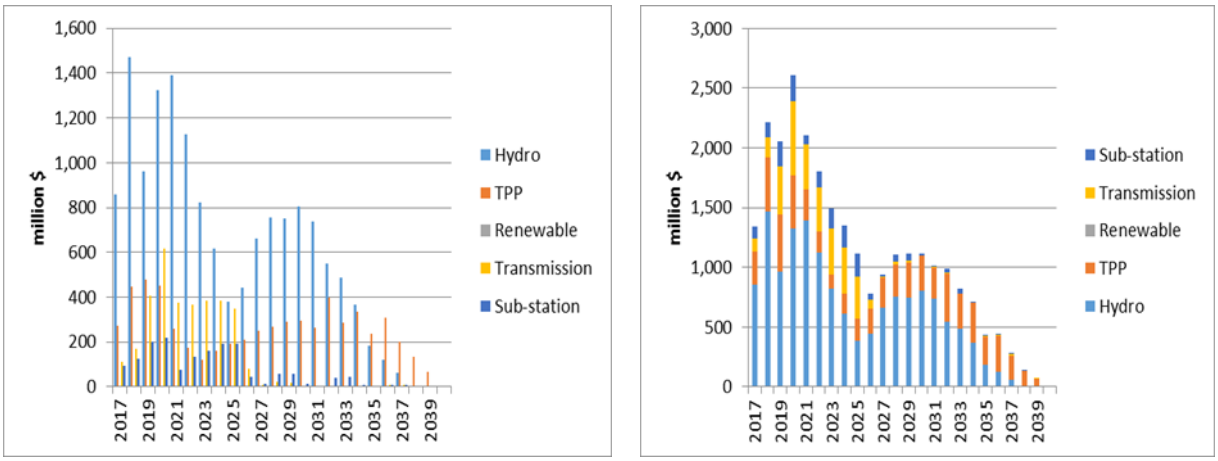


Figure 9-1 Annual Investment up to 2040 (in terms of the Construction Schedule)

The following describes the JICA Study Team's review of the scale of the long-term investment plan. As PRODEL is responsible for generation and RNT is responsible for transmission and sub-stations, the review estimates the size of the investment amounts compared to the sales and net profit levels of PRODEL and RNT in 2016.

Table 9-4 Long-term Investment and 2016 Sales and Net Profit levels of PRODEL and RNT

total investment amount up to 2040	Financial Statement (2016) (b)	(a)／(b)
investment for generation: 26,262 mil. $	PRODEL sales: 1,025 mil. $ (=220,420.7 mil. AOA) net profit: 8.66 mil. $ (=1,862.6 mil. $)	25,6 3,032
investment for transmission & sub-station: 6,187 mil. $	R N T sales：405.9 mil. $ (=87,297.665 mil. AOA) net profit: 20.3 mil. $ (=4,381.762 mil. AOA)	15,2 304,8

※USD is converted using the official exchange rate of Nacional Banco de Angola as of March 12, 2018 ($1=215.064 AOA (T.T.M))

The total investment in hydro and thermal power is 24.9 times the sales of PRODEL in 2016, or 2,944 times the net profit of PRODEL in the same year. The total investment in transmission and sub-stations is 14.9 times the sales of RNT in 2016, or 298.1 times the net profit of RNT in the same year. The investment amounts are so big, neither PRODEL nor RNT seems capable of obtaining the necessary funds with its current retained earnings. Thus, the new investment must be funded through borrowings from financial institutions.

(2) Long-term Investment in terms of the Construction Schedule

The agency implementing the new project will not need all of the funds in the commissioning year. Rather, it will require the funds year by year in accordance with the construction schedule. A standardized construction schedule for each facility is shown below.

Table 9-5 Standardized Annual Construction Schedule during the Construction Period.

	-8	-7	-6	-5	-4	-3	-2	-1
Hydro (Large)	5%	10%	15%	20%	20%	15%	10%	5%
TPP 1 (CC)					25%	30%	30%	15%
TPP 2 (Gas)				15%	25%	20%	15%	25%
Renewable (wind)	no construction but purchase power							
Renewable (solar)								
Transmission (220kV)					5%	40%	45%	10%
Transmission (400kV)					5%	40%	45%	10%
Sub-station (220kV)					5%	40%	45%	10%
Sub-station (400kV)					5%	40%	45%	10%

The total investment amount over the construction schedule is 26,023 million USD, consisting of 14,867 million USD for hydropower projects, 6,113 million USD for thermal power projects, 0 million USD for renewable energy projects, 3,339 million USD for transmission projects, and 1,705 million USD for sub-station projects.

Table 9-6 Long-term Investment Amount up to 2040 (in terms of the Construction Schedule)

(unit: mil.$)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Hydro	857	1,469	962	1,323	1,392	1,127	821	616	382	441	663	756	749	804
TPP	275	448	478	450	259	176	120	161	192	212	249	269	289	294
Renewable	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission	113	170	407	752	419	702	765	470	347	78	9	22	17	4
Sub-station	93	124	203	220	77	135	161	190	192	44	14	60	60	13
total	1,337	2,210	2,051	2,745	2,148	2,139	1,868	1,437	1,113	776	935	1,106	1,116	1,114

(unit: mil.$)

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	total
Hydro	737	548	488	366	183	122	61	0	0	767	**15,634**
TPP	265	398	288	337	239	308	203	135	68	0	**6,113**
Renewable	0	0	0	0	0	0	0	0	0	0	**0**
Transmission	3	6	4	3	3	8	9	3	0	0	**4,314**
Sub-station	5	41	46	10	1	7	8	2	0	0	**1,705**
total	1,010	993	825	716	427	446	281	139	68	767	**27,766**

The following study assumes that the necessary funds will be borrowed in accordance with the annual construction schedule. Depreciation and O&M expenses are incurred after the commissioning year. The interest and principal payments take place in accordance with the repayment schedule.

(3) Presumptions for borrowing

The presumed loans and loan conditions are summarized as follows.

- In other countries, the agency implementing a project generally becomes both the borrower and repayer of the loan. This means that the implementing agency is responsible for repaying the loan. In Angola, however, GAMEK seems to responsible for construction with a loan

obtained from an outside party. The newly constructed facility is to be handed over to PRODEL, RNT, or ENDE after commissioning, and the Government of Angola is responsible for repaying the loan. In this case, we cannot clearly discern who will borrow the loan and who will pay it off afterwards.

- It does not appear that PRODEL, RNT, and ENDE will be directly responsible for repaying the loan. This study assumes, however, that the implementing agency will be both the borrower and the repayer. It also assumes that all financial costs related from the borrowings, along with depreciation and O&M costs, will be debited in the financial statements of PRODEL and RNT.
- Considering the current financial conditions of PRODEL and RNT, they are very unlikely to be able to develop new projects with their own retained earnings. Thus, all projects are assumed to be developed through borrowings.
- The following three loans will be available for projects of Angola: (1) a Yen loan extended by JICA, (2) an ODA loan extended by African Development Bank (AfDB), (3) Export Credit extended by JBIC. Over the past few years, ODA agencies have tended to provide ODA loans to hydropower projects, transmission projects, and sub-station projects that have slim prospects for high profitability. Conversely, the agencies are unlikely to provide ODA loans to thermal power projects that have strong prospects for commercial profitability and are expected to be developed as IPP projects.
- The study therefore assumes that the hydropower projects and transmission and sub-station projects will be developed with ODA loans, while the thermal power projects will be developed with ECAs.
- The Yen loan extended by JICA and the ODA loan extended by AfDB are assumed to have upper ceilings of 85% of the total borrowing. This means that the implementing agency must fill the remaining 15% by itself while requesting to borrow 85% of the total investment. Likewise, the Export Credit is also assumed to be capped by a ceiling of 85% of the total investment.
- The study also considers the Interest During Construction (IDC) as part of the total asset after the commissioning year.

Table 9-7 Loan Conditions for Candidate Loans

	type	interest rate	currency	maturity year	grace year	front end fee	reference
Yen Loan	1	1.00%	JPY	30	10	0.20%	up to 85%
AfDB/(WB) loan	2	1.855%	USD	20	5	0.25%	up to 85%
(AfDB FSL USD)							
JBIC ECA USD	3	3.78%	USD	10	0	12.88%	

The total loan amount up to 2040 is 22,120 million USD. The interest, front-end fee, and repayment of principal respectively come to 2,963 million USD, 674 million USD, and 3,936 million USD.

Table 9-8 Borrowings up to 2040 and Financial Expenses

(unit: mil. $)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
loan amount	1137	1878	1743	2333	1826	1818	1587	1222	946	659	794	941	948	947
interest	0	28	54	84	103	120	132	141	148	151	156	163	170	177
f-end fee	0	52	55	56	32	23	16	20	23	24	28	31	33	34
principal	0	38	79	119	141	156	167	180	197	215	236	296	346	428
total	0	118	187	260	276	298	315	341	367	390	420	489	549	639

(unit: mil. $)

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	total
loan amount	859	844	702	609	363	379	238	118	58	652	**23,601**
interest	109	124	135	145	149	154	155	152	147	140	**3,035**
f-end fee	30	45	32	38	26	34	22	15	7	0	**676**
principal	28	61	86	114	135	161	178	190	195	195	**3,941**
total	166	230	253	297	310	349	355	357	350	335	**7,653**

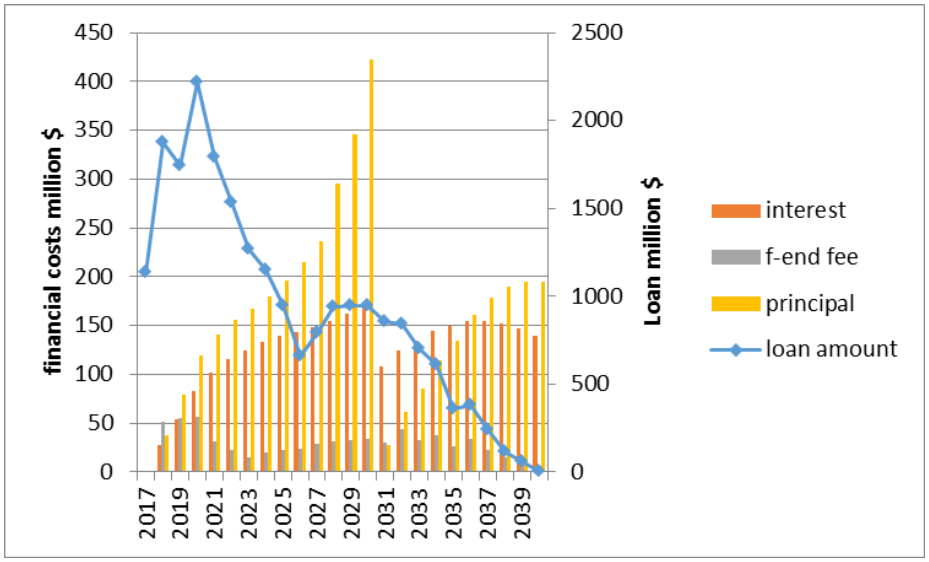


Figure 9-2 Borrowings up to 2040 and Financial Expenses

(4) Presumptions for O&M expense and depreciation

The presumptions after commissioning are as follows.

- New facilities are commissioned on the 1st of January of the commissioning year. Construction of transmission lines to be connected to newly constructed power plant will be completed one year in advance of the commissioning year of the power plant.
- Annual depreciation is calculated by the straight-line method. The residual value is zero.
- The O&M expense for a power plant, a transmission line, and a sub-station is to be calculated based on a certain percentage of the newly constructed asset. The O&M expense for a thermal power plant consists of the O&M expense and cost of fuel consumed at the power plant. The O&M expense for renewable power (wind power and solar power) includes no cost for plant construction, as construction is left to other parties. PRODEL is assumed to purchase power from other parties with a pre-determined power tariff.
- Interest during construction (IDC) is counted as a part of an asset after commissioning. Depreciation and the O&M expense are based on the abovementioned asset.

Table 9-9 Details on Depreciation and IDC

	project period	O&M cost (%)	IDC (%) /100mil.$	construction period (years)
Hydro (Large)	40	1	4.6	8
TPP 1 (CC)	25	3	10.41	4
TPP 2 (Gas)	20	5	11.51	5
Renewable (wind)	20	—	-	3
Renewable (solar)	20	—	-	3
Transmission (220kV)	40	2	2.42	4
Transmission (400kV)	40	2	2.42	4
Sub-station (220kV)	40	2	2.42	4
Sub-station (400kV)	40	2	2.42	4

9.3.2 Long-Run Marginal Cost (LRMC)

(1) **Calculation of the Long-Run Marginal Cost (LRMC)**

The JICA Survey Team hereby calculates a long-run marginal cost (LRMC) in accordance with the '*Internal Rate of Return (IRR) Manual for Yen Loan Projects*' (JBIC). LRMC is calculated as follows.

Long Run Marginal Cost (LRMC) = *total project cost* × *capital recovery factor* + *O&M expences*

capital recovery factor = $r / (1-(1+r)^{-n})$

r : 10%

n : durable years (hydropower, 40 years; thermal power, 25 years (CCGT) and 20 years (GT))

O&M expense = O&M expense + fuel cost (thermal)

O&M expense: calculated for a certain percent of the total construction cost

Fuel cost: annual fuel cost for thermal power plants

(2) **The Total Investment Cost and LRMC for Generation, Transmission, and Sub-station**

The total Investment Cost and unit cost per kWh shown below indicate the LRMC of the long-term investment plan. The unit cost may vary, but generally stays near 5-6 cents per kWh.

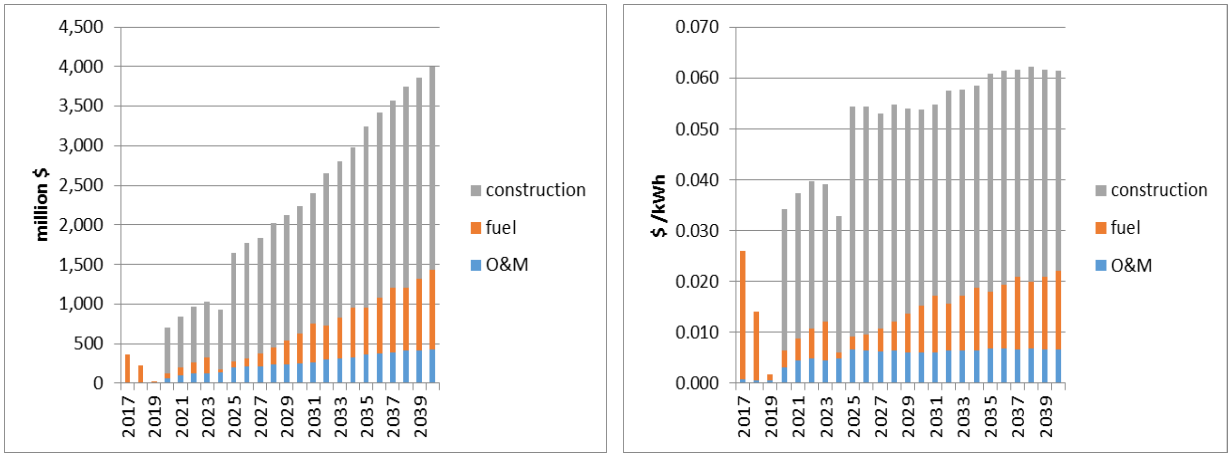


Figure 9-3 Total Annual Cost and Unit Cost for Generation

annual construction cost and unit cost for transmission lines and sub-stations are shown below. Unlike the thermal power plants, the transmission lines and sub-stations have fixed costs (e.g. construction and O&M costs) but no variable costs (e.g., fuel costs). The annual construction cost and unit cost for transmission lines and sub-stations are as follows. The unit cost peaks (1.5 cents/kWh) in 2027 and then falls to 0.8 cents/kWh in ensuing years.

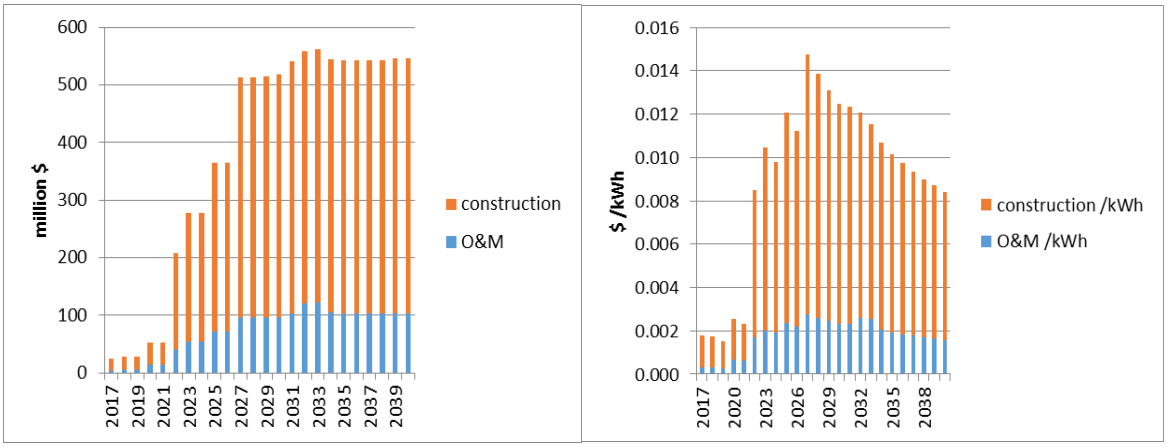


Figure 9-4 Total Annual Cost and Unit Cost for Transmission and Sub-station

(3) Review on the Proper Tariff

From here we review how much the incremental cost will rise based on the investment and O&M cost up to 2040, as well as the repayment schedule. (*)The cost consists of the construction cost, O&M cost, and depreciation. Thermal power plants bear fuel costs, as well. The payment of the interest, principal, and IDC will be considered after borrowings.

*: Actual construction cost for each year may fluctuate, depending on the construction schedule and repayment schedules. For this study, however, we adjust the annual cost for each candidate project to an equal level by applying the capital recovery factor.

The results are as follows. The unit price for generation will reach 8.5 cents USD at maximum, while the unit price for transmission and substation will reach 2 cents USD.

Table 9-10 Annual Unit Incremental Cost for Generation (hydro and thermal)

($ /kwh)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
incremental cost /kWh	0.002	0.003	0.003	0.006	0.006	0.013	0.016	0.015	0.019	0.018	0.022	0.021	0.020	0.019

($ /kwh)

type	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	total
incremental cost /kWh	0.018	0.018	0.017	0.016	0.015	0.014	0.014	0.013	0.013	0.012	-

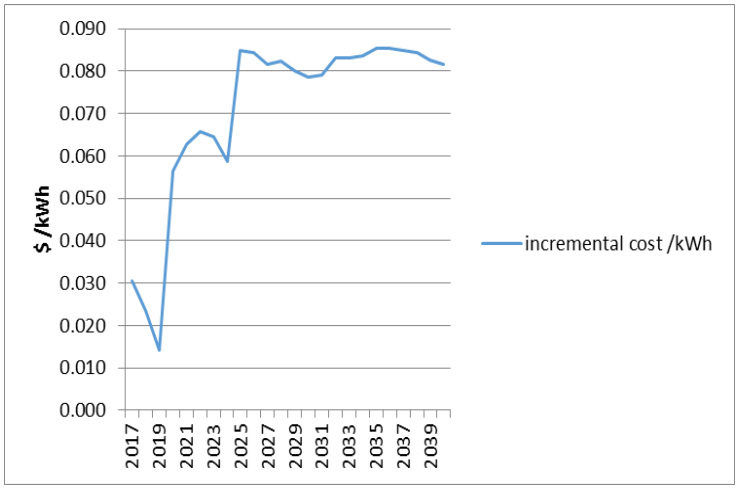


Figure 9-5 Annual Unit Incremental Cost for Generation

Table 9-11 Annual Unit Incremental Cost for Transmission and Sub-station

($ /kWh)

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
incremental cost $/kWh	0.002	0.003	0.003	0.006	0.006	0.013	0.016	0.015	0.019	0.018	0.022	0.021	0.020	0.019

($ /kWh)

type	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	total
incremental cost /kWh	0.018	0.018	0.017	0.016	0.015	0.014	0.014	0.013	0.013	0.012	-

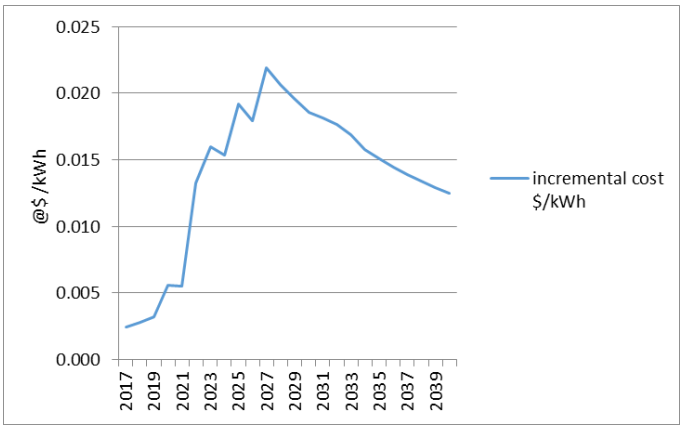


Figure 9-6 Annual Unit Incremental Cost for Transmission and Sub-station

From here we review the current unit revenue prices for PRODEL and RNT to cover the incremental cost as well as the existing cost.

The unit cost for PRODEL in 2016 is 19.86 AOA/kWh, which equals 0.09 $/kWh. The unit cost for RNT in 2016 is 8.15 AOA/kWh, which equals 0.037 $ /kWh.

A guest attending the workshop in 2018 pointed out that PRODEL did not debit the fuel cost. With this factored in, the total cost for PRODEL in 2016 seems to be smaller, as its unit price cost is also smaller than the real unit price cost, reflecting the missing fuel cost. （※）

※A guest attending the workshop held in January 2018 pointed out that PRODEL did not debit the fuel cost in its P/L. The JICA Study Team interpreted this as an indication that PRODEL did not count the fuel cost because it receives the fuel for free. Meanwhile, the JICA Study Team found amounts of 25,152 AOA listed under ‘fuel cost’ in the ‘Other Costs’ component of PRODEL’s P/L in 2016.This guest must have meant that the fuel was consumed by offices and buildings for administration activities, not by thermal power plants for generation.

Table 9-12 Unit Revenue Price/kWh and Unit Cost Price/kWh

(AOA, AOA/kWh)

	2016	2015
PRODEL		
sales (kWh)	10,929,810,809.00	6,308,876,489.00
@revenue unit price /kWh	20.17	18.49
@cost unit price /kWh	19.74	20.10
R N T		
sales (kWh)	9,348,186,285.76	6,136,127,637.00
@revenue unit price /kWh	9.34	8.93
@cost unit price /kWh	8.45	7.39
ENDE		
sales (kWh)	9,348,186,285.76	5,829,423,620.07
@revenue unit price /kWh	13.59	12.19
@revenue unit price (without subsidy) /kWh	6.27	3.78
@cost unit price /kWh	13.28	13.39

(Source: JICA Survey Team)

Meanwhile, the unit revenue price (generation) derived from the long-term investment is 18.3 AOA, and the total unit cost consisting of the current unit cost and long-term investment cost will be 38.19 AOA, or 0.177 $. Likewise, the unit revenue price (transmission) derived from the long-term investment is 4.3 AOA, and the total unit cost consisting of the current unit cost and long-term investment cost will be 12.45 AOA, or 0.57 $/kWh. (conversion rate: $1=215.064 AOA (T.T.M))

These figures indicate that the unit cost price for PRODEL needs to increase by 15 AOA, starting from the current 23.11 AOA. Likewise for RNT, the unit cost price needs to increase by 3.59 AOA, starting from the current 8.86 AOA.

Table 9-13 Unit Prices and Unit Incremental Costs

	PRODEL	RNT
1. unit revenue price in 2016	@0.09 $ /kWh	@0.043 $ /kWh
	(=@20.17 AOA/kWh)	(=@9.34 AOA/kWh)
2. unit cost price in 2016	@0.09$ /kWh	@0.039 $ / kWh
	(=@19.74 AOA/kWh)	(=@8.45 AOA/kWh)
3. incremental cost based on the long-term investment	@0.085$/ kWh	@0.02$/ kWh
	(=@18.3 AOA/kWh)	(=@4.3 AOA/kWh)
4.. Total cost (2+3)	@0.175 $/kWh	@ 0.059 $/kWh
	(=@38.04AOA/kWh)	(=@12.75 AOA/kWh)
5. increase of tariff (unit cost of investment／current unit cost)	17.9 AOA (1.92)	3.41 AOA (1.51)

※USD is converted using the official exchange rate of Nacional Banco de Angola as of March 12, 2018 ($1=215.064 AOA (T.T.M))

Following is a summary of the current power tariffs (announced in the national gazette as of December 2015). ENDE collects the sales revenue with these tariffs.

Table 9-14 Summary of Power Tariffs as of December 2015

voltage	type	reference	calculation formula
Low Voltage	Domestic	contracted power: 1.3 kVA contracted power: 3.0 kVA	～120kWh：@2.46 AOA/kWh ～200kWh：@3.00 AOA/kWh
	Public lighting	supplied less than 1KV	T=（1.80×d＋4.73×W） AOA
	General and Special Domestic	contracted power: 3.0 kVA～9.9 kVA	Single phase：T=(3.10×d×pc＋6.53×W) AOA Three phase：T=(4.20×d×pc＋7.05×W) AOA
	Commercial and Industry	commercial: industry:	T=(4.20×d×pc＋7.05×W) AOA T=(4.20×d×pc＋7.053×W) AOA
Middle Voltage	Commercial and Industry	voltage: less than 30 kV	T=(538.93×P＋5.88×W) AOA
		voltage: more than 30 kV	T=(538.93×P＋5.13×W) AOA
High Voltage	Industry and Distributors	industry: more than 30 kV	T=(598.36×P＋4.70×W) AOA
		distributor: more than 30 kV	T=(598.36×P＋4.70×W) AOA

d：days passed after issuance of the bill

pc：contracted power (kVA)

P：maximum power (KW) recorded at 15-minute meter

W：power (kWh) consumed

T：sales calculated with the formula (AOA)

The characteristics are as follows:

- Domestic in Low Voltage (contracted power: up to 3.0 kVA) is based on a gradual increase of prices. Consumed power per kWh is divided into two stages: up to 120 kWh and 120 kWh to 200 kWh. The unit price goes up from 2.46 AOA /kWh to 3.0 AOA /kWh.
- The unit price for General and Special Domestic (contracted power: more than 3.0 kVA) is double that of Domestic in Low Voltage (contracted power: up to 3.0 kVA). The calculation assumes that the amount the customer pays rises as the customer uses more power. The customer also has to pay more when the customer takes more days to pay the electricity bill.
- The formula for Commerce and Industry in Middle Voltage and in High Voltage considers the number of days (d) passed. The bill gets bigger as more days pass.
- Sales of Commerce and Industry in Middle Voltage and in High Voltage do not increase in proportion to the number of days (d). Rather, the figure increases with P (the maximum power (KW)) and W (power (kWh) consumed).
- The current level of tariff per kWh is around 7 AOA, while the unit cost price calculated with the accounting figures of ENDE is 13.28 AOA. The unit cost price calculated with the accounting figures of ENDE is double that of the current tariff. This reflects the national policy not to impose a high tariff on Angolan nationals, and to compensate the loss with subsidies.
- The tariff of ENDE shall generally include all costs of PRODEL and RNT, and the investment- related costs of the long-term investment plan is to to be added to the existing costs for distribution. In line with this approach, the incremental cost of the long-term investment is 0.232 $ (=50.64 AOA). In this sense, decision-making on the subsidy shall be separated from the calculation of the necessary revenue and cost.

※Table 9-13 The incremental unit cost of the long-term investment consists of one component coming from PRODEL and one component coming from RNT.

@0. 175 $ /kWh＋@ 0.057 $ /kWh＝@0.232 $ /kWh
When expressed in AOA,
@38.19 AOA /kWh＋@12.45 AOA /kWh＝@50.64 AOA /kWh

9.3.3 Recommendations on the Optimal Financial Strategy

(1) **Recommendations**

(a) Price Hike

As stated in the section 9.3.2, the unit cost caused by the investment up to 2040 is estimated at 0.175$ for generation and 0.057$ for transmission and sub-station. These estimates imply that the tariff must be raised to meet the increasing cost.

(b) Review of the candidate loans

Considering the current financial condition of PRODEL and RNT, it will be difficult for both to go on investing solely with their own retrained earnings. The study therefore assumes that both will depend on borrowing, and explains the candidate loan conditions available. Note, meanwhile, that some loans will need government guarantees and data on the project cycles and time by which the loans must be received.

(c) Proper Equity Ratio

If the agency implementing the project goes on borrowing, the equity ratio will decrease. A decreasing equity ratio would be unfavorable from a financial viewpoint, as it would increase the default risk. In this case, equity must be injected at the proper time. A 20-30% of equity ratio is generally favorable, though there seems to be no standard for a proper equity ratio in the power sector.

The table below shows the total assets, total equity, and equity ratios for PRODEL and RNT in 2016. The equity ratios for PRODEL and RNT were higher than 40% in 2016, which would be. If both companies go on investing solely with borrowing, their equity ratios will decrease: PRODEL (47.0%→3.8%) and RNT (41.1%→5.3%).

Table 9-15 Equity Ratios with Long-term Investment

accounting data in 2016 (equity ratio)	total investment up to 2040	total asset＋total investment （equity ratio）
PRODEL total asset: 2,838 million $ （47.0%）	26,262 million $	29.100 million $ (4.6%)
RNT total asset: 1,150 million $ （41.1%）	6,187 million $	7,337 million $ (6.4%)

(2) **Conclusion**

(a) Price Hike

The key implementing agencies in the Power Sector of Angola are PRODEL (generation), RNT (transmission and sub-station), and ENDE (distribution). ENDE receives a subsidy, which helps to lessen the financial burden for Angolan nationals.

The long-term investment plan consists of the generation development plan and transmission and the sub-station development plan. The plan requires increases in the unit revenue prices for PRODEL and for RNT, while direct tariff increases will not necessarily be required for ENDE. Revenue and expenditure will have to be calculated in each sector, but this might not lead to a higher tariff. This calculation of revenue and expenditure will be necessary even if a subsidy is provided to the distribution sector.

(b) Decision of the borrowings

As each financial institution has its own project-formation cycle and appraisal procedure, the implementation agency will select the financial institutions that are to be requested to provide loans. Taking the example of a project-formation cycle of JICA, the implementation agency may also request a grant to complete an Implementation Report (I/P) in the process of a project cycle.

If the candidate project needs a guarantee from the Government, the implementation agency has to pass through a step-by-step approval process within the Government. This implies that the Government of Angola sets up an official approval procedure internally.

(c) Maintain a Proper Equity Ratio

Compulsive injection of equity to a new project would be useful to maintain a certain equity ratio. An implementing agency for a new power project in India, for example, is requested to raise funds with a ratio of 70% (borrowing) and 30% (equity). In India, either the Central Government or the State Government provides equity to the implementing agency out of the budget or the long-term borrowing.

In fact, both the Central Government and the State Government in India are suffering from a red-ink budget and would be hard-pressed to provide equity from the start. The Government often provides funds to the implementing agency as long-term borrowing at the beginning but waives the liability if the implementing agency meets certain conditions. Thus, the implementing agency is finally able to keep a certain equity ratio by changing the status of the long-term liability into equity in future. (*)

*: India's '*Accounting for Government Grants and Disclosure of Government Assistance*' Accounting Standard (IND AS20) defines a forgivable loan. This standard allows the Government, the lender of the loan, to waive repayment under certain prescribed conditions. In this context, a certain prescribed condition would be one that allowed the borrower of the loan to complete the construction on schedule. Important conditions for the implementing agency are a possible future cancellation of the borrowing at the beginning and the ability to convert the liability into equity.

Chapter 10 Economic and Financial Analysis

10.1 Financial Analysis of RNT・PRODEL・ENDE

The JICA Survey Team received financial statements for RNT, PRODEL, and ENDE. While the financial statements in 2015 and in 2014 are now available for all three companies, the Profit and Loss Statement for ENDE is only available in 2017 (January to June). To keep consistency among the three companies, the JICA Survey Team only analyzes the statements of 2015 and 2014.

Two types of the financial statements are prepared: the first in the national currency (AOA) and the other in USD converted at the official rate as of 25 April, 2018. ($1= 270.68 AOA)

10.1.1 RNT

(1) **Financial Analysis of RNT**

The financial statements of RNT report figures in units of 1000 AOA.

(a) P/L

Operating Income in 2016 consisted of Sales (82,297 million AOA), other operating income (4,489 million AOA), and other. The main component of Costs in 2016 was the cost of goods (67,206 million AOA). Gross profit totaled 8,293 million AOA after deducting financial costs (-859 million AOA) and Corporate income tax (2,145 million AOA). Finally, RNT posted net profit 4,381 million AOA for the Year (2016).

Table 10-1 Profit and Loss Statement (P/L)

unit: 1000 AOA

	2016	2015
Operating Incomes	*87,297,665*	*54,811,737*
Sales	82,791,700	51,450,377
Provision of service	16,760	22,478
Other operating profits	4,489,205	3,338,882
Operating Costs	*79,004,626*	*45,341,594*
Changes in inventories of finished goods and work in progress	0	0
Works capitalized	0	0
Cost of goods sold and the materials consumed	67,206,922	37,787,871
Personnel costs	4,391,321	3,127,136
Amortizations	4,614,278	3,392,712
Other operationa costs and loss	2,792,105	1,033,875
Gross Profit	*8,293,039*	*9,470,143*
Financial costs	-859,334	-1,463,938
Subsidies and affiliate company results	0	0
Non-operating costs / income	-906,109	-579,007
Profit before Tax	*6,527,596*	*7,427,198*
Corporate income tax	2,145,834	2,228,159
Net Profit	*4,381,762*	*5,199,039*
Extraordinary results	0	0
Corporate income tax	0	0
Net Profit of the Year	4,381,762	5,199,039

(unit: 1000 USD)

	2016	2015
Operating Incomes	*322,598*	*202,550*
Sales	305,947	190,129
Provision of service	62	83
Other operating profits	16,589	12,338
Operating Costs	*291,952*	*167,555*
Changes in inventories of finished goods and work in progress	0	0
Works capitalized	0	0
Cost of goods sold and the materials consumed	248,355	139,641
Personnel costs	16,228	11,556
Amortizations	17,052	12,537
Other operationa costs and loss	10,318	3,821
Gross Profit	*30,646*	*34,996*
Financial costs	-3,176	-5,410
Subsidies and affiliate company results	0	0
Non-operating costs / income	-3,348	-2,140
Profit before tax	*24,122*	*27,446*
Corporate income tax	7,930	8,234
Net result from ordinary activities		
Extraordinary results	0	0
Corporate income tax	0	0
Net profit of the year	*16,192*	*19,212*

Table 10-2 Balance Sheet (B/S)

unit: 1000 AOA

	2016	2015
ASSETS		
Non Current Asset	*134,179,383*	*125,647,314*
Tangible fixed assets	134,178,838	125,646,596
Intangible fixed assets	545	718
Investments in subsidiaries and associates	0	0
Other financial assets	0	0
Other non-current Assets	0	*0*
Current Asset	*113,274,311*	*62,235,687*
cash	68,243	208,990
Accounts receivable	101,955,502	53,566,640
cash and bank depoeits	7,805,495	5,476,676
Other current assets	3,445,071	2,988,381
TOTAL ASSETS	**247,453,694**	**187,883,001**
EQUITY AND LIABILITY		
Equity	*101,884,053*	*102,548,357*
Equity		
Capital	11,579,155	11,579,155
Reserve	81,182,631	86,228,695
Retained earnings	4,740,507	-458,532
Net profit for the year	4,381,760	5,199,039
Total Equity	101,884,053	102,548,357
Non-current Liability	*14,616,216*	*16,851,862*
Medium and long-term loan	0	0
Deferred taxes	0	0
Provisions for pensions	0	0
Provisions for other risks	0	*0*
Other Non-liquid liability	14,616,216	***16,851,862***
Current Liability	*130,953,425*	*68,482,782*
Accounts payable	123,646,573	66,368,651
Short-term loan	4,832,965	0
Current part of medium and long-term loans	0	0
Other current liability	2,473,887	2,114,131
Total Liabilities	145,569,641	85,334,644
TOTAL EQUITY AND LIABILITY	**247,453,694**	**187,883,001**

(unit: 1000 USD)

	2016	2015
ASSETS		
Non current asset	*495,844*	*464,315*
Tangible fixed assets	495,842	464,312
Intangible fixed assets	2	3
Investments in subsidiaries and associates	0	0
Other financial assets	0	0
Other non-current Assets	0	0
Current Asset	*418,592*	*229,985*
cash	252	754
Accounts receivable	376,765	197,949
cash and bank deposits	28,844	20,238
Other current assets	12,731	11,043
TOTAL ASSETS	**914,436**	**694,300**
EQUITY AND LIABILITY		
Equity	*376,501*	*378,955*
Equity	0	0
Capital	42,789	42,789
Reserve	300,001	318,648
Retained earnings	17,518	-1,694
Net profit for the year	16,192	19,212
Total Equity	376,501	378,955
Non-current Liability	*54,013*	*62,274*
Medium and long-term loan	0	0
Deferred taxes	0	0
Provisions for pensions	0	0
Provisions for other risks	0	0
Other Non-liquid liability	54,013	62,274
Current Liability	*483,923*	*253,070*
Accounts payable	456,921	245,258
Short-term loan	17,860	0
Current part of medium and long-term loans	0	0
Other current liability	9,142	7,813
	0	0
Total Liabilities	537,935	315,344
TOTAL EQUITY AND LIABILITY	**914,436**	**694,300**

(b) B/S

Tangible assets in 2016 (134,178 million AOA) were the biggest component of non-current assets. Accounts payable in 2016 were the biggest component of current assets (101,955 million AOA), exceeding operating income for the year.

(c) C/F

Cash Flow from Operating Activities in 2016 was 446 million AOA, although RNT paid 18,881 million AOA to extraordinary items. Cash Flow from Investment in 2016 went into the red due to investment in subsidies and payment to tangible fixed assets. Meanwhile, RNT borrowed a loan of 4,649 million AOA, as net cash for the year was 2,328 million AOA. Finally, cash and cash equivalents at the end of that year totaled 7,805 million AOA.

Table 10-3 Cash Flow Statement (C/F)

(unit: 1000 AOA)

	2016	2015
Cash Flow from Operational Activities		
Receipt from customers	26,038,515	1,709,371
Payments to suppliers	46,224,491	1,121,398
Payment to employees	0	1,572,087
Cash flow from operation	-20,185,976	-984,114
Other receipts related to operational activities		39,916
Interest paid	1,750,305	
Cash Flow from Extraordinary items	-18,435,671	-944,198
Payments with extraordinary items	18,881,692	10,430,988
Cash Flow from Operating activities	***446,021***	***-11,375,186***
Cash Flow from Investment Activities		
Receipt from:		
Tangible fixed assets		
Intangible fixed assets	0	
Financial investment		
Investment to subsidy	2,235,645	20,188,370
Interest and similar income		
Dividends		
Total receipts	2,235,645	20,188,370
Payment to:		
Tangible fixed assets	4,448,443	
Intangible fixed assets	0	
Financial investment		
Subsidy to investment		3,336,508
Total payment	4,448,443	3,336,508
Cash Flow before Extraordinary	***-2,212,798***	***16,851,862***
Cash Flow from Financial Activities		
Receipts from:		10,241,186
Capital increase, supplementary paymants and own share sales		
Damage coverage		
Loan obtained	4,649,741	
Subisidy and donations		
Total receipts	4,649,741	0
Payment to:		0
Capital decrease, supplementary provisions		
Purchase of shares		
Loan obtained		
Depreciation of leasing contracts		
Interest and similar interest	554,144	
Total payment	554,144	
Cash Flow from Financial Activities	**4,095,597**	**0**
Net Cash Increase and its	***2,328,819***	***5,476,676***
Cash and its Equivalents at the Beginning of the Year	5,476,676	0
Cash and its Equivalents at the End of the Year	**7,805,495**	**5,476,676**

(unit: 1000 USD)

	2016	2015
Cash Flow from Operational Activities		
Receipt from customers	96,222	6,317
Payments to suppliers	170,817	4,144
Payment to employees	0	5,809
Cash flow from operation	-74,595	-3,637
Other receipts related to operational activities	0	148
Interest paid	6,468	0
Cash Flow from Extraordinary items	-68,127	-3,489
Payments with extraordinary items	69,775	38,546
Cash Flow from Operating activities	1,648	-42,036
Cash Flow from Investment Activities		
Receipt from:		
Tangible fixed assets		
Intangible fixed assets	0	0
Financial investment		
Investment to subsidy	8,262	74,604
Interest and similar income		
Dividends		
Total receipts	8,262	74,604
Payment to:		
Tangible fixed assets	16,439	
Intangible fixed assets	0	
Financial investment		
Subsidy to investment		12,330
Total payment	16,439	12,330
Cash Flow before Extraordinary	-8,177	62,274
Cash Flow from Financial Activities		
Receipts from:		37,845
Capital increase, supplementary paymants and own share sales		
Damage coverage		
Loan obtained	17,183	
Subisidy and donations		
Total receipts	17,183	0
		0
Payment to:		
Capital decrease, supplementary provisions		
Purchase of shares		
Loan obtained		
Depreciation of leasing contracts		
Interest and similar interest	2,048	
Total payment	2,048	
Cash Flow from Financial Activities	15,135	0
Net Cash Increase and its Equivalents	8,606	20,238
Cash and its Equivalents at the Beginning of the Year	20,238	0
Cash and its Equivalents at the End of the Year	**28,844**	**20,238**

(d) Conclusion

The major financial ratios were as follows.

The net profit margin in 2016 was 5.0 %, which was quite good. Return on Assets (ROA) in 2016 was quite small, falling to 1.8%, because accounts receivables were quite big compared to operating income. The current ratio, an indicator of financial stability, was 0.82, which was less than 1.0. The average collection (days) in 2016 was 426 days because the outstanding accounts receivables were bigger than operating income.

Table 10-4 Major financial ratios

	2016	2015
net profit margin	5.0%	9.5%
return on assets (ROA)	1.8%	2.8%
current ratio	0.86	0.91
asset turnover	0.35	0.29
average collection (days)	426	357

10.1.2 PRODEL

The financial statements of PRODEL report figures in units of 1000 AOA.

(a) P/L

The major component of operating income in 2016 was sales (42,255 million AOA). Other operating income consisted of subsidies (178,182 million AOA). More than 70% of the operating costs were costs of goods (164,235 million AOA). Gross profit was positive, though subsidies and affiliates and corporate income tax followed. Net profit for the Year in 2016 was 1,862 million AOA.

One guest attending the workshop held in January 2018 pointed out that PRODEL did not debit the fuel cost on its financial statement. The JICA Study Team found that PRODEL's Financial Statement in 2016 debited 25,152,000 AOA of fuel cost as 'Other Costs.' This guest must have meant that PRODEL consumed the fuel for administrative purposes in offices or buildings.

Table 10-5 Profit and Loss Statement (P/L)

unit: 1000 AOA

	2016	2015
Operating Incomes	*220,420,796*	*116,631,357*
Sales	42,238,471	25,655,726
Services rendered	0	0
Other operating profits	178,182,325	90,975,631
Operating Costs	*215,757,239*	*126,819,841*
Changes in inventories of finished goods and work in progress	0	0
Works capitalized	0	0
Cost of goods sold and the materials consumed	164,235,499	98,320,782
Personnel costs	10,401,554	7,146,216
Amortizations	15,055,711	11,246,853
Other costs and operating Loss	26,064,475	10,105,990
Gross Profit	*4,663,557*	*-10,188,484*
Financial results	1,297,742	-431,536
Subsidies and affiliate company results	-192,245	0
Non-operating costs / income	66,470	-83,047
Profit before tax	*5,835,524*	*-10,703,067*
Corporate income tax	0	0
Net result from ordinary activities	*5,835,524*	*-10,703,067*
Extraordinary results	0	11,033,610
Corporate income tax	-3,972,868	-99,357
Net profit of the year	1,862,656	231,186

(unit: 1000 USD)

	2016	2015
Operating Incomes	*814,539*	*430,997*
Sales	156,087	94,808
Provision of service	0	0
Other operating profits	658,452	336,190
Operating Costs	*645,351*	*389,741*
Variation in the finished product and in the process of manufacturing		
Work for the company itself	0	0
Cost of goods sold and the raw materials and supplies consumed	606,913	363,333
Personnel costs	38,438	26,408
Amortizations		
Other costs and Operating Loss		
Gross Profit	*17,233.63*	*-37,650.34*
Financial results	4,796	-1,595
Results from Subsidiaries and associated companies		
Non-operating results		
Profit before tax	*21,564*	*-39,552*
Taxes on income		
Net result from ordinary activities		
Extraordinary results		
Taxes on income		
Net profit of the year	***6,883.23***	***854.32***

Table 10-6 Balance Sheet (B/S)

unit: 1000 AOA

	2016	2015
ASSETS		
Non current assets	*417,084,219*	*415,089,591*
Tangible fixed assets	416,818,944	414,632,071
Intangible fixed assets	0	0
Investments in subsidiaries and associates	265,275	457,520
Other Financial Assets	0	0
Other non-liquid Assets	0	*0*
Current Asset	*193,269,597*	*61,714,599*
Cash	253,823	108,125
Accounts receivable	55,128,687	30,760,705
cash and bank deposits	17,870,497	26,635,522
Other current assets	120,016,590	4,210,247
TOTAL ASSET	**610,353,816**	**476,804,190**
EQUITY AND LIABILITY		
Equity	*286,949,652*	*309,013,298*
Share capital	233,910,935	233,910,935
Reserves	45,095,506	75,761,981
Retained earnings	6,080,555	-890,804
Result o travel	1,862,656	231,186
Results for the year	286,949,652	309,013,298
Total Equity	286,949,652	309,013,298
Non-current liabilities	*3,000,000*	*3,000,000*
Medium and long-term loan	3,000,000	3,000,000
Deferred taxes		
Provisions for pensions		
Provisions for other risks		
Other non-liquid liability		
Current liabilities	*320,404,164*	*164,790,893*
Accounts payables	311,917,639	149,893,665
Short-term loan	5,046,446	7,241,186
Current part of medium and long-term loans	3,000,000	0
Other current liability	440,079	7,656,042
Total Liability	323,404,164	167,790,893
Total EQUITY AND LIABILITY	**610,353,816**	**476,804,191**

(unit: 1000 USD)

	2016	2015
ASSETS		
Non current assets	*1,541,286*	*1,533,915*
Tangible fixed assets	1,540,305	1,532,224
Intangible fixed assets	0	0
Investments in subsidiaries and associates	980	1,691
Other Financial Assets	0	0
Other non-liquid Assets	0	0
Current Asset	*714,205*	*228,059*
Cash	938	400
Accounts receivable	203,722	113,673
cash and bank deposits	66,038	98,428
Other current assets	443,507	15,558
TOTAL ASSET	**2,255,491**	**1,761,974**
EQUITY AND LIABILITY		
Equity	*1,060,389*	*1,141,922*
Share capital	864,390	864,390
Reserves	166,645	279,969
Retained earnings	22,470	-3,292
Result o travel	6,883	854
Results for the year	1,060,389	1,141,922
Total Equity	1,060,389	1,141,922
Non-current liabilities	*11,086*	*11,086*
Medium and long-term loan	11,086	11,086
Deferred taxes		
Provisions for pensions		
Provisions for other risks		
Other non-liquid liability		
Current liabilities	*1,184,016*	*608,965*
Accounts payables	1,152,655	553,914
Short-term loan	18,649	26,759
Current part of medium and long-term loans	11,086	0
Other current liability	1,626	28,292
Total Liability	1,195,102	620,051
Total EQUITY AND LIABILITY	**2,255,491**	**1,761,974**

(b) B/S

Almost all of the non-current assets in 2016 were tangible assets (416,818 million AOA). Accounts payable in 2016 were 311,917 million AOA, exceeding accounts receivables. There was also a middle-term borrowing in 2016 (3,000 million AOA).

(c) C/F

Cash Flow from Operating Activities in 2106 went into the red (-69,075 million AOA) because payments to suppliers were much bigger than receipts and other incomes. Cash Flow from Investment Activities in 2016 was 49,988 million AOA because receipts from subsidy exceeded those to subsidy. Cash Flow from Financial Activities in 2016 mainly consisted of loans. (11,046 million AOA). Moreover, PRODEL received 151 million AOA as income from exchange rates.

As a result, net cash decreased -8,916 million AOA for the year and cash and cash equivalents at the end of the year totaled 17,870 million AOA.

Table 10-7 Cash Flow Statement (C/F)

unit: 1000 AOA

	2016	2015
Cash Flow from Operational Activities		
Receipt from customers	12,516,975	*2,052,676*
Payments to suppliers	-127,095,520	-142,521,055
Payment to employees	-12,539,480	-5,495,466
Cash flow from operation	**-127,118,025**	**-145,963,845**
Other receipts related to operational activities	58,042,079	104,933,775
Cash Flow from Operating activities	**-69,075,946**	**-41,030,070**
Payments with extraordinary items	0	0
Total cash flow from operating	***-69,075,946***	***-41,030,070***
Cash Flow from Investment Activities		
Receipts from subsidy	75,736,210	62,150,986
Investment to subsidy	-25,747,442	-11,033,610
Cash Flow from Investing Activities	***49,988,768***	***51,117,376***
Cash Flow from Financial Activities		
Receipts from loans	11,046,446	10,241,186
Payment to loans	-876,230	0
Cash Flow from Financial Activities	**10,170,216**	**10,241,186**
Net Cash Increase and its	**-8,916,962**	**20,328,492**
Income / loss from exchange rates	151,938.00	6,307,029.00
Cash and its Equivalents at the Beginning of the Year	26,635,522	0
Cash and its Equivalents at the End of the Year	**17,870,498**	**26,635,521**

(unit: 1000 USD)

	2016	2015
Cash Flow from Operational Activities		
Receipt from customers	46,255	7,585
Payments to suppliers	-469,667	-526,670
Payment to employees	-46,338	-20,308
Cash flow from operation	-469,750	-539,392
Other receipts related to operational activities	214,488	387,770
Cash Flow from Operating activities	-255,262	-151,622
Payments with extraordinary items	0	0
Total cash flow from operating	-255,262	-151,622
Cash Flow from Investment Activities		
Receipts from subsidy	279,874	229,672
Investment to subsidy	-95,147	-40,773
Cash Flow from Investing Activities	184,728	188,898
Cash Flow from Financial Activities		
Receipts from loans	40,821	37,845
Payment to loans	-3,238	0
Cash Flow from Financial Activities	37,583	37,845
Net Cash Increase and its Equivalents	-32,952	75,122
Income / loss from exchange rates	561	23,307
Cash and its Equivalents at the Beginning of the Year	98,428	0
Cash and its Equivalents at the End of the Year	**66,038**	**98,428**

(d) Conclusion

The major financial ratios were as follows.

The net profit margin in 2016 was positive, albeit small (0.8%). Given the low net profit margin, Return on Assets (ROA) in 2016 was also small (0.6%). The current ratio, an indicator of financial stability, was 0.6, which was less than 1.0. The average collection (days) in 2016 was 91 days, which was quite good compared to the other two corporations.

Table 10-8 Major financial ratios

	2016	2015
net profit margin	0.8%	0.2%
return on assets (ROA)	0.6%	0.1%
current ratio	0.6	0.4
asset turnover	0.68	0.70
average collection (days)	91	96

10.1.3 ENDE

The financial statements of ENDE originally reported figures in units of AOA. To keep consistency with the statements of the other corporations (PRODEL and RNT), the financial statements are analyzed on a 1000 AOA basis.

(a) P/L

Major operating income in 2016 consisted of subsidies in process (68,414 million AOA), as well as electricity power sales (48,336 million AOA) and other. The biggest portion of operating costs was subsidized and consumed raw materials (82,436 million AOA), followed by personnel expenses (17,209 million AOA). Gross profit was positive, though ENDE incurred both financial loss (-7,024 million AOA) and non-operating loss (-12,193 million AOA). Finally, the net profit for the Year in 2016 was -16,318 million AOA.

Table 10-9 Profit and Loss Statement (P/L)

(unit: 1000 AoA)

	2016	2015
Operating Incomes	*127,058,787*	*71,032,092*
Electricity Power sales	48,336,107	18,818,779
Subsidiy on Prices	68,414,297	49,009,948
Provision of services	8,782,110	2,097,476
Other operating income	1,526,272	1,105,888
Operating Costs	*124,164,811*	*78,075,986*
Costs of goods sold and materials		
Susidized and consumed raw materials	82,436,761	49,187,316
Personnel expences	17,209,246	13,953,362
Amortizations	8,769,867	6,115,252
Other costs operating losses	15,748,938	8,820,057
Gross Profit	*2,893,976*	*-7,043,894*
Financial incomet/ loss	-7,024,058	-1,496,678
Non-operating income / loss	-12,193,406	-14,234,891
Profit before Tax	*-16,323,488*	*-22,775,464*
Income tax	0	0
Profit after Tax	*-16,323,488*	*-22,775,464*
Extraordinary income/ loss	4,536	-27,877
Net Profit	***-16,318,952***	***-22,803,341***

(unit: 1000 USD)

	2016	2015
Operating Incomes	*469,530.79*	*262,490.73*
Electricity Power sales	178,620	69,543
Subsidiy on Prices	252,817	181,110
Provision of services	32,453	7,751
Other operating income	5,640	4,087
Operating Costs	*458,836*	*288,521*
Costs of goods sold and materials		
Susidized and consumed raw materials	304,635	181,766
Personnel expences	63,595	51,563
Amortizations	32,408	22,598
Other costs operating losses	58,198	32,593
Gross Profit	***10,694***	***-26,029.88***
Financial incomet/ loss	-25,957	-5,531
Non-operating income / loss	-45,059	-52,603
Profit before Tax	***-60,322***	***-84,164.04***
Income tax	0	0
Profit after Tax	***-60,322***	***-84,164***
Extraordinary income/ loss	17	-103
Net Profit	***-60,304.77***	***-84,267.06***

Table 10-10 Balance Sheet (B/S)

(unit: 1000 AoA)

	2016	2015
ASSETS		
Current Assets	*288,265,058*	*244,428,283*
Inventory	6,016,839	5,191,603
Accounts receivables	267,923,682	233,226,179
Cash and equivalents	12,112,350	4,760,025
Other current assets	2,212,187	1,250,476
Non-Current Assets	*183,090,288*	*191,098,017*
Fixed tangible assets	149,990,427	152,888,383
Fixed intangible assets	11,287,254	11,503,474
Other finaicial assets	17,699,466	17,986,697
Other non-current assets	4,113,142	8,719,462
Total Assets	*471,355,346*	*435,526,300*
LIABILITIES AND NET ASSETS		
Current Liabilities	*216,587,284*	*164,213,403*
Accounts payables	167,799,183	116,401,463
Short term loans	5,102,112	1,102,112
Other current liabilities	43,685,989	46,709,828
Non-Current Liabilities	*9,700,757*	*9,926,640*
Mid and long-term loans	169,412	395,294
Provisions for pension funds	9,416,453	9,416,453
Provisions for other risks and charges	114,892	114,892
Total Liabilities	226,288,041	174,140,043
EQUITY & CAPITAL		
Equity & Capital	*245,067,305*	*261,386,257*
Capital	284,194,598	284,194,598
Retained earnings	-22,808,341	0
Incomes from the related period	-16,318,952	-22,808,341
Equity & Capitals	245,067,305	261,386,257
Total Liabilities and Net Assets	**471,355,346**	**435,526,300**

(unit: 1000 USD)

	2016	2015
ASSETS		
Current Assets	*1,065,250*	*903,256*
Inventory	22,235	19,185
Accounts receivables	990,080	861,860
Cash and equivalents	44,760	17,590
Other current assets	8,175	4,621
Non-Current Assets	*676,589*	*706,180*
Fixed tangible assets	554,272	564,981
Fixed intangible assets	41,711	42,510
Other finaicial assets	65,406	66,468
Other non-current assets	15,200	32,222
Total Assets	***1,741,838***	***1,609,436***
LIABILITIES AND NET ASSETS		
Current Liabilities	*800,373*	*606,831*
Accounts payables	620,082	430,148
Short term loans	18,854	4,073
Other current liabilities	161,436	172,611
Non-Current Liabilities	*35,848*	*36,683*
Mid and long-term loans	626	1,461
Provisions for pension funds	34,797	34,797
Provisions for other risks and charges	425	425
Total Liabilities	*836,221*	*643,514*
EQUITY & CAPITAL		
Equity & Capital	*905,617*	*965,922*
Capital	1,050,208	1,050,208
Retained earnings	-84,286	0
Incomes from the related period	-60,305	-84,286
Equity & Capitals	*905,617*	*965,922*
Total Liabilities and Net Assets	***1,741,838***	***1,609,436***

(b) B/S

Accounts receivables were prominent in current assets, and accounts payables were prominent in current liabilities. Outstanding accounts receivables and payables in 2016 were 267,923 million and 167,799 million AOA, respectively. Accounts receivables far exceeded the operating income for the year, so the collection (days) was 770 days. The total billed amounts during the year 2015 to June 2017 are: 52,621,339,094.34 AOA for Law Voltage and 35,046,795,121.71 AOA for Medium Voltage. Meanwhile ENDE collected during the same period 38,292,121.097 AOA for Law Voltage and 20,138,340,323 AOA for Medium Voltage. It means that collection rate for Law Voltage is 72.7% but that for Medium Voltage is 57.4%. It seems that the bill collection of Medium Voltage is harder than that of Law Voltage. As a result, some accounts receivables of Medium Voltage have gone bad. One possible reason for

the gap was the practice of crediting bills to clients without necessarily collecting in some cases. Uncollected receivables accumulated, as some receivables were no longer collected. The same thing happened with accounts payables.

(c) C/F

Cash Flow from Operating Activities in 2016 was negative because payments to suppliers and payments to employees were bigger than receipts from clients. Cash flow from Investment Activities was negative (-1,936 million AOA). Cash Flow from Financial Activities included 26,708 million AOA of allocations to Exploration and Contributions. Moreover, ENDE borrowed 5,000 million AOA. Cash Flow from Financial Activities made up the losses for Cash Flow from Operating Activities and Cash Flow from Investment Activities.

Table 10-11 Cash Flow Statement (CF)

(unit: 1000 AoA)

	2016	2015
Cash Flow from Operational	***-19,750,661***	***-1,703,503***
Cash flow from operation	*-11,557,392*	*1,866,526*
Cash receipts from clients	36,938,612	16,532,900
Cash payments to suppliers	-32,928,684	-4,507,034
Payment to employees	-15,567,320	-10,159,340
Profits tax	-272,885	-137,051
Cash flow before other operational activi	*-7,791,191*	*-3,331,305*
Other receipts from operational activities	609,652	0
Other paymentes from operational activities	-8,400,844	-3,331,305
Cash flow before nonstandard items	-129,193	-101,672
Receipts from nonstandard items	27,094	50,420
Payments from nonstandard items	-156,287	-152,093
	0	0
Cash Flow from Investment Activiti	***-1,936,746***	***-2,039,147***
Receipts from:	*880,317*	*241,319*
Tangible fixed assets	3,753	2,081
Financial investments	0	0
Interests	876,563	239,237
Payments to	*-2,817,062*	*-2,280,466*
Fixed tangible assets	-2,817,062	-2,280,466
Fixed intangible assets	0	0
Casf flow from Financial Activities	***29,039,731***	***4,334,991***
Receipts from	*31,708,536*	*4,645,763*
Loans	5,000,000	0
Allocations to Exploration and Contributions	26,708,536	4,645,763
Payments to	*-2,668,804*	*-310,772*
Loans	-1,225,882	-169,412
Interests	-1,442,922	-141,360
	0	0
Net Cash Increase or Decrease of the Ye	7,352,325	592,341
Cash and Equivalent at the Beginning of the Year	4,760,025	0
Impact of the Addition of Cash Balances and its Equivalent from Winded -up ENE and EDEL	0	4,167,684
Cash and its Equivalent at the End of the Year	**12,112,350**	**4,760,025**

(unit: 1000 USD)

	2016	2015
Cash Flow from Operational Activities	***-72,986***	***-6,295***
Cash flow from operation	-42,709	6,898
Cash receipts from clients	136,502	61,095
Cash payments to suppliers	-121,684	-16,655
Payment to employees	-57,527	-37,543
Profits tax	-1,008	-506
Cash flow before other operational activities	-28,791	-12,310
Other receipts from operational activities	2,253	0
Other paymentes from operational activities	-31,044	-12,310
Cash flow before nonstandard items	-477	-376
Receipts from nonstandard items	100	186
Payments from nonstandard items	-578	-562
Cash Flow from Investment Activities	***-7,157***	***-7,535***
Receipts from:	3,253	892
Tangible fixed assets	14	8
Financial investments	0	0
Interests	3,239	884
Payments to	-10,410	-8,427
Fixed tangible assets	-10,410	-8,427
Fixed intangible assets	0	0
Casf flow from Financial Activities	***107,313***	***16,019***
Receipts from	117,175	17,168
Loans	18,477	0
Allocations to Exploration and Contributions	98,698	17,168
Payments to	-9,862	-1,148
Loans	-4,530	-626
Interests	-5,332	-522
	0	0
Net Cash Increase or Decrease of the Year	27,170	2,189
Cash and Equivalent at the Beginning of the Year	17,590	0
Impact of the Addition of Cash Balances and its Equivalent from Winded -up ENE and EDEL	0	15,401
Cash and its Equivalent at the End of the Year	***44,760***	***17,590***

(d) Conclusion

The major financial ratios were as follows.

The net profit margin in 2016 was negative (-12.8%). Return on Assets (ROA) in 2016 was small, falling to -3.5%, because accounts receivables were big due to the far bigger total assets versus operating income. The current ratio, an indicator of financial stability, was 1.33 because current assets were bigger than current liabilities. The average collection (days) in 2016 was 770 days, which was bigger than 1 year (365 days).

Table 10-12 Major financial ratios

	2016	2015
net profit margin	-12.8%	-32.1%
return on assets (ROA)	-3.5%	-5.2%
current ratio	1.33	1.49
asset turnover	0.27	0.16
average collection (days)	770	1,198

10.2 Analysis of Financial Soundness and Sustainability

10.2.1 Analysis of a unit revenue price per kWh

The JICA Study Team calculated a unit revenue price and unit cost price. Appropriate actual data for generation, transmission, and distribution were unavailable, which compelled the Survey Team to use the generation data shown in the '*Activity Report* 'issued by ENDE. As the revenue of ENDE consists of subsidies on prices as well as ordinary power sales, the Survey Team calculated two types of unit revenue prices: one without a subsidy on price and one with a subsidy on price.

The unit revenue price of PRODEL in 2016 was 4.43 AOA, which was far less than the unit cost price. For the other two companies, the unit revenue price and unit cost price were almost the same or the unit cost price was bigger than the unit revenue price. These figures suggest that none of the three companies have been maintaining appropriate profitability. The unit revenue price without a subsidy of ENDE in 2016 was 5.23 AOA, which was less than half of the unit cost price.

Finally the JICA Survey Team calculated the unit cost necessary to deliver electricity to the final users in Angola. The calculation assumes that the power purchased by Angolan nationals is generated by PRODEL, transmitted through the trunk-lines and sub-stations of RNT, and distributed by ENDE. Then the calculation divides the sum of all of the operational costs of PRODEL, RNT and ENDE by sales (kWh). The result is 44.81 AOA (=0.166 USD).

Table 10-13 Unit Revenue Prices and Unit Cost Prices

(AOA, AOA/kWh)

	2016	2015
PRODEL		
sales (kWh)	10,929,810,809.00	6,308,876,489.00
@revenue unit price /kWh	20.17	18.49
@cost unit price /kWh	19.74	20.10
R N T		
sales (kWh)	9,348,186,285.76	6,136,127,637.00
@revenue unit price /kWh	9.34	8.93
@cost unit price /kWh	8.45	7.39
ENDE		
sales (kWh)	9,348,186,285.76	5,829,423,620.07
@revenue unit price /kWh	13.59	12.19
@revenue unit price (without subsidy) /kWh	6.27	3.78
@cost unit price /kWh	13.28	13.39
Total cost of PRODEL, RNT and ENDE		
sales (kWh)	9,348,186,285.76	5,829,423,620.07
@total cost unit price /kWh in AOA	*44.81*	*42.93*
@total cost unit price /kWh in USD	0.208	0.200

※ USD1= 215.064 AOA based on the official announcement of Banco Nacional de Angola, as of March 12, 2018

10.2.2 Bill Collection

Next, the JICA Survey Team calculated how many days each company needs to collect receivables, from a viewpoint of profitability. In 2014 and 2015, RNT and ENDE took more than 1 year (365 days) to collect receivables, while PRODEL collected receivables in around 90 days. ENDE took an especially long time, more than 1,000 days, to collect receivable in 2015.

ENDE offers an explanation for this issue in its Activity Report: “ENDE sets the goal of collecting from 70% to up to 85% of billed amounts.” If a collection-day extends beyond 365 days, some of the accounts receivables go bad, making further collection almost impossible. This, in turn, makes it necessary to increase the collection rate further. At the same time, ENDE must review whether or not outstanding accounts receivables go bad.

Table 10-14 Collection (days) for Bills (days)

days	2016	2015
PRODEL	91	96
RNT	426	357
ENDE	770	1,198

10.2.3 Financial Soundness

(1) **Current ratio**

The current ratio is a financial indicator used to assess insolvency, especially short-term debt against current assets, including cash and high liquidity, to current liabilities. The current ratio should generally be higher than 2.0.

The low current ratios of the three companies, all below 2.0, reveal their poor solvency and financial soundness. The current ratio of ENDE in 2016 was 1.33, the highest among the three. This ratio, however, was calculated with very high accounts receivables. ENDE therefore needs to review accounts receivable more fully to see whether or not these assets are to become uncollectable.

Table 10-15 Current Ratio

	2016	2015
PRODEL	0.60	0.37
RNT	0.82	0.81
ENDE	1.33	1.49

(2) **Debt Equity Ratio**

The debt equity ratio is a financial indicator used to assess soundness against liabilities. The current debt equity ratios for all three companies exceeded 0.4.

The liabilities for the three companies are limited to short-term borrowings or middle-term borrowings at present, and there are no long-term borrowings. If these companies start borrowing to meet the long-term power development plan, the debt equity ratio will clearly decrease in the long run. These companies will have to either keep certain amounts of profit every year to transfer to retained earnings or periodically increase their capital to maintain their debt equity ratios at a certain level.

Table 10-16 Debt Equity Ratio

	2016	2015
PRODEL	0.47	0.65
RNT	0.41	0.55
ENDE	0.52	0.60

10.3 Review of the Financial Condition of PRODEL, RNT and ENDE

10.3.1 Tariff

As stated in the section 9.3.2, the unit prices of PRODEL and RNT are not big enough to cover the incremental cost derived from the future investment. Both companies need to raise the power tariff or inject a subsidy to cover the incremental cost.

Table 10-17 The Unit Incremental Cost Derived from the Long-term Investment

	PRODEL	RNT
1. unit revenue price in 2016	@0.09 $ /kWh	@0.043 $ /kWh
	(=@20.17 AOA/kWh)	(=@9.34 AOA/kWh)
2. unit cost price in 2016	@0.09$ /kWh	@0.039 $ / kWh
	(=@19.74 AOA/kWh)	(=@8.45 AOA/kWh)
3. incremental cost based on the long-term investment	@0.085$/ kWh	@0.02$/ kWh
	(=@18.3 AOA/kWh)	(=@4.3 AOA/kWh)
4.. Total cost (2+3)	@0.175 $/kWh	@ 0.059 $/kWh
	(=@38.04AOA/kWh)	(=@12.75 AOA/kWh)
5. increase of tariff (unit cost of investment／current unit cost)	17.9 AOA (1.92)	3.41 AOA (1.51)

10.3.2 Cost Structure

The JICA Study Team's review of the financial statements of PRODEL, RNT and ENDE failed to turn up any financial trends, as the statements were available for only two years. Some studies by JICA in other countries, however, were able to find the proper profit margins. In its '*Project Master Plan Study on the Electricity Sector in the Democratic Socialist Republic of Sri Lanka,*' for example, JICA calculated the Return on Asset (ROA) necessary for investment and profit margin that covered the decreasing generation of hydropower plants in the dry season. ※

※ A review of a series of past financial statements of the Ceylon Electricity Board (CEB) in the '*Project Master Plan Study on the Electricity Sector in the Democratic Socialist Republic of Sri Lanka*' (2018) determined that CEB needed an ROA of 5% to generate retained earnings and a profit margin of 3-7.5% to curb the impact of decreasing generation of hydropower plants in the dry season.

10.3.3 Borrowing

The liabilities of PRODEL, RNT and ENDE RNT are currently limited to short-term or middle-term liabilities. There are no long-term liabilities. If the three companies depend solely on borrowing, the credibility of each company will decline commensurately with the decreases in its equity ratio. In order to maintain a proper equity ratio, funds should be raised from a mixture of borrowings and equity, or from a forgivable loan, the approach followed India.

10.3.4 Regulation on the fiscal budget and the tariff

- All of the accounting data must be kept for use for the calculation of their tariffs.
- The net profit of ENDE went into the red in 2016 and a subsidy was received to compensate for the loss. Meanwhile, PRODEL and RNT went into the black.
- While amount of subsidy ENDE receives is important, the calculation of the unit cost for the generation, transmission and sub-station will be unaffected.

10.3.5 Some Financial Issues to be considered

It seems that no rating firms have ever rated PRODEL, RNT, and ENDE so far. From here we summarize several important considerations.

(1) **Improvement of profitability**

No financial institution would extend a loan to an implementing agency with low profitability. Hence, the implementing agency needs to improve its profitability. While it may not be possible to raise tariffs to cover all costs, it will be important to encourage efforts to improve profitability.

(2) **Financial Soundness**

(a) Current Ratio

All three corporations have big receivables stemming from their apparently big current ratios. Yet some portion of the receivables went bad. The implementing agencies need to review the receivables and try to collect them faster.

(b) Return on Equity (ROE)

If an investment is extended solely by borrowing, it will push Return on Equity (ROE) down. As continuous borrowing may lead to an ultimate default, overdependence on borrowing is discouraged. A proper capital injection would therefore be necessary from a financial viewpoint.

10.3.6 Other issues

(1) **Accounting and disclosure**

- The time will come to compare the fuel costs of different thermal power plants, which includes the ones developed by the private investor. This will require disclosure of information on how much fuel cost the implementing agency consumes (though this may not be disclosed in the financial statement of PRODEL).
- In order to access the financial condition of PRODEL, RNT and ENDE, a review must be conducted to determine how the three newly established corporations (PRODEL, RNT and ENDE) took over or did not take over the assets when they were first established. Alternatively, the report from the Audit Firm could be reviewed, if necessary.

(2) **Analysis on the fiscal condition of the Government of Angola**

The JICA Study Team reviewed the financial conditions of the three corporations in the power Sector. If Angola plans to develop power projects through borrowing, it needs to consider the fiscal condition of the Government of Angola as well as the three corporations of Angola.

As stated in the Chapter 9, borrowings from JICA, JBIC, and AfDB need government guarantees. Borrowings guaranteed by the government surely increase the General Government Gross Debt. As the rate of the Gross Debt in Angola has already reached a high level, failure to undertake a new guarantee may seriously impede long-term power development. （※）

※The power sector in Vietnam faces the same problem. The ratio of General Government Gross Debt already reached the upper ceiling of 65% in 2017. Consequently the Government of Vietnam is reluctant to undertake a new guarantee. Meanwhile, the Government of Vietnam is said not to provide government guarantees to new power project exceptionally. Rather the Government encourages the Electricity of Vietnam (EVN), the biggest utility power company in Vietnam, to raise funds by itself and raise the power tariff.

According to recent macro indices of Angola, the GDP in 2017 was 124.21 billion USD and the Rate of General Government Debt has reached 65.35% (=81.066 billion USD), starting from 44.3% in 2010. The total investment amount up to 2040 will reach 31,548 million USD, the equivalent of 25% of the 2017

GDP. If the Government of Angola goes on undertaking government guarantees, the total debt will almost reach Angola's 2017 GDP. This would not be favorable for the long-term sustainability of the country.

Table 10-18 GDP and General Government Gross Debt of Angola

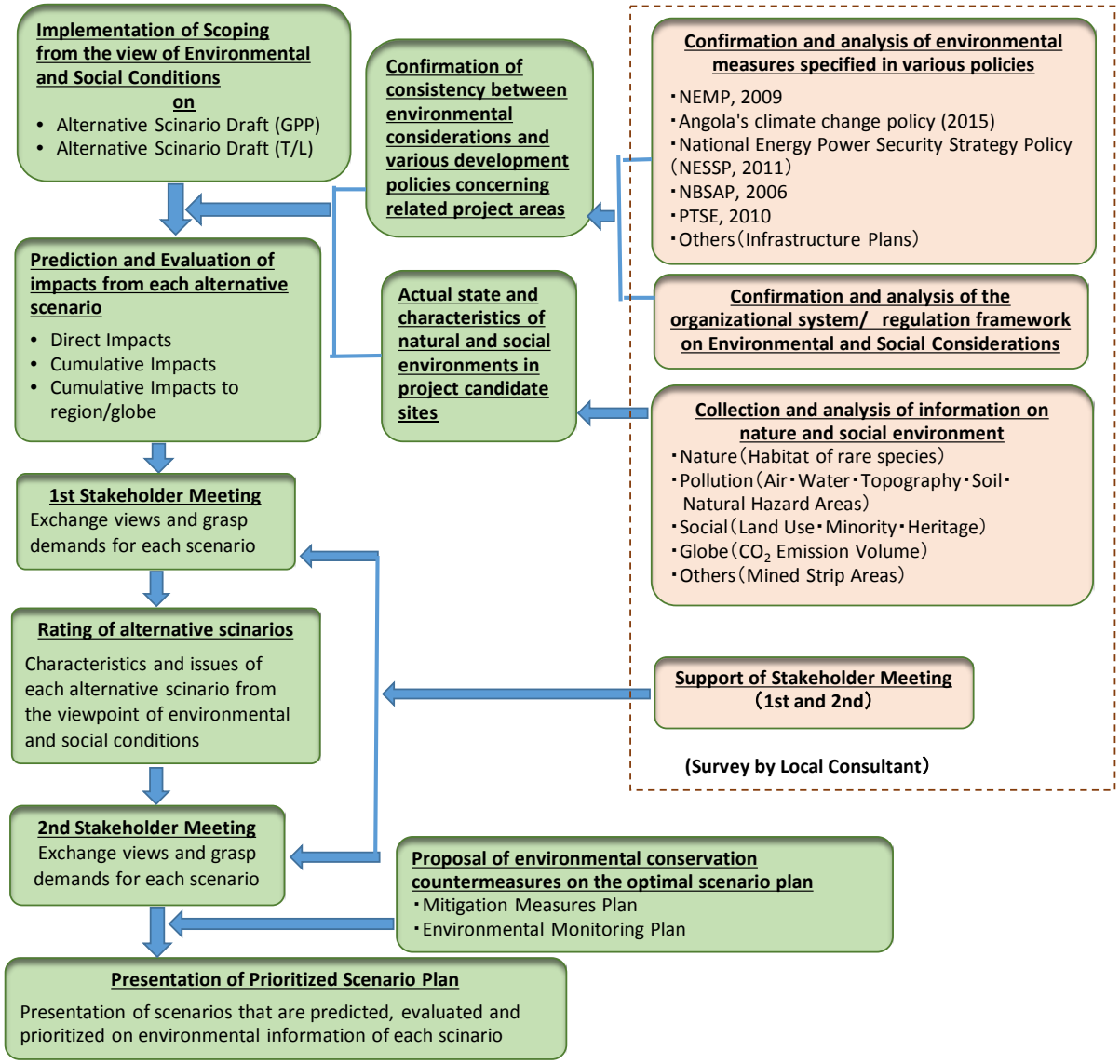
	2010	2011	2012	2013	2014	2015	2016	2017
GDP (billion USD)	82.53	104.12	113.92	124.91	126.73	102.62	96.34	124.21
General Government Gross Debt (%)	(44.3)	(33.8)	(29.9)	(32.9)	(40.7)	(64.6)	(79.8)	(65.3)

（Source: IMF World Economic Outlook 2018）

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 km^2 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.

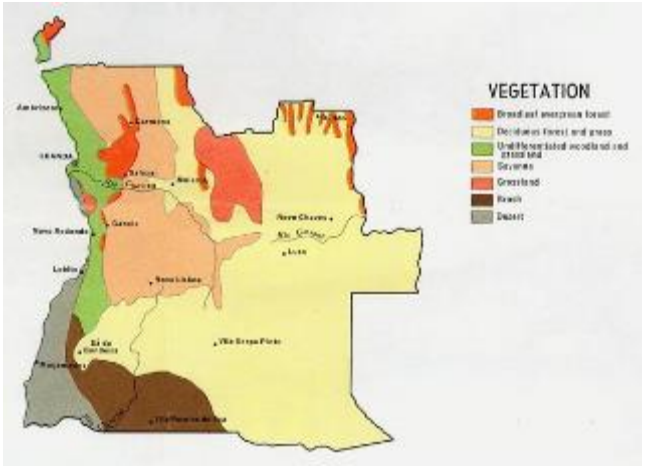
Angola can be divided into six geomorphological areas: coastal, marginal mountain chain (cadeia marginal de montanhas), the old tableland (planalto central), the Zaire Basin, and the Basins of the Zambezi and the Cubango.

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 ºC in the rainy season (September to April) and between 18 and 22 ºC 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.

(Source: ERM)

Figure 11-3 Welwitschia mirabilis

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.

Table 11-1 Number of Endangered Species in Angola

Category / Number		Critical (CR)	Endanger (EN)	Vulnerable (VU)
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 km^2).

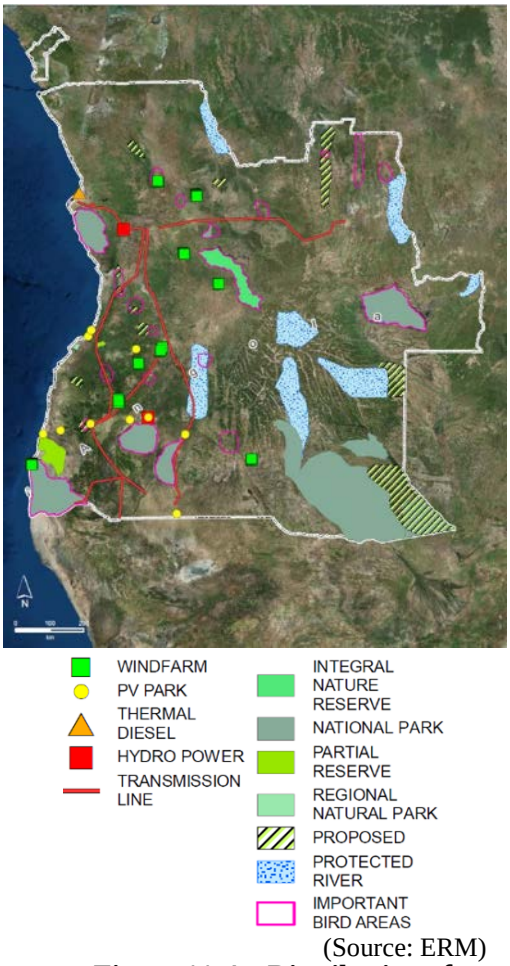
There were nine national parks (6.3%), four strict reserves (4%), two natural reserves, and one regional natural park (0.4%). Five public hunting reserves and a private hunting reserve were also established.

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)



(Source: ERM)

Figure 11-4 Distribution of Protected Areas

(2) **Social Environment**

The total area of Angola is 1,246,700 km^2. Angola's 2014 national census reports a national population of 25.8 million and population density of 21.8 head/km^2. (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 impinions 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 CO_2 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 (UNFCC).

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 tCO_2e per year.

2. Cambambe II Hydropower Plant:

   It will secure 700 MW capacity and aim to reduce emissions by 3,282,000 tCO_2e per year.

3. Tombwa Wind Farm Plant

   It will secure a capacity of 100 MW and reduce emissions by 157,258 tCO_2e 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 tCO_2e per year.

Based on the CO_2 emissions per 1 MW for each power development developed by the Angola government, the CO_2 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 CO_2-tons.

Table 11-6 Reduction of CO_2 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:

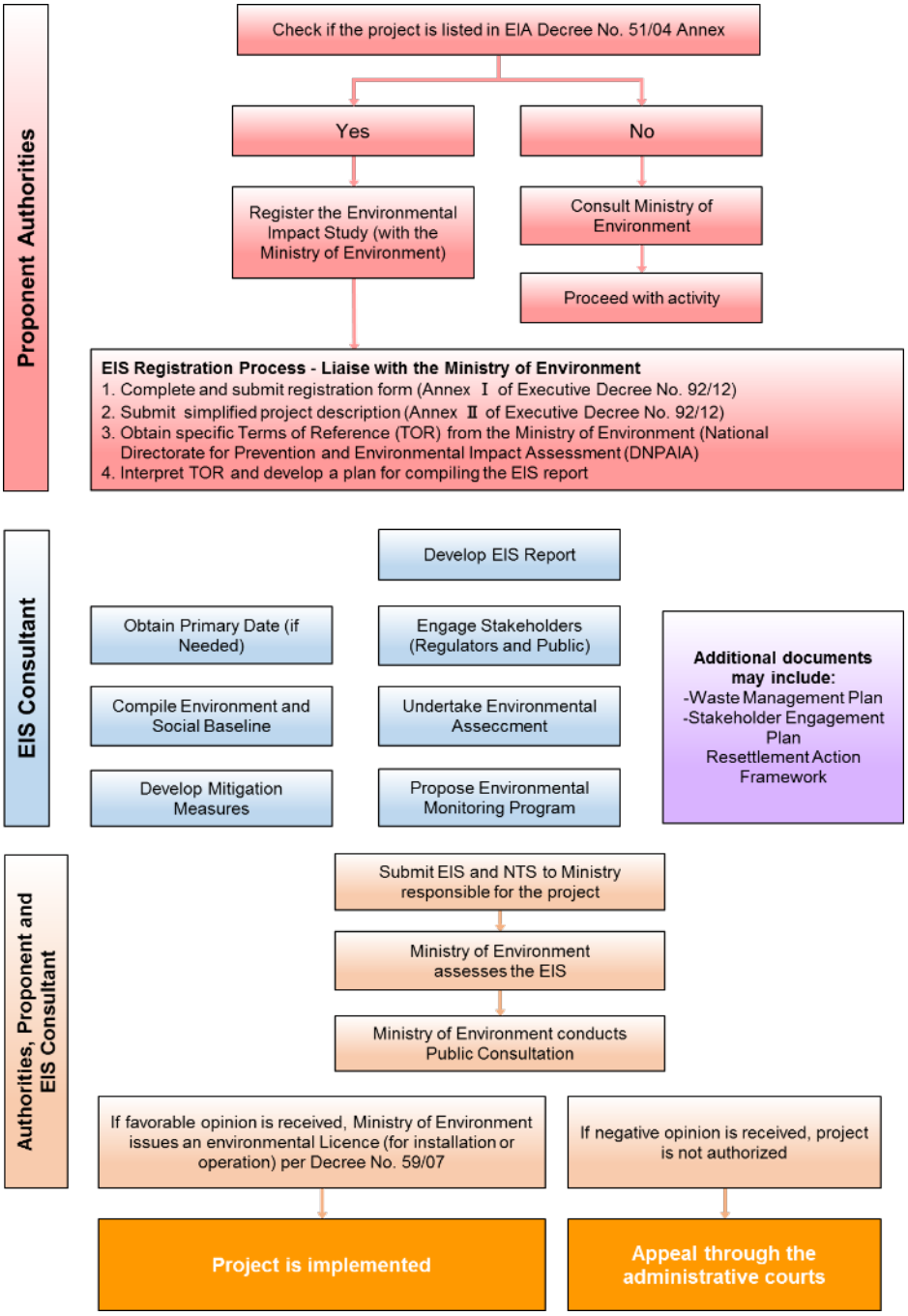
- Agriculture, fisheries and forestry;
- Extractive industries, such as petroleum, mining and dredging;
- Energy industry;
- Glass industry;
- Chemical industry;
- Infrastructure projects; and
- Other projects.

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	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.

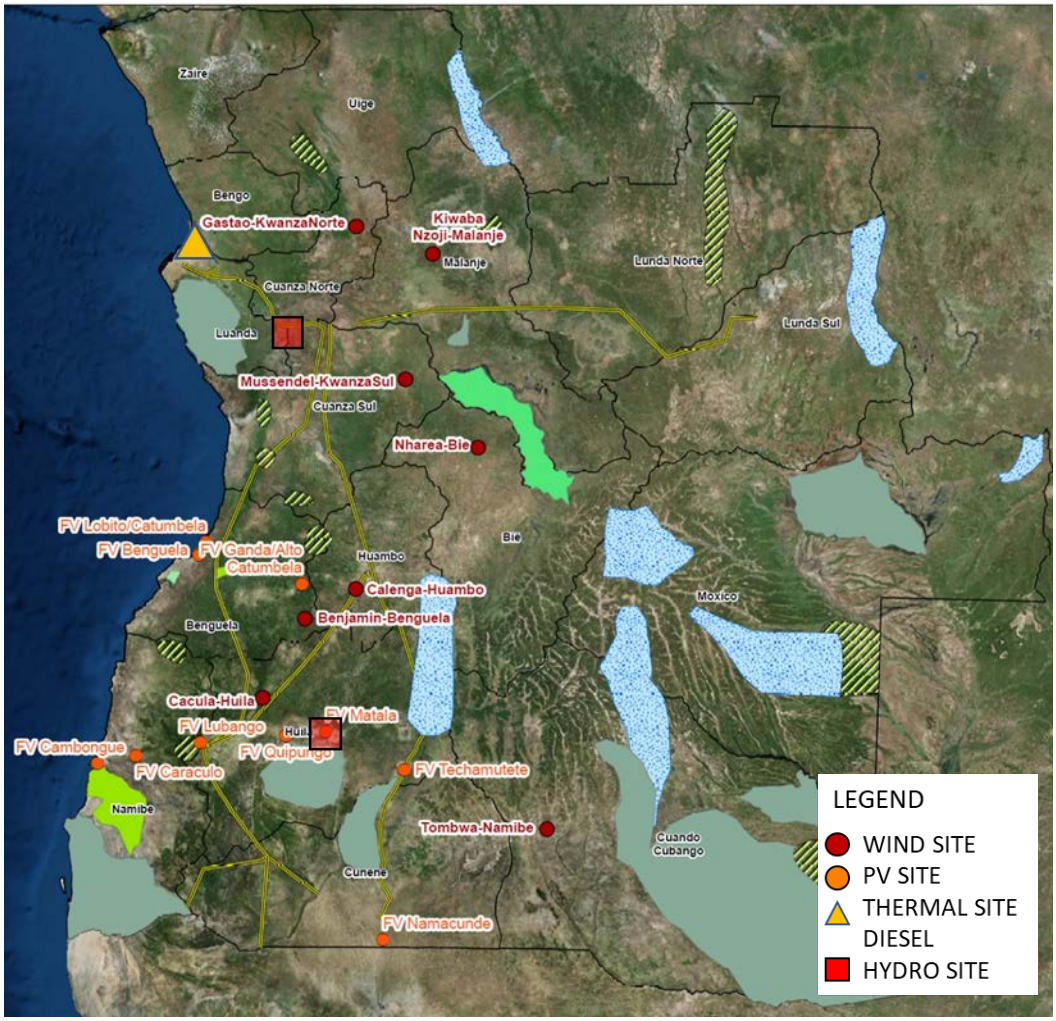
As no candidate sites for hydropower projects were nominated by MINEA, the environmental evaluation (scoring) for hydropower was done by evaluating the impacts of existing hydropower plants on nature, society, and the global environment, in lieu of conducting SEA evaluations on candidate sites. The environmental 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	CO2 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 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	-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	CO2 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.

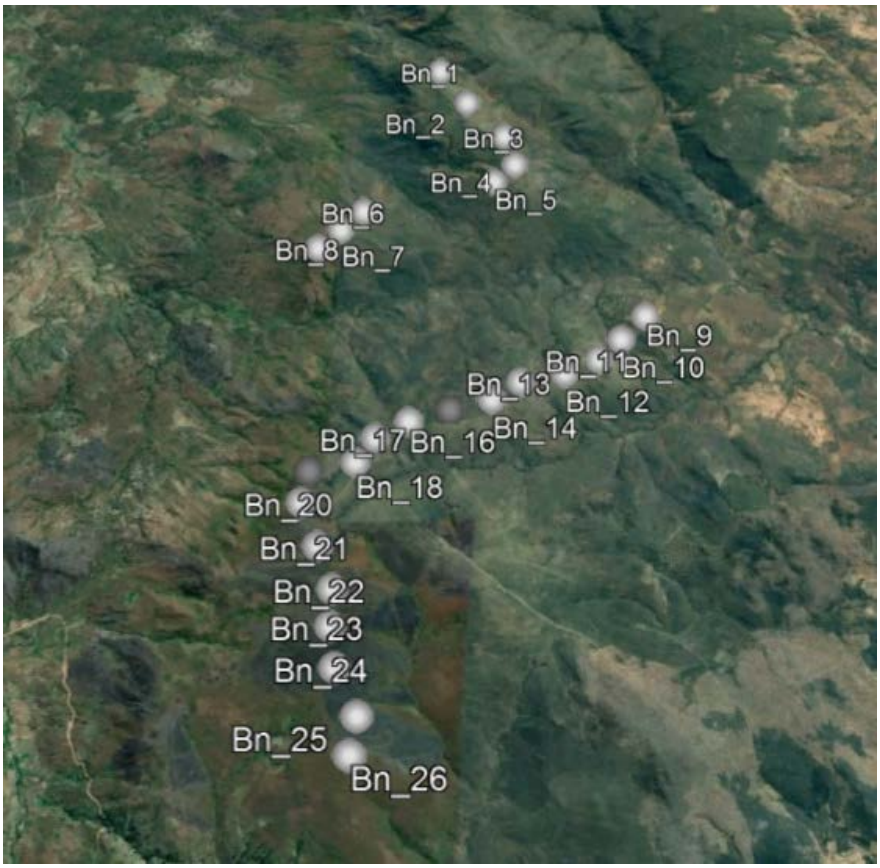


Figure 11-9 Site for BENJAMIN Wind Power Plant

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.

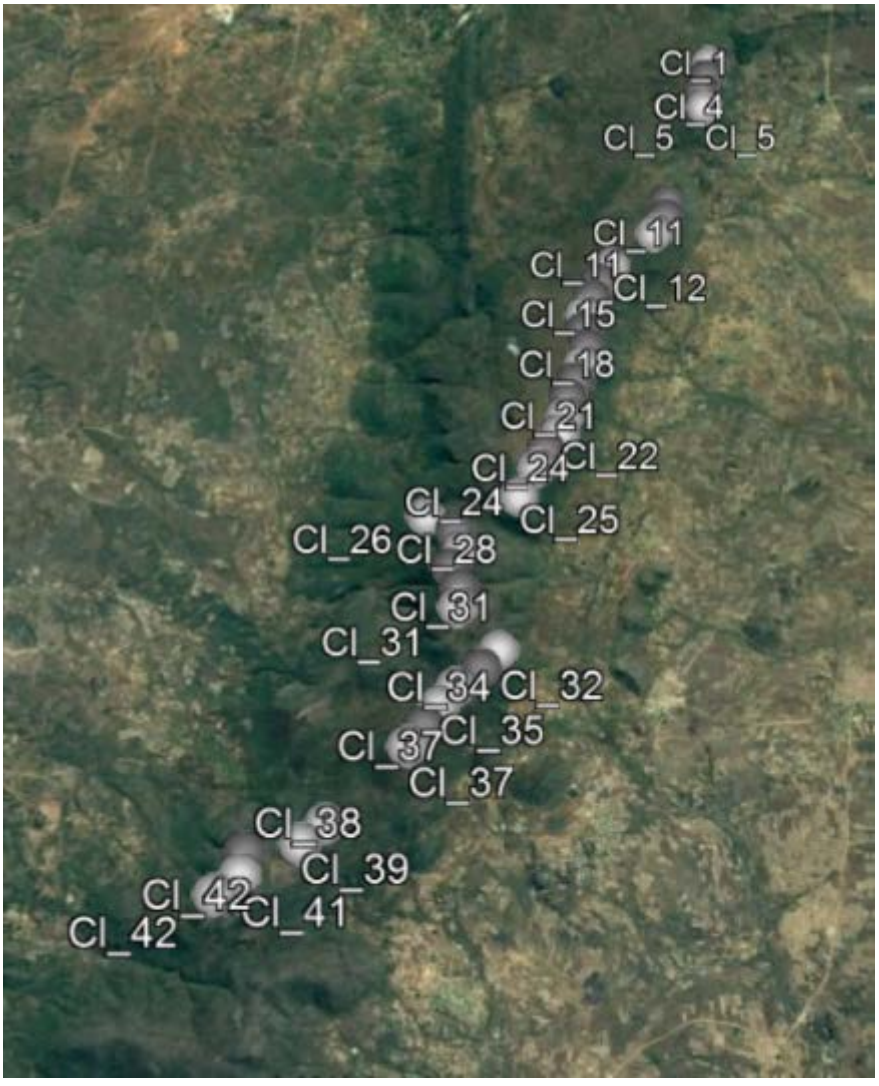


Figure 11-10 Site for CALENGA Wind Power Plant

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.

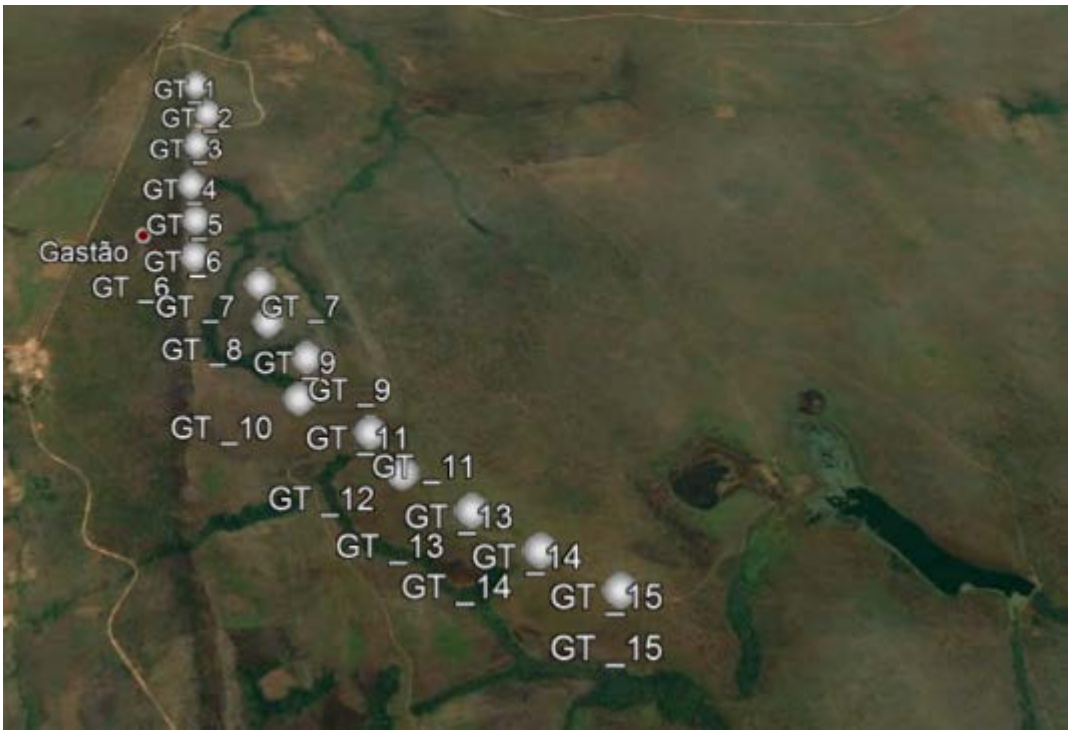


Figure 11-11 Site for GASTAO Wind Power Plant

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.)

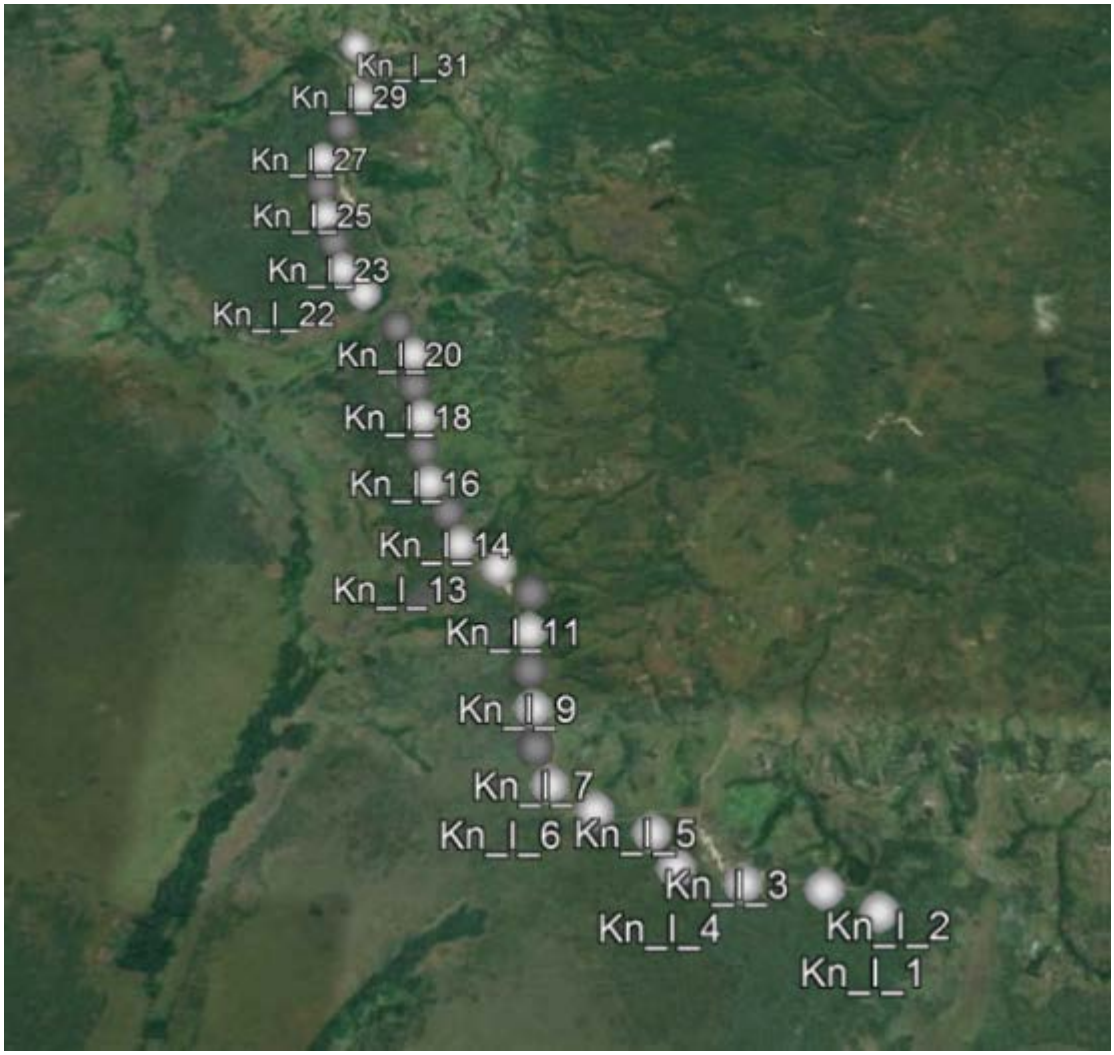


Figure 11-12 Site for KIWABANZOJI I Wind Power Plant

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.

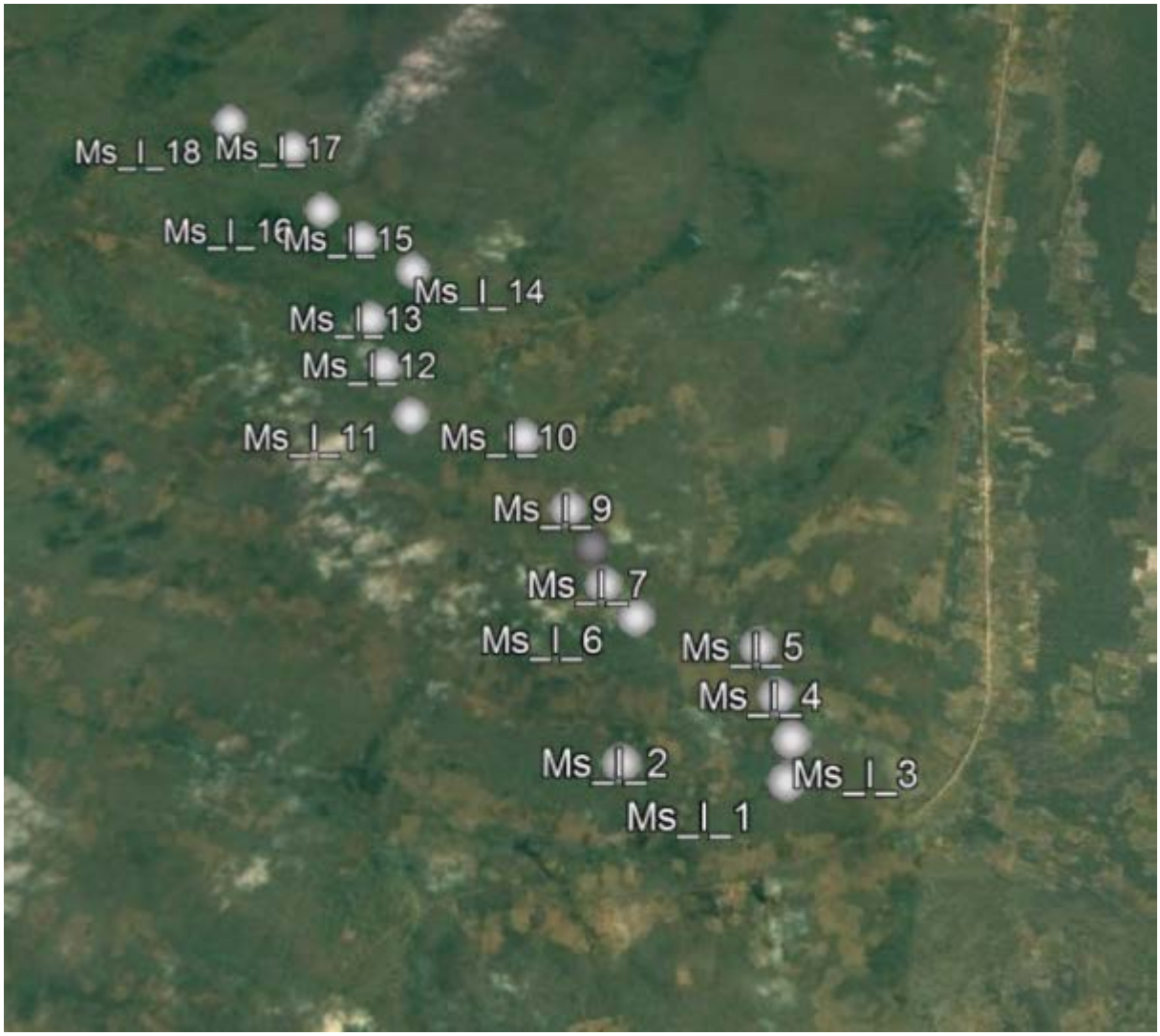


Figure 11-13 Site for MUSSENDE I Wind Power Plant

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.

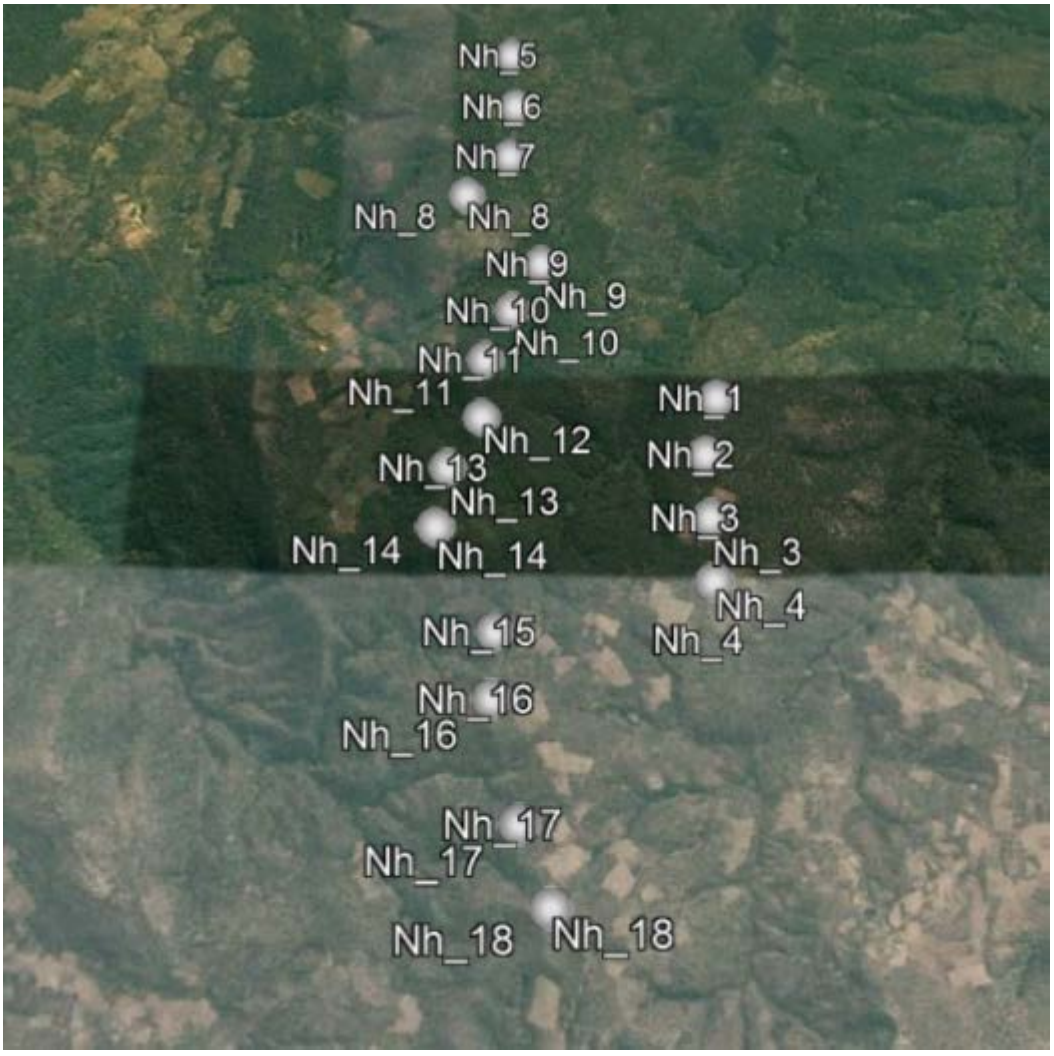


Figure 11-14 Site for NHAREA Wind Power Plant

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 facilties 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 facilties 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 facilties on the fling 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.)

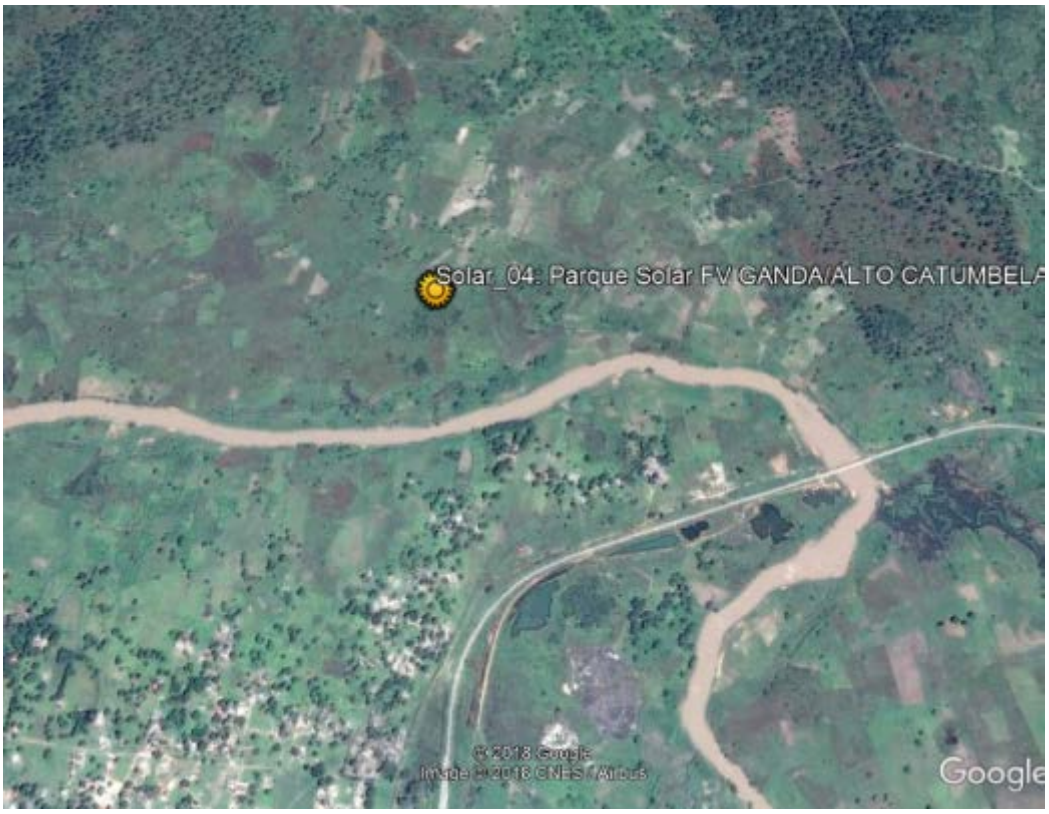


Figure 11-19 Site for GANDA/ALTOCATUMBELA Solar Power Plant

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 facilties 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.)

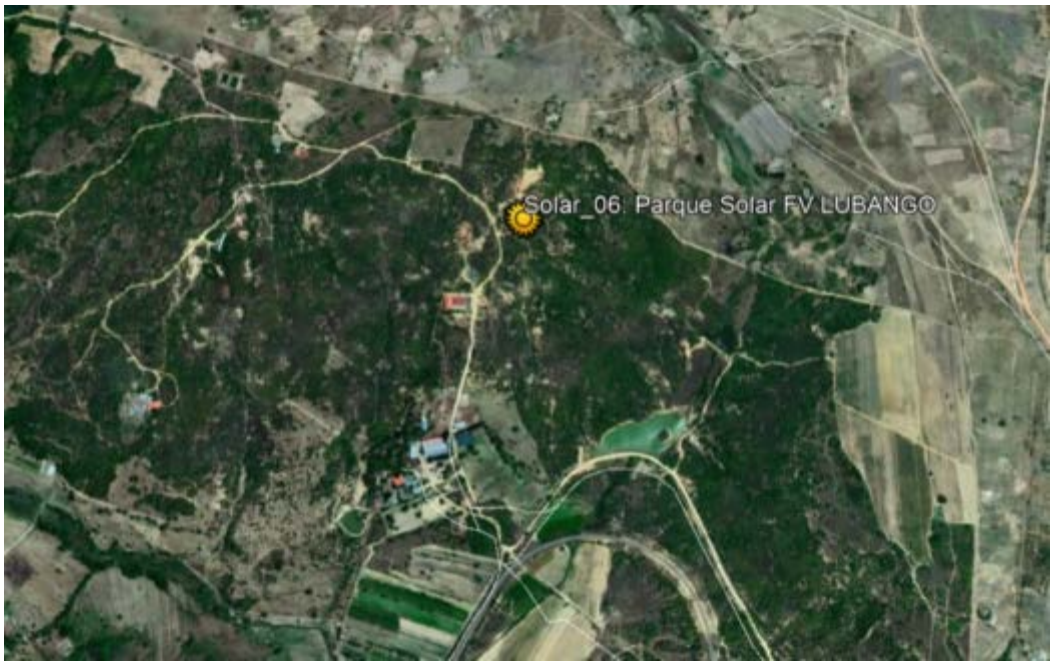


Figure 11-21 Site for LUBANGO Solar Power Plant

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 facilties 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 facilties 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 facilties 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**	

(Source: JICA Survey Team)

(d)-9. NAMACUNDE 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 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.).

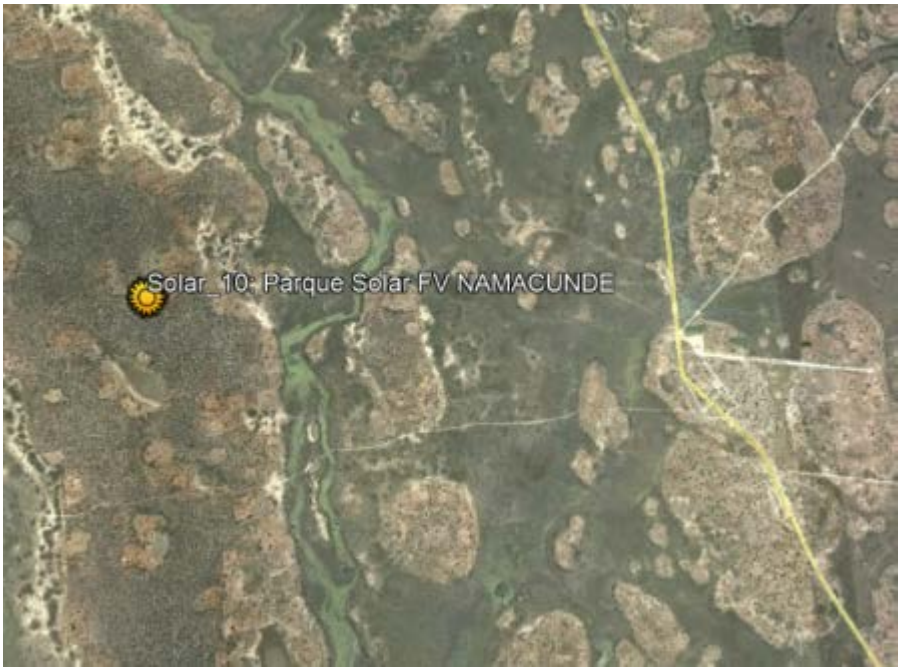


Figure 11-24 Site for NAMACUNDE Solar Power Plant

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 facilties 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 facilties 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 facilties 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 indiencator (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).

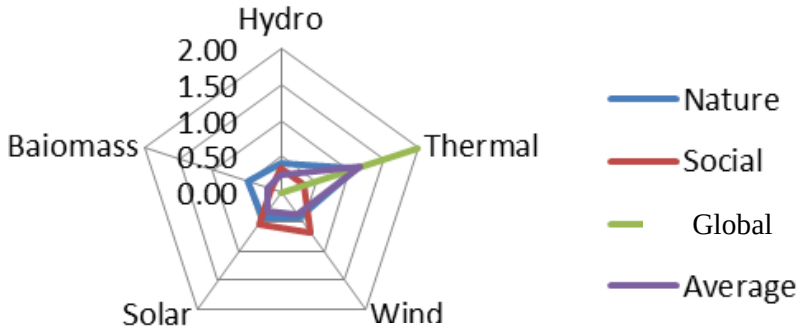
The relatively high total environmental impact of wind power and solar power generation stems from the large negative impact on the local landscape caused by the appearance of huge artificial structures in the vast plains of the continent of Africa (mainly savanna, shrub vegetation).

Table 11-34 Environmental indicator on each power generation plant

	Type	HYPP		THPP	Wind PP								Solar PP										Bio. PP
	Name	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	10	10	10	10	10	10	10	3
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	−1.0	−1.0	−1.0	−1.0	−1.0	−1.0	0.0	0.0	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	−1.0	−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	−1.0
Noise/Vibration		0.0	0.0	−1.0	−1.0	−1.0	0.0	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	−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	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
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	−3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Natural Environment)		−0.60	−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
(Aberage)		−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	−1.0	0.0	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	0.0
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	−0.66	−0.50	−0.50	−0.15
(Average)		−0.33		−0.33	−0.68								−0.53										−0.15
een 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
(Globale 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 (CO_2 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	・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)	・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 CO_2 emission from the power plant by energy-saving measures throughout the whole factory or by introducing renewable energy power plants.
Wind	・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	・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	・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).

	
Discussion by SHM participants	Explanations by the JICA study Team

LISTA DE PRESENÇAS 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	Holísticos	Engº Ambiental	[redacted]
Adérito Manico	IRSEA	Chefe de Dptº	[redacted]
Mariano Balanca	EXIDE	Director	[redacted]
Eudes Panzo	RNT	Chefe de Depto	[redacted]
Manuel Domingos	RNT	Engº Dominga	[redacted]
Paulino Brito	JICA	Tradutor	[redacted]
VALTER MIRANDA	FREE-LANCER	TRADUTOR	[redacted]
Masayuki ITO	JICA Team		[redacted]
Luciano Vidal	ENDE	DIRECTOR	[redacted]
Kiminori Nakamata	JICA		[redacted]
Hitoshi FURUKOSHI	JICA Team		[redacted]

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

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

LISTA DE PRESENÇAS 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)
NDONGALA VUANDA	MINEA	CHEFE DE DPTO	
LEONEL LUCALA	MINGA	CHEFE DE DPTO	
Antônio Furtado	MINEA	Chefe Dpto	
CARLOS FERREIRA	ENDE	DIRECTOR	
Manuel Passo	PRODEL	Director	
Manuel Quintino	INRH	Director	
ARLINDO CARLOS	GAMEK	Técnico	
Shigeki WADA	JICA	Expert	
Paula Francisco	GAMEK	Tecnico	
NEGIDIO BUAKELA	GAMEK	TECNICO	
[illegible]	GAMEK	TECNICO	

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

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

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

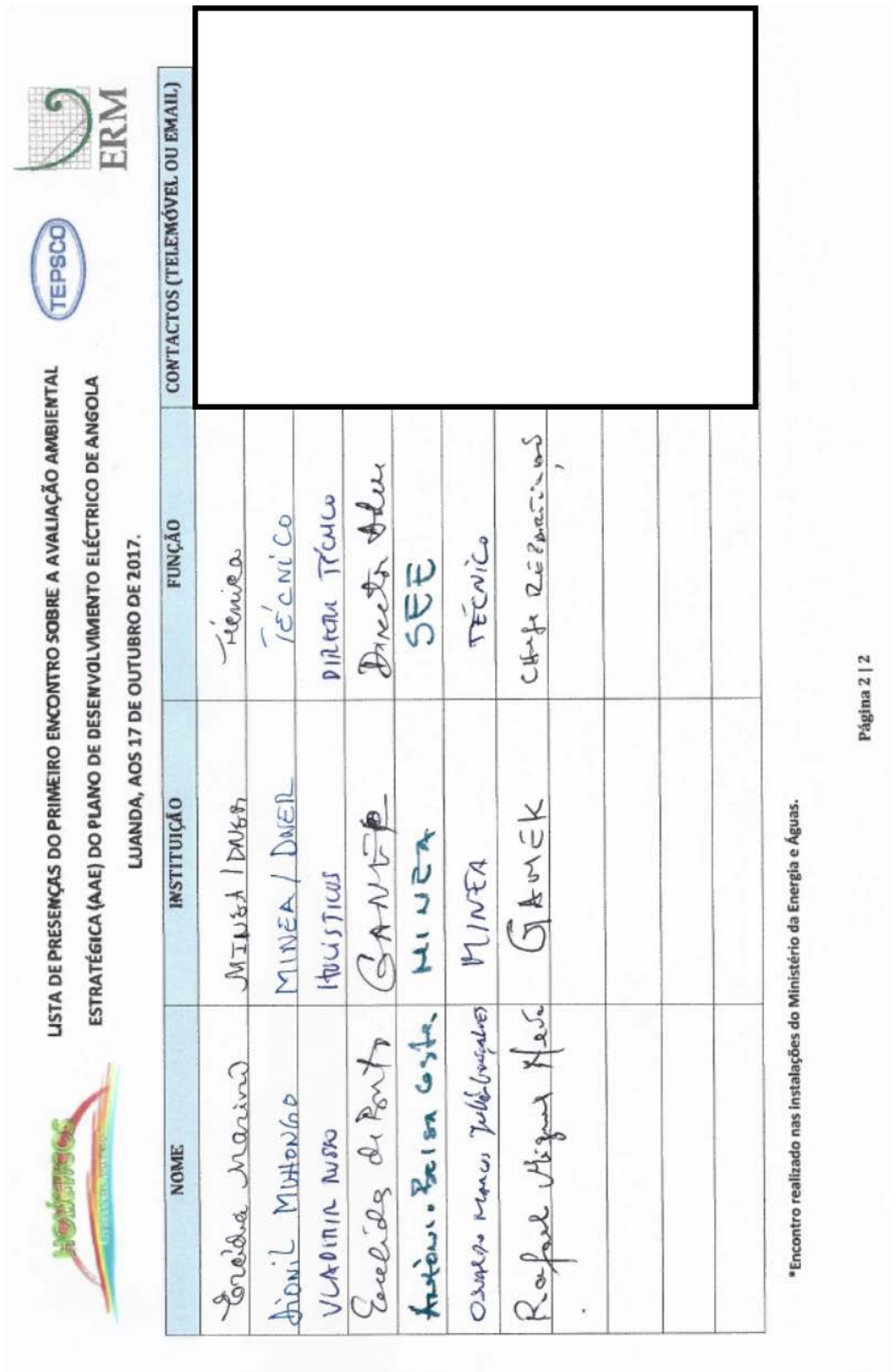
LUANDA, AOS 17 DE OUTUBRO DE 2017.

NOME	INSTITUIÇÃO	FUNÇÃO	CONTACTOS (TELEMÓVEL OU EMAIL)
Albano Gaspar	Gamek	Tecnico	
Morais Jimbo	//	//	
Adolfo do Santo	"	"	
Nuno Lopes	— " —	— " —	
João Micolo	Gamek	Tecnico	
Alberto Fernandes	IRSEA	Tecnico	
Alfredo J. S. [illegible]	PRODEL	"	
Eduardo M. F. dos Santos	PRODEL	Departamento	
Zacarias Ferreira	Prodel	Departamento	
Sandra Cristóvão	DNER	Director	
LANDA JOÃO	DNER	C. Departamento	

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

Página 1 | 2

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



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

LUANDA, AOS 17 DE OUTUBRO DE 2017.

TEPSCO

ERM

NOME	INSTITUIÇÃO	FUNÇÃO	CONTACTOS (TELEMÓVEL OU EMAIL)
Geraldo Mariano	MINEA / DNEA	Técnico	
Daniel Muhongo	MINEA / DNEA	TÉCNICO	
VLADIMIR NUNO	HOLISTICS	DIRETOR TÉCNICO	
Cecílio de Brito	GAMEK	Director Adjunto	
António Brito Costa	MINEA	SEE	
Osvaldo Manuel Julião Gonçalves	MINEA	TÉCNICO	
Rafael Miguel Maia	GAMEK	Chefe Repartição	

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

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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.

Photo 1: Opening ceremony of the Stakeholder Meeting.

Photo 2: Opening speech by Honourable Minister of Water and Energy, Eng.º João Baptista Borges

Photo 3: Participants of the stakeholder meeting.

Photo 4: Presentation by JICA Team

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

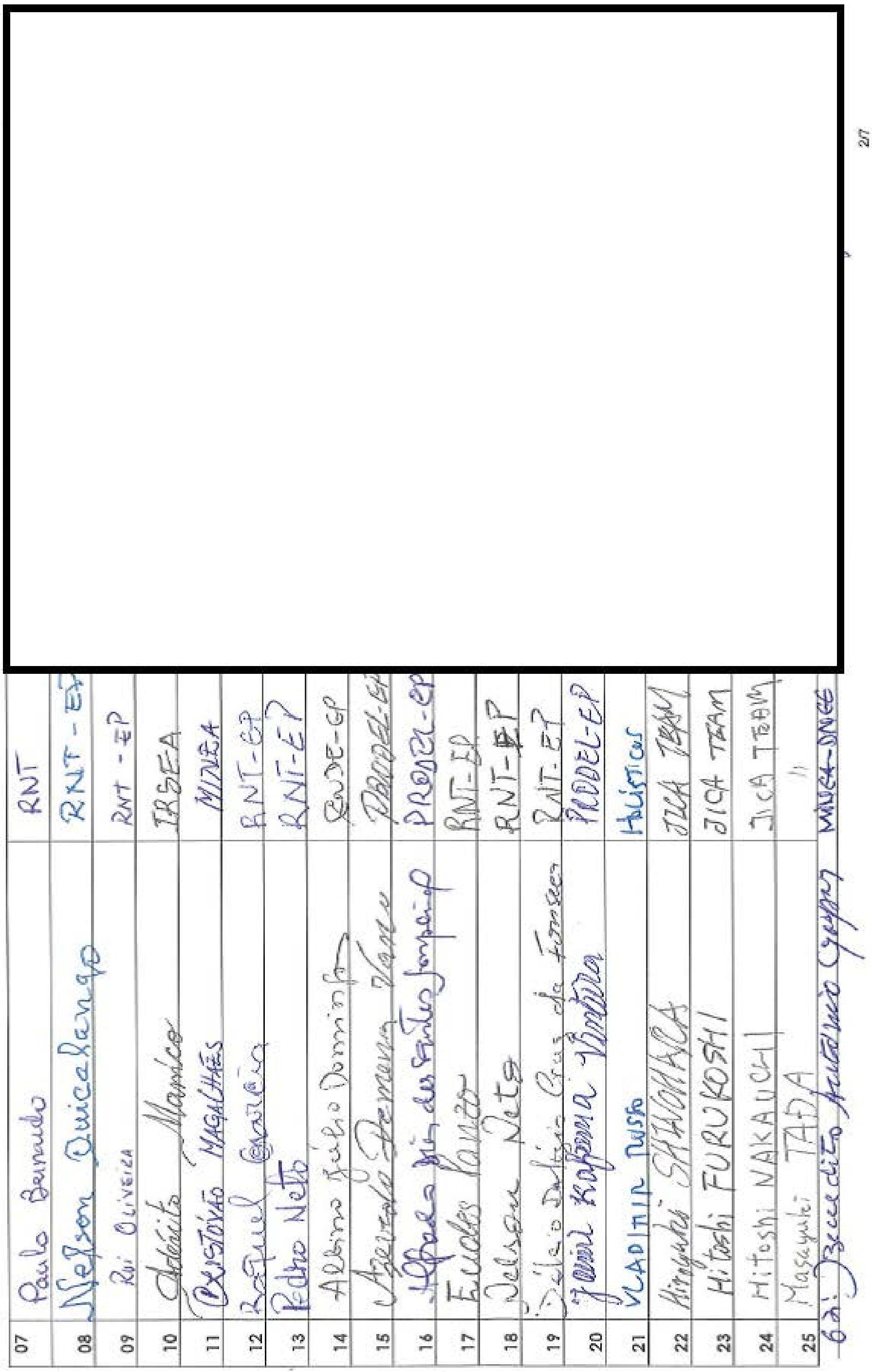
LOCAL: ANFITEATRO DA ENDE NO EDIFÍCIO SEDE

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

Nº	NOME	ORGANISMO	TELEMOVEL	E-MAIL
01	Osvaldo Marcos Julião Gonçalves	MINEA	[redacted]	
02	Rosa Maria Afonso Miguel	PRODEL		
03	Manuel de Sousa Panzo	PRODEL		
04	Fernando Alberto Pinto Quelas	GAMEK		
05	Gerson Emmanuel Neves Moleira	PRODEL		
06	Lourenço Paulo de Carvalho	RNT		

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

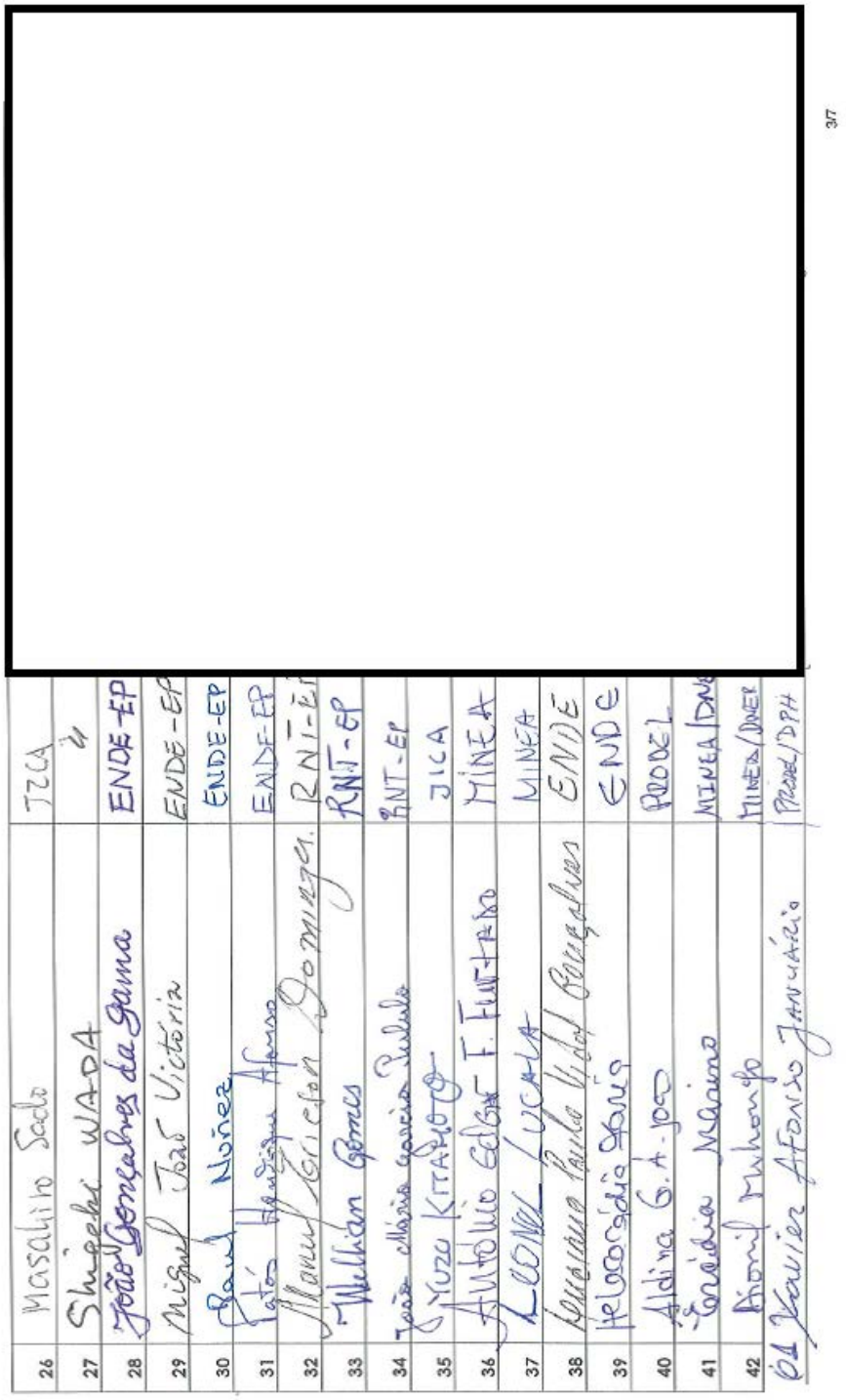
Participants List of 2nd Stake Holder Meeting (1/4)



[redacted]

07	Paulo Bernardo	RNT
08	Nelson Quicolango	RNT-EP
09	Rui Oliveira	RNT-EP
10	Adesito Mamico	IRSEA
11	Cristóvão Magalhães	MINEA
12	Rafael Carneiro	RNT-EP
13	Pedro Neto	RNT-EP
14	Albino Júlio Domingos	ENDE-EP
15	Azevedo Domingos Vaz	PRODEL-EP
16	[illegible] dos Santos Jorge	PRODEL-EP
17	Euclides Paulo	RNT-EP
18	Nelson Neto	RNT-EP
19	Délcio Dilício Cruz da Fonseca	RNT-EP
20	[illegible]	PRODEL-EP
21	Vladimir Tuso	Holísticos
22	Hiroyuki SAWAHARA	JICA TEAM
23	Hitoshi FURUKOSHI	JICA TEAM
24	Hitoshi NAKAUCHI	JICA TEAM
25	Masayuki TADA	"
62	Benedito Afonso Gregório	MINEA-DNEE

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



26	Masahiro Sada	JICA	
27	Shigeki WADA	〃	
28	João Gonçalves da Gama	ENDE-EP	
29	Miguel José Victória	ENDE-EP	
30	Raul Nunes	ENDE-EP	
31	Pedro Agostinho Afonso	ENDE-EP	
32	Manuel Ericelson Domingos	RNT-EP	
33	Wellikan Gomes	RNT-EP	
34	Teresa Maria Gonçalves Rufino	RNT-EP	
35	Yuzo KITAMOTO	JICA	
36	António Edgar F. Fontinha	MINEA	
37	Lourdes Lucamba	MINEA	
38	Alexandre Paulo Vidal Gonçalves	ENDE	
39	Helderádio Sousa	ENDE	
40	Aldina G. A. Joco	PRODEL	
41	Teresa Mariano	MINEA/DNE	
42	Ricardo Muhongo	MINEA/DNEP	
01	Xavier Afonso Januário	PRODEL/DPH	

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

43	Euclides da Brito	GAMEK	[redacted]
44	NEGIDIO BUAKELA	GAMEK	
45	ANTÓNIO MONTE	RNT-EP	
46	Domingas Lídia Adriano	PRODEL	
47	Dorivaldo F. Manuel	RNT	
48	Damásio Bravo de Jesus	RNT	
49	Elzo Caiumba	RNT	
50	Miguel Malakampova Quiala	RNT	
51	FRANCISCO MEIRELES	PRODEL	
52	Luis Mourão Silva	IRSEA	
53	Victor Vunge	GCII	
54	Penga Zolo	RNT	
55	Menezes CHAMACE	EASBIG	
56	António Inglês Pinto	RNT-E.P	
57	Adriano Amarildo M. Paulo	RNT	
58	Paulino Ernesto	JICA TEAM	
59	Hisanobu Kuroki	JICA TEAM	
60	Helder Maurício Cossamo Ndorochi	JICA Team	

4/7

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.
	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	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	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)-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.
	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	D	No specific negative impact is expected.

Item	Impact		Rating	Results
		Local Decision-making Institutions		
	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)-6 Cahama SS – Ruacana PS Route

Table 11-46 Scoping for Cahama SS – Ruacana PS 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 expected.
	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	C	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 date**

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	- Relevant environmental standards - Meteorological information - Current status of ambient atmosphere	- Obtain ambient air quality standards, - Measure the air pollutants (TSP), SO2, NO2, CO, O3, PM10, PM2.5.
Water Quality	- Relevant environmental standards - Current status of water quality	- Obtain water quality standards and effluent standards. - Measure the existing reservoir and river water quality (temperatures, salinity, COD, nutrients, etc.)
Soil Quality	- Relevant environmental	- Measure the soil quality and screen

Environmental Items	Survey Items	Survey Method
	standards	for any contamination.
Noise and Vibration	- Relevant environmental standards - Current status of noise and vibration	- Obtain noise level standards - Measure the noise levels (background)
Waste	- Relevant environmental standards	- Obtain waste handling standards / manuals / guidelines.
Subsidence	- Current status of soil conditions	- Geological survey
Protected Areas	- Current status of Protected Areas	- Collect relevant laws and regulations, information on Protected Areas
Ecosystem	- Current habitat status of flora, mammal, birds, reptiles, amphibians, fish, precious species (migrant birds)	- Survey the distribution of flora and fauna.
Topography and Geology	- Geological conditions	- Obtain geological information
Land acquisition / Resettlement	- 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	- 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	- Identify ethnic minority groups and indigenous people among the affected people	- 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	- Identify the present land use - Identify the jobs and livelihoods of the affected people	- Collect information on the employment and income in the affected area - Interviews with the households
Disturbance of Water Usage, Water Rights, etc.	- Identify the present water use for day-to-day life and agricultural activities.	- Household socioeconomic survey - Interviews with the households
Cultural Heritage	- Current status of Cultural Heritage Areas	- Collect information on relevant laws and regulations and information on Heritage Areas
Landscape	- Current status of outstanding scenery	- Collect information on relevant laws and regulations and information on outstanding scenery
Cross-boundary Impact and Climate Change	- Identify the present air quality	- Measure CO_2 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	➢ 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	➢ 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	➢ 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	➢ 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	➢ 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.

(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	(Countermeasure on Environment) ・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. (Work Environment and Accidents) ・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	
	Lomaúm (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	Beniamin 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	**Bita**	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	**Bita**	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	**Huila**	400	**Lubango2**	900	51.3	450 x 2, Pre-FS implemented*
10	2025	**Huila**	400	**Capelongo**	900	51.3	450 x 2
11	2025	**Huila**	400	**Calukembe**	120	32.6	60 x 2
12	2025	**Benguera**	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	**Huila**	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	**Bita**	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 (MUS$)	Remarks
1	2018	**Benguela**	220	**Benguela Sul**	240	24.5	120 x 2, under construction(China)
2	2020	**Luanda**	220	**Bita**	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	**Malanje2**	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 (MUS$)	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	**Malanje2**	120	18.1	120 x 1, upgrade
78	2040	**Huíla**	220	**Caluquembe**	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 (MUS$)	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**	**Bita**	1	580	172	134.2	under construction(Brazil)
4	2022	**Northern**	400	**Catete**	**Bita**	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

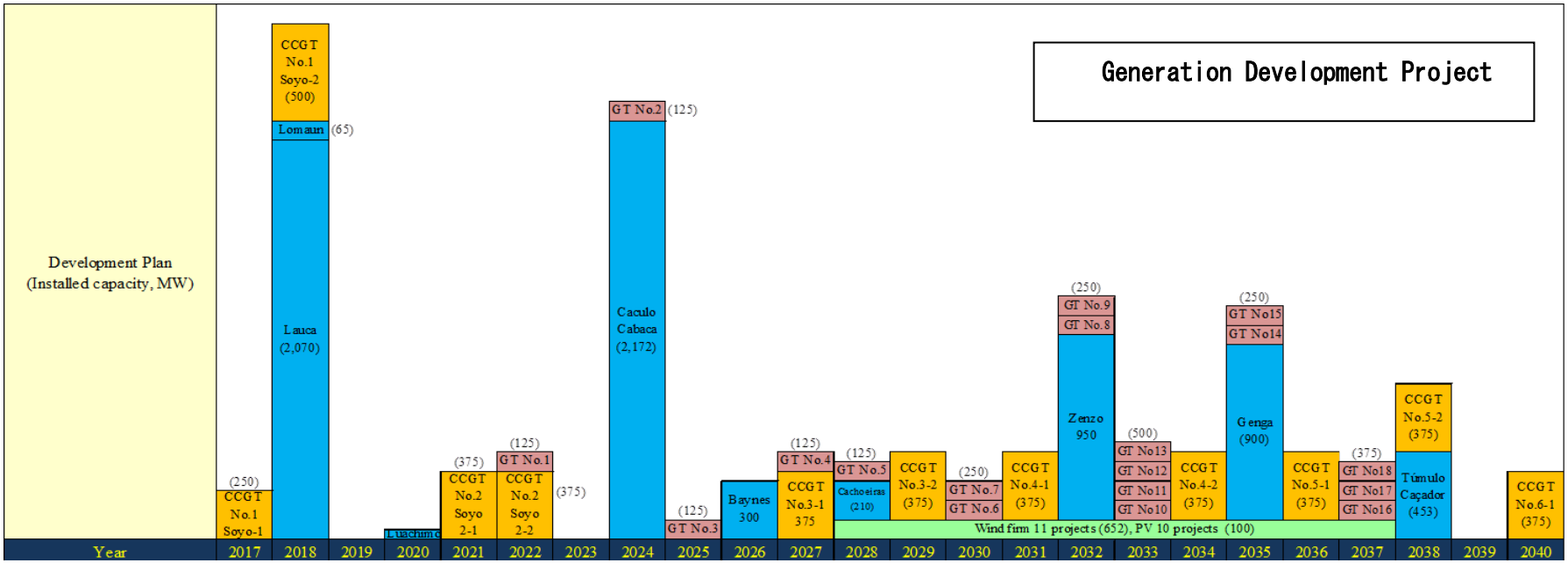
Project#	Year of operation	Area	Voltage (kV)	Starting point	End point	number of circuit	Required Capcity (MVA)	Line Length (km)	Cost (MUS$)	Remarks
1	2020	**Southern**	220	**Lubango2**	**Lubango**	2	360	30	13.5	Pre-FS implemented*
2	2020	**Southern**	220	**Lubango2**	**Namibe**	2	360	162	72.9	Pre-FS 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	**Bita**	**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**	**Golfe**	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 Substattion inserted
19	2025	**Northern**	220	**M'banza Congo**	**Tomboco**	2	220	5	2.3	For Substattion 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 Substattion inserted
27	2025	**Central**	220	**Lomaum**	**Bocoio**	2	120	5	2.3	For Substattion 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 Substattion inserted
43	2030	**Northern**	220	**Pambos de Sonhe**	**Negage**	2	620	5	2.3	For Substattion 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 Cacuaco GT #1**	**Cacuaco**	2	375	5	2.3	
6	2025	**Northern**	220	**TPP Cacuaco 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 Cambutasu – Gabela – Nova Biopio – Lubango	– 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

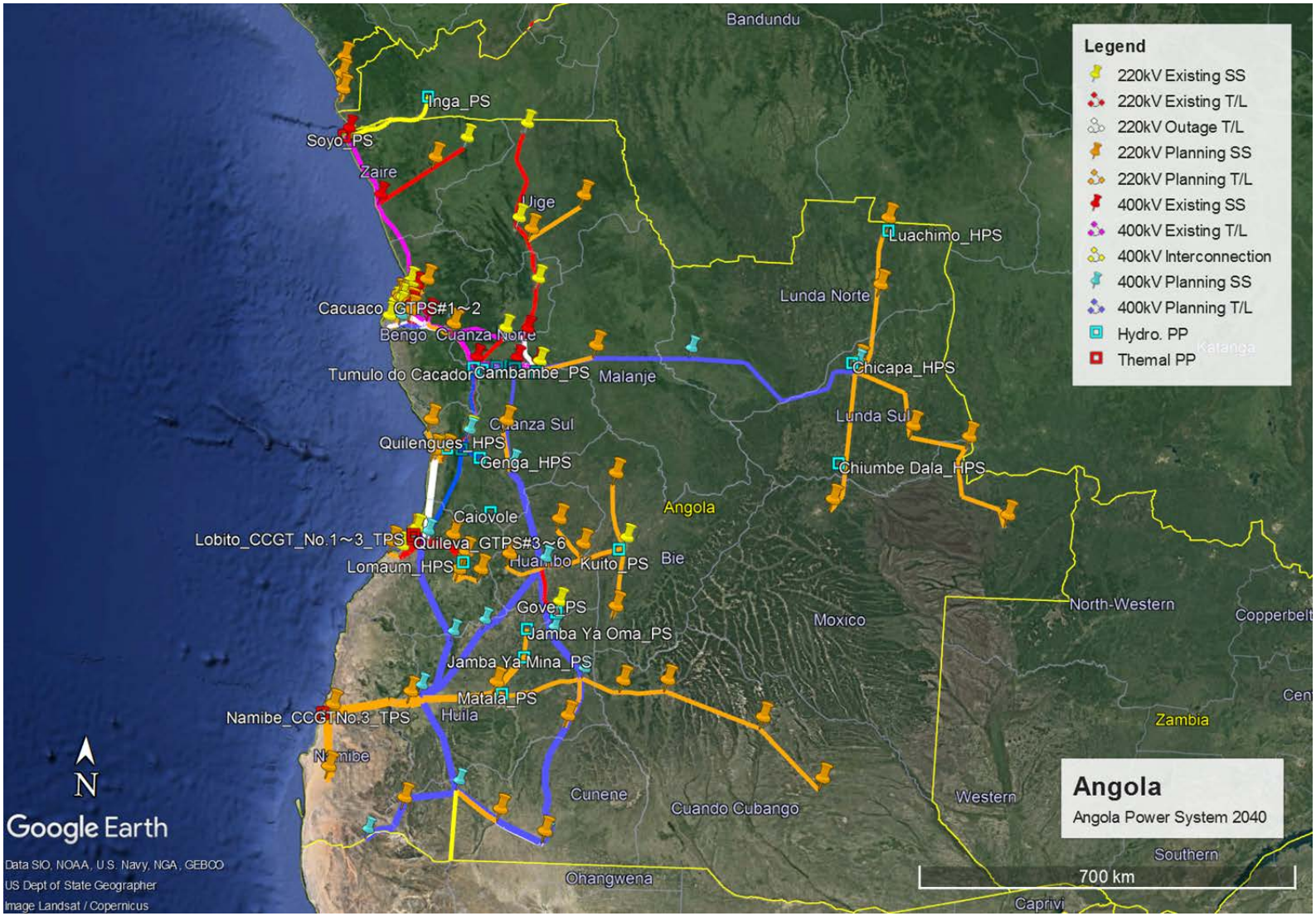


Figure 12-2 Project Map toward 2040

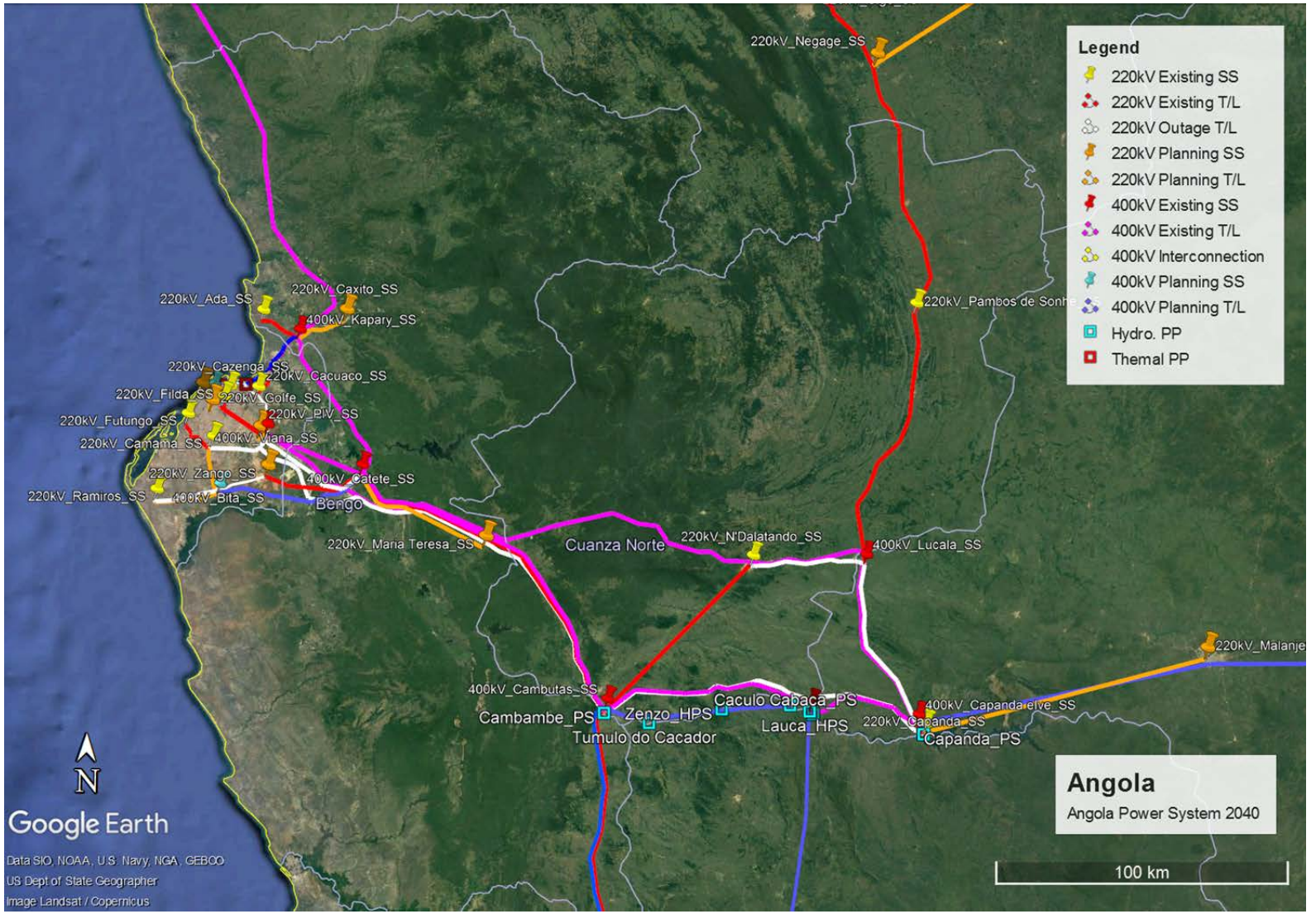


Figure 12-3 Project Map toward 2040 (nearby Luanda)

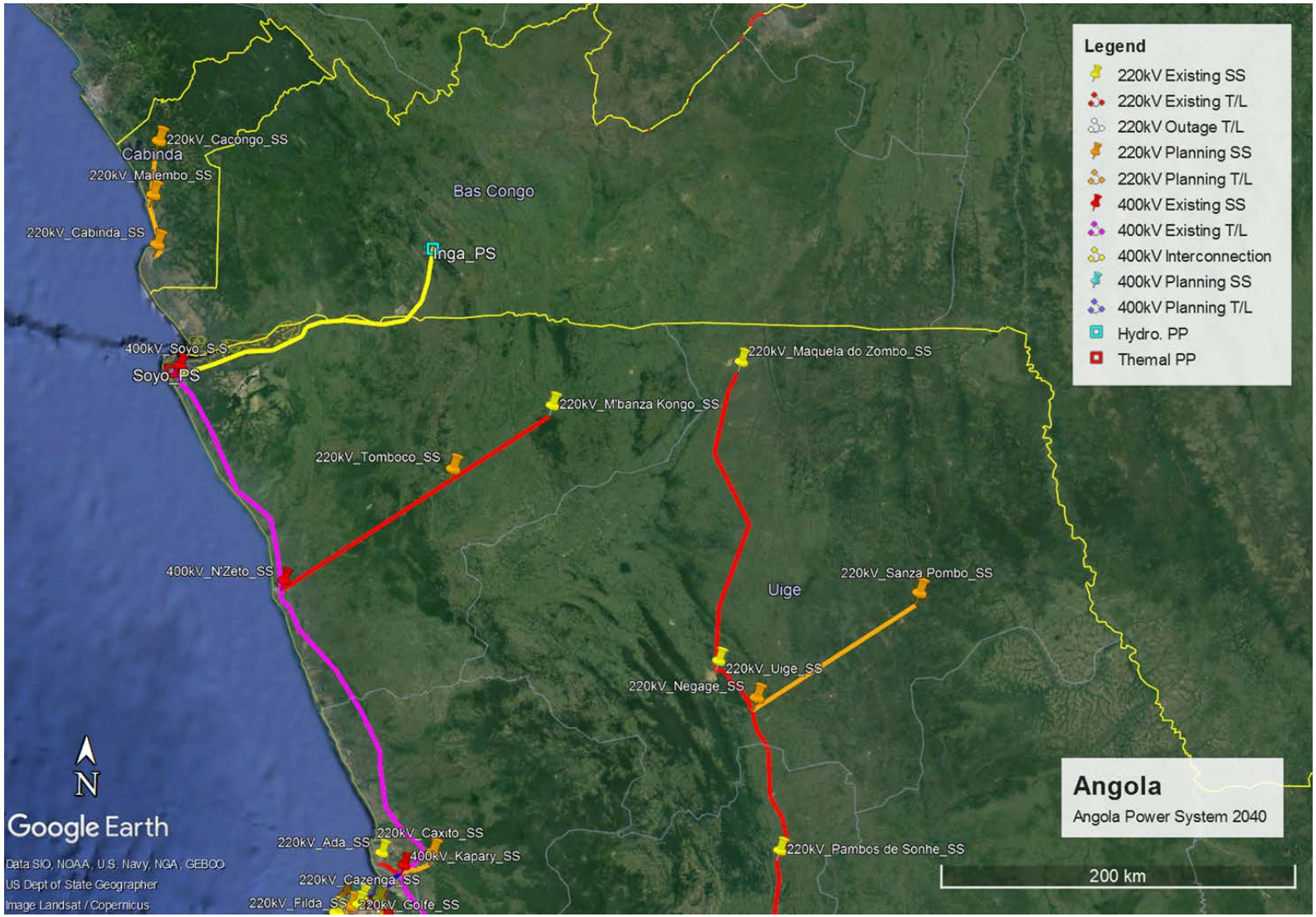


Figure 12-4 Project Map toward 2040 (Northern Region from Luanda)

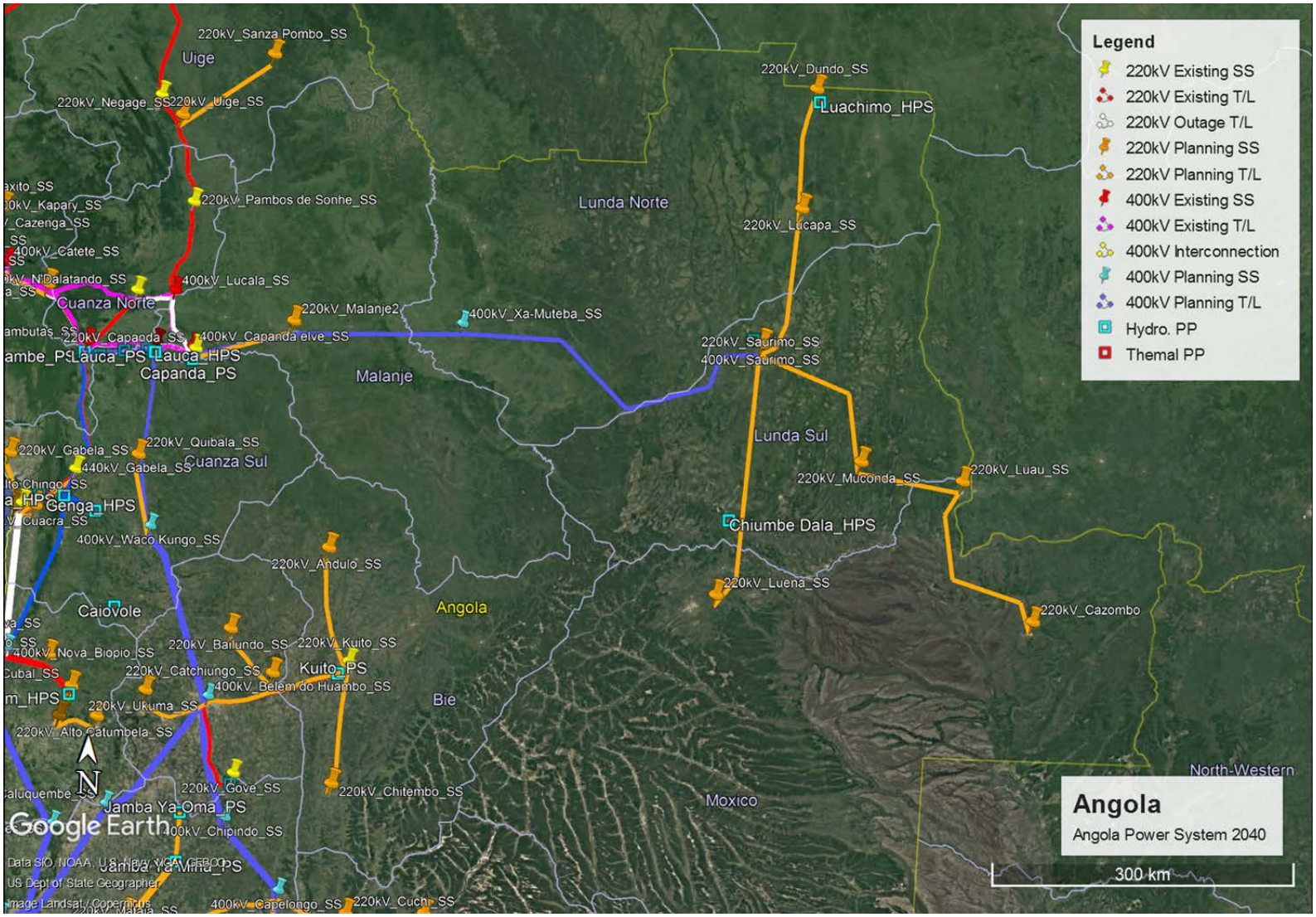


Figure 12-5 Project Map toward 2040 (Western Region from Luanda)

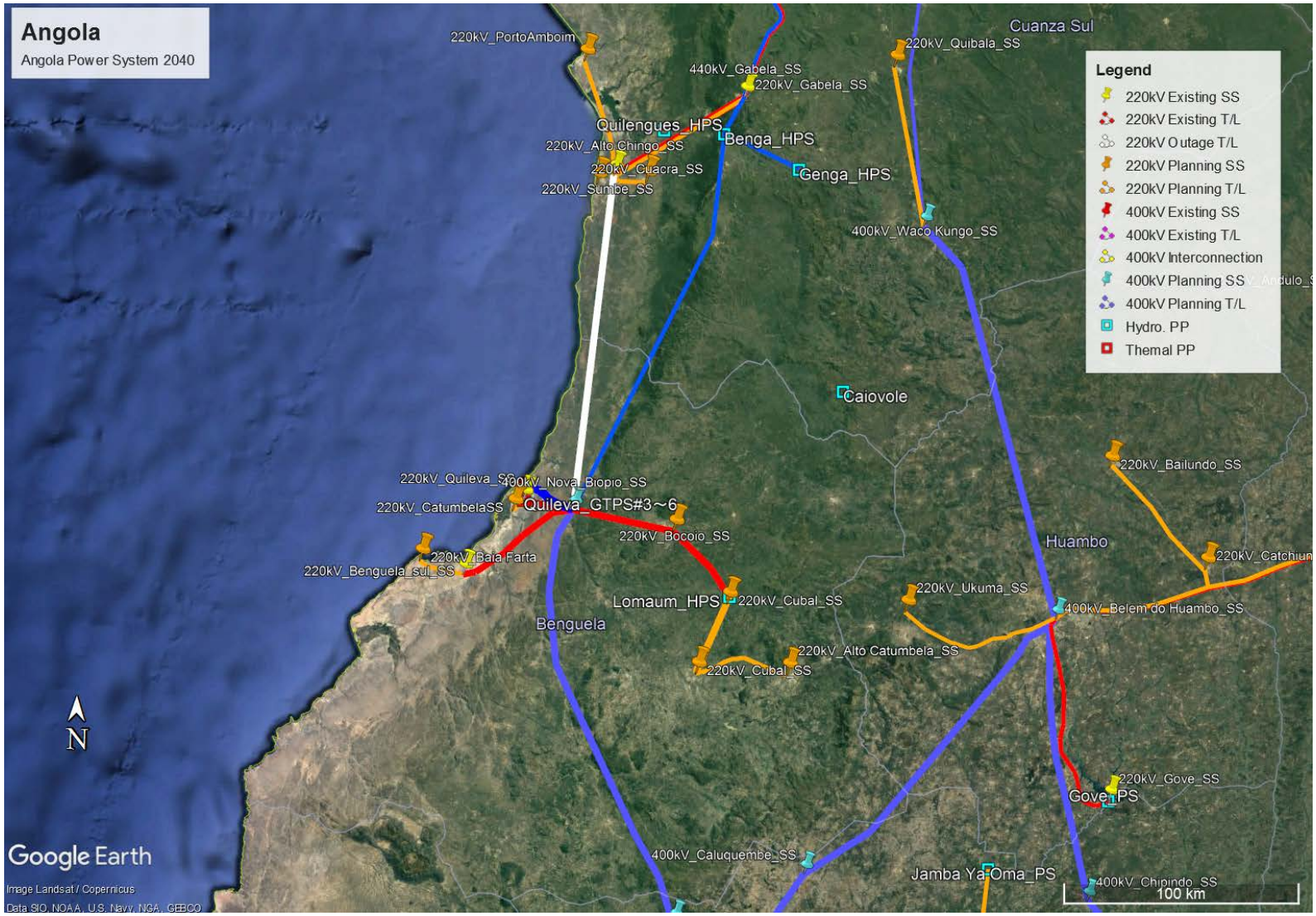


Figure 12-6 Project Map toward 2040 (Central Region)

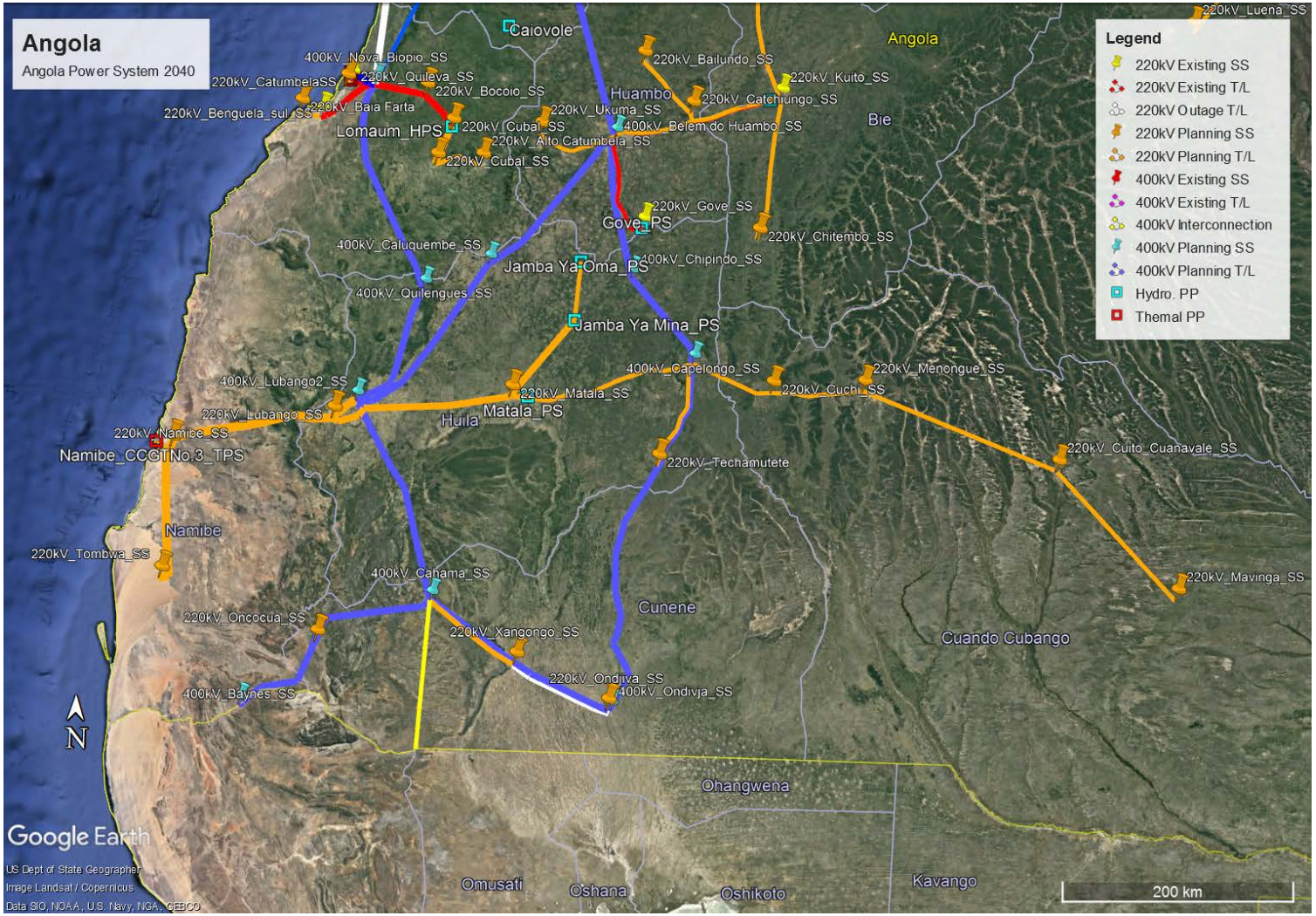


Figure 12-7 Project Map toward 2040 (South Region)

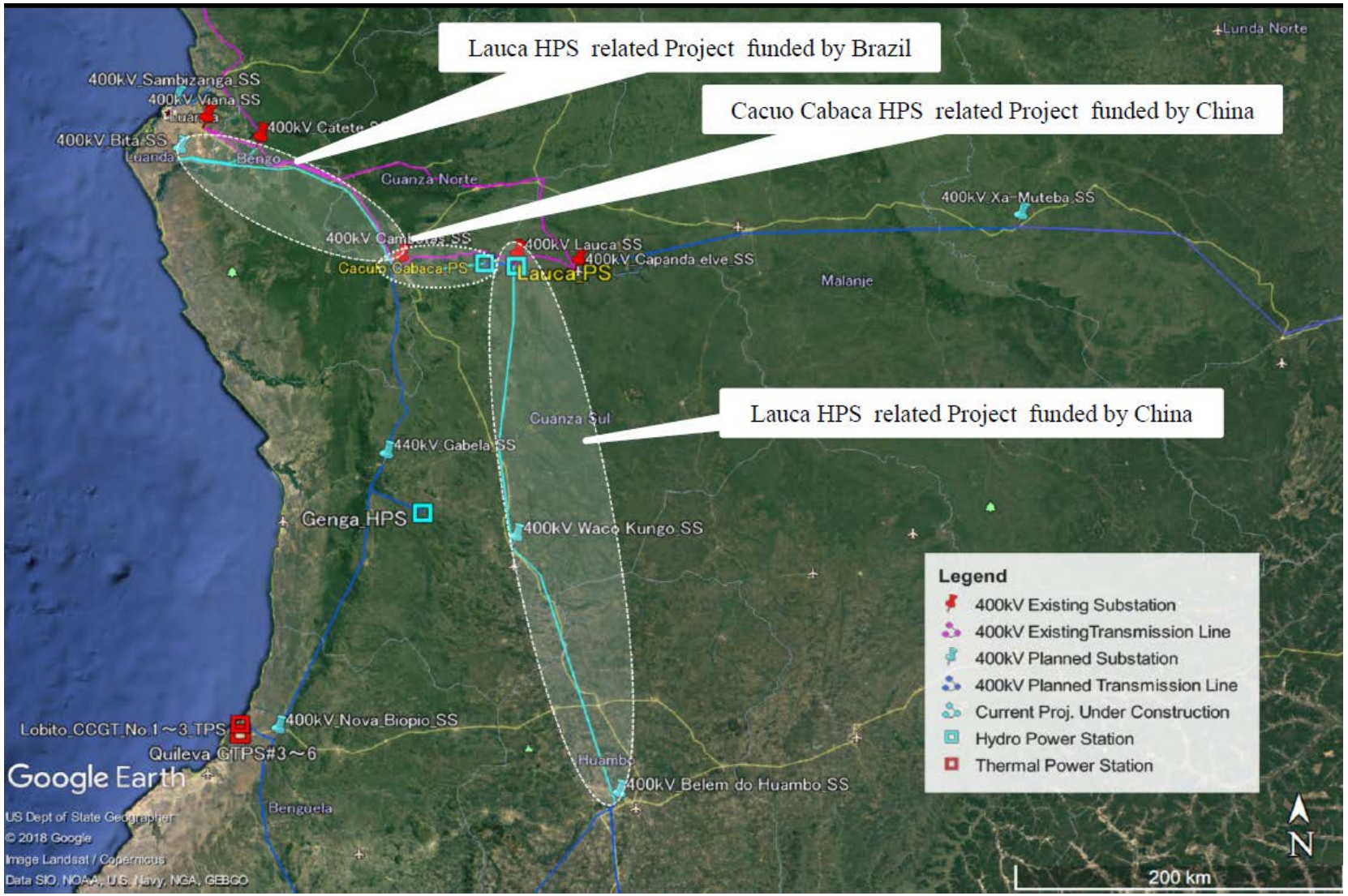


Figure 12-8 Current Project under Construction

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.

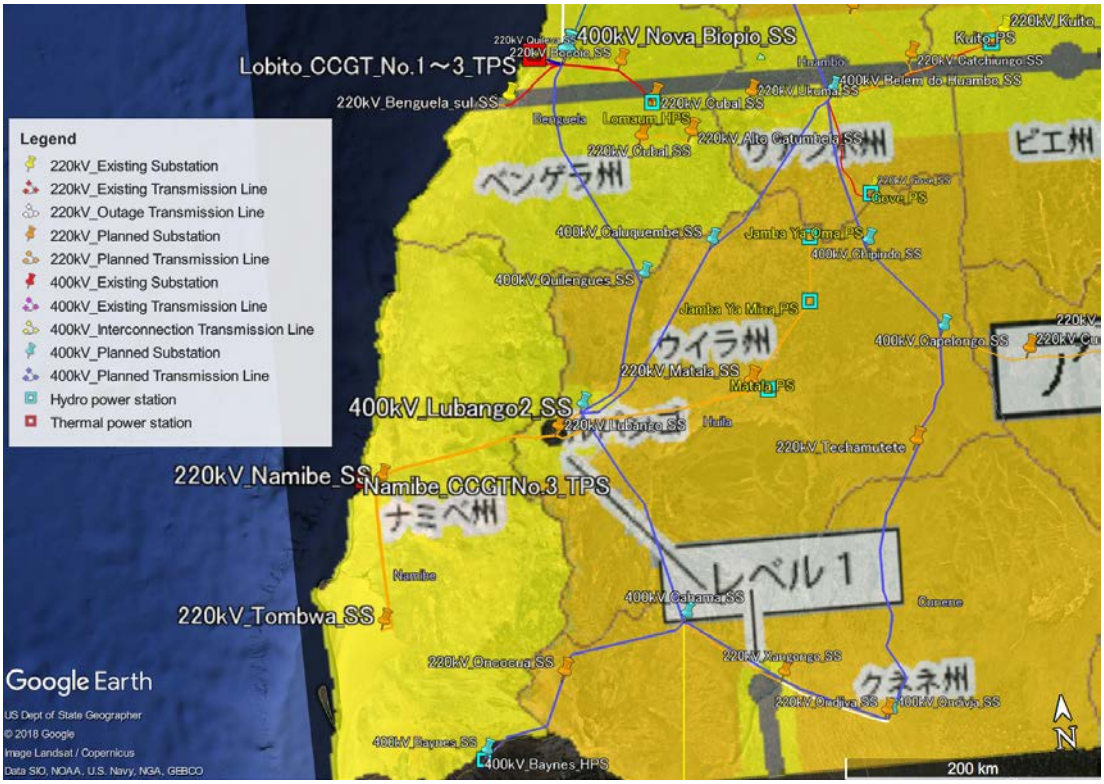


Figure 12-9 South Transmission System Enhancement Project Map

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
Transmmission 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)

<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

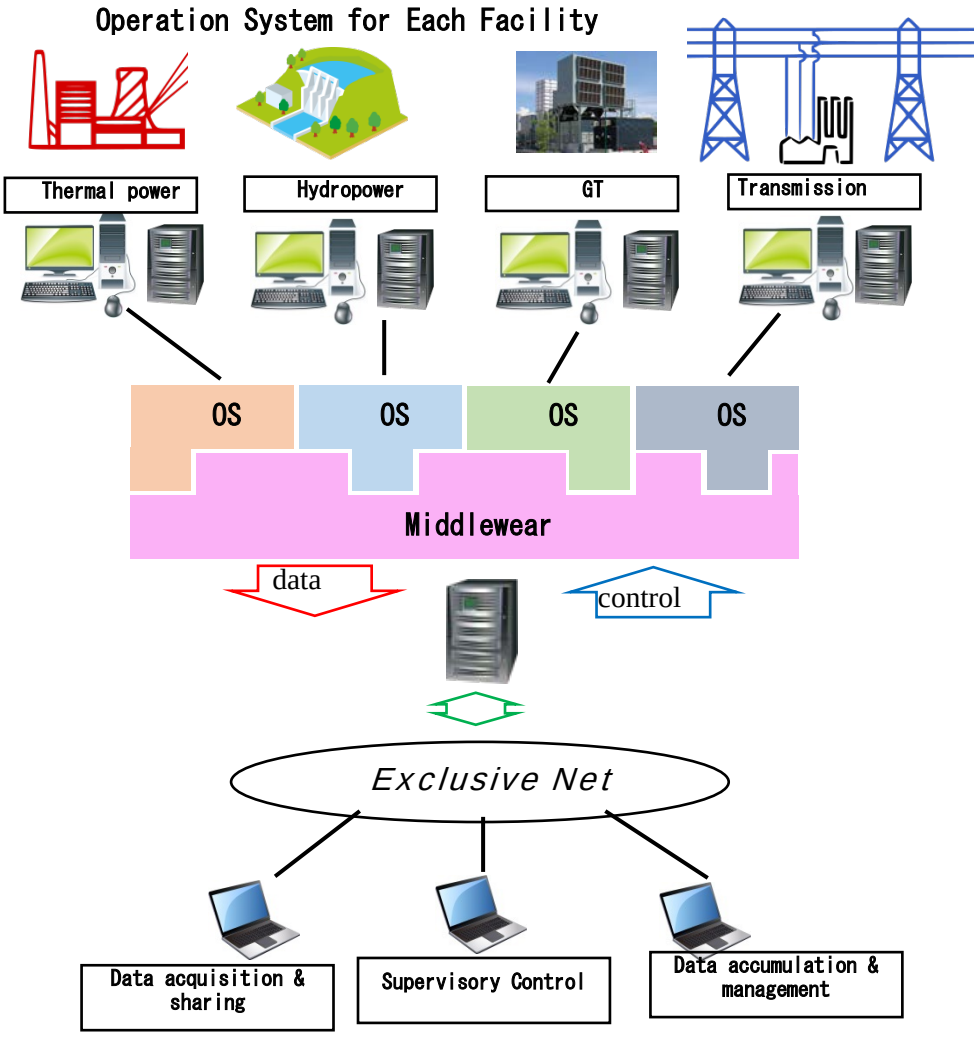
An examination of the optimal generation mix clearly showed that it will be necessary to introduce GT to some extent as a peak demand power supply. Japanese manufacturers are ideally suited to introduce the technology, as they are the world's most technologically advanced entities in this field.

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.

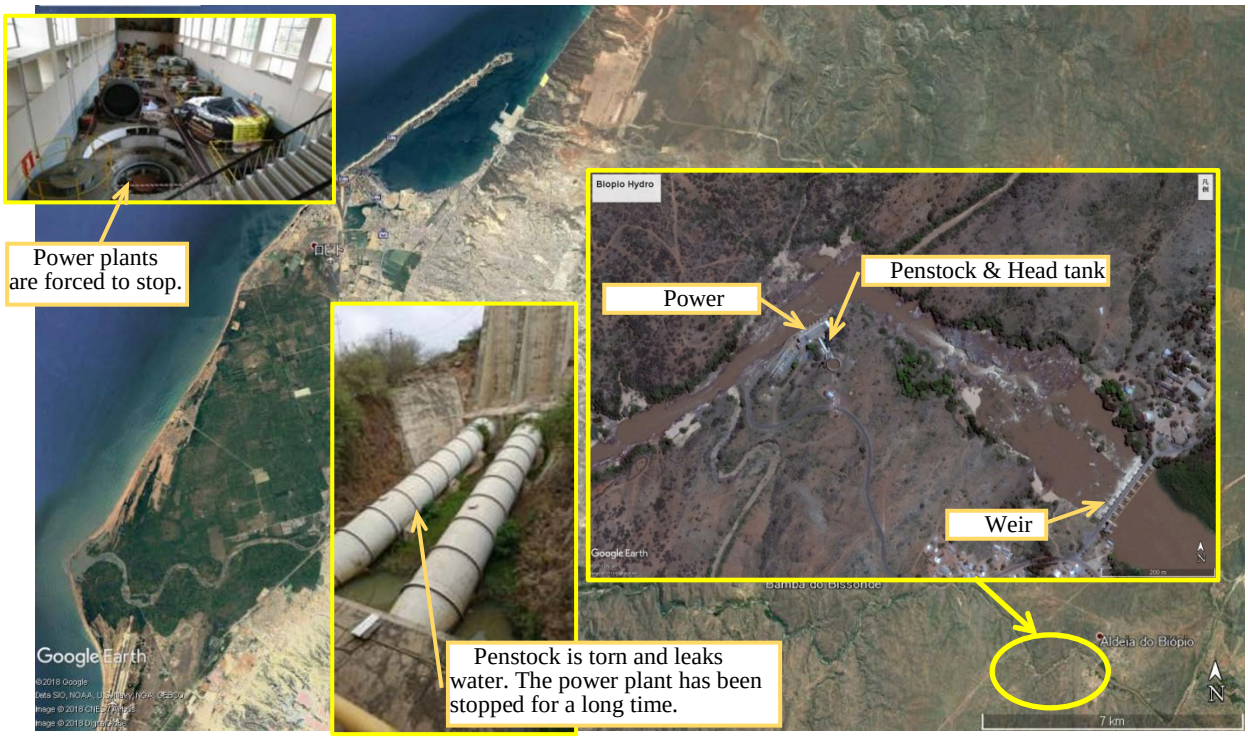


Figure 12-10 Biópio HPP's Current Status

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 ➢ 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 ➢ 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 ➢ 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	➢ Improvement of the tariff system ➢ Study on utilizing the foreign loan ➢ Study on introducing private sector funds
Others	Reform of dispatching organizations	➢ 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.

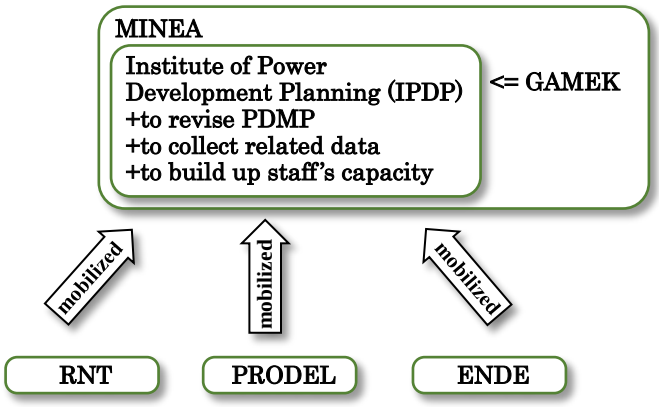


Figure 12-11 Example of Organization to Formulate PDPM

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.

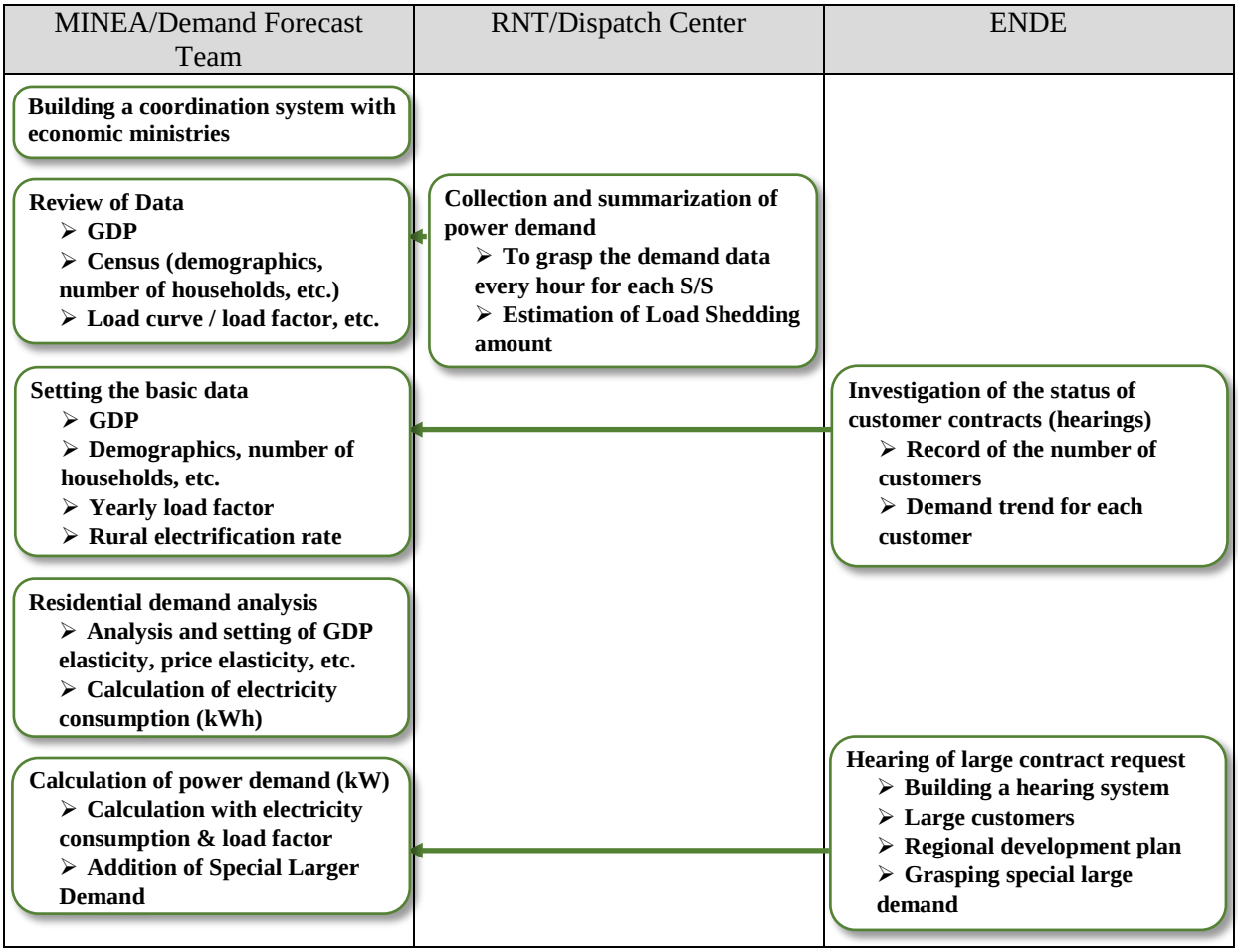


Figure 12-12 Action Plan and Structure for Power Demand Forecast

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) Estabishiment 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.

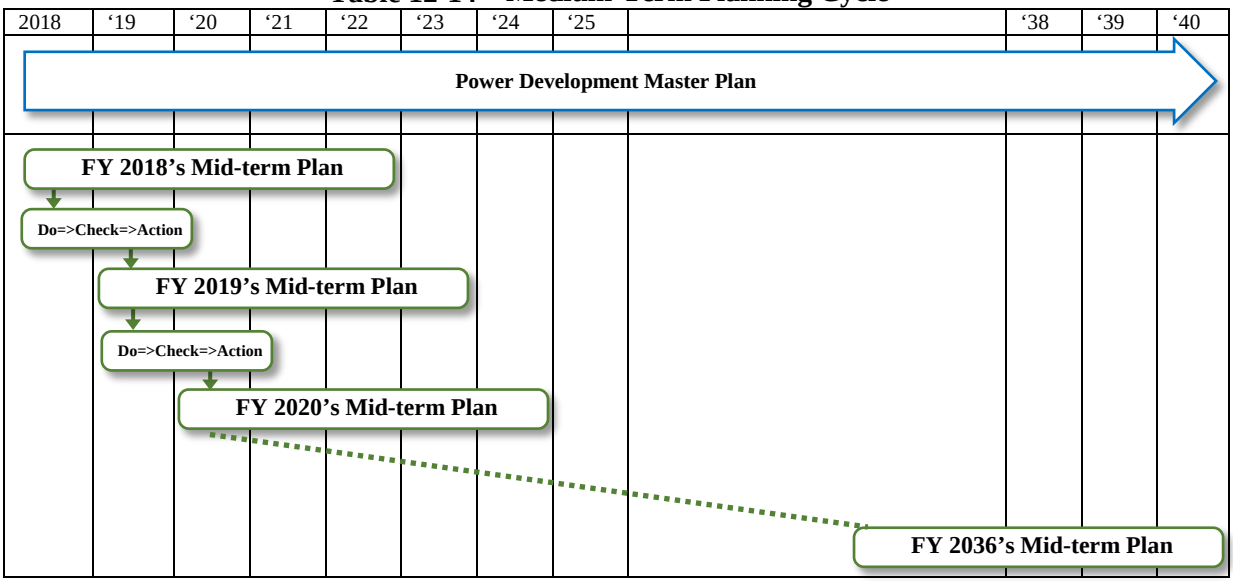
- Power demand forecast
- Generation development plan
- Transmission development plan
- Capital investment plan (based on the generation & transmission development plan)
- Fuel Procurement Plan
- Toll collection plan
- Fund procurement plan
- O&M plan
- Toll collection plan

- 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.

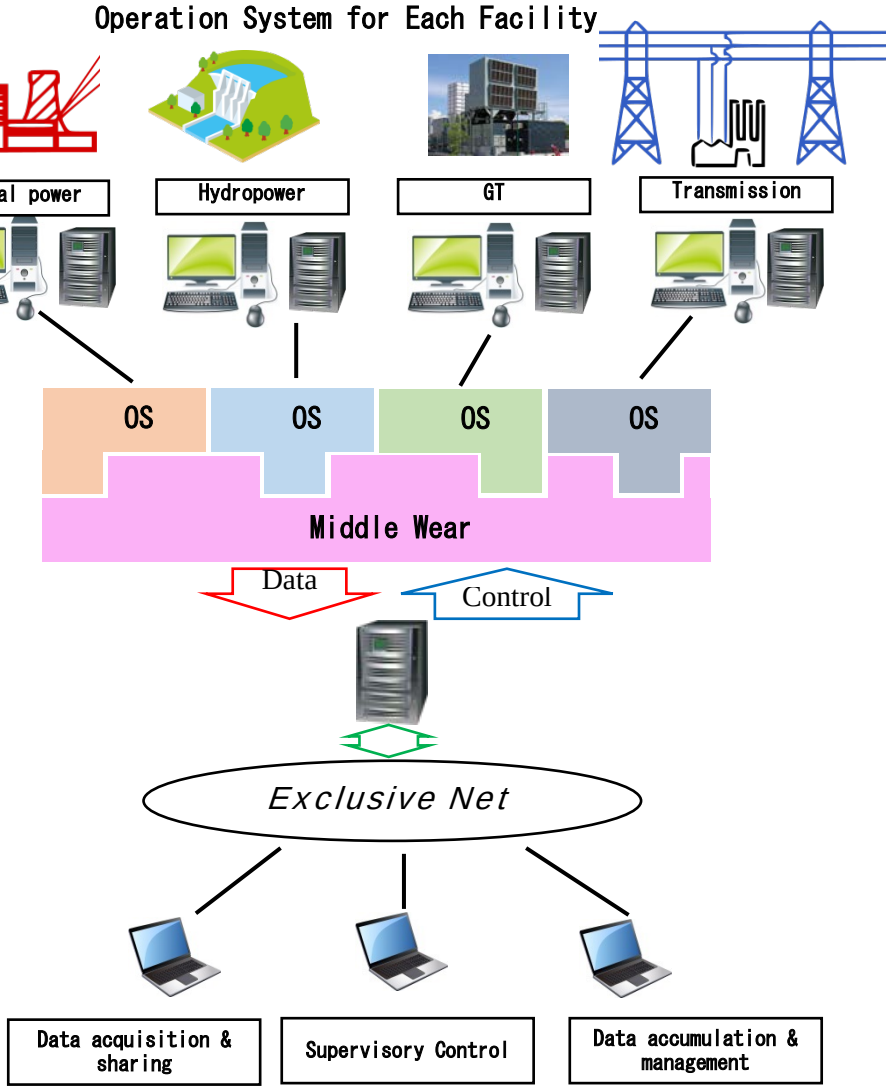


Figure 12-13 Example of SCADA

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.

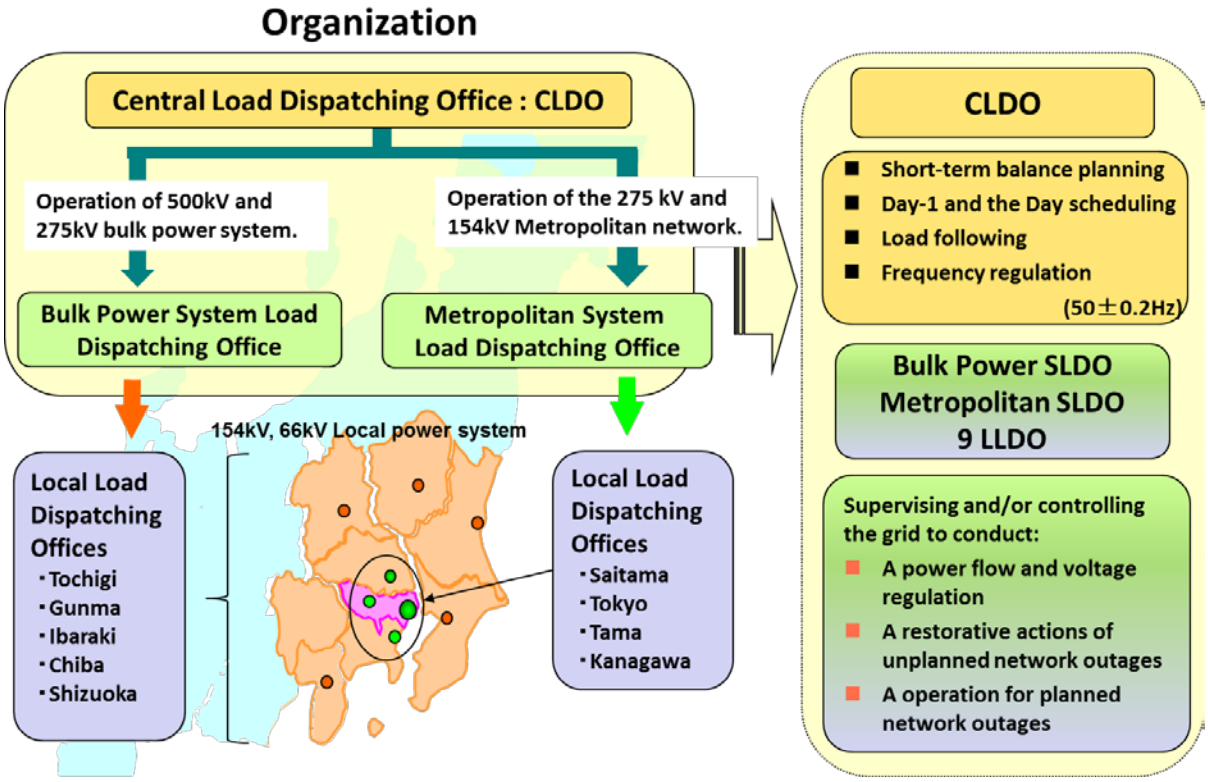


Figure 12-14 TEPCO's Load Dispatching Offices

○**Scheduling coordination**
To develop the next day's operation plan of each generation based on the area demand and the weather forecast.
○**Generation dispatch**
To send instruction of power output to power stations and adjust frequency to 50Hz.
○**Recording management**
To aggregate the several kinds of mainly performance record regarding the power demand, operation of generators, event of system operations, power failures, and so on.

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)

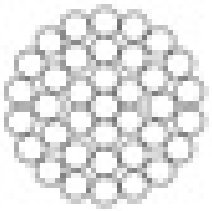
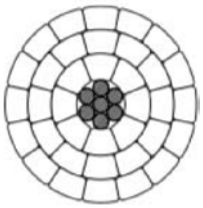
Particularly in the above table, since AAAC (all aluminum alloy stranded wire) is weak against breeze vibration fatigue and has a weak point that the creep amount is large, and its application to a place where the load becomes large (strong wind, icing, large difference in height, etc.), you should be 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

			Conventional	Recent
Description		Unit	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 resisitance 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		▼	▼	▼	▼
➢ 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				
➢ 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 ➢ Concession system, PPA system, etc.	IRSEA	Institution design for IPP entry	until the start of liberalization at the latest			
Renovation of load dispatching organization ➢ Reform of load dispatching offices ➢ Introduction of SCADA	RNT PRODEL	Reform of load dispatching offices				
		Introduction of				

Chapter 13 Technology Transfer & Capacity Building

The survey covers technology transfer activities related to the formulation of the Power Development Master Plan. The plans formed during the work implementation planning called for technology transfer through workshops and OJT. Later, for the following reasons, we narrowed down the approach to workshops alone. Approval from the Angola side' has been obtained for this approach.

- The personnel involved in the planning of the power sector are widely distributed within MINEA, RNT, PRODEL, ENDE, and IRSEA, making it difficult to grasp the target counterparts to whom the technology should be transferred. It will therefore be more efficient to invite the target counterparts to workshops than to visit and cooperate with them through OJT.
- The Survey Team works out of an office located at some distance from the office of the counterpart, making OJT physically impossible.
- MINEA wants as many personnel as possible to master the skills.

13.1 Workshop

The workshops shown in the table below were held over the course of four missions. PDPAT, a demand and supply operation simulation software package, was introduced on the Angola Side.

Table 13-1 Workshop Curriculum

Mission	Date	Curriculum
1st Mission	18-Jul	TEPCO's Power Development History
	25-Jul	Power Demand Forecasts +Methodology of Power Demand Forecasts Generation Development Plan +Supply reliability criteria
2nd Mission	28-Sep	Generation Development Plan +Screening Method
	29-Sep	Transmission Development Plan +Fundamental Concepts of power system planning in TEPCO
	4-Oct	Generation Development Plan +Annual Expenditure Transmission Development Plan +Power Flow Analysis
	5-Oct	Generation Development Plan +Dispatching game
	6-Oct	Transmission Development Plan +Outline of Transmission Line Design & Cost Estimation
3rd Mission	12-Jan	Financial & Economical Analysis +Basic item of Financial & Economical Analysis Generation Development Plan +How to operate PDPAT
	18-Jan,	Generation Development Plan +Configuration of data for GDP (1)
	25-Jan,	Power Demand Forecast +Confirming accomplishment Transmission Development Plan +Proceeding with formulation work +Clarifying matters entailed in the formulation of the TDP Generation Development Plan

	+Configuring data for GDP (2)
31-Jan	Environmental & Social Considerations +SEA General +Perspective of the Final Power Development Master Plan
Final Mission	Procedure to formulate the Power Development Master Plan

18-July Workshop

25-July Workshop

25-July Workshop

28-Sept. Workshop

28-Sept. Workshop

29-Sept. Workshop

13.2 Training in Japan

Angola side counterparts were invited to Japan for training to deepen their understanding of the status of Japan's power system operations (including operation at the central dispatching office) for stable power supply, the influence of renewable energy power supplies on the power system, and advanced technologies possessed by Japanese companies (high-efficiency thermal power generation, etc.).

13.2.1 Participants

Ten counterparts were invited to the training in Japan. The participants were affiliated with MINEA (including GAMEK), PRODEL, RNT, ENDE, and IRSEA.

Table 13-2 Participants List

	Name	Entity	Department	Position
Mr.	Osvaldo Marcos Julião Gonçalves	MINEA	National Directorate of Electrical Energy	Engineer
Mr.	Ernesto Milton Pereira da Costa	PRODEL	Hydraulic Production Directorate	Director
Mr.	Cláudio Morais Marques	PRODEL	Statistic and Planning	Senior Engineer
Mr.	Eudes Panzo	RNT	Power System Planning	Head of Department
Mr.	Leonardo Tshama	RNT	Power System Planning	Engineer
Mr.	Délcio Fonseca	RNT	Power System Planning	Engineer
Mr.	Caterça Calumbo da Costa	ENDE	Maintenance Protection	Engineer
Mr.	Kuatel Xeku Conceição	ENDE	Operation Division	Chief of Division Operation
Mr.	Negidio Francisco Neto da Silva Buakela	GAMEK	Technical Department	Engineer
Mr.	Adérito Pedro Manico	IRSEA	Technical Supervision and Quality of Electricity Service	Head of Department

13.2.2 Activity Records

The inspection site was chosen mainly from the following viewpoints.

- To understand the system operation status of the Japanese power utilities and the training policies of the operators
- To visit two plants: first, the mega solar power plant, to grasp the influence of renewable energy on the grid; second, the pumped storage power plant in charge of regulating the stability of the power system
- To grasp the state-of-the-art coal-fired thermal power generation technology and CCGT technology in Japan
- To understand the interconnection of power system technologies between companies

The details of the training program are summarized in the table below.

Table 13-3 Activity Record of Training in Japan

Date	Time			Program	Site
27-Nov-17		～	22:45	Arrival in Japan	
28-Nov-17	13:00	～	14:30	Courtesy call to JICA	JICA Ichigaya office
	14:30	～	15:30	Kick off	
29-Nov-17	9:00	～	10:00	Role of electric power company's central load dispatching office	TEPCO PG Central Load Dispatching Office
	12:30	～	14:00	Inspection of load dispatching operator training	TEPCO PG Training Center
	15:00	～	16:00	Inspection of Tokyo Electric's mega solar	TEPCO Renewable Power Company Ukishima Solar Power Plant
30-Nov-17	11:00	～	12:00	Confirmation of state-of-the-art coal fired power, IGCC construction status	TEPCO FP Hirono Thermal Power Plant
	14:00	～	15:00	Inspection of 500 kV switchgear	TEPCO PG Shin-Iwaki S/S
1-Dec-17	9:00	～		Inspection of small and medium type CCGT plant	Mitsubishi Hitachi Power Systems Hitachi Works
		～	12:00	Inspection of Hitachi Mitsubishi Hydropower related technology	Hitachi MitsubishiHydro Corporation Hitachi Works
2-Dec-17				Experience of Japanese culture	
3-Dec-17				ditto	
4-Dec-17	10:00	～	11:30	Inspection of More Advanced CCGT	TEPCO FP Kawasaki Therimal Power Plant
	13:00	～	15:00	Inspection of Toshiba's latest power related technology	Toshiba Energy Systems & Solutions Corporation Keihin Product Operations
5-Dec-17	13:30	～	16:30	Inspection of the state-of-the-art Large Gas Combined Cycle Manufacturing Factory	Mitsubishi Hitachi Power Systems Takasago Works
6-Dec-17				Experience of Japanese culture	
7-Dec-17	10:30	～	12:30	Inspection of pumped storage power plant with high head	TEPCO RPC Kannagawa Pumped Storage Power Plant
	15:30	～	16:30	Inspection of frequency converter substation	TEPCO PG Shin-Shinano Frequency Converter Station
8-Dec-17	15:00	～	16:30	Ministry of Economy, Trade and Industry	METI; Agency for Natural Resources and Energy
	17:00	～	18:30	Wrap-up	JICA Ichigaya office
9-Dec-17	22:00	～		Departure to Angola	

Date: 2017 Nov. 28 / Kick-off meeting (in JICA Ichigaya office)

Date: 2017 Nov. 29 / TEPCO PG Central Load Dispatching

Date: 2017 Nov. 29 / TEPCO PG Training Center

Date: 2017 Nov. 29 / TEPCO/Renewable Power Company Ukishima Solar Power Plant

Date: 2017 Nov. 30 / TEPCO FP Hirono Thermal Power Plant

Date: 2017 Nov. 30 / TEPCO PG Shin-Iwaki S/S

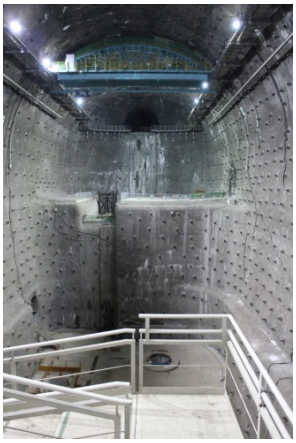
Date: 2017 Dec. 1 / Mitsubishi Hitachi Power Systems, Hitachi Mitsubishi Hydro Corporation Hitachi Works

Date: 2017 Dec. 4 / TEPCO FP Kawasaki Thermal Power Plant

Date: 2017 Dec. 4 / Toshiba Energy Systems & Solutions Corporation Keihin Product Operations

Date: 2017 Dec. 5 / Mitsubishi Hitachi Power Systems Takasago Works

Date: 2017 Dec. 7 / TEPCO RPC Kannagawa Pumped Storage Power Plant



Date: 2017 Dec. 7 / TEPCO PG Shin-Shinano Frequency Converter Station

Date: 2017 Dec. 8 / Ministry of Economy, Trade and Industry; Agency for Natural Resources and Energy

Date: 2017 Dec. 8 / Wrap-up meeting (in JICA Ichigaya office)

13.3 Additional Training in Japan

There was a plan to invite relevant parties of Angolan power industry to Japan for training so that they would have deeper understanding of Japan's power system operations for stable power supply (including operations at a Central Load Dispatching Center), impacts of renewable energy power supplies on electric power systems, and Japanese companies' advanced technologies for high-efficiency thermal power generation, etc. As Angola's power development master plan was formulated and it was expected that additional training of higher-level officials in Japan would deepen the counterparts' understanding and the knowledge would be reflected in Angolan policies, we invited the Minister of Energy and Aqua (MINEA) and other top officials of electric power companies and other controlling government offices for training in Japan. During the training, we also held a seminar about the Angolan Power Sector to present Angola's power development master plan to Japanese companies and attract interest in investment in Angola from Japanese companies through the presence of Angolan officials.

13.3.1 Participants

There were 8 participants – 4 members from MINEA including the MINEA Minister Borges, directors and chairpersons of the power companies and organizations of ENDE, PRODEL, RNT and IRSEA.

Table 13-1 Angolan Participants

	Name	Entity	Ministry or Company	Position
Mr.	João Baptista Borges	MINEA	Ministry of Energy and Water Affairs	Minister
Mr.	Carlos Gil Ferreira De Sousa	MINEA	Minister's Office of Energy and Water Affairs	Director
Mr.	Osvaldo Marcos Julião Gonçalves	MINEA	Ministry of Energy and Water Affairs, National Directorate of Electric Energy	Director
Mr.	Ruth Cardoso De Almeida Safeca	ENDE	National Electricity Distribution Company	Chairman of Board of Directors
Mr.	José Antõnio Neto	PRODEL	Public Electricity Production Company	Chairman of Board of Directors
Mr.	Rui Pereira Do Amaral Gourgel	RNT	National Electricity Transportation Company	Chairman of Board of Directors
Mr.	Luís Mourão Da Silva	IRESA	Regulatory Institute of Electricity and Water Services	Chairman of Board of Directors
Mr.	Benevildes Cabral Marcelino	MINEA	Minister's Office of Energy and Water Affairs	Head of Public Relations and Protocol Section

13.3.2 Activity Results

The participants learned Japan's state-of-the art technologies mainly through the attendance at the Angolan Power Sector Seminar, which was the major purpose of the training, and the activity contributed to the future technical cooperation for Angola.

The sites for visits were selected mainly from the following viewpoints.

- Understanding of the power system operations of the Japanese power companies and understanding of the operator training policies
- Understanding of Japan's technologies for state-of-the-art coal-fired power generation and gas-combined cycle power generation
- Understanding of Japan's latest technologies used for gas insulated transformers/switchgears installed at unmanned underground substations

The training program and contents are as shown in Table 13-5.

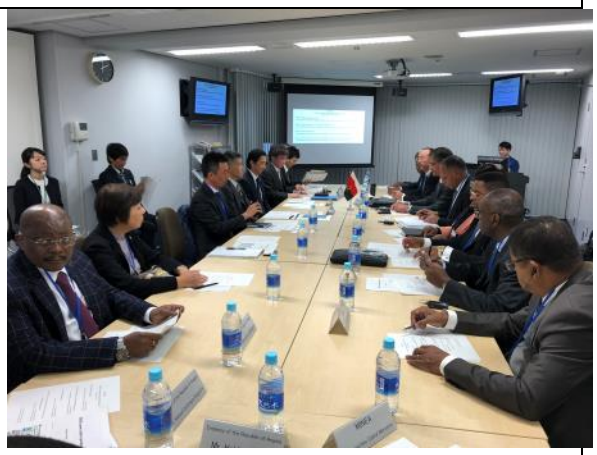
Table 13-2 Additional Training Activities in Japan

Date	Time	Program Contents	Destination
2018/12/8 (Sat.)	～ 22:45	Arrive in Japan	Haneda Airport
2018/12/9 (Sun)	All day	Briefings by the Embassy of Angola in Japan	Embassy of Angola in Japan
2018/12/10 (Mon)	10:00 ～ 11:30	Explanation of the itinerary, explanation of MP and potential Japanese collaborators	JICA Headquarters
	11:30 ～ 12:30	Courtesy visit to JICA executives	JICA Headquarters
	14:00 ～ 14:15	Courtesy visit to President of TEPCO Power Grid	Headquarters of Tokyo Electric Power Company Holdings
	14:15 ～ 14:30	Overview of major electric power companies in Japan	Central Load Dispatching Center of TEPCO Power Grid
	14:30 ～ 15:15	Explanation of roles of load dispatching centers of Japanese electric power companies	Central Load Dispatching Center of TEPCO Power Grid
	15:30 ～ 17:00	Visit to a state-of-the-art underground substation in Japan	Higashi Uchisaiwai-cho Substation of TEPCO Power Grid
2018/12/11 (Tue)	10:00 ～ 12:00	Seminar for Japanese companies & FR Transfer Ceremony	JICA Ichigaya Building
	14:00 ～ 16:00	Visit to a combined cycle gas turbine (CCGT) power station	Kawasaki Thermal Power Plant of TEPCO Fuel & Power
2018/12/12 (Wed)	9:45 ～	Leave Japan (Minister and others for London)	Haneda Airport
	22:00 ～	Leave Japan (Director and others for Angola)	Narita Airport

Report on the training results and materials used have already been submitted to JICA.

Date: 2018 Dec. 10 / Kick-off meeting (in JICA Head Quarter)

Date: 2018 Dec. 10 / TEPCO PG Central Load Dispatching Center



Date: 2018 Dec. 10 /TEPCO PG Higashi-uchisaiwai-cho Underground Substation

Date: 2018 Dec. 11 /Angolan Power sector Seminar in JICA Ichigaya Office

Date: 2018 Dec. 11 /TEPCO FP Kawasaki Thermal Power Plant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