Overall view

Expansion Space for new 225kV Switchgears

Existing 225kV swithchgears

Existing 225/90kV 65MVA transformer

Fig. 4.2-6 Photos of Kossou substation

4.2.3 Existing Bouake2 Substation

Bouake2 substation is one of the key substation for 225kV bulk power system. This substation is connected to Kossou substation (single circuit), Ferke substation (single circuite) and Serebou substation (single circuit). The 225kV transmission line for Serebou substation and 225kV double busbar was completed in 2019 by a Chinese contractor. As a result of site survey, the expected single line diagram and layout of JICA project is shown in Fig. 4.2-7 and Fig. 4.2-8.

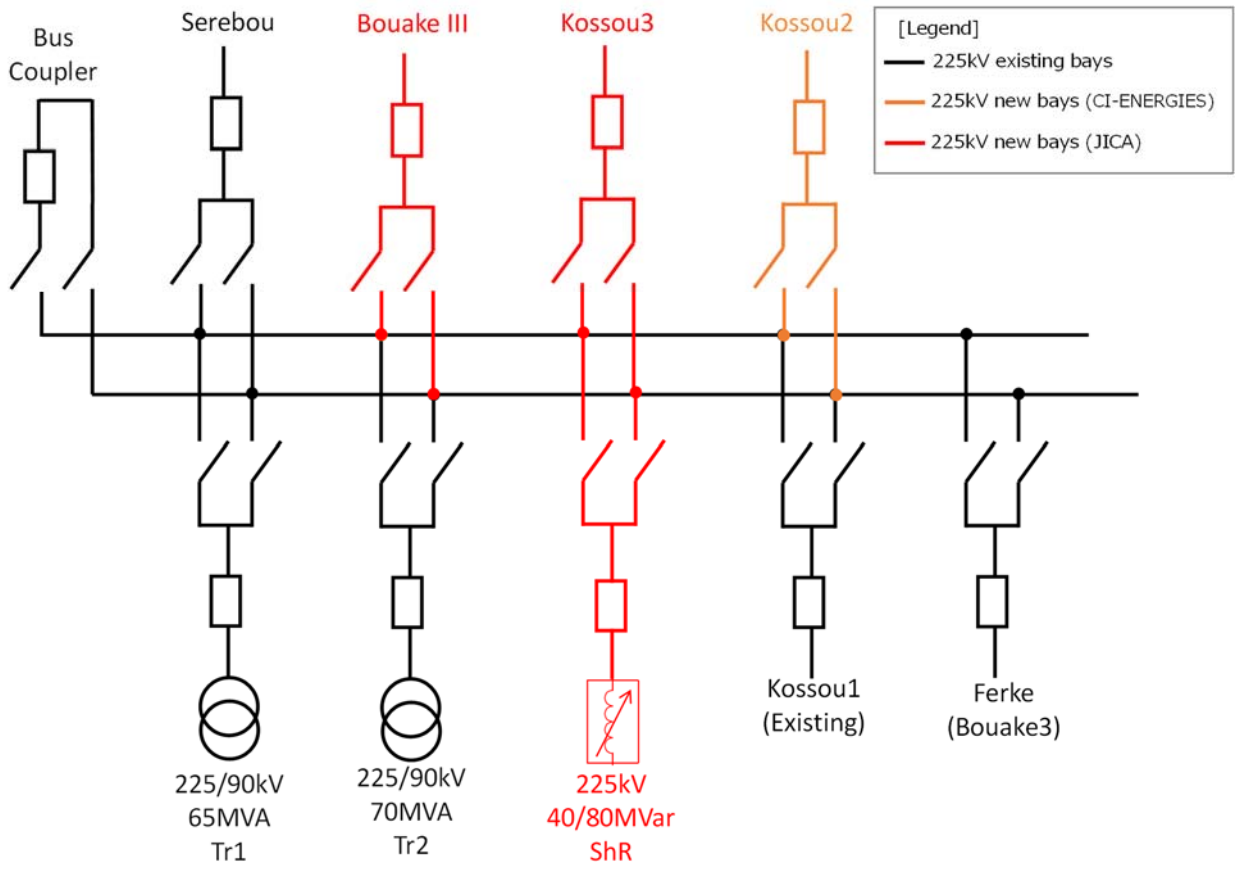


Fig. 4.2-7 Single line diagram of Bouake2 substation

Source: JICA Study Team

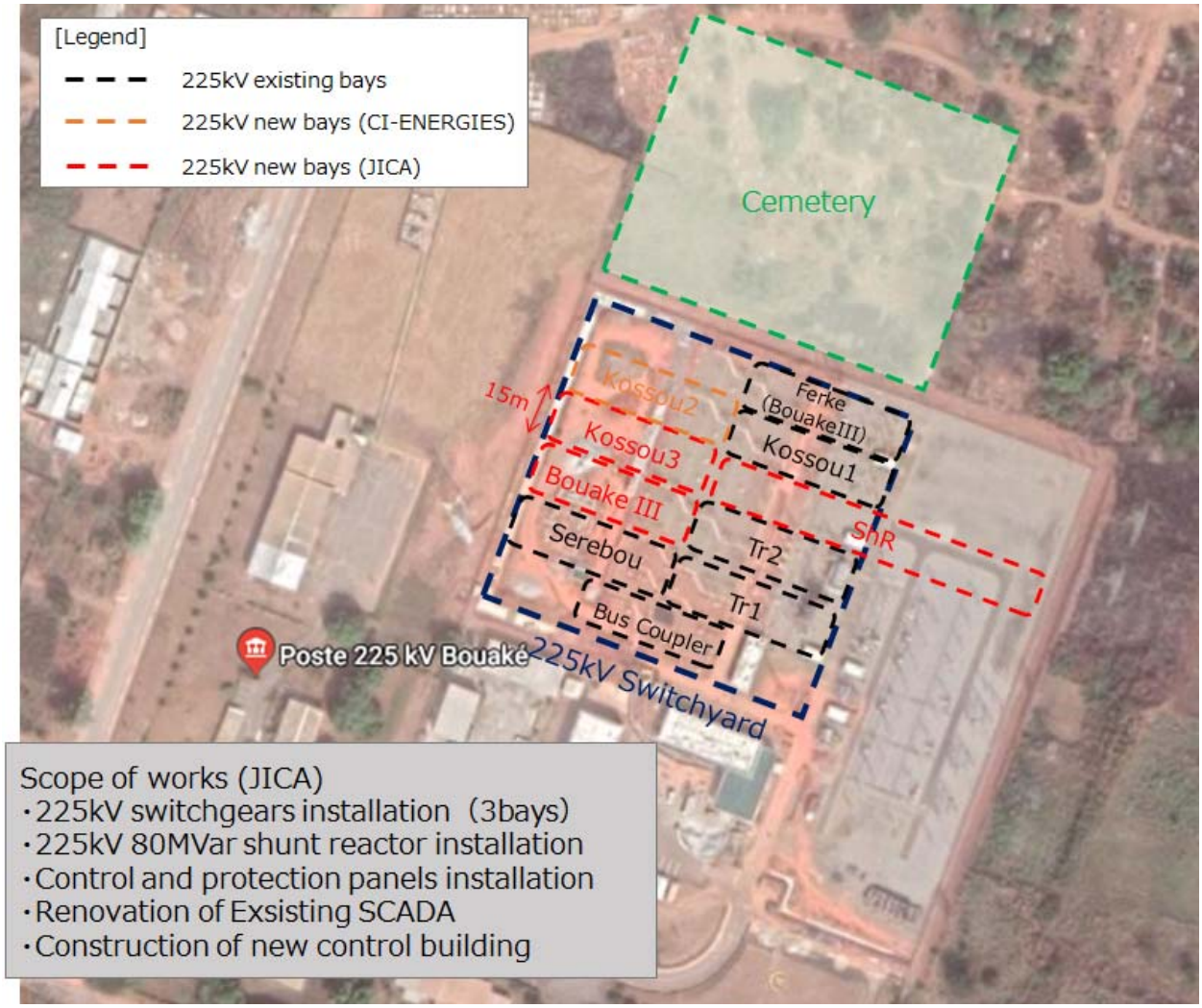


Fig. 4.2-8 Layout of Bouake2 substation

Source: JICA Study Team

The scope of CI-ENERGIES self-financing project is a plan to install a 225kV transmission line bay (for Kossou substation) and the control and protection panels. It is not necessary to extend the existing busbar. Due to the optimal arrangement of the underground cable around Bouake 2 substation, a 225kV transmission line bay shall be installed to leave two transmission line bays for JICA project. CI-ENERGIES had accepted it at web meeting on August 17, 2020.

The scope of JICA project is a plan to install two 225kV transmission line bays (for Kossou substation and Bouake 3 substation) , a 225kV 40/80 MVar shunt reactor bay, control and protection panels, and to renovate exisiting SCADA system. A variable capacitance type (capacity can be adjusted from 40 to 80MVar) shall be installed to suppress voltage fluctuations when the circuit breaker of shunt reactor is open to close or close to open. It is not necessary to extend the existing

busbar and expand the site of the substation. The connection to the transmission line is an underground cable.

Bouake 2 substation has an existing SCADA system made by NR (China). This SCADA system was installed with a 225kV transmission line bay (for Serebou substation) and double busbar in 2019. Therefore, the monitoring and control of this transmission line bay has been incorporated into the SCADA system. In JICA project, it is necessary to renovate this existing SCADA system to incorporate the monitoring and control functions of two transmission line bays and shunt reactor bays.

Due to space limitation for the installation of control and protection panels, and communication system, it is necessary to install a new control building at the area adjacent to the main building and 225kV switchyard.

Expansion Space for new 225kV Switchgears

Existing 225/90kV 65MVA transformer

Existing 225kV swithchgears

Existing 225kV swithchgears

Fig. 4.2-9 Photos of Bouake2 substation

4.2.4 Candidate site of Yamoussoukro 2 substation

The planned site of Yamoussoukro 2 substation is located 10km away from the existing 225kV transmission line between Taabo and Kossou towards the city of Yamoussoukro. The site has already acquired 100,000m^2 of land for Yamoussoukro 2 substation and the Dispatching Center, which is planned to be attached to the site. The Dispatching Center is currently located in Abidjan and has a supply and demand adjustment function as well as a 225kV and 90kV system operation function. These functions for non-Abidjan areas will be transferred to the dispatching center in this site. The Dispatching Center is scheduled to be operational in two years, and the foundation work had already started at the time of our visit.

The site conditions are shown in Fig. 4.2-1, and although some tree removal is assumed to be necessary for land development, the site is flat and no major land development is considered necessary. In addition, the location is close to a wide arterial road, so there are no particular restrictions on the transportation of equipment.

Fig. 4.2-1 The candidate site of Yamoussoukro 2 substation

In the Yamoussoukro 2 substation, one line of 225kV transmission line between Taabo and Kossou will be π-connected, and one line of 225kV transmission line for Taabo substation and one line for Kossou substation will be connected to the transmission line. With regard to the new distribution lines, two 225/30kV and two 225/15kV transformers each, or two 225/30/15kV transformers of three-windings, will be installed for distribution to the Yamoussoukro city. The capacity of the two-windings transformer is 60 MVA for 225/30kV and 50 MVA for 225/15kV, and the the three-windings transformer is 110 MVA for 225/30/15kV.

4.2.5 Candidate site of Bouaké 3 substation

The candidate site of Bouaké 3 substation is located approximately 10km north of Bouaké city centre, in the process of acquiring a 50,000m^2 site, directly below the existing 225kV transmission line between Bouaké 2 and Ferke. The land is currently in the process of being registered, and the landowner will be paid for it, and the acquisition will be completed once this is completed.

The site conditions are shown in Fig. 4.2-2, and although some tree removal is assumed to be necessary for land development, the site is flat and no major land development is considered necessary. In addition, the location is close to a wide arterial road, so there are no particular restrictions on the transportation of equipment.

Fig. 4.2-2 The candidate site of Bouaké 3 substation

One 225 kV transmission line between Bouaké 2 and Ferke was to be π-connected, and a new 225 kV transmission line (one line) between Bouaké 2 and Bouaké 3 was to be built in the Bouaké 3 substation. However, the power system analysis concluded that one more new 225 kV transmission line (one line) needs to be built between Bouaké 2 and Bouaké 3 in order to meet the N-1 criteria. Therefore, the Bouaké 3 substation needs to be designed to take into account the installation space of the switchgear for four lines of the 225 kV transmission line. Furthermore, the 225 kV transmission line between Bouaké 2 and Ferke will be pulled in at the Katiola substation, which is currently under construction, and it was found that the Bouaké 2-Katiola line will be pulled into this substation at the time of implementation of the project. With regard to the new distribution lines, two 225/30kV and two 225/15kV transformers each, or two 225/30/15kV transformers in

three-windings, will be installed for distribution to the Bouaké city in the same composition as the Yamoussoukro 2 substation. Similar to the Yamoussoukro 2 substation, the capacity of the two-windings transformer is 60 MVA for 225/30kV and 50 MVA for 225/15kV, and the the three-windings transformer is 110 MVA for 225/30/15kV. System diagram around Bouaké 3 considering Katiola substation is shown in Fig. 4.2-12.

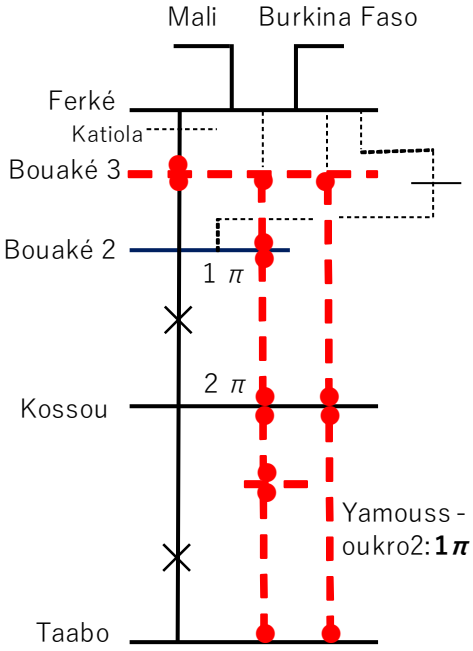


Fig. 4.2-1 System diagram around Bouaké 3 considering Katiola substation

4.2.6 Standard

CI-ENERGIS don't have original substation design standard. They reviews and approves the design proposed by consultants for each project. It is compliant with the international standard IEC and the French national standard NF. Therefore, it can be said that there is no particular problem. However, it is necessary to establish CI-ENERGIES' original design standard, since it is expected that different values may be adopted for each project. Some of the compliant international standards described in the bidding documents are shown in Fig. 4.2-13.

II.2.2 NORMES ET STANDARDS

Les prescriptions techniques et normes en vigueur pour l'étude, la réalisation et la réception des installations techniques et du génie civil des postes du présent projet sont les prescriptions et normes les plus récentes reconnues sur le plan international telles que :

- la dernière recommandation de la C.E.I. (Commission Électrotechnique Internationale)
- la NF (Normes Françaises), VDE ou DIN (Normes Allemandes).

Les principales recommandations CEI prises en compte sont :

CEI 114	Appareillage basse tension,
CEI 60034	Machines tournantes,
CEI 60044	Transformateurs de mesure (sera transféré en CEI 61869),
CEI 60051	Appareils de mesure électriques,
CEI 60060	Techniques des essais à HT,
CEI 60071	Coordination de l'isolement,
CEI 60076	Transformateurs de puissance,
CEI 60085	Isolation électrique - Evaluation et désignation thermiques,
CEI 60086	Piles électriques,
CEI 60099	Parafoudres à résistance variable,
CEI 60137	Traversées isolées pour tensions alternatives supérieures à 1000 V,
CEI 60214	Changeurs de prises en charge,
CEI 60255	Relais électriques,
CEI 60273	Caractéristiques des isolateurs extérieurs et intérieurs,
CEI 60282	Fusibles HT,
CEI 60296	Huile isolante pour transformateurs,
CEI 60289	Bobines d'inductance,
CEI 60353	Circuits-Bouchons,

Fig. 4.2-2 Excerpts from substation bidding documents (examples of compliant international standards)

4.3 DISTRIBUTION FACILITIES

4.3.1 Existing Distribution Felicities

(1) Distribution Voltage

The distribution network of Côte d'Ivoire is composed of medium voltage (HTA: 15/19/30kV) and low voltage (BT: 380/220V). The medium-voltage distribution network is energized from the source substation (HTB/HTA), which is connected to trunk transmission lines (HTB: 225/90kV). The scope of application of the three medium voltage levels is as follows:

- 15kV level: Distribution in the city center
- 30kV level: Distribution in rural and industrial areas
- 19kV level: Single-phase distribution in rural areas

The targets of this project, namely, Yamoussoukro and Bouaké have a medium-voltage distribution network, which is composed of 15 kV and 30 kV. In Abidjan, the area with the largest demand for electricity in Côte d'Ivoire, there is a plan to upgrade the distribution voltage from 15 kV to 20 kV by 2030 in order to increase supply capacity.

The low-voltage distribution network is powered by the distribution transformer (MV/LV) called "distribution poste", and it is connected to the medium-voltage distribution network and supplies electricity to consumers with single-phase 220 V or three-phase 380 V. The different types of customers supplied with low voltage are shown below:

- Domestic customer
- Commercial customer (SMEs)
- Public lighting

(2) Neutral earthing

The HTA neutral of the transformers at source substations is earthed by a resistance limiting the fault current to 300A for overhead networks and it is limited to 1000A for underground and mixed networks.

This earthing method allows the selection and elimination of earth faults by means of simple overcurrent relays.

(3) Distribution style

The distribution style can be broadly divided into overhead system (Fig. 4.3-1) and underground system (Fig. 4.3-2).

Table 4.3-1 shows the length of overhead and underground medium-voltage distribution lines and the ratio of underground lines in major cities including Yamoussoukro and Bouaké, which are the targets of this project, and Abidjan, which is the most important demand area.

In general, the overhead system is adopted in COTE D'IVOIRE, however the underground system is adopted in the city center. In recent years, the undergrounding of existing overhead lines has been promoted for environmental reasons and to prevent occurrence of accidents. CI-ENERGIES has published the planning standard for distribution planning (CHOIX TECHNIQUES ET DOCTRINE DE LA PLANIFICATION DES RÉSEAUX ÉLECTRIQUES DE DISTRIBUTION EN CÔTE D'IVOIRE) in 2016. It has been stipulated in this standard that all medium-voltage distribution lines in Abidjan, which is the economic capital of the country, and Yamoussoukro, Bouaké and San Pédro, which are the major cities in the country, should be underground system.

The percentage of underground system in Yamoussoukro is 68%, which is high when compared to the other major cities. Since Yamoussoukro is a relatively new capital city that was relocated in 1983, the underground system was systematically adopted at the initial stage of urban planning. On the other hand, the percentage of underground system in Bouaké is as low as 13%, however the undergrounding work mentioned above is currently underway in the city. In addition, since the underground system will be adopted for all medium-voltage distribution facilities to be installed in the future, it can be expected that the underground ratio of Bouaké will increase in a few years.

Fig. 4.3-1 Overhead system

Fig. 4.3-2 Underground system (under construction)

Table 4.3-1 Overview of medium voltage distribution line in major cities

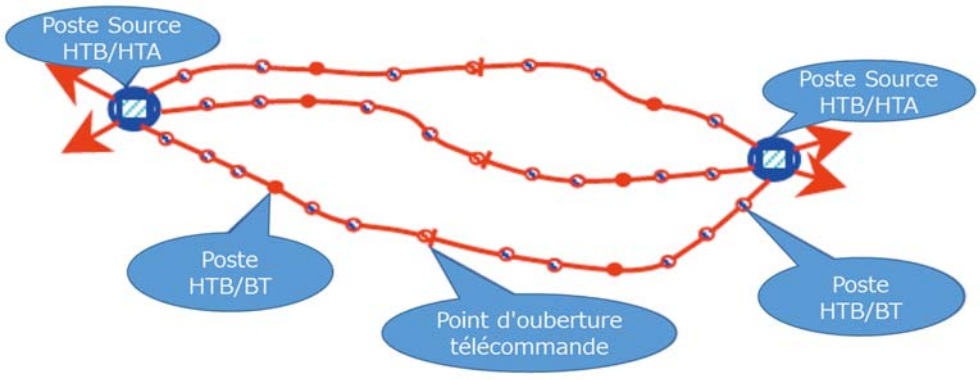
City	Length (km)			Ratio of underground
	Overhead	Underground	Total	
Yamoussoukro	375	779	1,154	68%
Bouaké	627	90	717	13%
Abidjan	964	1,479	2,443	61%
Other	20,030	190	20,220	1%
Total	21,996	2,538	24,534	10%

Source: JICA Study Team based on CI-ENERGIES

(4) Network system of medium voltage

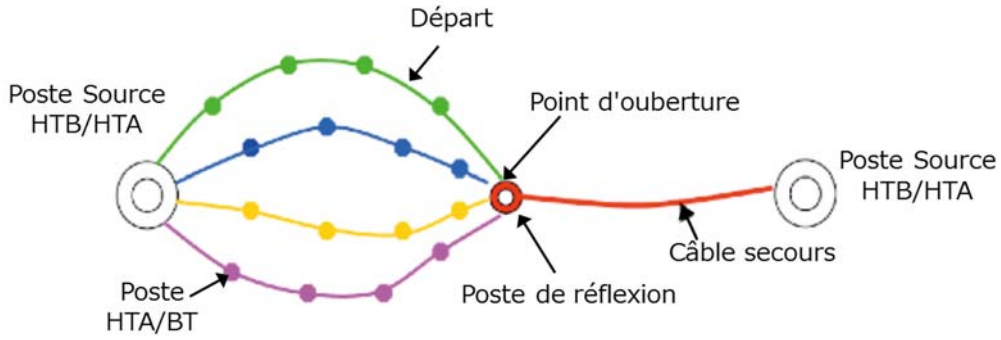
The basic medium-voltage distribution system is implemented as the loop system (Fig. 4.3-3) or spindle system (Source :CI-ENERGIES

Fig. 4.3-4) in major cities such as Yamoussoukro and Bouaké, which are target cities of this project. Both systems are highly reliable grids that aim at duplication of power sources. However, the planning standard (2016) has been established only recently, these grids have not been completed yet and it can be said that the current situation is a transition period aimed to convert these networks.



Source :CI-ENERGIES

Fig. 4.3-3 Conceptual diagram of loop distribution networks



Source :CI-ENERGIES

Fig. 4.3-4 Conceptual diagram of spindle distribution networks

In the spindle system, the outgoing distribution feeders (called as "Départ") from one source substation (Poste source) are configured to be integrated into a switching station (called as "Poste de réflexion") installed at the end of feeders. There are some distribution posts, which supply to the local demand along with the feeders. A spare cable dedicated for emergency (called as "Câble secours") from an adjacent substation is connected to the switching station, and when a power outage occurs in a distribution feeder, it is possible to transmit electricity to the sound section of the incident feeder excluding the faulty part through this emergency line and the switching station. In addition, the distribution substation (Poste HTA / BT) connected to the distribution feeders has a specification that allows it to be connected to two or more distribution feeders. It can be said that this network system has a very high reliability, because it is possible to secure a backup source from other feeders even if the distribution substation is connected to the faulty section of the feeder.

Since the change in power flow and network switching are expected to occur frequently both in loop and spindle network system because of its flexibility, the underground cables applied in the system are unified in XLPE 240mm^2.

Fig. 4.3-5 Poste de réflexion (left: outside, right :switching gear)

Fig. 4.3-6 Underground cable

(5) Distribution substation (Poste distribution HTA/BT)

There are mainly two types of distribution substation used in COTE D'IVOIRE;

- H61: Pole-mounted distribution substation (50,100,160kVA) mainly installed in the overhead distribution line area
- H59: Ground-mounted distribution substation (250,400,630,800kVA) mainly constructed in the underground distribution line area

Since the target area for this project is the underground distribution area, H59 should be adopted as distribution substations as mentioned above. The H59 is generally constructed in a brick building. This building should be constructed after the land is acquired by CI-ENERGIES. The H59 has one or two transformers, two or more medium voltage switching gear panels, transformer protection equipment, and low-voltage distribution boards, etc., inside the building. The low-voltage distribution board is connected to a maximum of 8 low voltage feeders for a distribution substation of 400 kVA or more and to a maximum of 4 feeders for 250 kVA or less, in order to supply electricity to low voltage consumers around the distribution substation.

（Building of distribution substation）

（Switching gear panel）

（Transformer）

（Low voltage distribution board）

Fig. 4.3-7　Distribution substation（H59）

(6) Low voltage distribution network

The low voltage distribution network is basically a radial system. In the case of an overhead system, bare conductors were used previously, however, recently they are being replaced with covered conductors (ABC: Aerial Bundled Cable). In dense areas such as city centers, the underground systems have been implemented for the purpose of low voltage distribution.

Installation of smart meters, a device used to measure the electricity used by the consumer, has also begun. This allows remote reading of the meter and remote operation of internal switches that can start and stop the electricity flow.

Fig. 4.3-8 Smart merter

(7) Distribution Automation

In the distribution network in COTE D'IVOIRE, remote monitoring and control is managed by the Distribution Control Center (BCC: Bureau Central de Conduite). The facilities that can be monitored and controlled are as follows:

- Source substation (Poste Source HTB/HTA)
- Switching station (Poste de réflexion)
- Distribution substation (Poste distribution HTA / BT)

The BCC at Abdjan, which is the only BCC in COTE D'IVOIRE at this point, operates the national distribution network, however, a second BCC is under construction in Yamoussoukro. After its completion, the national distribution network will be divided into two areas, the Abidjan area and the other areas. The former will be operated by the Abidjan BCC, and the later will be operated by the Yamoussoukro BCC. Both the BCC will have the same system configuration through which it is possible to control not only the concerned area but also the nationwide network. Therefore, in case of trouble in one BCC, the other BCC can provide back up and cover the entire country.

The monitoring and control signals of the distribution facilities are transmitted to the BCC after aggregation at the source substation near each facility. Each source substation and BCC are connected by an optical fiber, and this allows for high-speed transmission. The source substation and distribution facilities are connected by optical fiber, distribution line carrier, wireless, etc.

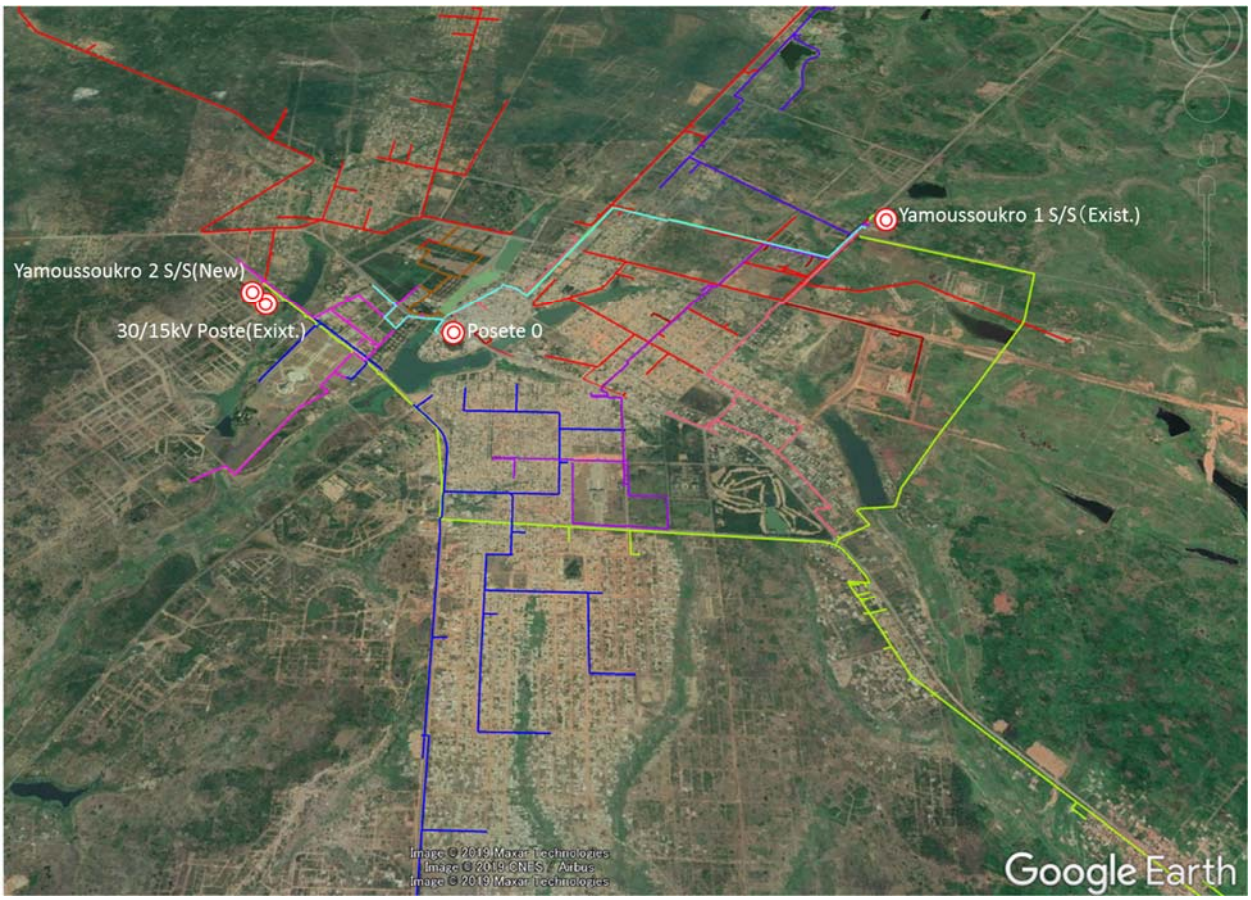
It should be noted that not all distribution facilities are currently connected to the supervisory control network, but they are being expanded in stages.

4.3.2 Distribution Network in the City of Yamoussoukro

(1) Existing Distribution Network

As described in Section 3.4, Yamoussoukro city is currently supplied from Yamoussoukro 1 substation (90/15kV) and 30/15kV substation. As for the distribution feeders are concerned, Yamoussoukro 1 has 10 feeders- 8 feeders of 15kV and 2 feeders of 30kV, and 30/15kV substation has 3 feeders of 15kV, and that is, a total of 13 feeders are used to supply electricity to Yamoussoukro city.

CI-ENERGIES is currently developing a facility database, which uses a geographic information system (GIS), for the management of distribution facilities. Fig. 4.3-9 shows a sample GIS data of the Yamoussoukro distribution network displayed on Google Earth.



Source: JICA Study Team based on CI-ENERGIES

Fig. 4.3-9 Sample for the management of distribution facilities by GIS (Yamoussoukro)

(2) The Route of new Distribution Feeder

The distribution component of the project aims to construct new distribution feeders from Yamoussoukro 2 substation, which will be constructed in the other component of the project and will reinforce the distribution network in the city. Along the distribution routes, there are several places where it is difficult to construct new distribution feeders, such as the location on the road to the city center where it is required to construct a maximum of 6 lines, and the location where it is required to cross the pond. Therefore, it is important to confirm the feasibility of each distribution route in this survey. Fig. 4.3-10 shows the crossing point of the pond. It has been confirmed that the road is constructed on a reclaimed land, and there are no bridges to cross the pond. It is possible to bury cables by excavating the road.

Fig. 4.3-10 The road at the city center of Yamoussoukro (crossing the pond)

(3) Existing Distribution Post

In this project, the new distribution feeders will be connected to the existing distribution posts along with the new feeders. Since it is necessary to add some switching board to connect the new distribution feeder to the existing distribution post, it is necessary to confirm whether there is an enough additional space for these switching boards.

Therefore, JICA Study Team conducted field survey to confirm the status of all the distribution posts that are planned to be connected by the project, i.e., a total number of 29 units. As a result of the survey, the following points were observed.

- Post not currently used, no connection required (1 unit)
- Insufficient space for additional switchgear due to small space inside the building (8 units)
- Impossible to connect new switching board due to incompatible existing switching boards (9

units)

- High risk of inundation due to construction in a lowland (2 units)

As for these points are concerned, it is necessary to revise the contents of F/S carried out by CI-ENERGIES, such as changing the distributing posts to be connected, renovating buildings to secure additional space, replacing existing switching boards, and relocating to highlands. Details of the revision will be described in Chapter 6.

Fig. 4.3-11 An example of insufficient expansion space

Fig. 4.3-12 An example of old switchgear


Fig. 4.3-13 Distribution posts at risk of inundation

(4) Newly installed Distribution Post

Initially, seven new distribution posts were planned to be built in Yamoussoukro City, however, new installations are added as a replacement for the existing distribution posts that are no longer required to be connected as the result of the survey results mentioned above. JICA Study Team confirmed a total of eight locations, where new distribution posts are planned to be constructed. As a result of the survey, it was found that there are no obstructions in any of the points that would prevent the construction of new distribution posts at all locations.

(5) Existing Switching Station

There is a switching station called "Poste 0", which was once operated as a hydro power plant, in the center of Yamoussoukro city. Two 15kV distribution feeders (Ville 3/1, Ville 3/2) from the Yamoussoukro 1 substation are connected into separate switchboards as power sources at this Poste 0. A circuit breaker for bus-connection is installed between the bus bars of distribution board, and the facilities are configured to support each other in the event of an accident on either source line. Each distribution board can connect to 5 outgoing feeders, thereby contributing to a stable supply to the city center and improvement of reliability.

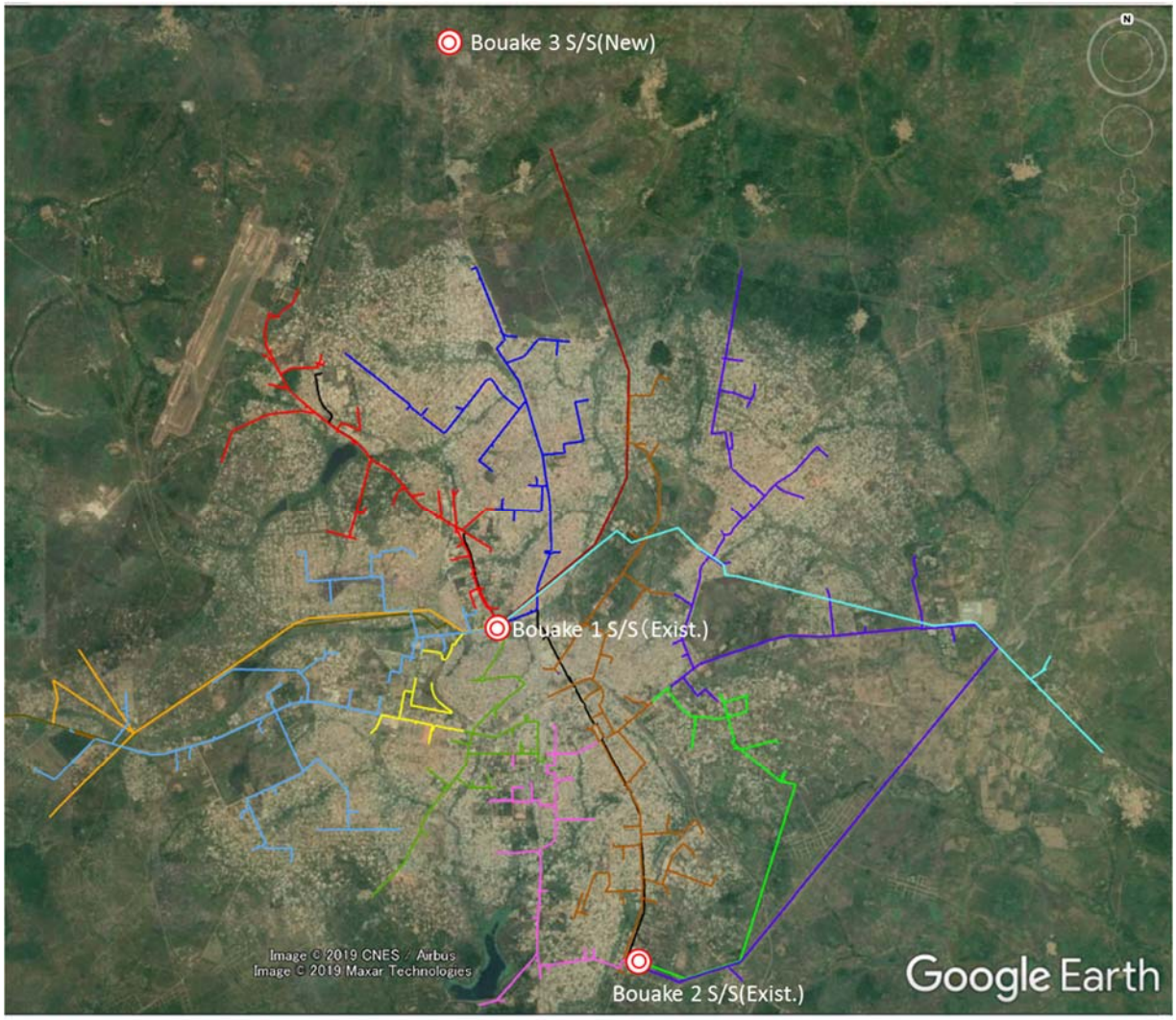
In the F/S conducted by CI-ENERGIES, the construction of 2 new power source lines from Yamoussoukro 2 substation and the extension of switching facilities to accommodate these are planned at Poste 0. Although it might be necessary to expand the existing building to add these facilities to Poste 0, there is sufficient space for expansion within the compound. Therefore, it is possible to install them.

Fig. 4.3-14 Poste 0

4.3.3 Distribution network in the city of Bouaké

(1) Existing Distribution Network

As described in Section 3.4, Bouake city is currently supplied by Bouake 1 substation (90/30/15kV) and Bouake 2 substation (225/90/15kV). As for the distribution feeders, Bouake 1 has 14 feeders-10 feeders of 15kV and 4 feeders of 30kV, and Bouake 2 substation has 5 feeders of 15kV, that is, a total of 19 feeders supply electricity to Bouake city. Fig. 4.3-15 shows a sample GIS data of Bouake distribution network displayed on Google Earth.



Source：CI-ENERGIES

Fig. 4.3-15　Sample for the management of distribution facilities by GIS（Bouaké）

(2) The Route of new Distribution Feeder

The distribution component of the project aims to construct new distribution feeders from Bouake 3 substation, which will be constructed in another component of the project and will reinforce the distribution network in the city. Along the distribution route, there are several places where it is difficult to construct new distribution facilities, such as the location on the road to the city center where it is required to construct a maximum of 7 lines. Therefore, it is important to confirm feasibility of each distribution route in this survey. In this survey, the JICA study team confirmed that the roads, where distribution facilities are planned to be constructed, have sufficient width, therefore, it is considered that there are no major obstacles to the construction of new underground distribution feeders at the moment.

(3) Existing Distribution Post

JICA Study Team conducted field survey to confirm the status of all the distribution posts that are planned to be connected by the project, i.e., a total of 20 units. As a result of the survey, the following points were found.

- Insufficient space for additional switchgear due to small space inside the building (1 units)
- Impossible to connect new switching board due to incompatible existing switching board (1 units)

As for these points are concerned, it is necessary to revise the contents of F/S carried out by CI-ENERGIES, such as renovating buildings to secure additional space, replacing existing switching board. Details of the revision will be described in Chapter 6.

(4) Newly installed Distribution Post

JICA Study Team confirmed the status of the new construction sites where a total of 6 distribution posts are planned in Bouaké city. As a result of the survey, it was found that two posts have already been constructed or are under construction by other projects such as ENERGOS I project. Therefore, the remaining 4 units will be targeted in this project. In terms of these 4 new posts, it was found that there are no obstructions that would prevent the construction of new distribution posts at all locations.

4.3.4 Standard design / Standard specification

CI-ENERGIES has established and applied the following four standards for distribution facility planning and design.

① TECHNICAL CHOICES AND DOCTRINE OF PLANNING OF ELECTRICAL DISTRIBUTION NETWORKS IN COTE D'IVOIRE
② TECHNICAL GUIDE DISTRIBUTION NETWORK Part_1: MV / LV STATION
③ TECHNICAL GUIDE DISTRIBUTION NETWORK Part_2: MV NETWORK
④ TECHNICAL GUIDE DISTRIBUTION NETWORK Part_3: LV NETWORK

As described in Section 4.3.1, above ① is the planning standard for distribution network and facilities, which defines the principles regarding the distribution network of Côte d'Ivoire, the concept of the network configuration and quality indicators, etc. Although this planning standard does not describe the technical specifications of the equipment used for distribution facilities, they are described in technical guides ② to ④ mentioned above. The contents related to distribution facilities in the technical guides are described below.

(1) Standards for distribution facilities

1) Electric pole

Table 4.3-2 shows the specifications of the electric pole used in COTE D'IVOIRE. The pole length is 12 to 15m and the strength is 200 to 1,650 daN. The strength to be applied on a pole is determined based a several conditions such as the size of the conductor, the angle of the line, and applications of the pole. Table 4.3-3 and Table 4.3-4 shows the conditions for the application of electricity poles.

Table 4.3-2 Specification of the electric poles

Type	Classification	Length (m)	Strength (daN)	Type	Length (m)	Strength (daN)
Concrete Pole	CLASSE A	12	300-1,000	Metallic Pole	14	920
	CLASSE A	13	300-1,600		12	200-1,650
	CLASSE A	14	300-1,600		13	400-1,650
	CLASSE B	12	1,000-1,600		14	1,650
	CLASSE B	13	1,000-1,600		15	500-1,580
	CLASSE B	14	1,000-1,600			

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Table 4.3-3 Conditions for the application of electric poles based on the line angle and the cross section of the conductors

CONDUCTEUR 54,6 mm		CONDUCTEUR 93,3 mm et 148 mm	
ANGLE (grades)	**SUPPORT**	**ANGLE (grades)**	**SUPPORT**
α ≦ 5 et alignement	12/300 or 13/300	α ≦ 5 et alignement	12/400 or 12/500
5 < α ≦ 10	12/400 or 13/400	5 < α ≦ 30	12/800 or 13/800
10 < α ≦ 30	12/650 or 13/650	30 < α ≦ 60	12/1250 or 13/1250
30 < α ≦ 50	12/1000 or 13/1000	60 < α ≦ 80	2x (12/1250) or 2x (13/1250)
50 < α ≦ 70	12/1250 or 13/1250	α > 80	2x (12/1600) or 2x (13/1600)
α > 70	2x (12/1250) or 2x (13/1250)	*100grades = 90°	

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Table 4.3-4 Conditions for the application of dead-end pole and the poles on which equipment is mounted.

	Characteristics	**Observations**
Support d'ARRET	12/1250 ou 13/1250	For conductors with a cross-section ≥ 93.3 mm^2, the supports are paired.
Support IACM	12/800 ou 13/800	
Support TFO H61	12/1250 ou 13/1250	

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

2) Conductor

The aluminum bare conductor is applied for 15/30kV overhead distribution network. The following three standardized sizes of the conductor are generally used- 148.1, 93.3, and 54.6mm2. The application scope and the technical specification of each conductor are shown in Table 4.3-5.

Table 4.3-5 Application scope and specification of conductors

	Aluminum bare wire			
	Unit	148.1mm^2	93.3mm^2	54.3mm^2
Section		Main	Primary branch	Secondary branch
Structural Characteristics				
Diameter of Bare wire	mm	3.15	2.25	3.15
Number of Bare wire	u	19	19	7
Nominal Outside Diamete	mm	15.75	11.25	9.45
Cross section of Conducto	mm^2	148.1	93.3	54.6
Unit Weight	kg/km	407	208	149
Electrical Characteristics				
Resistance (20℃)	Ohm/km	0.224	0.438	0.603
Allowable current	A	379	285	204
Mechanical characteristics				
Fracture load	kN	48.1	24.55	17.75

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

As described above, the conductor used for the low-voltage feeders is the covered aluminum electric wire (ABC: Aerial Bundled Conductor). Table 4.3-6 shows the technical specifications of the conductors used in low-voltage network.

Table 4.3-6 Specification of low-voltage conductors

Configuration	Resistance at 20℃ (Ω/ km)	Voltage drop (V/A･km)	Maximum current (A)	Maximum length (m)	Fracture load (daN)
3x35+54,6+16mm²	0.868	1.65	149	141	1660
3x70+54,6+16mm²	0.443	0.87	192	218	1660
3x150+70mm²+16mn	0.206	0.46	344	222	2050

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

3) Underground cable

As described in Section 4.3.1, underground cables used for medium voltage distribution network are basically unified to XLPE240 mm2 to avoid the occurrence of a bottleneck during a network configuration change, however, three sizes of the cable have been described in the technical guide- 240, 95 and 50 mm2. The technical specification of XLPE cable is shown in Table 4.3-7.

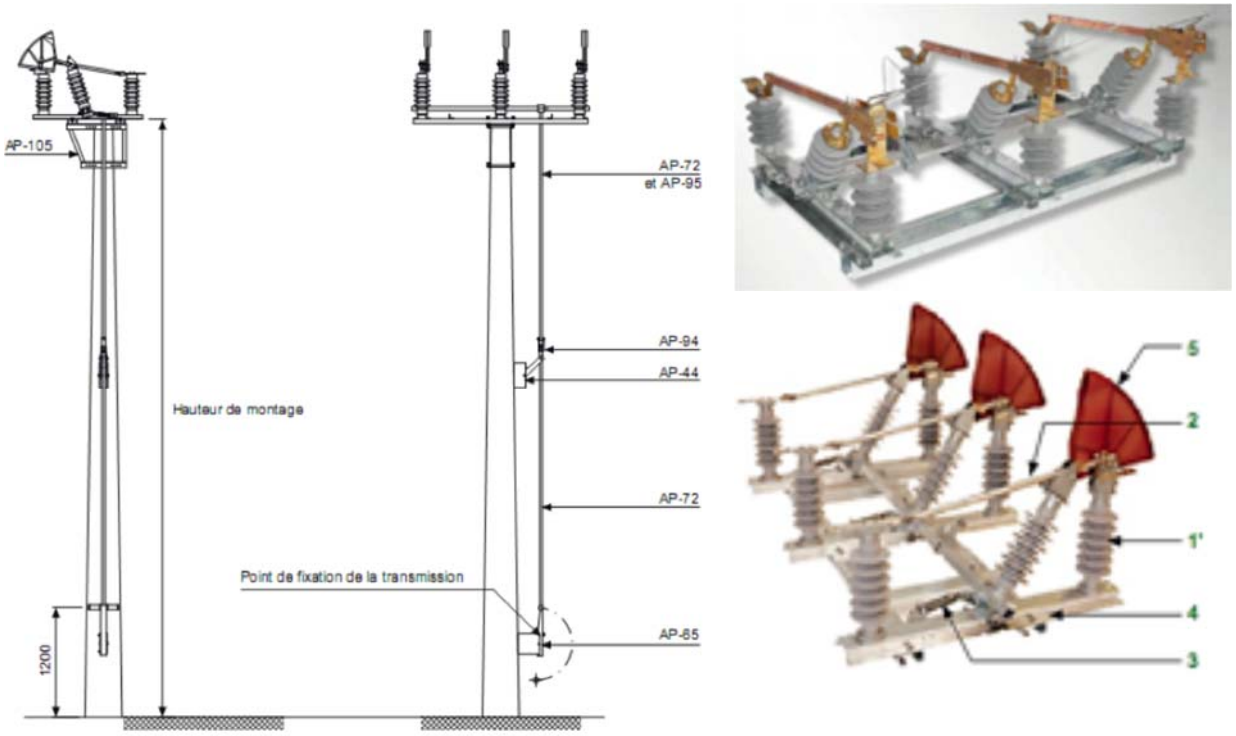
Table 4.3-7 Specification of XLPE cable

		XLPE Cable		
	Unit	240mm²	95mm²	50mm²
Structural Characteristics				
Diameter of Bare wire	mm	18	11.3	8.2
Outside Diameter	mm	78.7	-	-
Unit Weight	kg/km	4,260		
Electrical Characteristics				
Resistance at50HZ	Ohm/km	0.1	0.12	0.14
Allowable current	A	428	252	175

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

4) Switchgear

The switchgear used in COTE D'IVOIRE are classified into two types- pole mounted type and ground mounted type that is installed in distribution substation. The former type includes manually operated load break switchgear (IACM: les Interrupteurs aériens à commande manuelle) and remote-operable load break switchgear (IAT: les Interrupteurs aériens télé commandés), and the latter type includes gas switchgear (GIS) and air switchgear (AIS).



Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Fig. 4.3-16 Pole mouted switchgear（IACM）

Table 4.3-8 Specification of pole mounted switchgear（IACM 24kV）

	IACM 24kV		
Rated current	200A	400A	400A
Cutoff power	50A	100A	400A
Peak closing power at a speed dependent on the operator.	10 k A	10 k A	10 k A
Peak closing power at a speed independent of the operator by the addition of a Tumber type energy accumulation control:	20kA	20kA	20kA

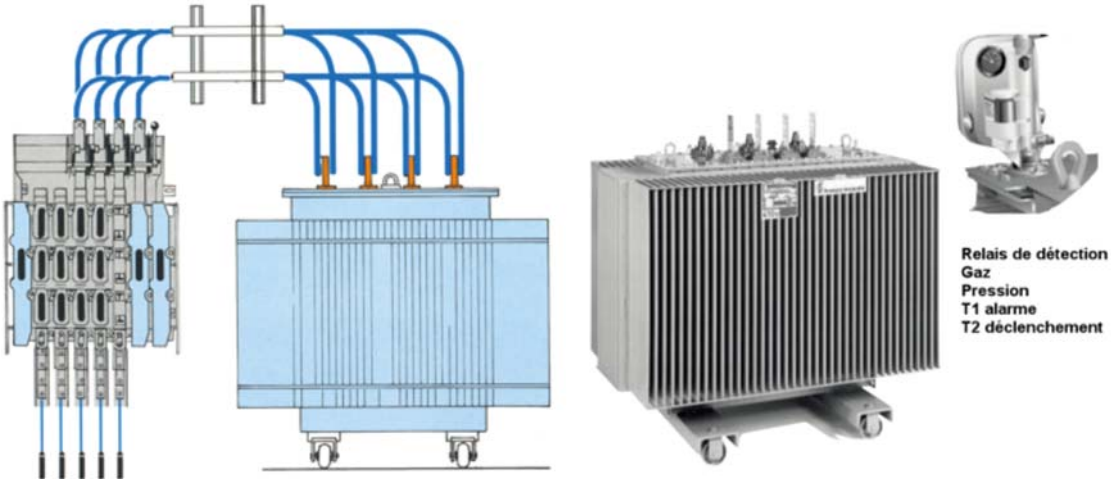
Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Fig. 4.3-17 Gas insulated switch gear installed in a distribution substation

5) Transformer

As mentioned in Section 4.3.1, two types of distribution substations operated in COTE D'IVOIRE are- H59 and H61. Among these two, only H59 posts (250, 400, 630kVA) will be applied to the target projects of this study. The transformer is a three-phase oil-insulated transformer, and the type of iron core is CRGO (Cold Rolled Grain Oriented Electrical Steel).



Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Fig. 4.3-18 Example of installation of distribution transformer

(2) Construction standard

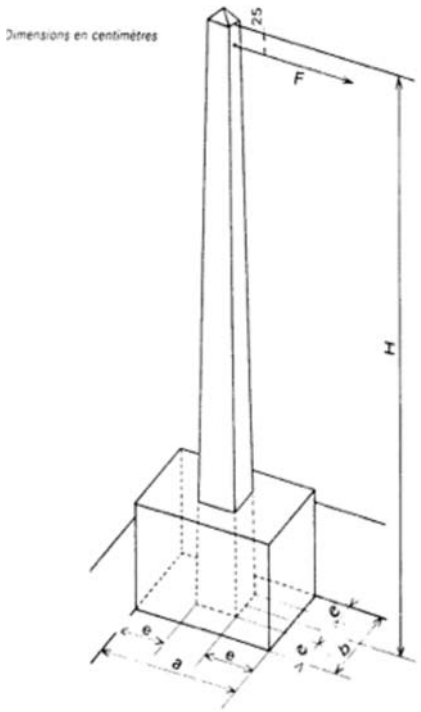
1) Electric pole

When constructing a pole, it is necessary to reinforce the base of the post with a concrete foundation, whose size must correspond to the strength required by the poles. The depth ”P” of the foundation is determined by the formula "P = H / 10 +0.5" according to the pole length "H". And the length "a" and the width "b" of the foundation are determined by Table 4.3-9 and Fig. 4.3-19.

Table 4.3-9 Dimensions of concrete foundation according to the heights and the strength of the poles

Design load	From 9 to 12 m		From 13 to 14 m	
	CUTTING DIMENSIONS		CUTTING DIMENSIONS	
	a (cm)	b (cm)	a (cm)	b (cm)
150-200	60	40	60	40
330	60	40	70	40
400	65	45	70	45
500	70	45	75	45
650	75	50	80	50
800	85	70	90	70
1,000	95	75	100	75
1,250	100	85	100	85
2,000	110	95	110	95

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

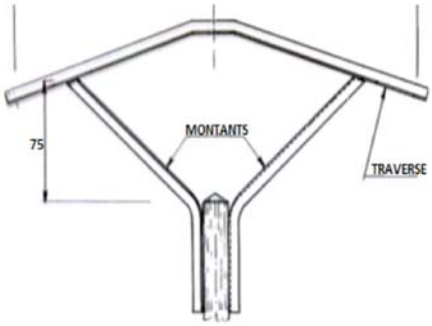


Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

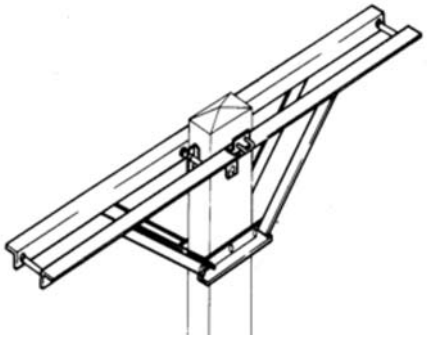
Fig. 4.3-19 Basic dimension of the distribution pole

2) Arms on poles

The armaments on the straight alignment pole adopt the suspension method using two types of metallic members called "Nappe-voûte". The armaments on the dead end poles or the angle alignment adopt the tension method called "Traverse d'Ancrage". Fig. 4.3-20 shows examples of armaments on poles.



Straight alignment



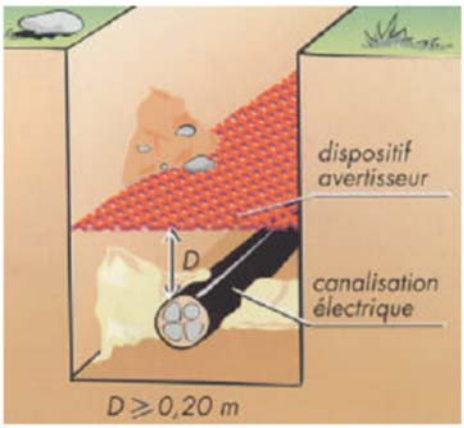
Dead end pole or angle alignment

Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Fig. 4.3-20 Examples of armament

3) Underground cable

The direct burial system using no conduit is the standard for underground cable system. The burial depth is 80 cm and the excavation width per line is 40 cm. The lower and upper parts around the cable are filled with sand to avoid damaging the cable sheath, and the cover, the red plastic protective sheet is installed 20 cm above the cable to prevent external factor accident.



Source : GUIDE TECHNIQUE RÉSEAU DE DISTRIBUTION, CI-ENERGIES

Fig. 4.3-21 Construction drawing for underground cable

CHAPTER 5

ENVIRONMENTAL AND SOCIAL CONSIDERATION

CHAPTER 5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

5.1 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

5.1.1 Description of project components and environmental and social impacts

The description of project components is shown in Table 5.1-1. The project area is shown in Fig. 5.1-1.

Table 5.1-1 Description of project components

No.	Project components	Environmental and social considerations
1	New construction of 225kV overhead transmission line	o New construction of 225 kV transmission line between Taabo and Kossou substations (137.9 km) o New construction of 225kV transmission line between Kossou and Bouaké 3 substation (133.7 km)
2	Expansion of existing substations (3 locations)	o Expansion of Taabo substation (construction within the existing facility) o Expansion of Kossou substation (construction outside of the existing facility but within the property of CI Energies) o Expansion of Bouaké substation (construction within the existing facility)
3	New construction of substation (2 locations)	o New construction of Yamoussoukro 2 (land acquisition process has been completed) o New construction of Bouaké 3 (land acquisition process has been completed)
4	Expansion of power grid in Yamoussoukro and Bouaké	o New construction of underground transmission line

Source: JICA Study Team

Source: JICA Study Team using abidjan.net (2018)

Fig. 5.1-1 Project area map

5.1.2 Status of Environmental and Social Baseline

The Republic of Côte d'Ivoire is composed of 14 districts, including 2 autonomous districts, 31 regions and 95 departments. The Project is located in central Ivory Coast, in (1) Lagunes District, (2) Agnéby-Tiassa Region (3) the Vallée du Bandama District, and (4) Yamoussoukro Autonomous District. The project area is located on sloping lands at an elevation of 200~300 m.

The major cities that are located along the transmission line are Bouaké City, the nation's capital, and Yamoussoukro City. Both of the cities have commercial areas and residential areas in their centers and have agricultural lands and forests near the periphery.

Table 5.1-2 Administrative categories of the project area

No.	District	Region	Capital	Department
1	Lagunes	Agnéby-Tiassa	Dabou	Agboville
				Sikensi
				Taabo
				Tiassale
2	Lacs	Bélier	Dimbokro	Didievi
				Djekanou
				Tiebissou
				Toumodi
3	Vallée du Bandama	Gbéké	Bouaké	Beoumi
				Botro
				Bouake
				Sakassou
4	Yamoussoukro Autonomous District			Attiegouakro
				Yamoussoukro

Source: JICA Study Team

(1) Natural Environment

1) Meteorology

The climate of Bouaké City and Yamoussoukro City are classified as tropical savanna climates (Aw) under the Köppen climate classification. The rainy season is during May and September and the dry season between October and April. The average annual temperature of Bouaké City is 26.2°C with an annual rainfall 1,139 mm, and the average annual temperature of Yamoussoukro City is 25.9°C with an annual rainfall of 1,118 mm[1].

2) Air Quality

Air quality monitoring was carried out in the project area, and it was carried out from November 2018 to March 2019. The daily average levels of $PM_{2.5}$ and PM_{10} were 7.0μg/m^3 -

[1] Source：https://en.climate-data.org/

79.0μg/m^3 and 18.0μg/m^3 -154.0μg/m^3, respectively, which were not compliant with WHO standards[2]. This could be attributed to vehicular traffic on unpaved roads.

Table 5.1-3 Air monitoring results

No.	Location	Coordinates	$PM_{2.5}$ (μg/m^3)	PM_{10} (μg/m^3)
1	Kossou	30N (X=225858, Y=775169)	15.6	29.2
2	Lolobo	30N (X=249750, Y=770143)	22.6	45.8
3	Manhounou Akouê	30N (X=237749, Y=768709)	23.8	49.3
4	Bringakro	30N (X=269154, Y=709013)	7.0	37.0
5	Wawakro	30N(X=0271046, Y=0720613)	**79.0**	**154.0**
6	N'Zere	30N(X=0260172, Y=0766446)	8.0	18.0
National standards[3]			-	-
IFC standards[4]			25	50

Source: Prepared by JICA Study Team based on EIA report (July, 2020; CI Energies)

3) Water Quality

Water quality monitoring was carried out in the project area, and it was carried out from November 2018 to March 2019. The analysis results are shown below. It is assumed that there is a low possibility that the project will cause water pollution; however, the survey was conducted in order to understand the baseline data.

Table 5.1-4 Water sampling results

No.	Items	Unit	Water sampling results (Above: location/ Below: coordinates)	National standards[5]
			Kan River (Tiebissou department)	
			7°07'56.4"N, 5°10'04.7"W	
1	Temperature	ºC	29.0	-
2	pH	-	7.432	-
3	BOD_5	mg/L	15	-
4	TSS	mg/L	30	-
5	Turbidity	N.T.U.	5.36	-
6	Electrical conductivity	μ S/cm	80.55	-
7	Copper (Cu)	mg/L	0.013	-
8	Zinc (Zn)	mg/L	0.015	-
9	Aluminum (Al)	mg/L	0.033	-
10	Manganese (Mn)	mg/L	0.090	-

Source: Prepared by JICA Study Team based on EIA report (July, 2020; CI Energies)

[2] IFC standard: $PM_{2.5}$ (daily average value) 25 μg/m^3; PM_{10} (daily average value) 50 μg/m^3. No standard on air ambient quality and moveable source (vehicles etc.) has been established in Ivory Coast (air emission standards have been only set up).

[3] No standard on air ambient quality and moveable source (vehicles etc.) has been established in Ivory Coast (air emission standards have been only set up).

[4] Source: IFC General EHS Guidelines, Environmental Air Emissions and Ambient Air Quality Table 1.1.1

[5] No standard on water quality applied for power supply projects (including river water quality standards) has been established in Ivory Coast (effluent quality standards applied for factories have been only set up).

4) Noise

Noise monitoring was carried out in the project area, and it was carried out from November 2018 to March 2019. The results of the noise monitoring are shown below. The national and IFC air quality standards were met for all of the monitoring stations.

Table 5.1-5 Noise monitoring results

No.	Location	Coordinates	Type	Noise level	National standards	IFC standards
1	Kossou	30N (X=225858, Y=775169)	Urban residential areas/ Rural areas with high traffic/ Daytime	57	60	55
		30N (X=224916, Y=774156)		46		
2	Lolobo	30N (X= 249488, Y= 770518)		57.2		
3	Manhounou Akouê	30N (X=237749, Y=768709)		58.2		
		30N (X=237355, Y=769407)		50.7		
4	Kouamekro	30N (X=273279, Y=695055)		63.0		

Source: Prepared by JICA Study Team based on EIA report (July, 2020; CI Energies)

5) Flora and Fauna

Since the project area has already been developed through the expansion of houses and agricultural lands, no wild animals have been identified except birds and wild pigs, etc. The main vegetation include evergreen forests and grasslands. A wildlife survey was carried out in the project area from November 2018 to March 2019. Some species identified around the project area are categorized as "VU (Vulnerable)" and "LC (Least Concern)"[6] by the International Union for Conservation of Nature (IUCN) Red List, as shown in Table 5.1-6 below.

Table 5.1-6 IUCN-categorized plant species

	Family	Scientific name	IUCN Red List Category	Notes
1	Moraceae	*Milicia excelsa*	NT	Distributed widely in Africa (Ivory Coast, Ethiopia, Kenya, Sudan etc.)
2	Sapotaceae	*Vitellaria paradoxa*	VU	Distributed widely in Africa (Ivory Coast, Ghana, Senegal, Uganda, Sudan etc.)

Source: Prepared by JICA Study Team based on EIA report (July, 2020; CI Energies) and IUCN red list (https://www.iucnredlist.org/)

6) Protected areas

The protected areas near the project area are: Abokouamekro National Park near Yamoussoukro and Lamto Scientific Reserve near Taabo. However, these protected areas are sufficiently distanced[7] from the project area, and there are no expected impacts from the

[6] IUCN red list is the list of endangered species. The categories are Extinct (EX), Extinct in Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) etc.

[7] Abokouamekro National Park and Lamto Scientific Reserve are located more than 10km from the project site.

project on these areas. There are also no habitats with important ecological value[8], nor historical and cultural heritage sites around the project area. (See also the section 5.1.2 (1) 5))

(2) Social Environment

1) Population census

According to the 2014 population census, the population within the project area in (1) Lagunes District Agnéby-Tiassa Region, (2) Lacs District Bélier Region, (3) Vallée du Bandama District Gbêkê Region and (4) Yamoussoukro Autonomous District were 606,852, 346,768, 1,010,849 and 355,573 persons, respectively. The gender ratio, number of households, and number of people in a single household are given in Table 5.1-7.

Table 5.1-7 Population distribution of the project Area

No.	District	Region	Department	Men (no. of people)	Women (no. of people)	Total (no. of people)	No. of households	Average no. of people per household
1	Lagunes	Agnéby-Tiassa	Agboville	150,957	141,152	292,109	56,032	5.2
			Sikensi	40,848	37,591	78,439	14,695	5.3
			Taabo	29,873	26,549	56,422	9,808	5.8
			Tiassale	98,702	81,180	179,882	38,996	4.6
			Total	**320,380**	**286,472**	**606,852**	**119,531**	**5.1**
2	Lacs	Bélier	Didievi	44,087	49,612	93,699	14,638	6.4
			Djekanou	13,768	12,742	26,510	4,718	5.6
			Tiebissou	49,976	48,758	98,734	17,852	5.5
			Toumodi	64,721	63,104	127,825	22,391	5.7
			Total	**172,552**	**174,216**	**346,768**	**59,599**	**5.8**
3	Vallee du Bandama	Gbéké	Beoumi	77,168	77,038	154,206	25,623	6.0
			Botro	38,545	42,879	81,424	13,026	6.3
			Bouake	342,609	338,085	680,694	116,672	5.8
			Sakassou	48,290	46,235	94,525	15,395	6.1
			Total	**506,612**	**504,237**	**1,010,849**	**170,716**	**5.9**
4	District autonome Yamoussoukro		Attiegouakro	23,317	22,200	45,517	7,575	6.0
			Yamoussoukro	158,183	151,873	310,056	63,562	4.9
			Total	**181,500**	**174,073**	**355,573**	**71,137**	**5.0**

Source: Prepared by JICA Study Team based on the Population Census (2014), Ivory Coast National Bureau of Statistics

2) Economy

The main income source[9] of the project area is agriculture. Yam, cassava and corns etc. are cultivated. The main cash crops are cashews, coffee and cocoa etc. Grazing and tourism are

[8] Ecologically important areas (Key Biodiversity Area etc.) were not identified around the project area (along the transmission and distribution lines as well as the substations). (Source: Integrated Biodiversity Assessment Tool (IBAT): https://www.ibat-alliance.org/)

[9] The gross national income of Ivory Coast is 1,610 USD. The umeployment rate is 2.5%. The average income etc. in the project area cannot be confirmed. (Source: Ministry of Foreign Affairs https://www.mofa.go.jp/mofaj/area/cote_d/data.html)

also a part of the income sources, and there are factories of clothes, tobacco, liquor and cotton etc.

3) Indigenous people

There are no indigenous people identified in the project area.

5.1.3 Legal and Institutional Frameworks for Environmental and Social Considerations

(1) Legal Framework for Environmental and Social Considerations in Ivory Coast

1) Environmental laws and regulations

The primary environmental legislation of the Ivory Coast is the Environment Act of 1996 (No.96-766), which establishes regulations for environmental conservation, effective use of natural resources and promotion of biodiversity conservation. Article 40 of the EIA Act (No. 96-894) outlines the general requirements and procedures of an Environmental Impact Assessment (hereinafter called "EIA"). Additionally, Ordinance No. 1164 stipulates standards for water and air quality and noise. The laws and regulations related to environmental and social considerations are outlined in Table 5.1-8.

Table 5.1-8 Legal framework for environmental and social considerations in Ivory Coast

No.	Legal framework in the Ivory Coast	Year enacted	Summary
General			
1	Ivory Coast constitution	2016	Stipulates the legal rights and principles of the Ivory Coast.
Environmental			
1	Environment act (No. 96-766)	1996	Promotes environmental conservation in the present and future and aims to minimise environmental degradation. Stipulates the contents of the EIA report.
2	EIA act (No. 96-894)	1996	Stipulates the procedures and requirements of the EIA.
3	Rules regarding emission standards for environmental protection (No. 1164)	2008	Implements environmental standards for water and air quality and noise.
4	Forest act (No. 65-425)	1965	Stipulates the categorisation, ownership and right to the use of forests.
5	Wildlife protection act (No. 65-255)	1965	Stipulates the principles related to the conservation of wildlife.
Social			
1	Law on rural land (No.98-750)	1998	Stipulates the principles related to land acquisition and ownership in rural areas.
2	Regulation on the conditions of acquisition of urban land ownership	2013	Stipulates the procedures of land acquisition in urban areas.
3	Decree on compensating the loss of agricultural crops	1995	Stipulates the compensation methods for loss of crops.
4	Order on the scale of compensation for agricultural crops	2018	Stipulates detailed of compensation including compensation rate and calculation methods.

Source: JICA Study Team

2) ESIA System in Ivory Coast

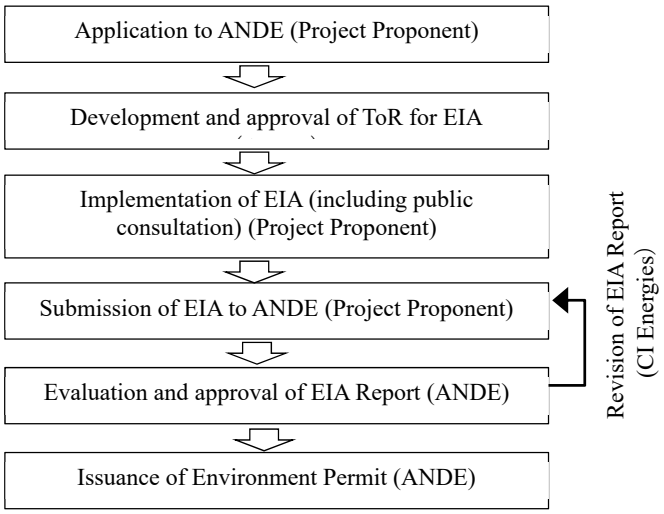
According to the EIA Act (No. 96-894), projects are categorized into three schedules based on whether an EIA would be required for the project.

(a) Schedule 1: projects that are expected to have a significant impact. A detailed EIA must be conducted.

(b) Schedule-2: projects are evaluated on a case-by-case basis for the necessity of an EIA.

(c) Schedule-3: Projects that are located in environmentally sensitive areas or areas with high environmental risk.

The EIA approval process is shown in the figure below.



Source: Prepared by JICA Study Team based on Ordinance No. 96-894. The parenthetical text indicates the responsible party.

Fig. 5.1-2 EIA Approval Process

The EIA Report for this project was submitted to the National Environmental Agency (ANDE) on 26 August 2019. In this study, the transmission line route was re-examined and modified in order to minimize the impact on resettlement. Based on this modification, the EIA report (July 2020) was prepared. On August 20, 2020, ANDE officially approved the report, and issued an environmental permit. The permit has the conditions below, and it is expected that CI Energies will meet these conditions.

(a) CI Energies shall implement and comply with the environmental management plan and monitoring plan.

(b) If the project is not conducted within 3 years after the approval, the environmental permit shall be invalid.

(c) CI Energies shall semi-annually submit a status report on environmental management plan and monitoring plan to ANDE.

(d) ANDE is allowed access to the project facilities to monitor the compliance with environmental management plan and monitoring plan. If incompliance is found, ANDE will issue a notice to CI Energies within 15 days; if incompliance is continued, the following actions shall be taken:

- CI Energies shall take mitigation measures at their cost.
- The project shall be postponed until the completion of mitigation measures.
- ANDE shall withdraw the approval.

3) Environmental standards in the Ivory Coast

Rules regarding emission standards for environmental protection (No. 01164, 4 November 2008) stipulate the standards for noise emissions in Ivory Coast.

Table 5.1-9 Noise emission standards in Ivory Coast

Area	Time period		
	Daytime (dB(A))	Evening (dB(A))	Nighttime (dB(A))
Hospitals, rest areas, environmental protection areas	40	35	30
Residential areas/ Rural areas with little traffic	45	40	35
Urban residential areas	50	45	40
Urban residential areas/ Rural areas with high traffic	60	55	45
Commercial and industrial areas	70	65	50
Industrial districts	75	70	60

Source: Rules regarding emission standards for environmental protection (No. 01164, 4 November 2008)

4) Gap analysis of EIA

The results of gap analysis between the JICA Guidelines for Environmental and Social Considerations, laws and regulations in the Ivory Coast and the policies to be adopted by this project are shown in Table 5.1-10.

Table 5.1-10 Results of gap analysis and policies to be taken by this project

Items	JICA Guidelines	Relevant laws/ regulations in Ivory Coast	Gaps/ Policies to be taken by this project
Underlying Principles	・ Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan. (JICA guidelines, Appendix 1, Underlying principles. 1)	・ In case negative impacts on environment are predicted, EIA shall be implemented. The analysis of alternatives shall be done, and the plan shall minimize the impacts. (Environmental act, EIA act) ・ There are no laws/regulations which stipulate that assessment in the earliest possible planning stage. (Environmental act, EIA act)	・ EIA will be implemented during the preparatory study; alternatives and mitigation measures will be examined and will be taken into account in the project budget and plan.
Information disclosure	・ EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to local residents, written materials must be provided in a language and form understandable to them. (JICA guidelines, Appendix 2) ・ It is necessary to make EIA reports available to the local residents of the country, in which the project is to be implemented. The EIA reports must be available at all times for perusal by project stakeholders such as local residents, and copying must be permitted. (JICA guidelines, Appendix 2)	・ There are no directives regarding the language to be used in the EIA report. (Environmental act, EIA act) ・ All the citizens have rights to access to EIA report. (Ivory Coast constitution Article 18) ・ EIA report shall be disclosed in the process of EIA. (EIA act Article 15 and 16) ・ There are no laws/regulations which stipulate the methods of EIA report disclosure as well as copying of EIA report. (Environmental act, EIA act)	・ EIA report will be prepared in the officially used language. ・ EIA report will be disclosed on the website of CI Energies. Residents are allowed to read EIA report in the offices of local governments.
Public consultations	・ For projects with a potentially large environmental impact, sufficient consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. (JICA Guidelines, Appendix 1, 5. Social acceptability. 1) ・ Appropriate consideration must be given to vulnerable social groups, such as women, children, the elderly, the poor, and ethnic minorities, all members who are susceptible to environmental and social impacts and may have little access to decision-making processes within society. (JICA Guidelines, Appendix 1, 5. Social acceptability. 2)	・ Citizens have rights to participate in the process of decision-making of projects. (Environmental act Article 35) ・ Public consultations shall be conducted in the process of EIA. (EIA act Article 11) ・ Appropriate considerations for women, children, the elderly and handicapped persons etc. shall be given. (Ivory Coast constitution Article 32) ・ There are no laws/ regulations which stipulate specific requirements of measures for vulnerable groups. (Environmental act, EIA act)	・ At the scoping stage and the preparation stage of the draft EIA report, comments from residents will be collected and reflected in the report. ・ Focus Group Discussion will be organized, so that vulnerable social groups such as women, children, elderly and the poor can participate in the process of EIA preparation.
Items to be assessed	・ The impacts to be assessed with regard to environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment	・ In the process of EIA, direct, indirect, cumulative and medium/long-term impacts shall be examined. (Environmental act Article 40) ・ In the process of EIA, the impacts on flora, fauna, soil landscape, land use, living environment, hygiene, noise, vibration and odor etc. shall be	・ The derivative, secondary and cumulative impacts, as well as the impacts of projects that are indivisible from the project will be examined in line with JICA

Items	JICA Guidelines	Relevant laws/ regulations in Ivory Coast	Gaps/ Policies to be taken by this project
	and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. (JICA Guidelines, Appendix 1, Scope of impacts to be assessed. 1) ・ In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project. (JICA Guidelines, Appendix 1, Scope of impacts to be assessed. 2)	assessed. (EIA act Article 12) ・ There are no laws/regulations which stipulate requirements of derivative and secondary impacts as well as the impacts of projects that are indivisible from the project. (Environmental act, EIA act)	Guidelines.
Monitoring/ Grievance mechanism	・ Project proponents etc. should make efforts to make the results of the monitoring process available to local project stakeholders. (JICA Guidelines, Appendix 1, Monitoring. 3) ・ When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems. (JICA Guidelines, Appendix 1, Monitoring. 4)	・ The methodologies of regular environmental monitoring (before/during construction, during operation and if possible after operation) shall be indicated in EIA report. (Environmental act Article 40) ・ There are no laws/ regulations which stipulate grievance mechanism and disclosure of monitoring results. (Environmental act, EIA act)	・ Monitoring results will be submitted to the Ministry of Environment and Sustainable Development. ・ Grievance mechanism will be established for the project, based on which any person can submit grievance.

Source: JICA Study Team

(2) Institutional Framework for Environmental and Social Considerations in Ivory Coast

1) CI Energies

There are three departments of CI Energies related to environmental and social considerations, which conduct the following work: 1) environmental planning and strategies, 2) implementation and monitoring of environmental activities, 3) planning, implementation and monitoring of land acquisition and resettlement.

2) Ministry of Environment and Sustainable Development（Ministère de l'Environnement et du Développement Durable）

In Ivory Coast, the Ministry of Environment overlooks environmental affairs and creates environmental regulations and standards. The National Environmental Agency (Agence

Nationale de l’ Environnement; ANDE) was established under the Ordinance No. 97-393 of 1997 and is responsible for the evaluating and approval of EIA reports and issuing environmental permits.

5.1.4 Comparison of the Alternatives

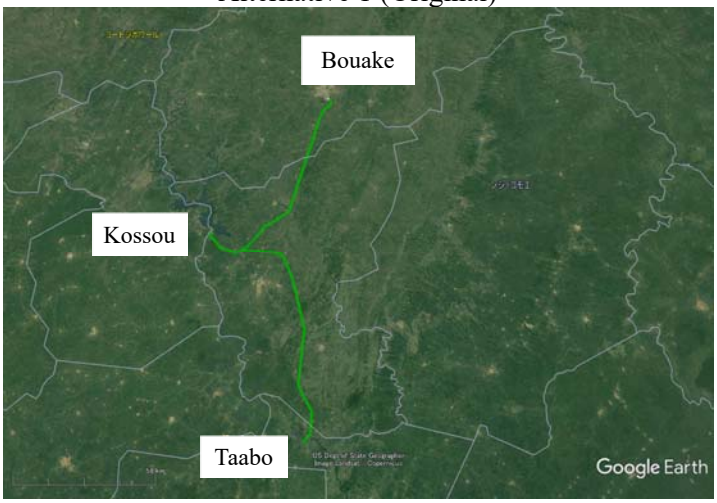
The analysis of the alternatives is shown in Table 5.1-11. The alternatives were comprehensively examined from the viewpoints of natural and social environment and project cost. With the no-project alternative (zero-option), social impacts such as resettlement and land acquisition can be avoided, and there would be no impacts to the natural environment. However, the power transmission and distribution facilities will not be improved to meet the increasing demand for power in Ivory Coast, and a stable power supply cannot be secured for the future. Unstable power supply may hinder economic development and improvement of living standards of people.

Table 5.1-11 Comparison of alternatives (225 kV transmission line route)

Item	Alternative 1 (Original)	Alternative 2 (Revised plan 1)	Alternative 3 (Revised plan 2)	Zero option
Outline	Transmission line routes based on FS Study conducted by CI Energies: Taabo-Kossou overhead transmission line (142.1 km) Kossou-Bouaké overhead transmission line (131.6 km)	Transmission line routes proposed by JICA Study Team: Taabo-Kossou overhead transmission line (137.6 km) Kossou-Bouaké overhead transmission line (128.9 km)	Transmission line routes proposed by JICA Study Team: Taabo-Kossou overhead transmission line (137.9 km) Kossou-Bouaké overhead transmission line (133.7 km)	No project implementation.
Benefits to the local communities	Electricity will be provided in a more stable manner.	Electricity will be provided in a more stable manner.	Electricity will be provided in a more stable manner.	No benefits to the local communities.
Consistency with city planning	Alternative 1 is consistent with the National Development Plan (2016-2020) and the Power Development/Transmission Master Plan (2015 June).	Alternative 2 is consistent with the National Development Plan (2016-2020) and the Power Development/Transmission Master Plan (2015 June).	Alternative 3 is consistent with the National Development Plan (2016-2020) and the Power Development/Transmission Master Plan (2015 June).	Zero option is not consistent with city planning.
Impact on natural environment	Temporary impact on the surrounding environment is expected during the construction such as noise and vibration. Trees within the ROW of transmission lines will be cut down.	Temporary impact on the surrounding environment such as noise and vibration is expected during the construction. Trees within the ROW of transmission lines will be cut down.	Temporary impact on the surrounding environment is expected during the construction such as noise and vibration. Trees within the ROW of transmission lines will be cut down.	No negative impacts are expected.
Impact on social environment	Large-scale resettlement (491 people), loss of agricultural land, demolition of religious facilities (such as churches and mosques) and deforestation of sacred forests are expected within the ROW. Impact on traffic is predicted during the construction.	Resettlement (11 people), loss of agricultural land, demolition of religious facilities (such as churches and mosques) and deforestation of sacred forest are expected within the ROW. Impact on traffic is predicted during the construction.	Resettlement (6 people) and loss of agricultural land are expected within the ROW. Impact on traffic is predicted during the construction.	No negative impacts are expected.
Project cost	The project cost is higher compared to that of Alternatives 2 and 3 because the distance of the transmission line is longer.	The project cost is lower than that of Alternative 1 because the distance of the transmission line is shorter.	The project cost is lower than that of Alternative 1 because the distance of the transmission line is shorter.	No project cost.
Benefits	◎	◎	◎	×
City planning	◎	◎	◎	×
Natural environment	○	○	○	◎

Social environment	×	△	○	◎
Project cost	○	◎	◎	◎
Evaluation	× (Alternative 1 is not recommended from a social standpoint)	△ (Alternative 2 is not recommended from a social standpoint)	◎ (Alternative 3 is recommended from a social and environmental standpoint)	× (Zero option is not recommended due to lack of benefits and inconsistency with city planning)

Alternative 1 (Original)



Alternative 2 (Revised plan 1)

Alternative 3 (Revised plan 2)

Source: JICA Study Team

Fig. 5.1-3 Comparison of alternatives (transmission line route)

5.1.5 Scoping

The scoping was conducted as shown in Table 5.1-12, in consideration of the impacts caused by this project.

Table 5.1-12 Scoping

	No.	Item	Planning Construction	Operation	Expected Impacts
Social Environment	1	Involuntary Resettlement	✓		Planning/construction phase: Involuntary resettlement is expected within the ROW due to the construction of the overhead transmission lines. However, no resettlement is expected for the construction of the substations (two substations in Yamoussoukro 2 and Bouaké 3). The expansion of the existing substations (Taabo substation, Kossou substation and two substations in Bouaké) will be limited to the existing facilities owned by CI Energies, and therefore no resettlement is expected. Operation phase: Land acquisition is not expected once the operation begins, and no impact is expected.
	2	Poverty	✓		Planning/Construction Phase: There may be poor people among the Project Affected Persons (PAPs) for resettlement. Operation phase: Land acquisition is not expected once the operation begins, and no impact is expected.
	3	Indigenous/Minorities			Construction/operation phase: There are no indigenous people or minorities within the project sites.
	4	Economic activities, living and livelihood	✓		Planning/Construction Phase: Some temporary adverse impacts are expected due to the construction work of transmission lines. On the other hand, positive impacts such as employment for construction works and contribution to local economic activities due to the presence of construction workers may be expected during construction. Operation phase: The project is expected to have positive socio-economic impacts on residences and industries due to stabilization of the power supply.
	5	Land Use and Utilization of local resources	✓		Construction phase: Land acquisition may be required for the construction of the substations (Yamoussoukro 2 and Bouaké 3), which may have an impact on land use and utilization of local resources. The expansion of the existing substations (Taabo, Kossou, Bouaké 2) will be limited to the existing facilities owned by CI Energies, and therefore no resettlement is expected. Operation phase: Land change is not expected once the operation begins, and no impact is expected.
	6	Water Use and Water Right			Construction/operation phase: Since the project is not expected to use river water, no impact on water use and water right is predicted.

	No.	Item	Planning Construction	Operation	Expected Impacts
	7	Existing social infrastructure and services	✓		Planning/Construction Phase: Traffic around the construction sites may be affected due to delivery of materials, etc. Temporary power cuts are expected due to the works on the existing lines. Operation phase: Stabilization of the power supply will lead to improvement of public service in the power sector.
	8	Social institutions such as social infrastructure and local decision-making institutions			Construction/operation phase: The project will contribute to the improvement of public service in power sector; hence will not cause any impact on social institutions.
	9	Misdistribution of benefits & damages			The project will contribute to the improvement of public service in power sector; hence will not cause any misdistribution.
	10	Local conflicts of interest			The project will contribute to the improvement of public service in power sector; hence will not cause any conflict
	11	Heritage	✓		Construction phase: In case there are churches or mosques near the project area, these may be impacted by the construction of the transmission line. Operation phase: Land acquisition is not expected once the operation begins, and no impact is expected.
	12	Landscape			Construction/operation phase: There are no naturally or culturally important landscapes near the project sites.
	13	Gender	✓	✓	Construction/operation phase: The purpose of the project is to secure a stable electricity supply, and adverse impact on gender issues is not predicted at the scoping stage. However, during this study, the current state of the project area will be confirmed, and the impact will be assessed.
	14	Children's right	✓	✓	Construction/operation phase: The purpose of the project is to secure a stable electricity supply, and adverse impact on children's rights is not expected at the scoping stage. However, during this study, the current state of the project area will be confirmed, and the impact will be assessed.
	15	Infectious Disease (HIV/AIDS, etc.)			Construction phase: No impact on infectious diseases due to workers coming from outside is expected, because workers during the construction stage are planned to be hired from the surrounding local communities, and the number of workers coming from outside is limited (no workers camp will be constructed for this project). Operation phase: No risk of accidents or risk of infectious accidents are expected due to the improvement of electricity facilities.
	16	Occupational health hazards	✓		Construction phase: It is necessary to protect workers from the hazards and risk of accidents. Operation phase: No work that would negatively affect occupational health is expected during the operation phase.
N	17	Protected Areas			No protected areas are present near the project sites

	No.	Item	Planning Construction	Operation	Expected Impacts
	18	Ecosystem	✓	✓	Construction phase: The project sites are within built-up areas, and there is no important fauna and flora which will be affected by the project. However, deforestation associated with the project may impact the ecosystem. Operation phase: There is a possibility of bird strike on the overhead transmission lines during operation.
	19	Hydrology			Construction/operation phase: No activities that may impact hydrology of rivers are planned. Water from the rivers will not be used.
	20	Geological Features	✓		Construction phase: Land will be levelled at the newly constructed substations as well as the tower base, so localized impacts such as soil erosion may be caused. Operation phase: No activity that may impact geological features is planned.
Pollution Control	21	Air Pollution	✓		Planning/construction phase: Due to the land leveling work during the pre-construction phase and the operation of heavy machineries during the construction phase, temporary impacts on air pollution are expected. Operation phase: No activity that may cause air pollution is expected.
	22	Water Pollution			Construction/operation phase: No activity that may cause water pollution is expected. No water bodies are present near the project sites.
	23	Soil Pollution	✓	✓	Construction/Operation Phase. Insulating oil will be used for transformers. It may cause soil pollution if leaked.
	24	Waste	✓		Construction phase: Land grading is necessary for the tower construction. However, a large volume of cuttings is not expected and there are no expected impacts due to waste. However, during this study, the current state of the project area will be confirmed, and the impact will be assessed. Operation phase: A large volume of waste that would impact the surrounding environment is not expected.
	25	Noise/Vibration	✓		Construction phase: Temporary impacts are expected due to the operation of heavy machineries for earthwork and construction. Operation phase: Transformers at the substation may cause noise. However, these will be located away from the boundaries of the site, and no impact is expected.
	26	Ground subsidence			Construction/operation phase: There are no project activities that would results in ground subsidence; hence, no impact is expected.
	27	Odor			Construction/operation phase: No odor is expected from the substation and transmission facilities.
	28	Bottom sediment			Construction/operation phase: There are no project activities that would impact rivers or swamps near the project site; hence, no impact is expected.

	No.	Item	Planning Construction	Operation	Expected Impacts
	29	Electromagnetic field		✓	Construction phase: No impact is expected. Operation phase: Some negative impacts are expected if residential areas are located near the project site.
Others	30	Accidents	✓	✓	Construction Phase: Erecting towers and rewiring may trigger general accidents caused by construction works, such as falling of workers or parts. Operation Phase: Electrocution may be caused on climbing towers. Fire accidents may occur due to the broken conductors or lighting.
	31	Global warming			Construction/operation phase: The project will not cover a large area; hence global warming or impacts across the boarders are not expected.

Source: JICA Study Team

5.1.6 TOR for Environmental and Social Considerations Study

Based on the above scoping results, the TOR for EIA study was determined as shown in Table 5.1-13.

Table 5.1-13 TOR for Environmental and Social Considerations Study

No.	Item	Study Item	Methods
1	Involuntary resettlement	• Confirming the magnitude of impacts caused by the project • Planning of mitigation measures for the impacts of involuntary resettlement	• Examination of resettlement scale and preparation of draft resettlement action plan by a local consultant • Site visit
2	Poverty	• Confirming the project-affected households by the project	• Socio-economic study by local consultant
4	Economic activities, living and livelihood	• Confirming the project-affected households by the project • Land use and socio-economic activities in the project site • Benefits	• Socio-economic study by local consultant • Review of existing documents and data
5	Land use and utilization of local resources	• Confirming the scale of land acquisition • Confirming the local environment of the project sites	• Site visit • Interview with CI Energies and other stakeholders
7	Existing social infrastructure and services	• Distribution of public facilities around the project sites	• Site visit • Interview with CI Energies and other stakeholders
11	Heritage	• Distribution of churches around the project site	• Site visit • Interview with CI Energies and other stakeholders
13	Gender	• Current state of gender issues and examining mitigation measures	• Review of existing documents and data • Interview with CI Energies and other stakeholders

No.	Item	Study Item	Methods
14	Children's rights	• Confirming the presence of child labor	• Review of existing documents and data (relevant laws/legislations) • Interview with CI Energies and other stakeholders
16	Occupational health hazards	• Labor safety measures	• Review of existing documents and data (Labor-related laws/legislations, CI Energies' occupational health guidelines, etc.)
18	Ecosystem	• Situation of the site in and around the proposed project site	• Site visit • Review of existing documents and data (distribution of birds, etc.)
20	Geological Features	• Land leveling for the tower base and the newly constructed substation	• Review of existing documents and data (design, methods, etc.) • Site visit
21	Air Pollution	• Operation of heavy machineries during construction	• Review of existing documents and data (CI Energies environmental and social guidelines, etc.)
23	Soil Pollution	• Method for installing transformers and managing insulating oil	• Review of existing documents and data (CI Energies' environmental and social guidelines, examples from other substations, etc.)
24	Waste	• Disposal of wastes generated from the construction	• Review of existing documents and data (CI Energies socio-environmental guidelines, etc.)
25	Noise/ Vibration	• Noise level • Current environment of the project area	• Review of existing documents and data • Construction methods/design of electrical lines and substations
29	Electric magnetic fields	• Current environment of the area nearby transmission line and residences underneath the power line	• Review of existing documents and data (national guidelines, etc.) • Site visit
30	Accident	• Current environment of the project area • Accident prevention measures during construction phase	• Review of existing documents and data (contract manual for construction, etc.) • Interview with CI Energies and other stakeholders

Source: JICA Study Team

5.1.7 Results of Environmental and Social Consideration Study

The results of the Study based on the above TOR are summarized in Table 5.1-14.

Table 5.1-14 Results of Environmental and Social Consideration Study

No.	Item	Results
1	Involuntary resettlement	• Involuntary resettlement (1 household; 6 persons; those who live in a rented house) are expected.
2	Poverty	• There are no poor people who will be affected by resettlement and land acquisition. No impact on poverty is expected by the project.
4	Economic activities, living and livelihood	• Some temporary impacts on living and livelihood are expected due to the loss of crops (total area: 739,848.5m^2). Since agricultural activities within the ROW are allowed during operation, the impact is considered to be temporary[10]. • During the construction, positive impacts caused by the employments for construction works, and contribution to local economic activities, due to the presence of construction workers may be expected. • Positive impacts on socio economic aspects of residences and industries are expected, due to the stable power supply.
5	Land use and utilization of local resources	• Expansion of Kossou substation: The construction work outside of the existing substation site is planned, but within the property of CI Energies; hence, the impact on existing social infrastructure and services is not expected. • New construction of Yamoussoukro 2 substation: The land acquisition was completed, and the impact on existing social infrastructure and services is not expected. • New construction of Bouake 3 substation: The land acquisition was completed, and the impact on existing social infrastructure and services is not expected.
7	Existing social infrastructure and services	• Traffic around the construction sites may be affected due to the delivery of materials, etc. Temporary power cuts are expected due to the works on the existing lines. • Operation Phase: Positive impacts are expected due to the stable power supply.
11	Heritage	• 36 locations of cemeteries etc. were found along the planned transmission lines.
13	Gender	• In the Ivory Coast constitution and labor law, gender equality is stipulated, and no gender discrimination is allowed. In addition, local policies have been set up, including the declaration of gender equality in employment (2007), the national policy on gender equality in employment (2009) and the national strategy for eradication of gender violence (2012). The project will be implemented in line with these policy and strategy. Since the aim of this project is to secure a stable electricity supply, no significant impact on gender is expected.
14	Children's rights	• In the Ivory Coast labor law, child labor is prohibited, and this project will not allow child labor. Since the aim of this project is to secure a stable electricity supply, no significant impact on children's rights is expected.
16	Occupational health hazards	• Absence of proper measures may give rise to accidents and poor labor environment during the construction phase.
18	Ecosystem	• Some trees along the electrical lines will be removed. However, the forest and trees are geographically limited and scattered along the ROW of transmission lines (vacant land and agricultural land etc. are also observed under the ROW), and the affected area within the ROW is considered to be limited. • Flora and fauna survey was conducted. 2 species categorized as VU and LU of IUCN red list were identified around the project site. The tree cutting within the ROW of transmission lines is planned, but the affected area is limited. Therefore, the impact on these species will be also limited. • 75 species of birds identified along the ROW were categorized as LC of IUCN red list. Since the new transmission lines are constructed along the existing transmission lines, no significant impact on birds (such as bird strike) is expected.

[10] It is assumed that the period to affect crops is the time for laying electrical lines after the construction of towers (approximately 1 week).

No.	Item	Results
20	Geological Features	• Levelling of the land is necessary for the newly constructed substation and tower base, but it is limited to the site and will not have any major impact.
21	Air Pollution	• Due to the land leveling work and the operation of heavy machineries during the construction works, temporary impacts on air pollution are expected.
23	Soil Pollution	• Insulating oil will be used for transformers. It may cause soil pollution if it is leaked.
24	Waste	• Construction work includes construction of tower base etc. However, no surplus soil will be generated, because soil from construction work is used for embankment and backfilling. Hence, no impact will be caused by waste.
25	Noise/Vibration	• Construction Phase: Temporary impacts are expected due to the operation of heavy machineries. • Operation Phase: Transformers at substations may cause some noises; however, they will be located away from the boundaries of the site. There are no hospitals or schools around the project sites. • The conductors applied for this project is single conductors, which cause less noise than double conductors during strong wind. Hence, no significant impact of noise is expected.
29	Electric magnetic fields	• In accordance with local regulations, the distance between electrical lines and houses will be secured to prevent impacts of electric magnetic fields. Hence, no significant impact on residents is predicted.
30	Accident	• General accidents related to construction activities may happen. • Without proper measures, electrocution may be caused on touching the tower, and there may be risks of fire caused by broken conductors and lightening, during the operation phase.

Source: JICA Study Team

5.1.8 Impact Evaluation

Based on the above study results, the impacts of the project are evaluated and compared to the evaluations at the time of scoping as shown in Table 5.1-15.

Table 5.1-15 Impact Evaluation

	No.	Item	Evaluation at Scoping		Evaluation Based on Results (*1)		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
Social Environment	1	Involuntary Resettlement	✓		B-	N/A	Planning phase: Resettlement (1 household) is expected.
	2	Poverty	✓		D	N/A	Planning phase: No impact due to the absence of the poor among PAPs.
	3	Indigenous/Minorities			N/A	N/A	
	4	Economic activities, living and livelihood	✓		B+/-	A+	Planning phase/ Construction phase: The impacts on crops etc. are expected, but they are expected to be temporary. Local employment will be promoted for construction work. Operation phase: Local employment will be promoted.

	No.	Item	Evaluation at Scoping		Evaluation Based on Results (*1)		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
	5	Land Use and Utilization of local resources	✓		D	N/A	Planning phase/ Construction phase: No impact is predicted, because there is no significant change in land use and utilization local resources.
	6	Water Use and Water Right			N/A	N/A	
	7	Existing social infrastructure and services	✓		B-	A+	Construction phase: The impact is limited during construction phase. It is temporary and locally limited. Operation phase: Existing social infrastructure and services will be improved by securing stable power supply.
	8	Social institutions such as social infrastructure and local decision-making institutions			N/A	N/A	
	9	Misdistribution of benefits & damages			N/A	N/A	
	10	Local conflicts of interest			N/A	N/A	
	11	Heritage	✓		B-	N/A	Construction phase: Resettlement of 10 cemeteries and 26 sacred sites (36 locations in total) is required. (*2)
	12	Landscape			N/A	N/A	
	13	Gender	✓	✓	D	D	Construction phase/ Operation phase: This project will be implemented in line with local policies, and no significant impact on gender is expected.
	14	Children's rights	✓	✓	D	D	Construction phase/ Operation phase: Child labor will not be allowed for this project, and no significant impact on children's rights is expected.
	15	Infectious disease (HIV/AIDS, etc.)			N/A	N/A	
	16	Occupational health hazards	✓		B-	N/A	Construction phase: The impact is only limited during construction phase.
N	17	Protected Areas			N/A	N/A	

	No.	Item	Evaluation at Scoping		Evaluation Based on Results (*1)		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
	18	Ecosystem	✓	✓	D	D	Construction phase: The impact of cutting trees within the ROW is geographically limited. Therefore, the impact on ecosystem is considered to be limited. (*3) Operation phase: The new transmission lines will be constructed along the existing electrical lines. Therefore, no significant impact on ecosystem is expected.
	19	Hydrology			N/A	N/A	
	20	Geological Features	✓		D	N/A	Construction phase: Leveling will not cause any significant impact.
Pollution Control	21	Air Pollution	✓		B-	N/A	Construction phase: The impact is limited during construction phase. It is temporary and locally limited.
	22	Water Pollution	✓		B-	N/A	Construction phase: In case of insulating oil leakage, the impact on water quality is predicted, but is considered to be limited.
	23	Soil Pollution	✓	✓	B-	B-	Construction phase/ Operation phase: In the case of leakage of insulating oil, soil pollution is predicted, but is considered to be limited.
	24	Waste	✓		D	N/A	Construction phase: No surplus soil will be generated by the construction work, and no significant impact is expected.
	25	Noise/Vibration	✓	✓	B-	D	Construction phase: the impact is temporary and geographically limited. Operation phase: Noise from substation operation is limited, and no significant impact is expected.
	26	Ground subsidence			N/A	N/A	
	27	Odor			N/A	N/A	
	28	Bottom sediment			N/A	N/A	
	29	Electromagnetic field		✓	N/A	D	Operation phase: No significant impact is expected because enough distance is secured between the electrical lines and houses.

	No.	Item	Evaluation at Scoping		Evaluation Based on Results (*1)		Reason for Evaluation
			Planning Phase Construction Phase	Operation Phase	Planning Phase Construction Phase	Operation Phase	
Others	30	Accidents	✓	✓	B-	B-	Construction phase/ Operation phase: Risks of accidents such as electrocution and fire is predicted.
	31	Global warming			N/A	N/A	

Source: JICA Study Team

(*1)
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
For the items evaluated as “D” at Scoping, “N/A” was applied in the Impact Evaluation.

(*2)
Sacred sites to be relocated are the places to be used for traditional rituals etc. The following points were confirmed:
1) There are no alternative transmission line routes. (Based on the examination of the transmission lines, the relocation of sacred sites are scattered and the relocation of these 26 sacred sites are unavoidable.)
2) No significant negative impact on biodiversity values or ecologically important functions is predicted. (The sacred sites are used for traditional rituals etc., and no impact from ecological viewpoint is expected.)

In addition, the sacred sites to be relocated are not strongly religious places (the sites are used for rituals, but the location itself is allowed to be relocated. After the relocation, the function of the sites will be conserved at a newly relocated location.). Also, according to the local laws and regulations, it is not prohibited to relocate the sacred sites. The following requirements were also confirmed in line with JICA Guidelines:
1) There are no alternative transmission line routes. (It was confirmed that based on the examination of the transmission lines, the relocation of sacred sites are scattered and the relocation of these 26 sacred sites are unavoidable.)
2) The project activities within the sacred sites are allowed in local laws and regulations. (It was confirmed that local laws and regulations do not prohibit the relocation of the sacred sites.)
3) The project activities within the sacred sites should be in line with local laws and ordinances as well as local management plans. (this requirement is not applicable, because there are no specific laws or ordinances for the sacred sites.)
4) The project implementing agency conducts consultations with local management body, communities and other stakeholder, and the agreement on relocation of the sacred sites is reached. (It was confirmed that CI Energies conducted stakeholder consultations, and relocation of the sacred sites was agreed upon among the stakeholders.)
5) The project implementing agency conducts additional program to conserve and manage sacred sites (when necessary). (It was confirmed that RAP prepared by CI Energies include the cost of relocation of the sacred sites, and the function of sacred sites will be preserved even after the relocation.)

(*3)
Trees along the electrical lines will be removed. However, the forest and trees are geographically limited and scattered along the ROW of transmission lines (vacant land and agricultural land etc. are also observed under the ROW), and the affected area within the ROW is considered to be limited. According to Google Earth, the estimated area of deforestation is 40-50 ha. (this is a rough estimation and is not based on the detail sit survey nor analysis of satellite images.)

5.1.9 Mitigation Measures

Mitigation measures towards the items with adverse impacts are summarized in Table 5.1-16.

Table 5.1-16 Mitigation Measures

No.	Item	Impact	Mitigation Measures	Implementation/ Responsible Body	Cost (FCFA)
	Construction Phase				
1	Involuntary Resettlement	Involuntary Resettlement	• In accordance with JICA guidelines and WB OP4.12, an RAP was prepared based on the consensus with people affected by the project; compensation at full replacement cost and support will be provided.	CI Energies	1,014,410,277
4	Economic activities, living and livelihood	Loss of crops due to the construction work	• In accordance with JICA guidelines and WB OP4.12, an RAP was prepared based on the consensus with people affected by the project; compensation at full replacement cost and support will be provided.	CI Energies	Included in the above "1. Involuntary resettlement".
7	Existing social infrastructure and services	Impacts on traffic during construction works Power Cut during construction works	• Preparation of power cut plan and sharing the plan with affected communities	CI Energies	N/A
11	Heritage	Relocation of cemeteries etc.	• In accordance with JICA guidelines and WB OP4.12, an RAP was prepared based on the consensus with people affected by the project; compensation for relocation cost will be provided.	CI Energies	Included in the above "1. Involuntary resettlement".
16	Occupational health hazards	Health and safety of construction workers	• Based on laboring laws, the contractor must provide protective gear to workers, ensure them to wear them and provide safe working environment. • The contractor must ensure proper safety management to minimize the risk of accidents with residents. • Construction site (especially the storage site) will be fenced, lighted and guarded by security guards to prevent intruders and theft.	CI Energies/ Contractor	Included in construction costs
21	Air Pollution	Air pollution by heavy machineries during leveling and construction works	• Sprinkling water at the site to avoid dust • Controlling vehicle speed in unpaved roads	Contractor	N/A
22	Water Pollution	Spillage of insulating oil from transformer	• Insulating oil as well as transformers will be set in the metal box. To prevent spillage, oil dike will be set under the transformers and filled with stone chips.	Contractor	Included in construction costs
23	Soil Pollution				

No.	Item	Impact	Mitigation Measures	Implementation/ Responsible Body	Cost (FCFA)
25	Noise/ Vibration	Noise during leveling and construction	• Controlling operation time (7a.m.-5p.m.) to reduce impact by noise as much as possible. • Conducting inspection of vehicles	Contractor	N/A
30	Accidents	Accidents involving workers and residents	• The contractor must ensure proper safety management to minimize the risk of accidents with residents. • Construction site (especially the storage site) will be fenced, lighted and guarded by security guards to prevent intruders and theft.	Contractor	Included in construction costs
	Operation Phase				
23	Soil pollution	Spillage of insulating oil from transformers	• Insulating oil as well as transformers will be set in the metal box. To prevent spillage, oil dike will be set under the transformers and filled with stone chips.	CI Energies	N/A
30	Accidents	Electrocution caused by contacting with wire or tower/ Fire risks caused by broken insulators	• Tower will be equipped with metals to prevent climbing and signboard indicating high voltage. Residents nearby will be informed about prevention of electrocution. • CI Energies will check house wiring carefully. • Ground wires with enough capacity will be set.	CI Energies	N/A

Source: JICA Study Team

5.1.10 Environmental Monitoring Plan

Monitoring plan for each item is described in Table 5.1-17.

Table 5.1-17 Monitoring Plan

No.	Monitoring items	Monitoring methods	Monitoring location	Frequency	Implementation body	Responsible body
	Construction Phase					
1	Involuntary Resettlement	Checking compensation records and grievance records	Project affected communities	Monthly	CI Energies	CI Energies
4	Economic activities, living and livelihood (Loss of crops)	Checking compensation records and grievance records	Project affected communities	Monthly	CI Energies	CI Energies
7	Existing social infrastructure and services (Road to be affected by the project)	Visual observation, Checking grievance records	Construction site, roads around the project site	Monthly	CI Energies	CI Energies
11	Heritage	Checking compensation records and grievance records	Project affected communities	Monthly	CI Energies	CI Energies
16	Occupational health hazards (Training and provision of protective gears etc.)	Visual observation, Checking accident records	Construction site	Daily	CI Energies	CI Energies
21	Air Pollution (Dust etc.)	Checking grievance records, Checking contractors' monthly reports (results of vehicle inspection)	Project affected communities, construction site	Monthly	Contractor	CI Energies
22	Water Pollution	Visual observation (confirming leakage of insulating oil from transformers as well as the amount of the insulating oil), Photographic recording	Construction site	Once a year	CI Energies	CI Energies
23	Soil Pollution					
25	Noise/ Vibration	Checking grievance records, Checking contractors' monthly reports (results of vehicle inspection)	Construction site	Monthly	CI Energies	CI Energies
30	Accidents (Safety management provision of safety gears, training, traffic conditions)	Visual observation, Checking accident records	Construction site, project affected communities	Daily	CI Energies	CI Energies
	Operation Phase					
23	Soil pollution	Visual observation (confirming leakage of insulating oil from transformers as well as the	Project site	Once a year	CI Energies	CI Energies

No.	Monitoring items	Monitoring methods	Monitoring location	Frequency	Implementation body	Responsible body
		amount of the insulating oil), Photographic records				
30	Accidents (Contact with electrical lines, cutting trees etc.)	Visual observation, Interview with facility managers	Project site	Quarterly	CI Energies	CI Energies

Source: JICA Study Team

5.1.11 Stakeholder Meetings

Stakeholder meetings were held at the scoping stage of ESIA as well as at the stage of draft ESIA report preparation (for both before and after revising the transmission line routes) [11].

The meetings at the scoping stage were organized in November 2018, while the meetings for the draft ESIA report were held in March, 2019 (before revising the transmission line route) and in April - June, 2020 (after revising the transmission line route). Individual meetings were held for community leaders mainly at their house; public meeting were organized for PAPs at the meeting places such as community leaders' house. During these meetings, the outline of the project and ESIA as well as the potential impacts on environment were explained. As part of gender considerations, women group representatives were interviewed.

The notification of stakeholder meetings was done mainly through telephone and e-mail. Local leaders (youth group leaders etc.) supported for dissemination of the stakeholder meetings, such as the date and venue.

All the communities agreed with the project implementation, and no objections or grievance were raised during the meetings. However, there were some worries about the loss of houses or agricultural lands and requests on proper compensation for the loss of assets. It was also commented to minimize the impacts on sacred sites. In consideration of these opinions, the alternatives, mitigation measures and compensation etc. were examined.

[11] In the socio-economic survey, PAHs were studied to identify any vulnerable groups, including widows/widowers, pregnant women, children under the age of five, disabled persons, chronically ill persons over the age of 70 years old with no support. According to the survey, one household with two children under the age of five was identified as a socially vulnerable people. The project outlines etc. were explained to this PAH. Apart from this PAH, other vulnerable groups who required special assistance for stakeholder meetings were not identified.

Table 5.1-18 Outline of stakeholder meetings

	Affected area	Dates	Participants[12]	Outline of discussion
1	Taabo department	November 19, 2018/ November 23, 2018	Community representatives, youth leaders etc.	Explanation/ Discussion about the project purposes, components, expected impacts, compensation for loss etc.
2	Djekanou department	November 15, 2018/ November 16-26, 2018	Community representatives, PAPs etc.	
3	Kpouebo department	November 25-26, 2018	Community representatives etc.	
4	Toumodi department	November 14, 2018/ November 18-21, 2018	Community representatives, PAPs etc.	
5	Attiégouakro department	November 17-19, 2018	Community representatives, PAPs etc.	
6	Tiebissou department	March 28, 2019	Community representatives, PAPs etc.	Explanation/ Discussion about ESIA draft report (before revising transmission line route)
7	Djebonoua department	March 27, 2019	Community representatives, youth leaders, PAPs etc.	
8	Bouake department	March 26, 2019	Community representatives, youth leaders, PAPs etc.	
9	Yamoussoukro department	May 30, 2020/ June 1, 2020	Community representatives, PAPs etc. 16 persons (8 men, 8 women)	Explanation/ Discussion about ESIA draft report (after revising transmission line route)
10	Attiegouakro department	May 25, 2020/ June 1, 2020	Community representatives, PAPs etc. 27 persons (19 men, 8 women)	
11	Bouake department	April 20, 2020/ April 23, 2020/ May 25, 2020/ June 1, 2020	Community representatives, PAPs etc. 44 persons (30 men, 14 women)	
12	Djebonoua department	May 25, 2020/ May 27, 2020	Community representatives etc. 5 persons (3 men, 2 women)	
13	Tiebissou department	April 23, 2020/ May 27, 2020	Community representatives etc. 4 persons (3 men, 1 woman)	

Source: JICA Study Team

Table 5.1-19 Discussion results during stakeholder meetings

Participants	Main opinions and worries raised by the participants (*1)	Responses from CI Energies
Community representatives, youth leaders, PAPs etc.	・ They agreed with the project. They requested that the opinions of community representatives should be taking into consideration when examining the impact and compensation.	・ To prepare environmental management plan and monitoring plan by incorporating PAPs comments.
	・ They requested to minimize the impacts on sacred sites if these are located within the ROW; if the relocation is unavoidable, a ritual should be done; and the compensation should be paid.	・ To avoid the transmission lines passing over sacred sites as much as possible; if unavoidable, the cost of relocation and the ritual etc. will be paid.
	・ They said that the survey details have to be fully announced to the public prior to the commencement of the survey.	・ To conduct stakeholder meetings and fully explain about the survey details.
	・ They requested that compensation for the PAPs within the ROW should be properly paid.	・ To prepare and implement RAP in accordance with local laws and international standards.
	・ They expected that the project would contribute to securing stable power supply for their own community.	・ To secure stable power supply by this project.

Source: JICA Study Team

[12] The number of participants of stakeholder meetings No. 1-8 is not available.

5.2 LAND ACQUISITION/ RESETTLEMENT

5.2.1 Necessity of Land Acquisition and Resettlement

Table 5.2-1 below summarizes the necessity of land acquisition, resettlement and economic resettlement.

Table 5.2-1 Necessity of land acquisition and resettlement

No.	Project component	Land acquisition	Physical and economic resettlement
1	New construction of 225kV transmission line (between Taabo substation and Kossou Substation)	Land acquisition is required for the towers of the transmission line.	Resettlement is required within the ROW. Agricultural and economic resettlement is expected.
2	New construction of 225kV transmission (between Kossou substation and Bouaké 3 substation)	Land acquisition is required for the towers of the transmission line.	Resettlement is required within the ROW. Economic resettlement (such as loss of agricultural land) is expected.
3	Expansion of existing substations (Taabo and Bouaké 2 substations)	The construction is limited to the existing facilities' property, so land acquisition is not required.	Resettlement is not required since the construction is limited to the existing facilities' property.
	Expansion of existing substations (Kossou Substation)	Some parts of the construction work will be outside of the existing facilities' property, but within the property of CI Energies; hence, land acquisition is not required.	Some parts of the construction work will be outside of the existing facilities' property; however, since it is within the property of CI Energies, no resettlement is expected.
4	New construction of Yamoussoukro 2 Substation	The land acquisition process has already been completed for the Yamoussoukro Substation.	Resettlement is not required since there are no residences within the acquired land.
	New construction of Bouaké 3 substation	The land acquisition process has already been completed for Bouaké 3 substation.	Resettlement is not required since there are no residences within the land to be acquired.
5	Expansion of power grid in Yamoussoukro and Bouaké	Since the power lines are installed underground, no land acquisition is required.	Since the power lines are installed underground, no resettlement is required.

Source: JICA Study Team

The Resettlement Action Plan (RAP) developed by CI Energies (May 2019) was obtained through a site visit. The RAP indicated that the number of people living within the ROW of the transmission lines, and the same is shown in Table 5.2-2 below.

Table 5.2-2 Expected scale of resettlement (prior to revision of the transmission line route)

No.	Project component	Expected resettlement	
		Households	Persons[13]
1	Lot 1 Taabo – Yamoussoukro 2	20	108
2	Lot 2 Lolobo – Kossou	38	205
3	Lot 3 Kossou – Tiebissou	22	119
4	Lot 4 Tiebissou – Bouaké	11	59
	Total	**91**	**491**

Source; JICA Study Team

[13] The number of project-affected people was calculated as (number of project-affected households) x 5.4 people/household). The average number of people per household was reported by the Population Census (2014), Ivory Coast National Bureau of Statistics.

Based on the above, the JICA Study Team and the project manager/ environmental manager of CI Energies held a consultation on September 16 and 19, 2019. As a result, CI Energies agreed to revise the route of the transmission line to avoid resettlement to the extent possible.

An additional study was necessary to revise the RAP, and CI Energies and its local environmental consultant had confirmed that the RAP would be revised to reflect the revised route. The revised RAP (October 2020) was completed after examining the scale of land acquisition and resettlement, compensation strategies, grievance mechanism and the cost.

The expected scale of resettlement after revising the route is as shown in Table 5.2-3 below.

Table 5.2-3 Expected scale of resettlement (after the revision of the transmission line route)

No.	Project component	Expected resettlement	
		Households	Persons
1	Lot 1 Taabo – Yamoussoukro 2	0	0
2	Lot 2 Lolobo – Kossou	1	6
3	Lot 3 Kossou – Tiebissou	0	0
4	Lot 4 Tiebissou – Bouaké	0	0
	Total	**1**	**6**

Source: JICA Study Team

Even though the ROW of electrical lines in the Ivory Coast is not stipulated by a law or regulation, the standard practice for 225 kV transmission lines is a 40 m wide ROW[14]. The construction of any structure is prohibited within the ROW. CI Energies has confirmed that the project will adopt the same ROW, as shown in Table 5.2-4 below.

Table 5.2-4 ROW for the project's 225 kV overhead transmission lines

Item	Criteria
ROW	40 m wide (20 m on both sides from the center)
Land acquisition	Land acquisition is required for the towers that will be built.
Structures that will need be displaced	Any structure within the ROW will be displaced.
Trees	Trees underneath the transmission line (along a 40 m wide line; 20 m on both sides from the center) will be logged.

Source: JICA Study Team

5.2.2 Legal Framework on Land Acquisition and Resettlement

(1) Legal Framework in Ivory Coast

The legal framework for land acquisition and resettlement in the Ivory Coast is as shown in Table 5.1-8. The outline of legal framework is described in the section below.

[14] According to the environmental manager of CI Energies, the Department of Petroleum, Energy and Renewable Emergy is developing a decree regarding ROW, with a plan to stipulate a 40 m wide ROW for a 225 kV transmission line.

The outline of legal framework for land acquisition and resettlement in Ivory Coast is described below.

1) Law on rural land (No. 98-750/ 23 December 1998)

This law stipulates land ownership rights and recognizes the nation, government and individuals as land owners.

2) Regulation on the conditions of acquisition of urban land ownership (No. 2013-481/2 July 2013)

This regulation stipulates the procedures necessary for acquiring and owning land in urban areas. Land owners must hold a land registration certificate issued by the relevant ordinance's land urban planning department.

3) Decree on compensating the loss of agricultural crops (No. 95-817/ 29 September 1995)

This decree stipulates the compensation method and prices to compensation agricultural crops that are lost due to a project. Compensation must be sufficient for the assets that are lost, and the Ministry in charge of Agriculture, Economy and Finance holds jurisdiction over the price setting for crops. Compensation is based on (1) the value of the lost crops, (2) the cost required to prepare the relocated agricultural land and (3) the costs associated with obtaining a register (in case the production was meant for export).

4) Order on the scale of compensation for agricultural crops (No. 453/ 1 August 2018)

This order stipulates the specific pricing and calculation methods for the compensation. For the loss caused by the construction of transmission and distribution line facilities, the Ministry in charge of the energy sector holds jurisdiction for the determination of the compensation. The calculation of the compensation is based on (1) the quantity of production per area, (2) the year in which the crops were lost, and (3) an additional 10% compensation etc.

(2) JICA Policies on Resettlement

The key principles of JICA policies on involuntary resettlement are summarized below.

I. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

II. When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

III. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

IV. Compensation must be based on the full "replacement cost" as much as possible.

V. Compensation and other kinds of assistance must be provided prior to displacement.

VI. For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

VII. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

VIII. Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

IX. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

The principles above are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principles based on World Bank OP 4.12 are as follows.

X. Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

XI. Eligibility of Benefits include; the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

XII. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

XIII. Provide support for the transition period (between displacement and livelihood restoration).

XIV. Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

XV. For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the core principles of the JICA policy stated above, emphasis is given to a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed financial plan, etc.

(3) GAP Analysis between the JICA Guidelines and Laws of Ivory Coast

Table 5.2-5 below shows the gap analysis between the JICA Guidelines and laws of Ivory Coast, as well as the policies applied to fulfill the gaps.

Table 5.2-5 GAP Analysis between the JICA Guidelines and Laws of Ivory Coast

Item	JICA Guidelines/WB OP 4.12	Laws of Ivory Coast	Gap	Policies applies to the Project
Avoidance of land acquisition and resettlement	・ Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	・ There is no directive regarding the avoidance of land acquisition and resettlement.)	Yes (There is no directive regarding the avoidance of land acquisition and resettlement)	・ Alternative analysis, including no project option, was studied to minimize impacts of involuntary resettlement and loss of means of livelihood.
Minimization/ Compensation of land acquisition and resettlement	・ When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	・ There is no directive regarding the minimization of land acquisition and resettlement. ・ It is required to compensation lost ownership in a just manner and with prior compensation to conduct consultations with the affected people. (Ivory Coast constitution)	Yes (There is no directive regarding the minimization of land acquisition and resettlement)	・ Consensus with project-affect people will be achieved in line with World Bank Safeguard Policy and JICA Guidelines.

Item	JICA Guidelines/WB OP 4.12	Laws of Ivory Coast	Gap	Policies applies to the Project
Livelihood restoration	・ People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	・ There is no directive regarding livelihood restoration.	Yes (There is no directive regarding the livelihood restoration)	・ The compensation will be paid at full replacement cost prior to the resettlement. In addition, livelihood restoration support will be provided, as necessary.
Compensation at full replacement cost	・ Compensation must be based on the full replacement cost as much as possible. (JICA GL)	・ Compensation is based on the full replacement cost (Decree on compensating the loss of agricultural crops (No. 95-817/ 29 September 1995)/ Order on the scale of compensation for agricultural crops (No. 453/ 1 August 2018))	No gap	・ Compensation will be paid at full replacement cost.
Timing of compensation and support	・ Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	・ Compensation and other kinds of assistance must be provided prior to displacement. (Ivory Coast constitution)	No gap	・ The compensation and support will be provided prior to the resettlement.
Preparation of RAP	・ For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	・ There is no directive regarding the preparation of a RAP.	No gap	・ RAP will be prepared, because the project does not require a large-scale resettlement.
Consultations	・ In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	・ There is no directive regarding public consultations at the stage of RAP preparation.	Yes (There is no directive regarding public consultations at the stage of RAP preparation.)	・ Information about the project and RAP will be shared with PAPs and their communities in advance, and their opinions will be reflected in the RAP.
Method of consultations	・ When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	・ There is no directive regarding the language, but French is the commonly used language in the Ivory Coast.	No gap	・ Consultations will be held in the local language and in French. Related documents will be prepared in the officially language, French.
Public participation	・ Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	・ Consultation with project-affected people is required. (Ivory Coast constitution)	No gap	・ Public consultation will be promoted in the process of RAP preparation, in line with JICA Guidelines.

Item	JICA Guidelines/WB OP 4.12	Laws of Ivory Coast	Gap	Policies applies to the Project
Grievance mechanism	・ Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	・ The procedure of grievance mechanism is stipulated. (Decree on compensating the loss of agricultural crops (No. 95-817/ 29 September 1995))	No gap	・ The procedure of grievance mechanism will be described in the RAP based on local laws/regulations JICA Guidelines.
Identification of eligibility and cut-off date	・ Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)	・ It is stated that no eligibilities are given to those who encroach after the cut-off date. (Decree on compensating the loss of agricultural crops (No. 95-817/ 29 September 1995) and Order on the scale of compensation for agricultural crops (No. 453/ 1 August 2018))	No gap	・ The cut-off date will be set as the commencement date of census survey. It will be informed that those who encroach after the cut-off date will not be eligible for compensation and support.
Eligibility	・ Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12)	・ The persons who are eligible for compensation and support should have legal rights. (No. 95-817/ 29 September 1995)/ Order on the scale of compensation for agricultural crops (No. 453/ 1 August 2018))	Yes (There is no directive regarding the PAPs without legal rights.)	・ Yes (There is no directive regarding the PAPs without legal rights.)
Compensation type	・ Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12)	・ Compensation may be in the form of cash or land (Order on the scale of compensation for agricultural crops (No. 453/ 1 August 2018))	Yes (There is no directive regarding the prioritization of a land-based resettlement strategy.)	・ The project-affected people are not dependent on land for their livelihoods and request monetary compensation. Compensation will be cash-based.
Support during resettlement	・ Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12)	・ There is no directive regarding this item.	Yes (There is no directive regarding the support for transition period.)	・ Since full compensation is by cash transfer payment as opted by all PAPs, there will be no need for support during the transition period.

Item	JICA Guidelines/WB OP 4.12	Laws of Ivory Coast	Gap	Policies applies to the Project
Vulnerable groups	・ Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12)	・ There is no directive regarding this item.	Yes (There is no directive regarding vulnerable groups.)	・ Additional financial support will be provided to vulnerable groups.
ARAP	・ For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12)	・ There is no directive regarding this item.	Yes (There is no directive regarding ARAP.)	・ ARAP will be prepared, because the project will displace less than 200 people.

Source: JICA Study Team

(4) Policies Applied to the Project

I. The Government of Ivory Coast will use the Project Resettlement Policy (the Project Policy) for this project specifically because existing national laws and regulations have not been designed to address involuntary resettlement according to international practice, including JICA's policy. The Project Policy is aimed at filling-in any gaps in what local laws and regulations cannot provide in order to help ensure that PAPs are able to rehabilitate themselves to at least their pre-project condition. This section discusses the principles of the Project Policy and the entitlements of the PAPs based on the type and degree of their losses. Where there are gaps between the Ivory Coast legal framework for resettlement and JICA's Policy on Involuntary Resettlement, practicable mutually agreeable approaches will be designed consistent with Government practices and JICA's Policy.

II. Land acquisition and involuntary resettlement will be avoided where feasible, or minimized, by identifying possible alternative project designs that have the least adverse impact on the communities in the project area.

III. Where displacement of households is unavoidable, all PAPs (including communities) losing assets, livelihoods or resources will be fully compensated and assisted so that they can improve, or at least restore, their former economic and social conditions.

IV. Compensation and rehabilitation support will be provided to any PAP, that is, any person or household or business which on account of project implementation would have his, her or their:

- Standard of living adversely affected;

- Right, title or interest in any house, interest in, or right to use, any land (including premises, agricultural and grazing land, commercial properties, tenancy, or right in annual or perennial crops and trees or any other fixed or moveable assets, acquired or possessed, temporarily or permanently;
- Income earning opportunities, business, occupation, work or place of residence or habitat adversely affected temporarily or permanently; or
- Social and cultural activities and relationships affected or any other losses that may be identified during the process of resettlement planning.

V. All affected people will be eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing and any such factors that may discriminate against achievement of the objectives outlined above. Lack of legal rights to the assets lost or adversely affected tenure status and social or economic status will not bar the PAPs from entitlements to such compensation and rehabilitation measures or resettlement objectives. All PAPs residing, working, doing business and/or cultivating land within the project impacted areas as of the date of the latest census and inventory of lost assets (IOL), are entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if available and restoration of incomes and businesses, and will be provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

VI. PAPs that lose only part of their physical assets will not be left with a portion that will be inadequate to sustain their current standard of living. The minimum size of remaining land and structures will be agreed during the resettlement planning process.

VII. People temporarily affected are to be considered PAPs and resettlement plans address the issue of temporary acquisition.

VIII. Where a host community is affected by the development of a resettlement site in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize the adverse impacts of resettlement upon host communities.

IX. The resettlement plans will be designed in accordance with the laws and regulations of Ivory Coast and JICA's Policy on Involuntary Resettlement.

X. The Resettlement Plan will be translated into local languages and disclosed for the reference of PAPs as well as other interested groups.

XI. Payment for land and/or non-land assets will be based on the replacement cost.

XII. Compensation for PAPs dependent on agricultural activities will be land-based wherever possible. Land-based strategies may include provision of replacement land, ensuring greater security of tenure, and upgrading livelihoods of people without legal land titles. If replacement land is not available, other strategies may be built around opportunities for re-training, skill development, wage employment, or self-employment, including access to credit. Solely cash compensation will be avoided as an option if possible, as this may not address losses that are not easily quantified, such as access to services and traditional rights, and may eventually lead to those populations being worse off than without the project.

XIII. Replacement lands, if the preferred option of PAPs, should be within the immediate vicinity of the affected lands wherever possible and be of comparable productive capacity and potential. As a second option, sites should be identified that minimize the social disruption of those affected; such lands should also have access to services and facilities similar to those available in the lands affected.

XIV. Resettlement assistance will be provided not only for immediate loss, but also for a transition period needed to restore livelihood and standards of living of PAPs. Such support could take the form of short-term jobs, subsistence support, salary maintenance, or similar arrangements.

XV. The resettlement plan must consider the needs of those most vulnerable to the adverse impacts of resettlement (including the poor, those without legal title to land, ethnic minorities, and women, children, elderly and disabled) and ensure they are considered in resettlement planning, and the mitigation measures are identified. Assistance should be provided to help them improve their socio-economic status.

XVI. PAPs will be involved in the process of developing and implementing resettlement plans.

XVII. PAPs and their communities will be consulted about the project, the rights and options available to them, and proposed mitigation measures for adverse effects, and to the extent possible be involved in the decisions that are made concerning their resettlement.

XVIII. Adequate budgetary support will be fully committed and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. The funds for all resettlement activities will come from the Government.

XIX. Displacement does not occur before provision of compensation and other assistance required for relocation. Sufficient civic infrastructure must be provided in resettlement site prior to relocation. Acquisition of assets, payment of compensation, and the resettlement and start of the livelihood rehabilitation activities of PAPs, will be completed prior to any construction activities, except when a court of law orders so in expropriation cases. (Livelihood restoration measures must also be in place but not necessarily completed prior to construction activities, as these may be ongoing activities.)

XX. Organization and administrative arrangements for the effective preparation and implementation of the resettlement plan will be identified and in place prior to the commencement of the process; this will include the provision of adequate human resources for supervision, consultation, and monitoring of land acquisition and rehabilitation activities.

XXI. Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place as part of the resettlement management system. An external monitoring group will be hired by the project and will evaluate the resettlement process and final outcome. Such groups may include qualified NGOs, research institutions or universities.

Cut-off-date of Eligibility

The cut-off date for this Project was set as June 5, 2020, which is when the census survey was commenced. This date was disclosed to the PAPs during preliminary meetings with PAPs and local authorities. It was notified that any structures built after this date or any persons who move into the area after this date are not eligible for compensation or support.

Principle of Replacement Cost

All compensation for land and non-land assets owned by households/ shop owners who meet the cut-off date will be based on the principal of full replacement cost. The full replacement cost was calculated before displacement and will also cover the cost of depreciation and any taxes or fees incurred during the process.

The RAP for the Project was developed based on the above policies.

(5) Scope of Land Acquisition and Resettlement

Census survey, and asset inventory and socio-economic survey were conducted from July 13 to 15, 2018. The Project Affected Households (PAHs) and PAPs are shown in Table 5.2-6. Due to the

construction of transmission lines, 1 household (6 persons) will be physically resettled, while 1,247 households (6,733 persons)[15] will be economically resettled.

Table 5.2-6 Number of PAHs and PAPs

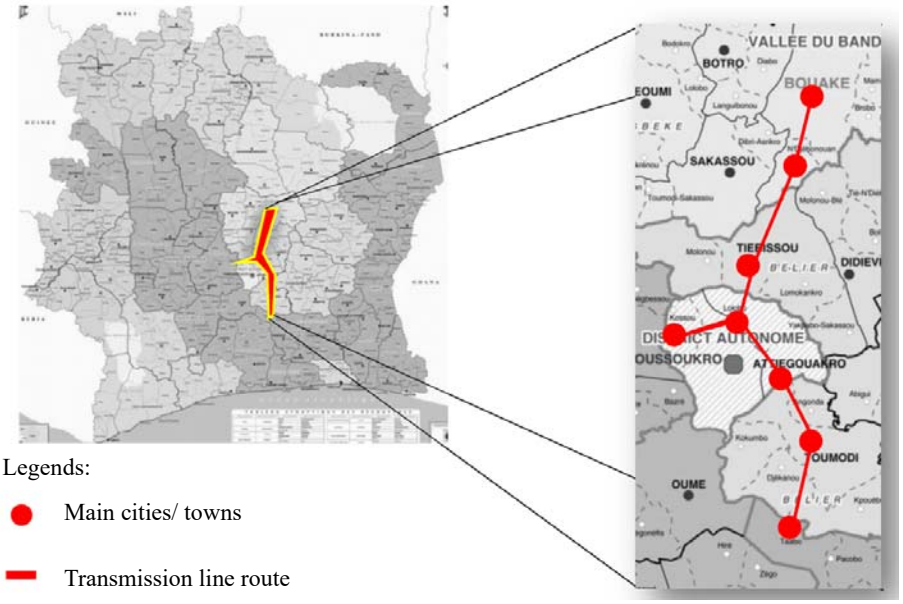
Type of loss	Impact	Unit	Magnitude of displacement			Total
			Overhead transmission lines	Substations	Distribution lines	
Loss of living space (rented house)	Physical displacement	PAH	1	0	0	**1**
		PAP	6	0	0	**6**
Loss of houses and other structures (storage, workshop etc.)	Economic displacement [16]	PAH	6	0	0	6
		PAP	32	0	0	32
Loss of income		PAH	6	0	0	6
		PAP	32	0	0	32
Loss of land		PAH	311	0	0	311
		PAP	1,679	0	0	1,679
Loss of crops		PAH	923	0	0	923
		PAP	4,984	0	0	4,984
Sub-total		PAH	1,247	0	0	**1,247**
		PAP	6,733			**6,733**
Transfer of cemeteries etc.	Loss of other assets[17]	PAH	36	0	0	**36**
		PAP	-	0	0	**-**

Source: JICA Study Team

[15] The number of households to be economically resettled is a cumulative number of persons. (for example, some PAPs will be affected by both loss of land and agricultural crops.; in the RAP prepared by CI Energies, the actual number of households to be economically resettled is not described)

[16] In the RAP prepared by CI Energies, the number of PAPs for economic displacement was not surveyed; therefore, the number of PAPs for economic displacement was calculated by multiplying by 5.4 persons per household (the number of average family members is based on the Population Census (2014), Ivory Coast National Bureau of Statistics).

[17] This project will require the resettlement of cemeteries etc. (owned by individuals). The compensation (including the cost necessary for rituals of transferring assets) will be paid for each individual who owns the assets.



Source: RAP (October, 2020; prepared by CI Energies)

Figure 5.2-1 Project affected area (along the transmission line route)

1) Asset Inventory

The implementation of this project will cause the loss of buildings, land and crops. The outline of the loss of buildings, land and crops is described in Table 5.2-7 to Table 5.2-9.

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Table 5.2-7 Buildings to be affected by the project

No.	Component	Type of buildings	Total (no. of structure)
1	Overhead transmission line	Rented house : 1 story, brick, galvanized iron roof, 2 rooms	1
2		Storage: 1 story, wood, 1 room	1
3		Workshop (handicrafts): 1 story, wood	2
4		Structure under construction: 1 story	2
Total			**6**

Source: JICA Study Team

Table 5.2-8 Land to be acquired for the project

No.	Component	Breakdown	Total (m^2)
1	Overhead transmission line	Public land	2,762.16
2		Private land[18]	148,093.14
Total			**150,855.30**

Source: JICA Study Team

[18] The private land to be acquired for the project is a vacant land to be used for housing purpose, not for use of income sources (agriculture etc.)

Table 5.2-9 Crops to be affected by the project

No.	District	Region	Department	Affected area (m^2)	No. of affected land	Type of crops
1	Lagunes	Agnéby-Tiassa	Agboville	0	0	
			Sikensi	0	0	
			Taabo	0	0	
			Tiassale	0	0	
			Sub-total	**0**	**0**	
2	Lacs	Bélier	Didievi	0	0	
			Djekanou	59,670	64	Yam, cassava, cashew, corn, coffee etc.
			Tiebissou	24,815	24	Yam, cassava, cashew, corn, orange etc.
			Toumodi	12,550	34	Cassava, yam, banana, tomato, cacao etc.
			Sub-total	**97,035**	**122**	
3	Vallee du Bandama	Gbéké	Beoumi	0	0	
			Botro	0	0	
			Bouake	213,427	286	Cassava, yam, cashew, corn, peanut etc.
			Sakassou	0	0	
			Sub-total	**213,427**	**286**	
4	District autonome Yamoussoukro		Attiegouakro	229,331.5	330	Yam, cassava, eggplant etc.
			Yamoussoukro	200,055	185	Cassava, yam, coffee, banana, cacao, corn etc.
			Sub-total	**429,386.5**	**515**	
			Total	**739,848.5**	**923**	

Source: JICA Study Team

2) Vulnerable Groups

In the socio-economic survey, PAHs were studied to identify any vulnerable groups, including widows/widowers, pregnant women, children under the age of five, disabled persons, chronically ill persons over the age of 70 years old with no support. According to the survey, one household with two children under the age of five was identified as a socially vulnerable people. This PAH will be monitoring, and additional compensation will be paid.

3) Compensation and Assistance Policy

In accordance with the above-mentioned laws and regulations as well as the JICA guideline and World Bank Safeguard Policy, the Policy to be applied for this project is described as follows:

- Type: Loss of partially or fully displaced buildings and structures, Loss of crops, Loss of income sources or livelihood accompanied with resettlement

- Eligibility: All the PAPs (including PAPs without legal rights)

- Compensation methods: Cash compensation, Recovery of structure loss

- Calculation methods: Replacement cost

(a) Compensation toward Loss

The cut-off date for compensation and assistance is the commencement date of census survey, or 5 June 2020. Losses caused by the project and compensation toward them are as summarized below.

Loss of living space (rented house)

Due to the loss of living space (rented house), 1 household (6 people) will lose their residential space. The compensation will include five months' rent of an equivalent residential space and moving fees, paid in cash.

Loss of houses and other structures (storage, workshop etc.)

8 structures will be lost due to the Project: one house (rented residence), 1 workshop (handicrafts), 4 other structures (storages etc.) and 2 structures under construction. The replacement cost will be calculated based on floor plans, building materials, condition of the structures and its location. This cost also includes the cost to dismantle and displace the structures.

Loss of income

Due to the loss of the workshop (handicrafts), 1 household will temporarily lose its income. The compensation will be provided based on income per day and the number of days that cannot be worked.

Loss of land

150,855.3m^2 of land (private land (148,093.14m^2) and public land (2,762.16m^2)) will be lost due to the project. The replacement cost of private land will be based on market prices. The lost land will not be replaced by other land, as the PAPs did not request this form of compensation. The cost of public land includes the fee required for changing land use registration.

Loss of agricultural crops

Agricultural crops will be lost due to the Project. Compensation will be provided based on the Order on the scale of compensation for agricultural crops (No. 453/ 1 August 2018), which calculates compensation cost based on (1) the quantity of production per area, (2) the year in which the crops were lost, and (3) an additional 10% compensation etc.

Displacement of cemeteries etc.

8 cemeteries and 15 sacred sites (total: 35 locations) will be displaced due to the project. The replacement cost will be paid in cash, including cost incurred for rituals.

(b) Livelihood Restauration

Temporary loss of crops and livelihood is expected due to the project; however, the magnitude of impact is limited, and no significant adverse impacts on livelihood are predicted. In this project, PAPs will be given priority to be employed as unskilled and skilled laborers during the construction period. They will also be hired as skilled and unskilled laborers to work during the maintenance of towers and clearing trees within the ROW and access roads. Agricultural cultivation along transmission line routes is allowed during operation.

(c) Entitlement Matrix

In line with the laws and regulations of Ivory Coast, JICA Guidelines and World Bank Safeguard Policy, the compensation and assistance policy for the project, such as eligibility and compensation valuation is shown in Table 5.2-10.

Table 5.2-10 Entitlement Matrix

Type of asset lost	Eligible groups	Impact	Entitlement	Responsible party
Living space (rented house)	Residents	Loss of living space (rented house)	• Cash compensation will include five months' rent of an equivalent residential space and moving fees, paid in cash (*1)	CI Energies
Houses and other structures (storages, workshops etc.)	Property owner	Displacement of structure	• Cash compensation for the replacement of the entire structure and other individual assets (based on floor plans, building materials, condition of the structures and location) • This cost also includes the cost to dismantle and displace the structures.	CI Energies

Type of asset lost	Eligible groups	Impact	Entitlement	Responsible party
Income	Handicraft worker	Loss of livelihood	• Compensation will be provided based on income per day and the number of days that cannot be worked.	CI Energies
Land	Land owner	Displacement of agricultural crops	• Cash compensation based on market prices.	CI Energies
Agricultural crops	Owner of agricultural crops	Loss of livelihood and crops (temporary)	• Cash compensation based on the area of agricultural land lost and crop prices. • Agricultural cultivation is allowed within the ROW during operation at a height that does not interfere with the transmission line.	CI Energies
Cemeteries	Managing community	Displacement of cemetery	• Cash compensation for displacement cost (including costs incurred for rituals).	CI Energies
Day-wage laborers	Laborer	Loss of livelihood	• Displaced laborers will be prioritized as construction laborers for the Project.	CI Energies

Source: JICA Study Team

(*1) One household was identified as socially vulnerable people to be affected by the Project and will lose their house (rented). According the laws and regulations of Ivory Coast, 4 months' rent is required to be compensated, but in consideration of the vulnerability, an additional one month's rent along with moving fees will be provided through cash compensation.

4) Grievance redress mechanism

The grievance redress mechanism will be implemented as shown below in order to ensure transparency in the resettlement process and secure additional support for PAPs.

- Sub-prefecture committee: The first level of the grievance redress mechanism related to the RAP, composed of the representatives of the sub-prefectures affected by the Project.
- Department committee: Composed of the department head, representatives of the Project-affected sub-prefectures and NGOs. Addresses the grievances that could not be solved at the sub-prefecture level.
- RAP implementation unit: Composed of CI Energies, Ministry of Construction and Urban Development, RAP consultant, NGOs, and representatives of the PAPs. Addresses the grievances that could not be solved at the department level.

The grievance redress mechanism for the project will follow the procedure below.

- Grievances will be recorded by the representative of the PAP submitting the grievance and the NGO associated with the relevant Department. The sub-prefecture committee and department committee will convene within one week of receiving the grievance and hold a consultation with the PAP.

- If an agreement cannot be reached during the consultation, the meeting minutes will be signed, and the grievance will be submitted to the RAP implementation unit. The unit will hold a consultation with the PAP.

- If an agreement cannot be reached during the consultation with RPA implementation unit, PAP can raised the issue to the court, and the case will be examined.

5) Institutional Framework

Institutional framework for the implementation of RAP is as follows.

(a) CI Energies

There are three departments of CI Energies related to environmental and social considerations, which conduct the following work: (1) environmental planning and strategies, (2) implementation and monitoring of environmental activities, (3) planning, implementation and monitoring of land acquisition/ resettlement. There are five staff members in each of the three departments, who will review the RAP of the transmission line and power generation, conduct monitoring, serve as the contact point for grievances and manage the funds for RAP implementation.

(b) Ministry of Petroleum, Energy and Renewable Energies

The Ministry of Petroleum, Energy and Renewable Energies serves as the head of the steering committee and establishes the RAP Implementation Unit. The ministry holds jurisdiction over the compensation process.

(c) Steering committee

Once the steering committee is established, the Minister of Petroleum, Energy and Renewable Energies will serve as the head of the steering committee, and CI Energies will serve as the administrative head. Other committee members include members of the Ministry of Economy, Ministry of Construction and Urban Development and Ministry of Agricultural Development. The committee will be the decision-making and coordination body for the RAP implementation.

(d) RAP implementation unit

The RAP implementation unit will be established under the Ministry of Petroleum, Energy and Renewable Energies. CI Energies will serve as the head of the committee, and other

members will include members of the Ministry of Construction and Urban Development, RAP consultants and NGOs. The unit will have the following duties:

- Updating a list of PAPs
- Preparing and signing compensation certificates and compensation receipts
- Supporting the payment of compensation to PAPs and resettlement procedures
- Preparing the documents necessary for implementing the RAP (meeting minutes, reports, tender documents, contracts, etc.)

Table 5.2-11 Members of the RAP Implementation Unit

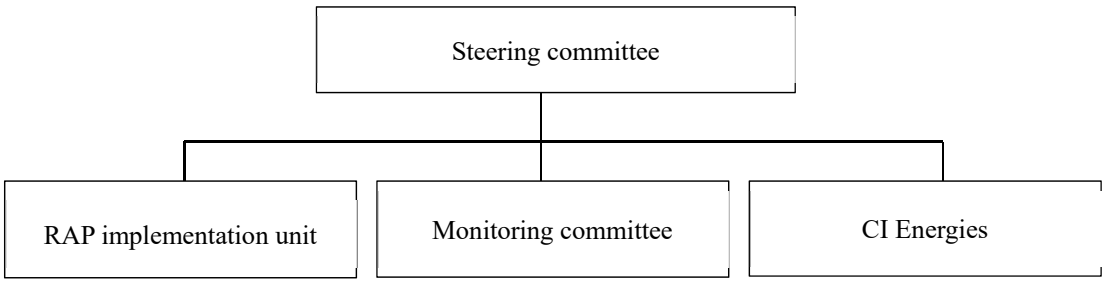
No	Member of the RAP Implementation Unit	Role
1	Ministry of Petroleum, Energy and Renewable Energies	To oversees the RAP implementation process.
2	Ministry of Construction and Urban Development	To identifies and conduct a study on the structures that will be affected by the Project.
3	RAP Consultant	To create a list of PAPs and negotiates the amount of compensation; To conduct community meetings, monitoring of compensation and prepares the compensation certificates and RAP report.
4	NGO	To notify the community of the compensation process and manages its progress.

Source: JICA Study Team

(e) Monitoring committee

A monitoring committee will be established under each department. The department governor will serve as its head, and the head of the RAP implementation unit will serve as a secretariat. Other members will include members of the Department of Agricultural Development, the regional branches of the Department of Construction and Urban Development, and representatives of the PAHs. The monitoring committee will periodically monitor the progress of the RAP and verify that the compensation method is appropriate.

The RAP implementation framework is given below.



Source: JICA Study Team

Figure 5.2-2 RAP Implementation Framework

6) Implementation schedule

The schedule for RAP implementation is given in Table 5.2-12 below.

Table 5.2-12 RAP Implementation Schedule

No.	Activity	Timeframe	Responsible body
1	Consultation with PAPs regarding the payment of compensation	Two weeks	CI Energies/RAP Consultant
2	Public hearing	1 month	Ministry of Construction and Urban Development
3	Verification of RAP implementation	2 months	Ministry of Construction and Urban Development
4	Procedures to secure funds for RAP implementation	1 week	CI Energies
5	Signature to establish RAP implementation framework	2 months	Ministry of Construction and Urban Development
6	Arrangement of RAP implementation bodies and staff	1 week	District/Ministry of Construction and Urban Development
7	Agreement on compensation details and signing of compensation certificates	2 weeks	RAP Implementation Unit
8	Grievance redress	2 weeks	RAP Implementation Unit, NGO
9	Payment of compensation	3 weeks	Ministry of Finance, RAP Implementation Unit, NGO
10	Support of resettlement; monitoring	6 months	NGO
11	Preparation of RAP report	1 week	RAP Consultant

Source: JICA Study Team

7) Cost and Finance

The total cost and breakdown of compensation is summarized below in Table 5.2-13.

Table 5.2-13 Total cost and breakdown of compensation

No.	Description	Total (FCFA)
1	Compensation for loss of living space (rented house)	241,030,000
2	Compensation for loss of houses and other structures (storages, workshops etc.)	350,000
3	Compensation for loss of income	9,590
4	Compensation for loss of land	302,800,565
5	Compensation for loss of agricultural crops	180,912,006
6	Compensation for transfer of cemeteries etc.	37,089,000
7	Management fees for RAP implementation	150,000,000
8	Monitoring fees	10,000,000
	Total	922,191,161
	Contingency (10% of total)	92,219,116
	Total	**1,014,410,277**

Source: JICA Study Team

(6) Monitoring System

The monitoring of compensation payment will be carried out by CI Energies, following the process outline below.

Internal monitoring will be conducted to confirm that the progress of the compensation process aligns with the RAP and will be reported in a monitoring report. CI Energies will hire an

experienced consultant as necessary to conduct the monitoring. The items to be monitored are as listed below.

a) Payment of compensation according to the compensation policy of the RAP
b) Confirmation that the necessary procedures have been followed prior to the disbursement of compensation
c) Information disclosure and dissemination and consultation method
d) Grievance redressal
e) Satisfaction of PAPs with the compensation and resettlement

In addition, the monitoring committee will periodically conduct monitoring. After the compensation has been paid, a third party expert will evaluate the process and confirm that the compensation process was appropriately implemented in line with the RAP.

(7) Stakeholder meetings

For this Project, stakeholder consultations were carried out on May 25 2020 to June 1, 2020 with various stakeholders, including PAHs, the local government, women's groups and youth groups during the RAP preparation.

Public meetings, focus group discussions and individual meetings were held with PAPs at community leaders' houses etc., and government officials were interviewed and consulted individually at their offices. As part of gender considerations, women group representatives were interviewed.

During the stakeholder discussions, the project details and impacts were explained, and the stakeholders were consulted on the necessary mitigation measures. An agreement was reached with PAHs concerning compensation methods for the land and agricultural crops that will be lost and the displacement of spiritual places.

The outline of stakeholder meetings is described in Table 5.2-14.

Table 5.2-14 Summary of stakeholder consultations

Methods	Date	Participants	Outline
Public meetings	May 26, 2020	PAPs along transmission lines; 16 persons (Tiebissou department; 14 men, 2 women)	• Project summary and explanation of similar past projects • Consultation and opinion exchange with PAHs on the impacts, mitigation measures and concerns about the project
	May 27, 2020	PAPs along transmission lines; 13 persons (Toumodi department; 13 men)	
	May 30, 2020	PAPs along transmission lines; 32 persons (Attiegouakro department; 31 men, 1 woman)	
	May 31, 2020	PAPs along transmission lines; 9 persons (Attiegouakro department; 9 men)	
Individual meetings	May 25, 2020	Local government officer; 1 person (Djebonoua department; 1 man)	
	May 26, 2020	Local agricultural department officer; 1 person (Toumodi department; 1 man)	
	May 29, 2020	Local government officer; 1 person (Toumodi department; 1 man)	
Focus group discussion	May 30, 2020	Female organization representative along transmission lines; 1 person (Attiegouakro department; 1 woman)	
	May 31, 2020	Women's group representative along transmission lines; 2 persons (Bouake department; 2 women)	
	June 1, 2020	Youth group representative along transmission lines; 4 persons (Attiegouakro department; 4 men)	

Source: JICA Study Team

The responses of CI Energies to the questions raised during the consultations are summarized below in Table 5.2-15.

Table 5.2-15 Summary of stakeholder consultations

Stakeholder	Opinions and concerns	Responses from CI Energies
PAPs	• They were concerned whether the Project will impact agricultural crops and land, whether sufficient compensation will be provided for these and whether cemeteries will be displaced. • They were concerned whether high-pressure transmission line will impact health.	• Compensation for any losses or displacement due to the Project will be paid prior to the resettlement, in line with local regulations and international standards, • The project will have positive impacts, such as promotion of hiring local people for the project and road improvement etc.
Local government officials (agrivultural department etc.)	• They were concerned whether agricultural crops and lands and the livelihood of farmers will be impacted by the project and whether sufficient compensation will be provided for any losses. • They expect that it will be difficult to conduct surveys with land owners when the head of the household is absent.	• Compensation will be calculated according to the RAP and will be paid before the resettlement. • The project will have positive impacts, such as promotion of hiring local people for the project and road improvement etc. • Local residents will be notified when implementing the census survey. The RAP will be prepared based on the results.
Women's groups, youth groups	• They were concerned whether compensation payments will be delayed, economic impacts of the project on agricultural crops and livelihood and whether there will be loss of land in the ROW. • Part of the sub-prefecture does not have electricity. Will the price of electricity be lowered and will accessibility improve?	• Compensation will be paid before resettlement. • Local youths will be prioritized for employment during the construction phase. • The Project will support the construction of local youth centers and hospitals. • The Project will improve accessibility to electricity, such as reducing the frequency of power outages.

Source: JICA Study Team

5.3 OTHERS

5.3.1 Draft Monitoring Form

Draft monitoring forms for environmental management, as well as, resettlement/ land acquisition are shown below.

I. Preconstruction Phase

1. Progress of Compensation Payment

Components/ location	Planned Total	Unit	Monthly Progress			Progress (%)		Expected Date of Completion	Responsible Organization
			M-1	M-2	M-3	Till the last month	Up to the month		
Compensation payment for loss of housing									
		No. of PAPs							CI Energies
Compensation payment for loss of buildings									
		No. of PAPs							CI Energies
		No. of PAPs							CI Energies
Compensation payment for loss of income									
		No. of PAPs							CI Energies
		No. of PAPs							CI Energies
Compensation payment for loss of land									
		No. of PAPs							CI Energies
		No. of PAPs							CI Energies
Compensation payment for loss of crops									
		No. of PAPs							CI Energies
		No. of PAPs							CI Energies
Compensation payment for the loss of cemeteries etc.									
		No. of PAPs							CI Energies
		No. of PAPs							CI Energies
Others									
		No. of PAPs							CI Energies
		No. of PAPs							CI Energies

2. Record of grievance management

Monitoring Item	Monitoring Results during Report Period
Number of grievance	
Contents of grievance	
Actions to be taken	

II. Construction Phase

1. Response /Action to comments and guidance from government authorities and public

Monitoring Item	Monitoring Results
Number of comments made by the public and government agencies	
Contents of comments made by the public and government agencies	
Actions to be taken	

2. Biophysical/Natural Environnent

2.1 Air quality (Dust)/ Noise, Vibration

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Monthly report/ Results of vehicle inspection etc.		Construction site	Once/month

2.2 Soil

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Conditions of insulating oil of transformers		Construction site	Once/year
Amount of insulating oil of transformers			

3. Social Environment

3.1 Existing social infrastructure and services

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Location, type, length of roads and public utilities affected		Construction site and the surrounding areas	Once/month
Location, type, length of roads and public utilities restored upon completion of construction works			

3.2 Occupational health hazards/ Accidents

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
No. of workers provided with protective clothing & equipment		Construction site	Daily during active construction period
No. of work zone secured safe through fencing, posting signs, barricades, reflectors etc.		Construction site and the surrounding areas	
Traffic management situation around construction sites - speed limits, provision of alternative routes to divert traffic from construction sites			
No. of traffic accidents occurred			

3.3 Record of grievance management

Monitoring Item	Monitoring Results during Report Period
Number of grievance	
Contents of grievance	
Actions to be taken	

III. Operation Phase

1. Response /Action to Comments and Guidance from Government Authorities and Public

Monitoring Item	Monitoring Results
Number of comments made by the public and government agencies	
Contents of comments made by the public and government agencies	
Actions to be taken	

2. Soil pollution

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Conditions of insulating oil of transformers		Construction site	Once/year
Amount of insulating oil of transformers			

3. Accidents

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
No. of accidents occurred		Project site	Quarterly
Conditions of electrical lines (avoidance of growing trees under electric lines)			

4. Record of grievance management

Monitoring Item	Monitoring Results during Report Period
Number of grievance	
Contents of grievance	
Actions to be taken	

5.3.2 Environmental Check List

Table 5.3-1 below is the Environmental Check List of the Project based on the JICA Guidelines for Environmental and Social Consideration.

Table 5.3-1 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) N/A	(a)-(b) The ESIA report was submitted to ANDE (the environmental authority in charge of ESIA approval) and approved on August 20, 2020. (c) The conditions are generally required items (such as semi-annual reporting to ANDE), and will be satisfied. (d) No additional approval is required.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) In line with JICA guidelines and local laws/regulations, stakeholder meetings were conducted. (b) Main comments raised during meetings were reflected on the project design.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Alternative plans, including no-project option were examined. The routes of overhead transmission lines were examined. The present project is most preferable in terms of benefits to the public, lower impacts on natural, social and economic aspects as well as the consistency with city planning.
2 Pollution Control	(1) Water Quality	(a) Is there any possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? If the water quality degradation is anticipated, are adequate measures considered?	(a) N	(a) The project requires land levelling of tower bases; however, the impacted area is limited, and no significant impact on geological features are expected. Therefore, soil erosion into the rivers or lakes is not predicted.
3 Natural Environment	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no protected area nearby.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs,	(a) N (b) N	(a) There is no primeval forests, tropical rain forests, ecologically valuable habitats nearby.

		mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate measures taken to prevent disruption of migration routes and habitat fragmentation of wildlife and livestock? (e) Is there any possibility that the project will cause the negative impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases where the project site is located in undeveloped areas, is there any possibility that the new development will result in extensive loss of natural environments?	(c) N (d) N (e) N (f) N	(b) 2 species categorized as VU and LU of IUCN red list were identified around the project site. The tree cutting within the ROW of transmission lines is planned, but the affected area is limited. Therefore, the impact on these species will be also limited. 75 species of birds identified along the ROW were categorized as LC of IUCN red list. Since the new transmission lines are constructed along the existing transmission lines, no significant impact on birds (such as bird strike) is expected. (c) Since the new transmission lines are constructed along the existing transmission lines, no significant impact on flora and fauna is expected. (d) No significant impacts are expected on habitat fragmentation and migration routes. (e) No significant impacts are expected, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystem. (f) Some parts of the project area are located in undeveloped area; however, since these areas are limited, no extensive loss of natural environment is predicted.
	(3) Topography and Geology	(a) Is there any soft ground on the route of power transmission and distribution lines that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there any possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a) There are no locations along the electrical lines which have risks of slope failure and land sliding. (b)-(c) The project requires land levelling of tower bases; however, the impacted area is limited, and no significant impact on geological features are expected. The sites of these areas are also is flat and the soil is relatively hard, there are no risks of slope failure and landslides. No cutting and filling will be done for the construction of electrical lines, and there are no risks of slope failure and landslides.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement?	(a) N/A (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A	(a) The project requires resettlement of 1 household (6 persons). In addition, loss of buildings, land and crops are expected. No resettlement occurs within the project site of substations. The route of transmission lines was examined to minimize the impacts on involuntary resettlement.

		(c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, and people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(g) N/A (h) N/A (i) N/A (j) N/A	(b) Stakeholder consultations were held. During the consultations, compensation and livelihood restoration measures were explained, and agreed upon with the PAPs. As a livelihood restoration measure, the local people will be prioritized for the employment during construction work. (c) Socio-economic survey and asset inventory survey were conducted, based on which the RAP was prepared. The RAP includes compensation at full replacement cost and livelihood restoration measures. (d) The compensation will be paid prior to the resettlement, which is also stipulated in Ivory Coast laws and regulations. (e) The compensation policy (eligibility, entitlement matrix etc.) is described in the RAP. (f) In the socio-economic survey, PAHs were studied to identify any vulnerable groups, including widows/widowers, pregnant women, children under the age of five, disabled persons, chronically ill persons over the age of 70 years old with no support. According to the survey, one household with two children under the age of five was identified as a socially vulnerable people. Additional compensation will be paid for this PAH. (g) Agreements with PAPs will be reached prior to resettlement. PAPs will agree with compensation and sign the agreement, based on which the RAP will be implemented. (h) CI Energies is in charge of RAP implementation. (i) Monitoring of resettlement and land acquisition will be conducted on a monthly basis. The monitoring plan is included in RAP. (j) Grievance mechanism was established through discussion at community level as well as an arbitration at a court.
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary?	(a) Y (b) N (c) N (d) Y	(a) Economic displacement such as the loss of crops is expected. RAP was developed and the loss will be compensated at full replacement cost. (b) No influx of population from outside of the project site is predicted. (c) The project will not cause radio interference. (d) Compensation under power lines will be paid according to

		(c) Is there any possibility that installation of structures, such as power line towers will cause radio interference? If any significant radio interference is anticipated, are adequate measures considered? (d) Are the compensations for transmission wires given in accordance with the domestic law?		the local laws and RAP.
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) 36 locations of cemeteries and sacred sites etc. were found along the planned transmission lines. However, the compensation (including the cost incurred for rituals) will be paid, which was agreed with stakeholders. There is no possibility to damage any other local archeological, historical, cultural, and religious heritages.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) The project will not affect the landscape. The area around the project site is already developed.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N/A (a) N/A	(a) There are no ethnic minorities and indigenous people affected by the project. (b) There are no ethnic minorities and indigenous people affected by the project.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project do not violate safety of other individuals involved, or local residents?	(a) N (b) Y (c) Y (b) Y	(a)- (d) CI Energies will observe all laws and ordinances associated with working conditions of the country, conducting necessary tangible and intangible safety measures.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)?	(a) Y (b) N/A (c) Y	(a) Based on the local laws and regulations, mitigation measures will be conducted. The expected impacts are noise, vibrations, dust, exhaust gas, waste and soil.

		(b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?		Mitigation measures to be taken will include water sprinkler, installation of cover to prevent dust and control of construction working hours. (b) 2 species categorized as VU and LU of IUCN red list were identified around the project site. The tree cutting within the ROW of transmission lines is planned, but the affected area is limited. Therefore, the impact on these species will be also limited. 75 species of birds identified along the ROW were categorized as LC of IUCN red list. Since the new transmission lines are constructed along the existing transmission lines, no significant impact on birds (such as bird strike) is expected. Since the construction is geographically limited and completed within short period, no impacts on surrounding environment are expected. (c) Construction activities may disturb the traffic around the site. CI Energies requires the contractor to control traffic with collaboration with local police, securing the smooth traffic and safety around the project site. The power cuts will be informed to the surround communities and residents in advance.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a)-(d) For the items with impacts, CI Energies will be monitoring. Monitoring plan and responsible organizations were developed in the EIA report.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Road checklist should also be checked (e.g., projects including installation of electric transmission lines and/or electric distribution facilities).	(a) N/A (b)	(a) There are no additional environmental Items that may be affected.

	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N/A	(a) Since the construction is geographically limited and completed within short period, no impacts to transboundary or global issues are expected.

CHAPTER 6

PRELIMINARY DESIGN

CHAPTER 6 PRELIMINARY DESIGN

6.1 TRANSMISSION LINE EQUIPMENT

This section outlines the basic design of 225 kV overhead transmission lines.

6.1.1 Outline of Transmission Line Route

The transmission line routes were examined by paying attention to the following matters.

- ✓ To minimize resettlement as much as possible and consider environmental and social impacts.
- ✓ To run in parallel to the existing T/L's and the new T/L's of CI-ENERGIES
- ✓ To utilize the original route considered by POWER COM as much as possible.

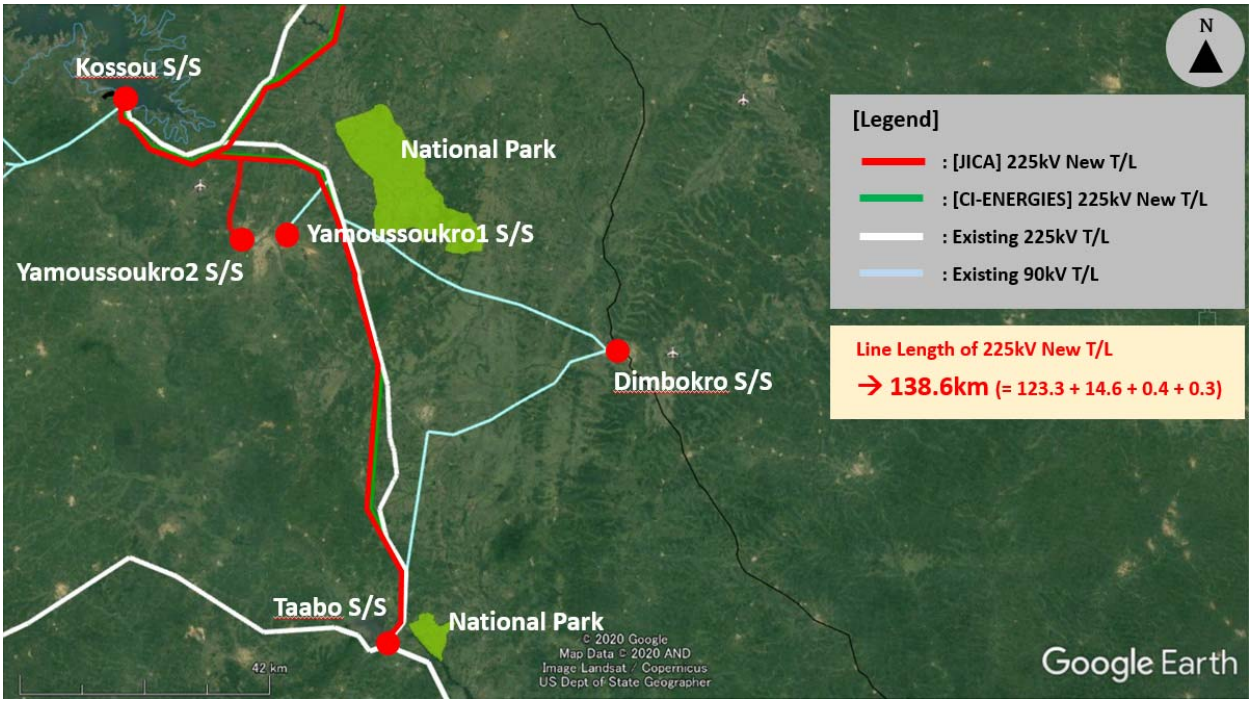
The route between Taabo S/S and Kossou S/S runs parallel to the new T/L's of CI-ENERGIES, and is sufficiently distant from Bringakro, Tenikro, and Amonkro villages, thereby reducing the relocation of residents. In addition, it is necessary to construct the T/L with 2 routes and 4 lines around Kossou S/S, and both routes run on the south side. Furthermore, the route between the branch tower and Yamoussoukro2 S/S was examined to shorten the original route constructed by POWER COM.

The route between Kossou S/S and Bouaké 3 S/S runs parallel to the new T/L's of CI-ENERGIES, and is sufficiently far from Fasou, Tounzuebo, Bobo and Kongouekro villages, thereby reducing the relocation of residents. The route toward Bouaké2 S/S consists of the overhead and underground T/L's. Table 6.1-1 shows the outline of routes followed by the location map of routes.

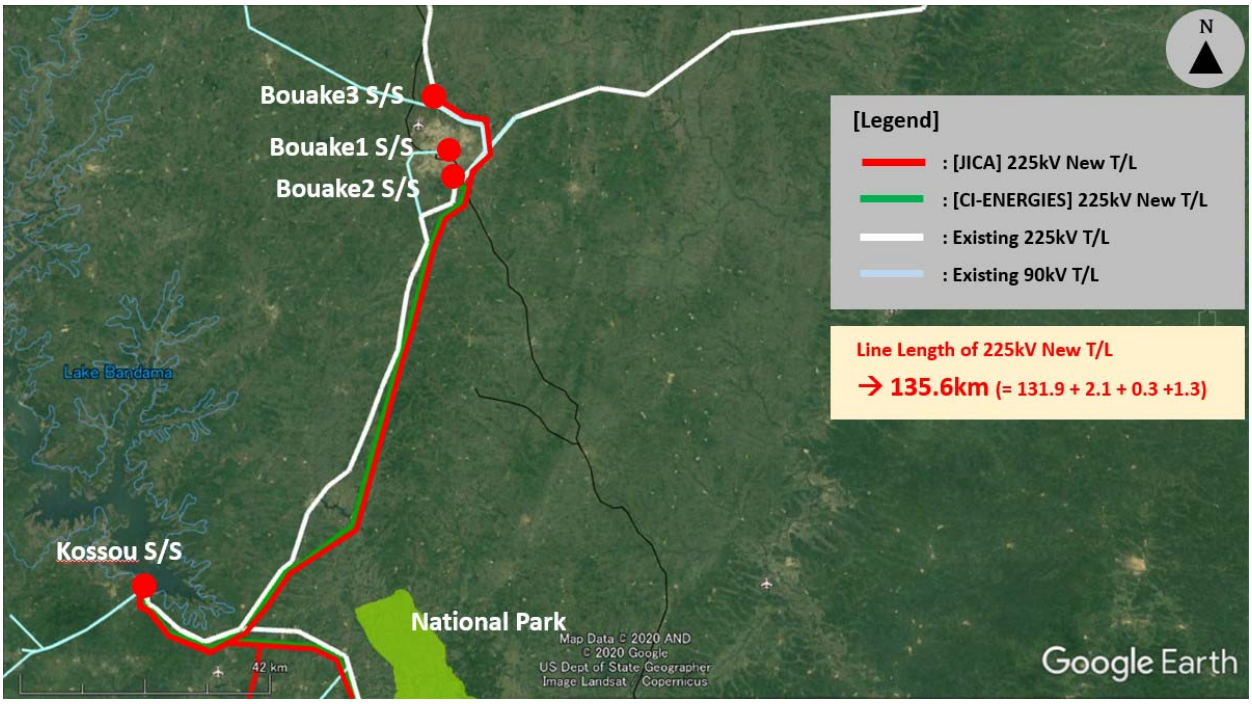
Table 6.1-1 Outline of Routes of Transmission Line

	Section		Line Length	
	Start Point	End Point		
Taabo – Kossou	Connection Tower (Taabo S/S)	Connection Tower (Kossou S/S)	123.3 km	OH
	Branch Tower (π Branch)	Yamoussoukro2 S/S	14.6 km	OH
	Taabo S/S	Connection Tower (Taabo S/S)	0.4 km	UG
	Connection Tower (Kossou S/S)	Kossou S/S	0.3 km	UG
Kossou – Bouaké3	Connection Tower (Kossou S/S)	Bouaké3 S/S	131.9 km	OH
	Branch Tower (π Branch)	Connection Tower (Bouake2 S/S)	2.1 km	OH
	Kossou S/S	Connection Tower (Kossou S/S)	0.3 km	UG
	Connection Tower (Bouake2 S/S)	Bouaké 2 S/S	1.3 km	UG

Source: JICA Study Team



(a) Taabo S/S - Yamoussoukro2 S/S - Kossou S/S



(b) Kossou S/S - Bouaké2 S/S - Bouaké3 S/S

Source: JICA Study Team

Fig. 6.1-1 Location Map of Routes

6.1.2 Thermal Capacity

(1) Outline of 225 kV Transmission Line

Table 6.1-2 shows the outline of 225 kV transmission lines.

Table 6.1-2 Outline of Transmission Lines

	Taabo-Yamoussoukro2-Kossou	Kossou-Bouaké2-Bouaké3
Nominal Voltage	225 kV	
Number of Circuit	2 cct	
Total Length	138.9 km First Tower-Kossou: 124.3 km Pi Branch-Yamoussoukro2: 14.4 km Taabo-First Tower: 0.2 km	134.9 km Kossou-Bouaké3: 131.6 km Pi Branch-First tower: 2.1 km First Tower-Bouaké2: 1.2 km
Conductor	LL-ACSR[1] 633 mm^2 or 637 mm^2 (Double Bundle)	
Ground Wire	AACSR[2] PHLOX 94 mm^2 or equivalent	
Ground Wire	OPGW[3] 94 mm^2 or equivalent	

Source: JICA Study Team

(2) Thermal Capacity of 225 kV Transmission Line

In consideration of (n-1) criteria, LL-ACSR 633 mm^2 or 637 mm^2, which have the thermal capacity of 740 MVA per single circuit and double bundle, will be applied.

Table 6.1-3 shows the thermal capacity of LL-ACSR followed by the ambient conditions for the thermal capacity calculation.

Table 6.1-3 Thermal Capacity

Type		Current	Thermal Capacity
LL-ACSR	633 mm^2 x 2 637 mm^2 x 2	Approx. 950 A	740 MVA/cct

Source: JICA Study Team

[1] LL-ACSR: Low Loss Aluminum Conductor Steel Reinforced
[2] AACSR: Aluminum Alloy Conductor Steel Reinforced
[3] OPGW: Optical-Fiber Composite Overhead Ground Wire

Table 6.1-4 Ambient Conditions for Thermal Capacity Calculation

	Value
Ambient Temperature	30 ℃
Velocity	0.5 m/s
Solar Radiation	0.1 W/cm^2
Emissivity	0.9
Maximum Operating Temperature	75 ℃

Source: JICA Study Team

6.1.3 Preliminary Design of Transmission Line

The preliminary design was prepared based on the criteria obtained from CI-ENERGIES. The criteria are shown below.

- ✓ CAHIER DES CHARGES GENERAL Lignes Aériennes HTB - Ouvrages Neufs (CCG - LA Ouvrages Neufs)
- ✓ CONDITIONS TECHNIQUES AUXQUELLES DOIVENT SATISFAIRE LES DISTRIBUTIONS D'ÉNERGIE ÉLECTRIQUE

In addition, it was decided to carry out the basic design according to the following procedure.

- ✓ Weather Conditions
- ✓ Selection of Conductor and Ground Wire
- ✓ Conditions of Clearance
- ✓ Conditions of Conductor and Ground Wire
- ✓ Insulator Assembly
- ✓ Supporting Structure (Tower) and Foundation

(1) Weather Conditions

As the new 225 kV transmission lines run through unpaved land, it is necessary to take into account the presence of sand dust. In addition, CI-ENERGIES recommends a pollution level of "IV (Very Heavy)" as defined in IEC 60071-2. Thus, it is desirable to apply "IV (Very Heavy)" as the pollution level. Table 6.1-5 shows the weather conditions.

Table 6.1-5 Weather Conditions

Items	Range	Value
Temperature	Maximum	45 °C
	Minimum	15 °C
	Average	27 °C
Altitude above sea level		Not exceed 1,000 m
Isokeraunic Level (IKL)		105 thunderstorm days/year
Climate		Tropical
Annual Rainfall	Average	1,900mm
Maximum Wind Velocity		36.0 m/s
Maximum Humidity		100 %
Pollution Level		IV (Very Heavy)

Source: JICA Study Team based on Detailed Design Report by POWER COM, October 2018

(2) Selection of Conductor and Ground Wire

Table 6.1-6 shows the technical characteristics of conductors followed by the structure of low loss conductors. AACSR PHLOX 94 mm^2, which is mainly applied in Republic of Cote d'Ivoire, and OPGW shall be adopted as ground wires. Table 6.1-7 shows the technical characteristics of ground wires. The number of optical fibers shall be 24, and the dimensions, mechanical and electrical characteristics shall be equivalent to AACSR PHLOX 94 mm^2.

Table 6.1-6 Technical Characteristics of Conductors (225 kV)

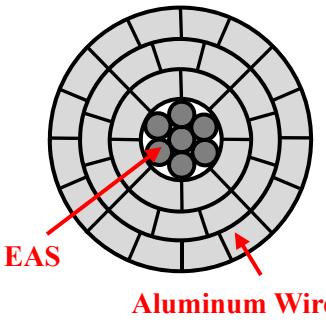
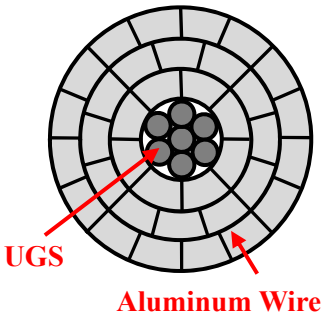
Type of Conductor	LL-ACSR 633 mm^2	LL-ACSR 637 mm^2
Component of stranded wires	Al 16/4.67, 12/4.80, 8/4.74 EAS[4] 7/2.80	Al 16/4.80, 12/4.70, 8/4.70 UGS[5] 7/3.10
Total area of Aluminum wires	632.5 mm^2	636.6 mm^2
Total Diameter	31.1 mm	31.1 mm
Weight	2,176 kg/km	2,177 kg/km
Ultimate Tensile strength	185,300 N	186,000 N
Modulus of elasticity	71.1 kN/mm^2	72.8 kN/mm^2
Coefficient of linear expansion	20.7×10^{-6} /°C	20.5×10^{-6} /°C
DC resistance at 20°C	0.0448 ohm/km	0.0455 ohm/km

Source: JICA Study Team

Code Name	LL-ACSR 633	LL-ACSR 637

[4] EAS: extra high strength aluminum-clad steel

[5] UGS: ultra - high strength galvanized steel

Identification	LL-ACSR: Low Loss Aluminium Conductor Steel Reinforced	
Cross Section		
Al [mm^2]	632.5	636.6
UTS [daN]	18,530	18,600
Dia [mm]	31.1	
Thermal Capacity	Approx. 950 A	

Source: JICA Study Team

Fig. 6.1-2 Structure of Low Loss Conductors

Table 6.1-7 Technical Characteristics of Ground Wires (225 kV)

Type of Ground Wire	AACSR PHLOX 94 mm^2 or equivalent
Component of stranded wires	Al 15/2.10, St 19/1.68
Total area of wires	94.1 mm^2
Total Diameter	12.7 mm
Weight	490.5 kg/km
Ultimate Tensile strength	80,350 N
Modulus of elasticity	116,000 N/mm^2
Coefficient of linear expansion	14.7×10^{-6} /°C
DC resistance at 20 °C	0.642 ohm/km

Source: JICA Study Team

(3) Conditions of Clearance

The tower height is determined by the minimum height, the minimum clearance and the sag of conductors. Table 6.1-8 shows the minimum height and clearance. The minimum height of the navigable waterway is 15 m considering the mast height of approx. 13 m.

Table 6.1-8 Minimum Height and Clearance (225 kV)

Height	225kV	Remarks
General Land	8.0 m	
Road	9.0 m	Insulator Assembly with Double String
Structures, Pillars, Walls	5.2 m	
Expressway, 2-lane Road	10.0 m	Insulator Assembly with Double String
Navigable Waterway	15.0 m	Insulator Assembly with Double String
Pipe Line (Oil, Gas, Water)	10.0 m	Insulator Assembly with Double String
Transmission & Distribution Line, Telephone Line	4.6 m	Insulator Assembly with Double String
Rail Way	9.0 m	Insulator Assembly with Double String

Source: JICA Study Team based on Detailed Design Report by POWER COM, October 2018

(4) Conditions of Conductor and Ground Wire

1) Horizontal Maximum Tension of Conductor (Tmax)

The horizontal maximum tension of conductors (Tmax) is decided so as to satisfy the following condition (Tmax = 45 kN).

- ✓ 40 %UTS > T (Temperature: 27 degree, Wind Pressure: 48 daN/m^2)
- ✓ 40 %UTS > T (Temperature: 15 degree, Wind Pressure: 18 daN/m^2)
- ✓ 23 %UTS > T (Temperature: 15 degree, No Wind)
- ✓ 20 %UTS > T (Temperature: 27 degree, No Wind)
- ✓ 16 %UTS > T (Temperature: 45 degree, No Wind)

2) Horizontal Maximum Tension of Ground Wire (Tmax)

The horizontal maximum tension of ground wires (Tmax) is decided so as to satisfy about 80 % of conductor sag. Just for information, the maximum span length is 400 m. Also, the sag of OPGW is set in such a way that it is equal to the sag of AACSR PHLOX 94 mm^2 (Tmax = 18 kN).

Table 6.1-9 shows the maximum working tension of conductors and ground wires.

Table 6.1-9 Maximum Working Tension and Every Day Stress (Max Span Length = 400 m)

Type	UTS	Maximum Working Tension	Every Day Stress
LL-ACSR 633 mm^2 LL-ACSR 637 mm^2	185,300 N	39,520 N (MWT / UTS =21%)	36,880 N (EDS/UTS=20%)
AACSR PHLOX 94 mm^2 or equivalent	80,350 N	14,910 N (MWT / UTS[6] =19%)	14,030 N (EDS/UTS=17%)

Source: JICA Study Team

3) Sag of Conductor

Table 6.1-10 shows the calculation results of the conductor sag. For your information, the maximum span length is 400 m.

Table 6.1-10 Sag of Conductor (at 75 °C with no wind)

Span Length [m]	200	250	300	350	400
Sag [m]	4.6	6.8	9.4	12.5	16.0

Source: JICA Study Team

(5) Insulator Assembly

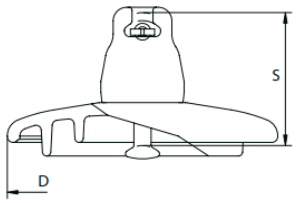
Insulator units shall be ball and socket type suspension insulators that satisfy IEC 60120 and IEC 60305 or equivalent standards. The number of insulator units will be about 19, which is the same as the existing transmission lines. The new transmission lines are far away from the coast, but CI-ENERGIES has set the domestic pollution level to "IV (Very Heavy)". Also, the pollution level of the transmission line between Bouake2 S/S located near this project and Serebou S/S is "IV (Very Heavy)". Thus, the pollution level shall be "IV (Very Heavy)". Table 6.1-11 shows the characteristics of the insulator type followed by the characteristics of the insulator unit.

Table 6.1-11 Characteristics of Insulator type

Type	Height	Diameter	Minimum Mechanical Falling Load	Remarks
U160BS x 2	146 mm	280 mm	320 kN	Tension
U160BS x 2			320 kN	Suspension
U160BS			160 kN	Suspension

Source: JICA Study Team

[6] UTS: Ultimate Tensile Strength

Type	Glass U160BS
Cross Section	
Minimum Mechanical Failing Load [kN]	160
Diameter (D) [mm]	280
Spacing (S) [mm]	146
Metal Fitting Size [mm]	20
Creepage Distance [mm]	400
Power Frequency Withstand Voltage (Dry) one minute [kV] **Power Frequency Withstand Voltage (Wet) one minute [kV]**	75 45
Weight [daN]	Approx. 5.4

Source:: Catalog from Sediver Homepage

Fig. 6.1-3 Characteristics of insulator Unit

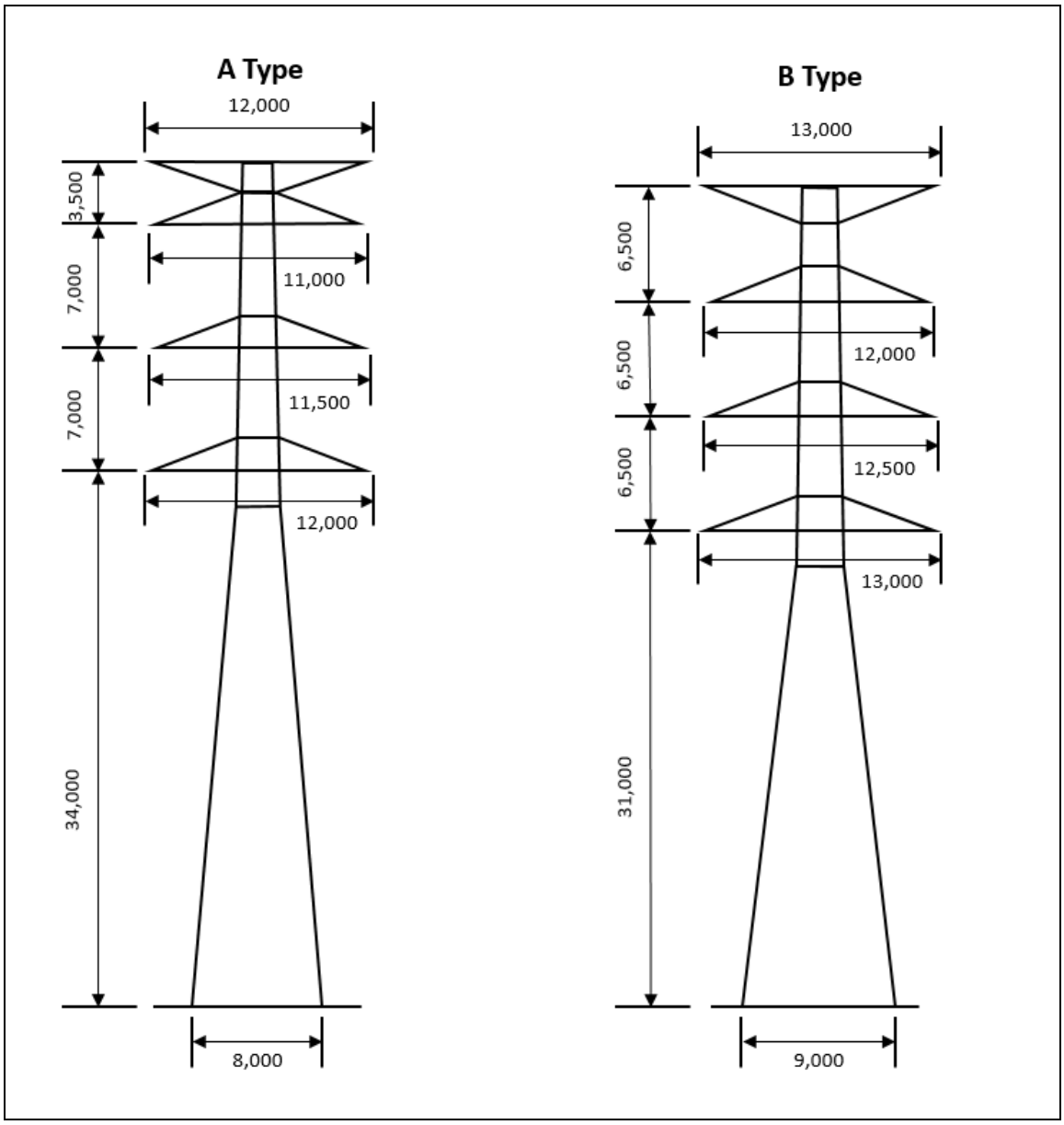
(6) Supporting Structure (Tower)

The supporting structures shall be steel towers using equal angle steel. Table 6.1-12 shows the basic type of tower (Type A, Type B, Type C and Type D). Crossing towers, connecting towers and branch towers will be designed individually. Fig. 6.1-4 shows the main tower structure.

Table 6.1-12 Type of Tower

Tower Type	Insulator Assembly	Horizontal Angle of Line
A	Suspension	0° ～ 3°
B	Tension	0° ～ 30°
C	Tension with supporting	0° ～ 60°
D	Tension with supporting	Dead end tower

Source: JICA Study Team



Source: JICA Study Team

Fig. 6.1-4 Main Tower Structure

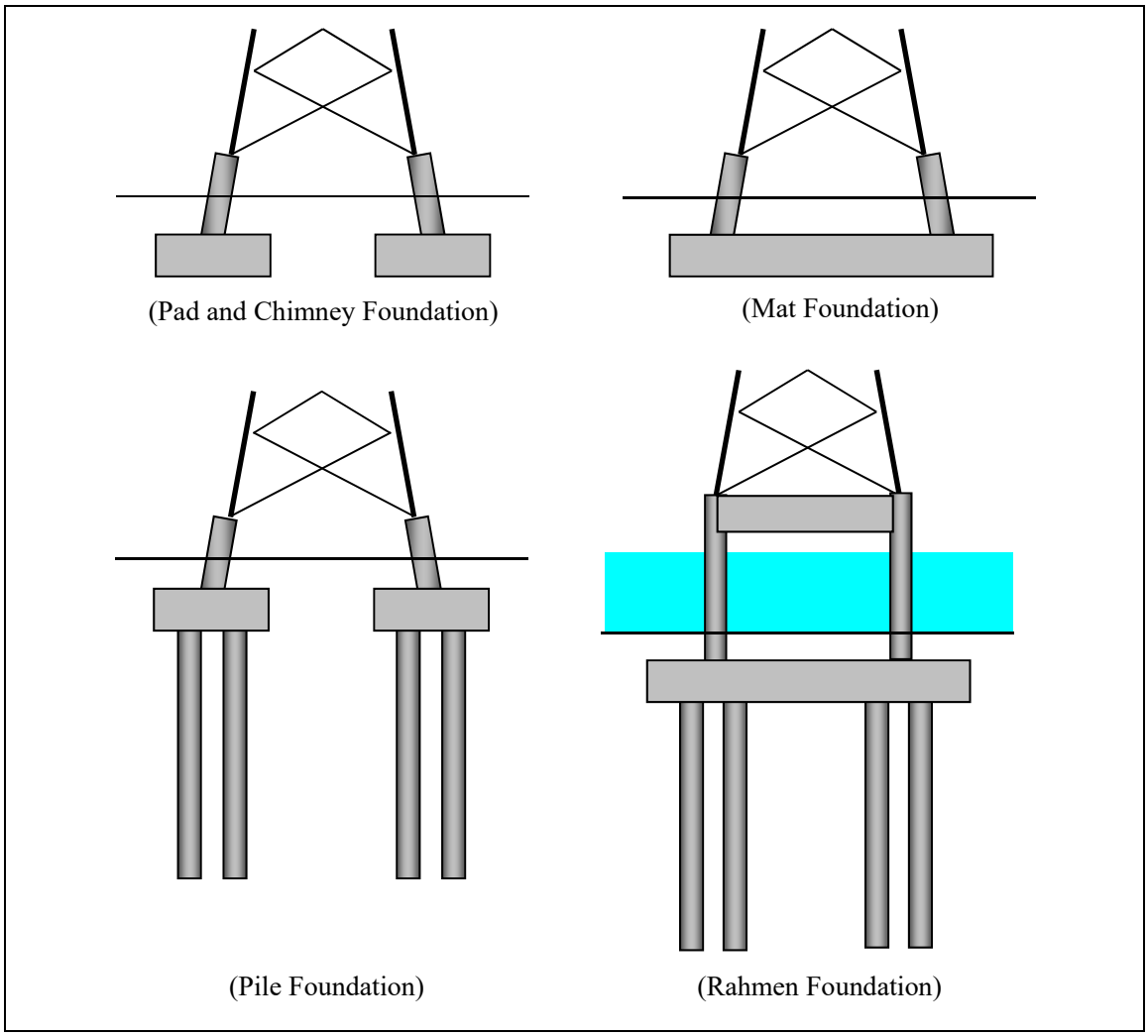
(7) Foundation

Table 6.1-13 shows the 4 types of foundation applied in this project. Fig. 6.1-5 shows examples of each foundation type.

Table 6.1-13 Types of Foundation

Type	Description	Application
I	Pad and Chimney Foundation	- N value: Basically more than 10 - Flat area with good soil condition
II	Mat Foundation	- N value: Less than 10 - Flat area with soft soil condition, and in which differential displacement might occur at Type I
III	Pile Foundation	- N value: Less than 10 - Flat area with soft soil condition, and in which it is difficult to withstand compression stress at Type I and II
IV	Rahmen Foundation	- N value: Less than 10 - Flat area with soft soil condition and high water level

Source: JICA Study Team



Source: JICA Study Team

Fig. 6.1-5 Type of Foundation

(8) Other Studies

1) Crossing Tower over Existing Transmission Line

It is necessary to install towers crossing over the existing 225 kV and 90 kV overhead transmission lines.

2) Connecting Tower between Overhead and Underground Transmission Lines

It is necessary to install connecting towers inside the Taabo S/S and near the Bouaké2 S/S.

3) Branch Tower

It is necessary to make π branch to the Yamoussoukro2 S/S and Bouaké2 S/S.

6.1.4 Budgetary Cost Estimate

Nonpublic Information

6.1.5 Construction Schedule

Nonpublic Information

6.2 EXISTING SUBSTATION FACILITY

6.2.1 Preliminary Design Concept (Existing substation)

The scope of this study includes expansion of 3 existing substations. Preliminary design concept of the substation facility related to this study is explained below.

(1) Type of substation

There is no big concern regarding site constraint in the existing Taabo and Bouake2 substation. Therefore, the existing Taabo and Bouake2 substation will be expanded as Air Insulated Switchgear (Hereinafter called "AIS") to meet the criteria of the existing facilities.

From the view point of site constraint, Kossou substation will be expanded as Gas Insulated Switchgear (hereinafter called "GIS") to reduce the size of substation site compared to AIS. Indoor type GIS shall be installed in Kossou substation. It has been mainly installed in Western countries and Côte d'Ivoire.

(2) Substation capacity and adopted voltage

The decision regarding the substation capacity and the adopted voltage of each substation is based on the request from CI-ENERGIES and the network system analysis.

(3) Bus bar configuration (scheme)

Existing substation shall meet the existing busbar configuration. Kossou substation is currently a single busbar configuration. However, it will be upgraded to a double busbar configuration by CI-ENERGIES' self-funded project. Therefore, a double busbar configuration shall be installed in Taabo, Kossou and Bouake2 substations.

(4) Shunt Reactor

225kV shunt reactor will be installed in Taabo, Kossou and Bouake2 substation. The decision regarding the shunt reactor capacity of each substation is based on the network system analysis. A variable capacity type shall be installed to suppress voltage fluctuations when the circuit breaker of shunt reactor is open to close or close to open.

(5) Grounding scheme

Existing substation shall meet the configurations of the existing scheme. Earth mesh of substations,

which will be expanded, are connected with the existing earth mesh properly.

(6) Protection relay scheme

Basic properties of the main protection relays are shown below. These relays would be changed as per the actual situation of each substation.

- 225kV T/L protection： Current differential relay, Distance relay
- 225kV Busbar protection： Differential relay (voltage suppressed type)
- 225kV Shunt Reactor protection：Over current relay, Unbalanced current relay

(7) Substation control system

Bay Control Unit (hereafter referred to as BCU) compliant with IEC61850 will be adopted, in order to maintain consistency with the existing substation systems.

(8) Countermeasures against disaster

These 3 substations are located in areas where major earthquakes and floods are unlikely to occur. However, the necessary measures have to be considered at the time of detailed design for each individual substation.

(9) Countermeasures against environmental safety

Shunt reactor insulating oil outflow prevention equipment is installed in these substations.

6.2.2 Existing Taabo substation

Proposed single line diagram and layout of Taabo substation are shown in Fig. 6.3-3 Fig. 6.3-5.

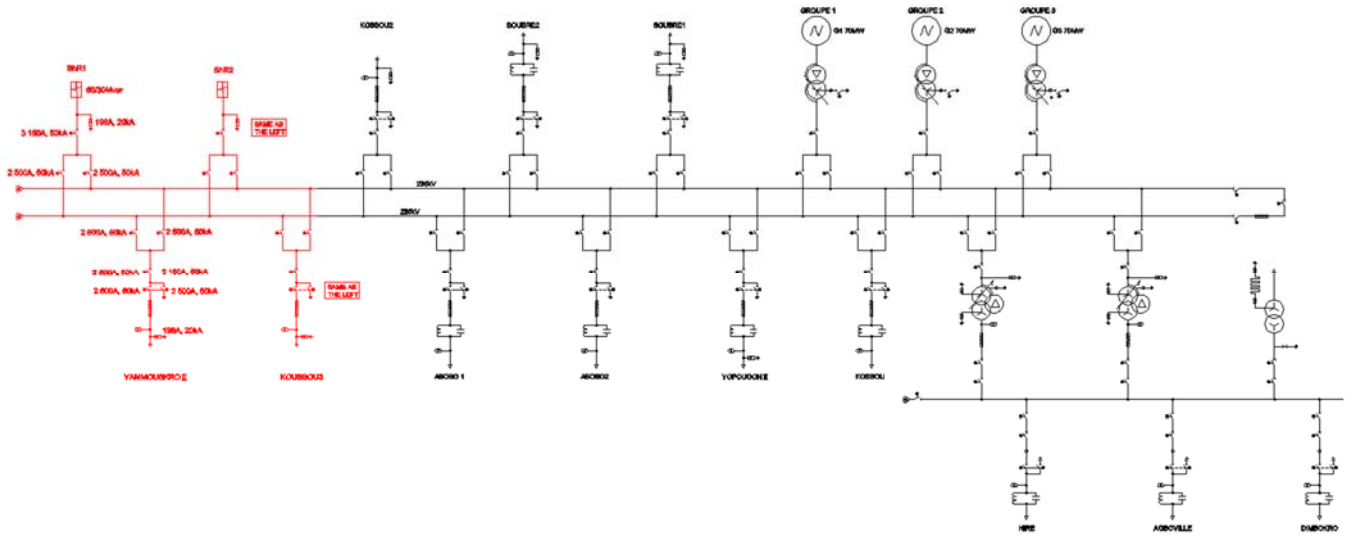


Fig. 6.2-1 Single Line Diagram of Taabo Substation

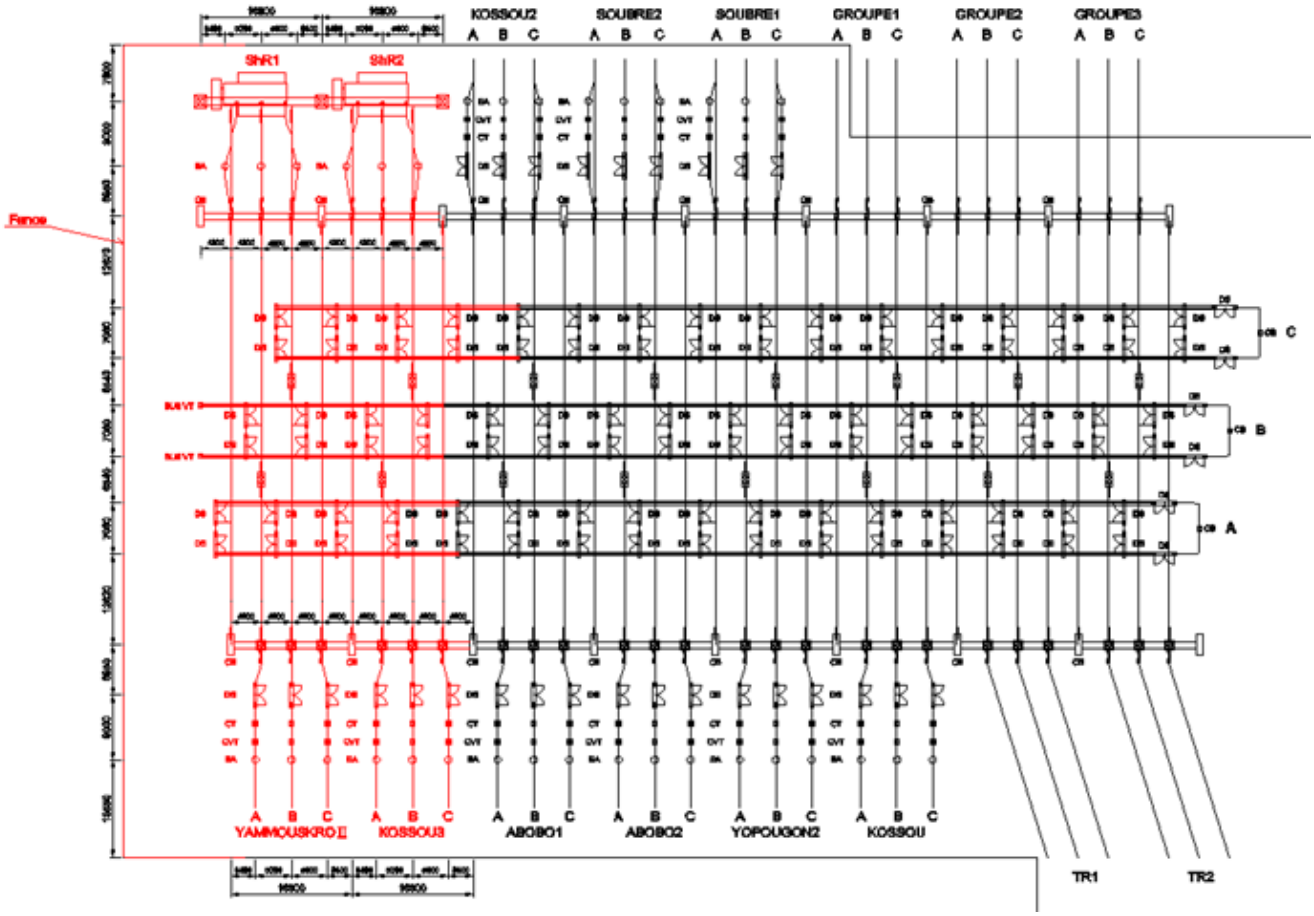


Fig. 6.2-2 Layout of Taabo Substation

The number of each equipment and basic specifications of the Taabo substation are described below.

(1) Main switchgear

Two transmission line bays will be installed.

- 225kV Circuit Breaker 2 sets (single phase x 3 x 2)
- 225kV Disconnector with Earthing Switch 2 sets (single phase x 3 x 2)
- 225kV Disconnector without Earthing Switch 4 sets (single phase x 3 x 4)
- 225kV Surge Arrester 2 sets (single phase x 3 x 2)
- 225kV Current Transformer 2 sets (single phase x 3 x 2)
- 225kV Voltage Transformer 6 phases (single phase x 3 x 2)

Two shunt reactor bays will be installed.

- 225kV Circuit Breaker 2 sets (single phase x 3 x 2)
- 225kV Disconnector without Earthing Switch 4 sets (single phase x 3 x 4)
- 225kV Surge Arrester 2 sets (single phase x 3 x 2)
- 225kV Current Transformer 2 sets (single phase x 3 x 2)

Description	Basic specification
Rated Voltage	225kV
Rated current	GCB:3150A, DS: 2500A
Rated short time current	GCB: 50kA, DS: 50kA,

(2) Shunt Reactor

Two additional shunt reactors will be installed.

- 225kV 60/30Mvar Variable Shunt Reactor 2 sets

(3) Other equipment

Depending on additional two transmission line bays and two shunt reactor bays, the aluminum pipe busbars, steel structures, etc. will be installed.

- 225kV Yard Earthing System 1 lot
- 225kV Conductor and Electrical Connections 1 lot
- 225kV Insulators 1 lot
- 225kV Aluminum tubular Busbar 1 lot
- 225kV Steel Structures 1 lot
- Low Voltage & Control Cable 1 lot

(4) Control and Protection relay

Control system and protection relays for Taabo substation will be of Bay Control Unit (hereinafter called "BCU") type based on IEC61850.

- 225kV Transmission line bay control panel 4 units
- 225kV T/L protection panel 4 units
- 225kV Shunt Reactor protection panel 2 units

(5) SCADA system and Communication system

Existing SCADA system made by Alstom will be modified and the communication system will be installed.

- Renovation of Existing SCADA 1 lot
- FO Terminal for 225kV AC system 1 set
- Optical Fiber Cable 1 lot
- Optical Distribution Frame (ODF) 1 set

(6) Civil and building work

Depending on additional two transmission line bays and two shunt reactor bays, the necessary land expansion and grading of south part of Taabo substation will be carried out. Due to lack of enough space in the existing control building, a new control building will be constructed.

- Substation land grading 1 lot
- Equipment foundation 1 lot
- Control building 1 lot
- Cable pit installation 1 lot

6.2.3 Existing Kossou substation

Proposed single line diagram and layout of Kossou substation are shown in Fig. 6.3-3 and Fig. 6.3-54.

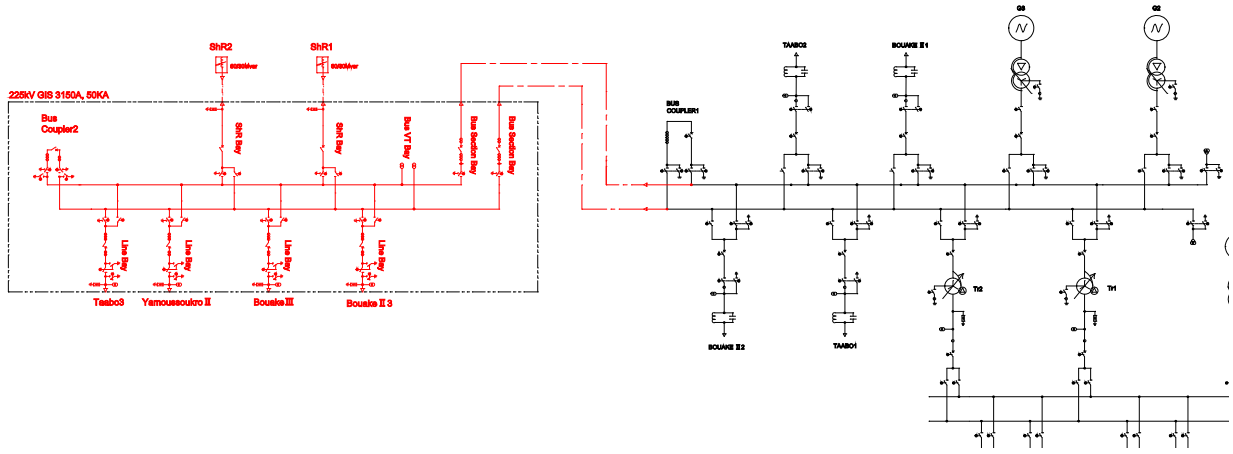


Fig. 6.2-3 Single Line Diagram of Kossou Substation

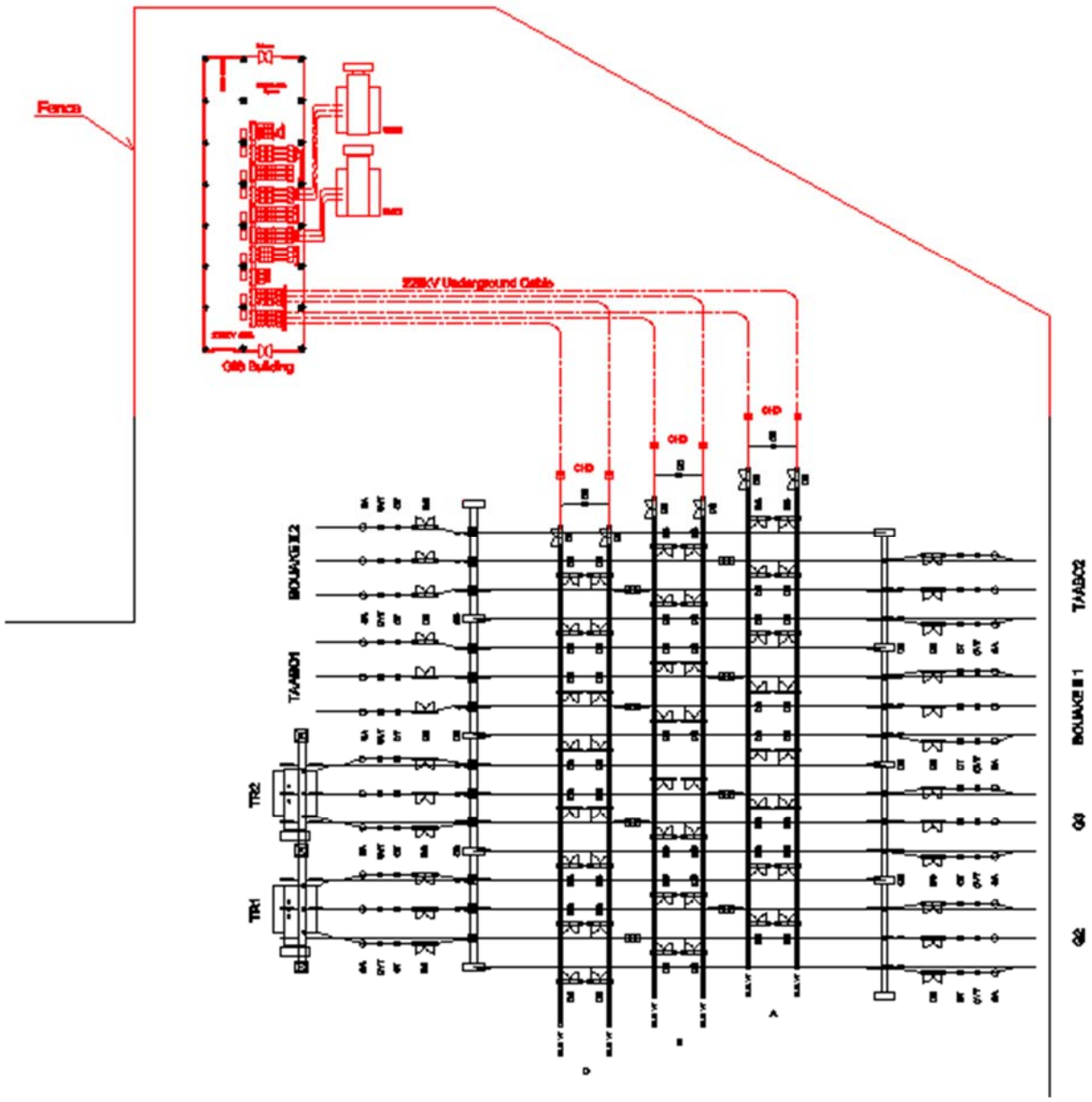


Fig. 6.2-4 Layout of Kossou Substation

The number of each equipment and basic specifications of the Kossou substation are described below.

(1) Main switchgear

Four transmission line bays will be installed.

- 225kV Double Bus Gas Insulated Switchgear (T/L Feeder) 4 sets

Two shunt reactor bays will be installed.

- 225kV Double Bus Gas Insulated Switchgear (Shunt Reactor) 2 sets

Two bus section bays will be installed.

- 225kV Double Bus Gas Insulated Switchgear (Bus Section) 2 sets
- 225kV Disconnector without Earthing Switch 2 sets (single phase x 3 x 2)

A bus coupler bay will be installed.

- 225kV Double Bus Gas Insulated Switchgear (Bus Coupler) 1 sets

A bus voltage transformer bay will be installed.

- 225kV Double Bus Gas Insulated Switchgear (VT) 1 sets

Description	Basic specification
Type of GIS	Indoor type GIS
Bus type	Double Bus
Rated Voltage	225kV
Rated Current	3150A
Rated Short Circuit Current	50 kA

(2) Shunt Reactor

Two additional shunt reactors will be installed.

- 225kV 60/30Mvar Variable Shunt Reactor 2 sets

(3) Other equipment

Power cables, etc. will be required for the connection between the new 225kV GIS and the existing 225kV bus.

- 225kV Yard Earthing System 1 lot
- 225kV Conductor and Electrical Connections 1 lot
- 225kV Steel Structures 1 lot
- 225kV power cable and accessories 1 lot
- Low Voltage & Control Cable 1 lot

(4) Control and Protection relay

Control system and protection relays for Kossou substation will be of BCU type based on IEC61850.

- 225kV Transmission line bay control panel 11 units
- 225kV Bus protection panel 1 lot
- 225kV Line protection panel 4 units
- 225kV Shunt Reactor protection panel 2 units

(5) SCADA system and Communication system

Existing SCADA system made by SIFANG (China), which will be installed in the World Bank project, shall be modified.

- Renovation of Existing SCADA 1 lot
- FO Terminal for 225kV AC system 1 set
- Optical Fiber Cable 1 lot
- Optical Distribution Frame (ODF) 1 set

(6) Civil and building work

To install a new GIS building, the necessary land expansion and grading of northeast part of Kossou substation will be carried out. Due to the lack of sufficient space in the existing control building, a new control building will be constructed.

- Substation land grading 1 lot
- Equipment foundation 1 lot
- GIS building 1 lot
- Control building 1 lot
- Cable pit installation 1 lot

6.2.4 Existing Bouake2 substation

Proposed single line diagram and layout of Bouake2 substation are shown in Fig. 6.3-3 and Fig. 6.3-5.

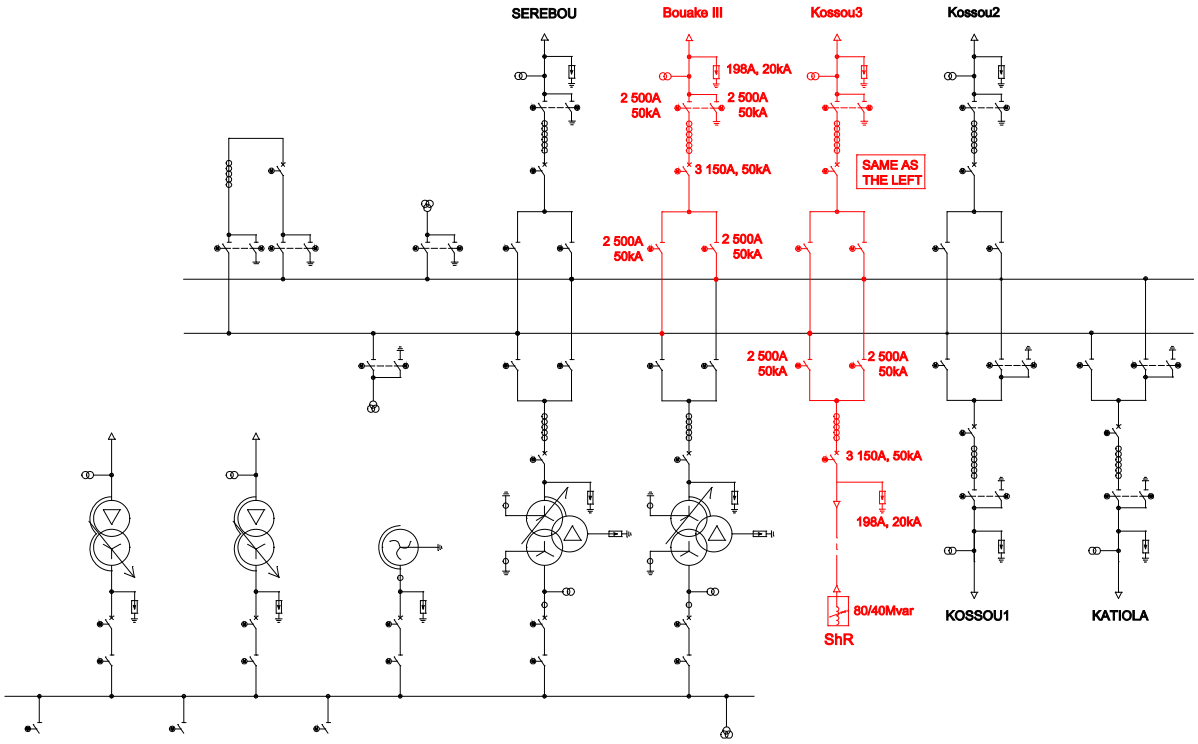


Fig. 6.2-5 Single Line Diagram of Bouake2 Substation

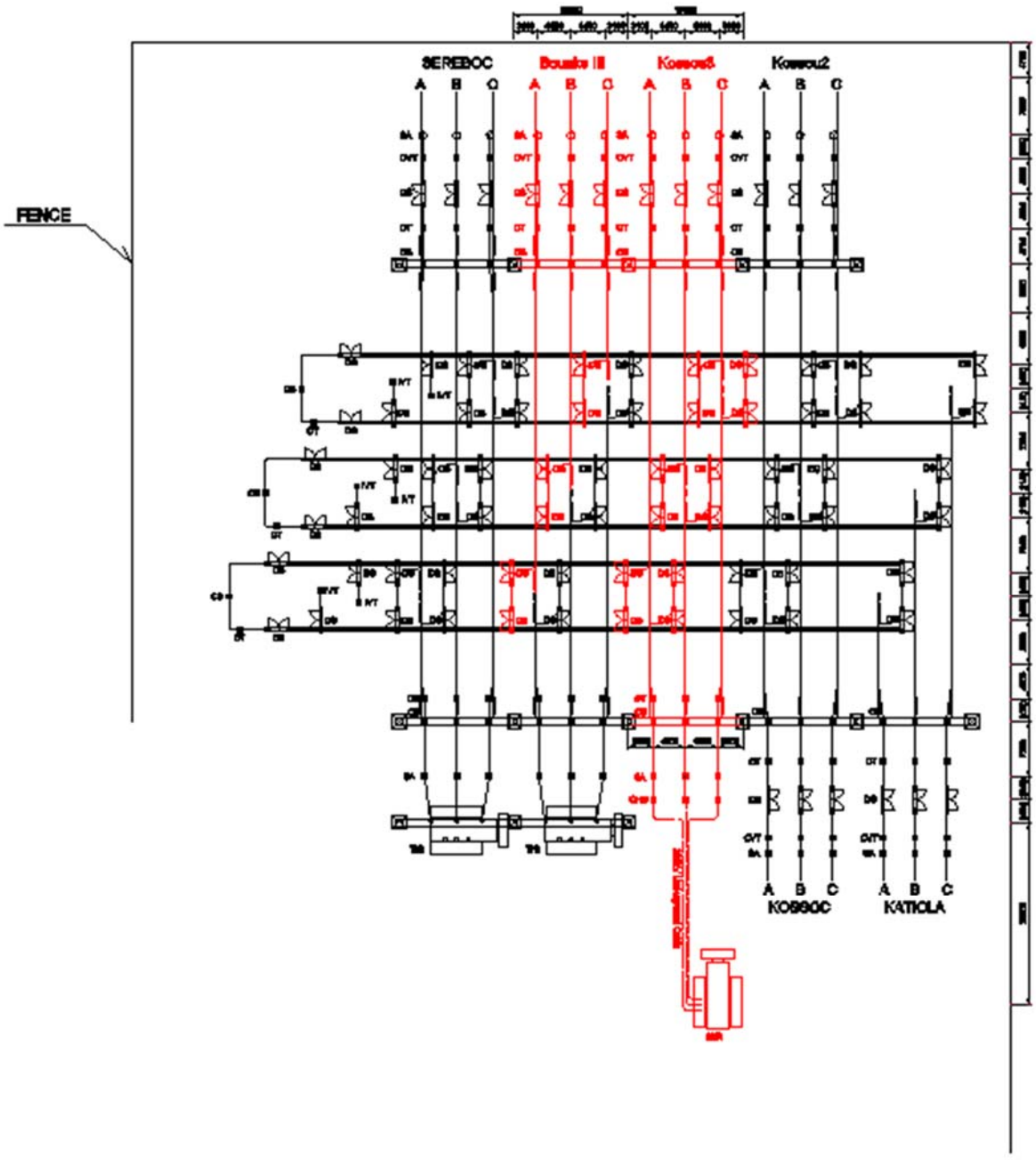


Fig. 6.2-6 Layout of Bouake2 Substation

The number of each equipment and basic specifications of the Bouake2 substation are described below.

(1) Main switchgear

Two transmission line bays will be installed.

- 225kV Circuit Breaker 2 sets (single phase x 3 x 2)
- 225kV Disconnector with Earthing Switch 2 sets (single phase x 3 x 2)
- 225kV Disconnector without Earthing Switch 4 sets (single phase x 3 x 4)
- 225kV Surge Arrester 2 sets (single phase x 3 x 2)
- 225kV Current Transformer 2 sets (single phase x 3 x 2)
- 225kV Voltage Transformer 6 phases (single phase x 3 x 2)

A shunt reactor bay will be installed.

- 225kV Circuit Breaker 1 sets (single phase x 3 x 1)
- 225kV Disconnector without Earthing Switch 2 sets (single phase x 3 x 2)
- 225kV Surge Arrester 1 sets (single phase x 3 x 1)
- 225kV Current Transformer 1 sets (single phase x 3 x 1)

Description	Basic specification
Rated Voltage	225kV
Rated current	GCB:3150A, DS: 2500A
Rated short time current	GCB: 50kA, DS: 50kA,

(2) Shunt Reactor

Additional shunt reactor will be installed.

- 225kV 80/40Mvar Variable Shunt Reactor 2 sets

(3) Other equipment

Depending on additional two transmission line bays and a shunt reactor bay, the aluminum pipe busbars, steel structures, etc. will be installed.

- 225kV Yard Earthing System 1 lot
- 225kV Conductor and Electrical Connections 1 lot
- 225kV Insulators 1 lot

- 225kV Aluminum tubular Busbar 1 lot
- 225kV Steel Structures 1 lot
- Low Voltage & Control Cable 1 lot

(4) Control and Protection relay

Control system and protection relays for Taabo substation will be of BCU type based on IEC61850.

- 225kV Transmission line bay control panel 3 units
- 225kV Bus protection panel 1 lot
- 225kV T/L protection panel 2 units
- 225kV Shunt Reactor protection panel 1 units

(5) SCADA system and Communication system

Existing SCADA system made by NR (China) will be modified and the communication system will be installed.

- Renovation of Existing SCADA 1 lot
- FO Terminal for 225kV AC system 1 set
- Optical Fiber Cable 1 lot
- Optical Distribution Frame (ODF) 1 set

(6) Civil and building work

Due to the lack of sufficient enough space in the existing control building, a new control building will be constructed.

- Equipment foundation 1 lot
- Control building 1 lot
- Cable pit installation 1 lot

6.2.5 Budgetary Cost Estimate

Nonpublic Information

6.2.6 Construction Schedule

Nonpublic Information

6.3 NEW SUBSTATION FACILITY

6.3.1 Preliminary design concept

The basic design concept of the Yamoussoukro 2 and Bouaké 3 substations is explained below.

(1) Type of substation

The types of substations can be categorized into AIS, which is an air insulation, and GIS, which is a gas insulation. The following table shows the characteristics of AIS, outdoor GIS and indoor GIS. Generally, the AIS system is adopted because of higher cost merit. On the other hand, when the size of the land is limited, the GIS system is adopted from the viewpoint of feasibility instead of cost, and the system can reduce the installation space.

Switchgear type	Installation cost	Necessary footprint	Recovery time in equipment accident	Reliability against pollution
AIS	Low	Large	Short	Low
Indoor GIS	High	Small	Long	High
Outdoor GIS	High	Very small	Long	High

The results of the study on whether or not to introduce the AIS system are shown in Fig.6.3-1 and Fig.6.3-2. Both the Yamoussoukro 2 and Bouaké 3 substations have sufficient space for the installation of the AIS as shown in the figure. Therefore, it is possible to adopt AIS system at both the substations.

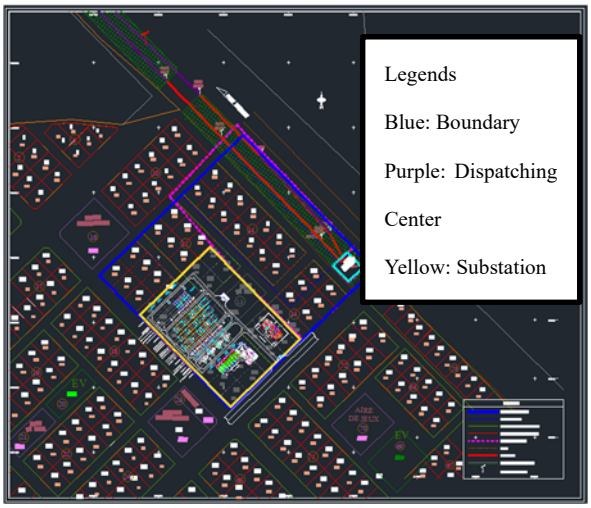


Fig. 6.3-1 AIS introduction in Yamoussoukro 2 substation

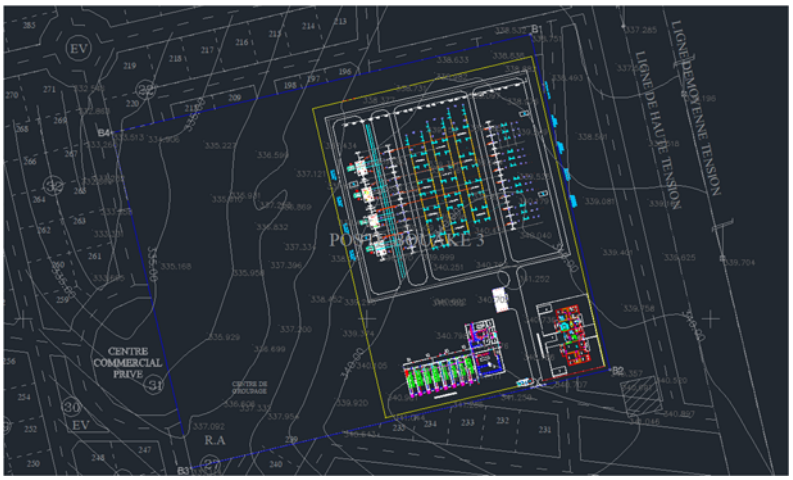


Fig. 6.3-2 AIS introduction in Bouaké 3 substation

(2) The substation capacity and adopted voltage

The capacity and voltage for each substation will be determined based on the request from CI-Energies.

(3) Busbar configuration

The Yamoussoukro 2 and Bouaké 3 substations will be core 225kV substations, so the double busbar system is highly reliable.

(4) Power transformer

All new transformers shall be equipped with an on-load tap changer. The on-load tap changer should be of vacuum valve type for maintenance-free operation. Both two-wire and three-wire transformer connections are considered at the request of CI-Energies. YNyn0 (primary side star connection, neutral point ground, secondary side star connection, and resistance ground) is adopted for 33kV, and YNd11 (star connection on the primary side, neutral grounding, delta connection on the secondary side, phase 30 degree delay) is adopted for 15kV.

The advantages and disadvantages related to the number of transformer windings are shown in Table 6.3-1. Since there is enough space in the land of the new Yamoussoukro2 and Bouake3 substations, two-windings transformers should be adopted with priority given to reliability (range of influence during transformer accidents and maintenance) and operation (voltage controllability on the MV side) and the details are listed in the below table. However, it is designed to

accommodate two cases: adoption of two winding transformers, and adoption of three winding transformers.

Table 6.3-1 Comparison of two- and three-winding transformers

Type	2 windings	3 windings	
Voltage [kV]	225/33+225/15	225/33/15	
Capacity [MVA]	60+50	110 (60+50)	
OLTC Nos.	HV 1unit	HV 1unit	MV 2units (33&15kV)
Reliability	+++	+	+
Operability	+++	+	+++
Required Space	++ (100%)	+++ (70%)	++ (95-100%)
Cost	++ (100%)	+++ (85%)	++ (95-100%)

+ : bad, ++: normal, +++: good

(5) Reactive power equipment

33, 15 kV power capacitor shall be installed to prevent voltage drop in the distribution lines.

(6) Grounding scheme

The 225kV earthing system shall be directly grounded, 33 kV system shall be a resistance earthing system, and 15 kV shall be a non-earthing system using an earthing transformer.

(7) Protection system

The design should be consistent with the existing substation considering the maintenance and operability. The main protection relays are listed below.

- 225kV transmission line protection: Current deferential relay, Distance relay
- 225kV busbar protection: Deferential relay (voltage suppressed type)
- 225kV transformer protection： Current deferential relay
- 15,33 kV distribution line protection： Over current relay

(8) Substation control system

Bay Control Unit (hereafter referred to as BCU) compliant with IEC61850 will be adopted in order to be consistent with the existing substation systems.

(9) Communication system

It is most important to unify the communication system throughout the system. Thus, the communication system is based on multiplexing equipment installed at the existing 225 kV substation. Specifically, the FOX615 manufactured by ABB shall be used.

(10) Countermeasures against disaster

Both the substations are located in areas where major earthquakes and floods are unlikely to occur. However, the necessary measures have to be considered at the time of detailed design for each individual substation.

(11) Countermeasures against environmental safety

Transformer insulating oil outflow prevention equipment is installed in these substations.

6.3.2 New Yamoussoukro 2 substation

Proposed layout of the new Yamoussoukro 2 substation and its single line diagram are shown in Fig. 6.3-3 to Fig. 6.3-5. In this report, the drawings for the transformers are presented for the two-windings transformers, which need a larger site area when compared to the three-windings transformers. A single-line diagram for the installation of three-windings transformers is attached in the annexure. The arrangement of the medium voltage cubicles is designed according to the CI-Energies standard configuration.

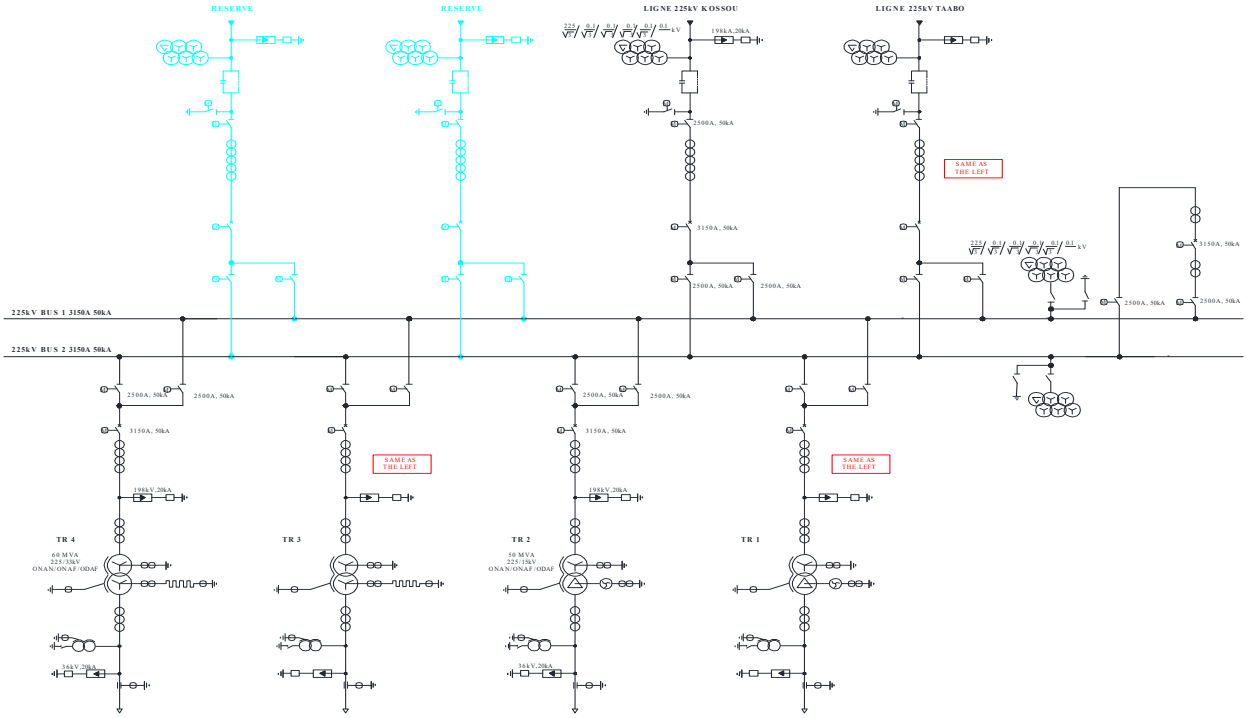


Fig. 6.3-3 Yamoussoukro 2 substation single line diagram (225kV)

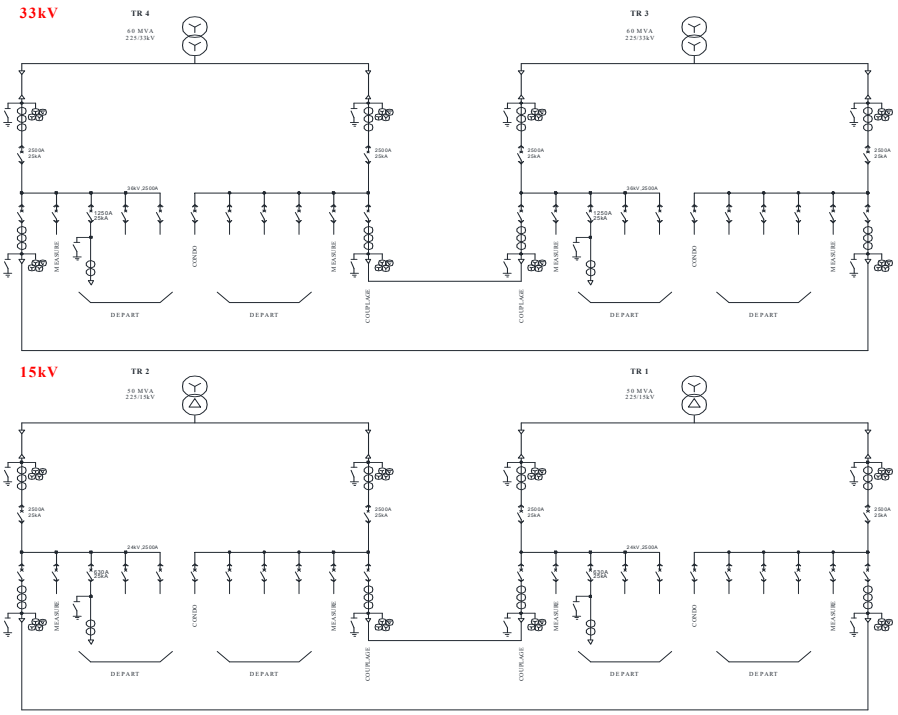


Fig. 6.3-4 Yamoussoukro 2 substation single line diagram (33・15kV)

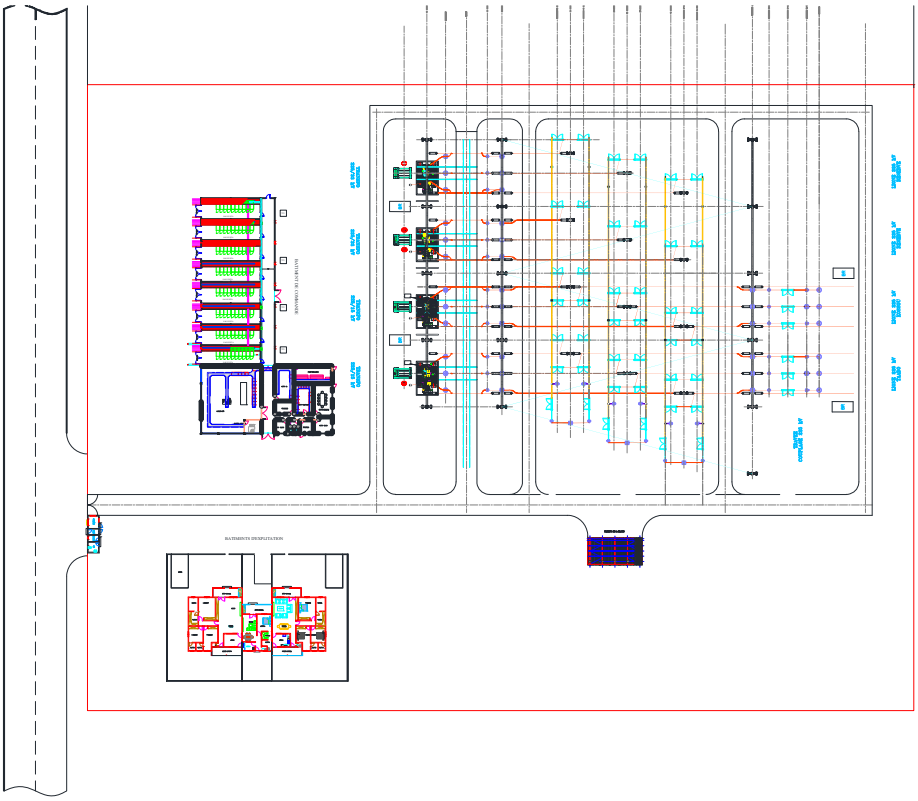


Fig. 6.3-5 Yamoussoukro 2 substation layout

The number of units delivered and the basic specifications of each major component of the Yamoussoukro 2 substation are shown below.

(1) Main switchgear

The AIS system will be installed with two (2) new transmission line bay unit.

- 225kV Circuit breaker 2 sets（single phase x 3 x 2）
- 225kV Disconnector with earthing switch 2 sets（single phase x 3 x 2）
- 225kV Disconnector 4 sets（single phase x 3 x 4）
- 225kV Lighting arrester 2 sets（single phase x 3 x 2）
- 225kV Voltage transformer 2 sets（single phase x 3 x 2）
- 225kV Current transformer 2 sets（single phase x 3 x 2）

The AIS system will be installed with four (4) new transformer bay units.

- 225kV Circuit breaker 4 sets（single phase x 3 x 4）
- 225kV Disconnector with earthing switch 8 sets（single phase x 3 x 8）
- 225kV Lighting arrester 4 sets（single phase x 3 x 4）
- 225kV Voltage transformer 4 sets（single phase x 3 x 4）

The AIS system will be installed with one (1) new bus coupler bay unit.

- 225kV Circuit breaker 1 set（single phase x 3 x 1）
- 225kV Disconnector 2 sets（single phase x 3 x 2）
-225kV Current transformer 1 set（single phase x 3 x 1）

One (1) new voltage transformer bay for busbar will be installed.

- 225kV Voltage transformer 2 sets（single phase x 3 x 2）
- 225kV Disconnector 2 sets（single phase x 3 x 2）

- Description	- Basic specification
- GIS or AIS	AIS
- Rated Voltage	225kV
- Rated current	GCB:3150A, DS: 2500A
- Rated short time current	GCB: 50kA, DS: 50kA,

(2) Power transformer

Four (4) new units of transformer will be installed.

- 225/33kV Power transformer 2units
- 33kV Power cable and its accessories 1 lot

- Description	- Basic specification
- Rated Voltage	HV: 225kV, LV: 33kV
- Rated Capacity	50 MVA (ONAN) / 60MVA (ONAF)
- Winding Type	YNyn0

- 225/15kV Power transformer 2 units
- 15kV Power cable and its accessories 1 lot

- Description	- Basic specification
- Rated Voltage	HV: 225kV, LV: 15kV
- Rated Capacity	40 MVA (ONAN) / 50MVA (ONAF)
- Winding Type	YNd11

(3) Reactive power equipment

Four (4) new Capacitor bank will be installed.

- 33kV 7.2MVA (2.6MVA x 3) Capacitor bank 2 units
- 15kV 7.2MVA (2.6MVA x 3) Capacitor bank 2 units

(4) Metal-enclosed, medium voltage cubicles

The following new metal-enclosed, medium voltage cubicles will be installed.

- 33kV Cubicle for secondary of transformer 2 units
- 33kV Cubicle for distribution line 12 units
- 33kV Cubicle for 33kV voltage transformer 6 units
- 33kV Cubicle for 33kV capacitor bank 2 units

- 33kV Cubicle for busbar coupler 4 units
- 33kV Power cable and its accessories 1 lot

- Description		- Basic specification
- Rated Voltage		33 (36) kV
- Rated current	33kV	Transformer bay: 2500A Bus: 2500A Feeder: 1250A
- Rated short time current		25kA

- 15kV Cubicle for secondary of transformer 2 units
- 15kV Cubicle for distribution line 12 units
- 15kV Cubicle for 33kV voltage transformer 6 units
- 15kV Cubicle for 33kV capacitor bank 2 units
- 15kV Cubicle for busbar coupler 4 units
- 15kV Power cable and its accessories 1 lot

- Description		- Basic specification
- Rated Voltage		15 (24) kV
- Rated current	15kV	Transformer bay: 2500A Bus: 2500A Feeder: 630A
- Rated short time current		25kA

(5) Miscellaneous accessories

Aluminum pipe busbar, steel structure, etc. will be installed in accordance with the installation of 225kV busbar bay units, two (2) power transmission line bay units, and four (4) power transformer bay units.

-225kV Yard earthing system 1 lot
-225kV Conductor and electrical connections 1 lot
-225kV Insulators 1 lot
-225kV Aluminum tubular busbar 1 lot
-225kV Steel Structures 1 lot

-33kV Surge Arrester	2 sets (single phase x 3 x 2)
-33kV Insulators	1 lot
-15kV Surge Arrester	2 sets (single phase x 3 x 2)
-15kV Insulators	1 lot
-Low Voltage Control Cable	1 lot

(6) Low Voltage AC/DC system

For securing reliability, this new substation will consist of two (2) units of auxiliary transformer and two (2) units of charger (Rectifier). However, the battery unit will be only one unit.

- 33kV/400-230V Auxiliary transformer	2 units
- LVAC distribution panel	2 units
- 127V Charger (Rectifier)	2 units
- 48V Charger (Rectifier)	2 units
- DC127V battery unit	1 unit
- DC48V battery unit	1 unit
- Emergency generator	1 unit

(7) Control system and protection relay

The control system and protection relay of this new substation will be of Bay Control Unit (hereinafter called “BCU”) type based on IEC61850

- 225kV Transmission line bay control panel	2 units
- 225kV Transformer bay control panel	4 units
- 225kV Busbar coupler control panel	1 unit
- 225kV Transmission line protection relay	2 units
- 225kV Transformer protection relay	4 units
- 225kV Busbar protection relay	1 unit

(8) SCADA Telecommunication System

The SCADA system and the communication system of this new substation will be installed. Furthermore, the existing whole SCADA system was provided by Alstom and can be integrated with this system.

- SCADA system	1 lot
- MUX/SDH	1 lot
- Optical Fiber Cable	1 lot

- Optical Distribution Frame (ODF) 1 lot
- PBX system 1 lot

(9) Civil and building work

- Land preparation 1 lot
- Equipment foundation and oil pit 1 lot
- Control building 1 lot
- cable pit installation 1 lot

6.3.3 New Bouaké 3 substation

Fig. 6.3-6 to Fig. 6.3-8 show the layout of the new Bouaké 3 substation and its single line diagram. In this report, the drawings for the transformers are presented for the two-windings transformers similar to the Yamoussoukro 2 substation. A single-line diagram for the installation of three-windings transformers is attached in the annexure. The arrangement of medium voltage cubicles is designed according to the CI-Energies standard configuration.

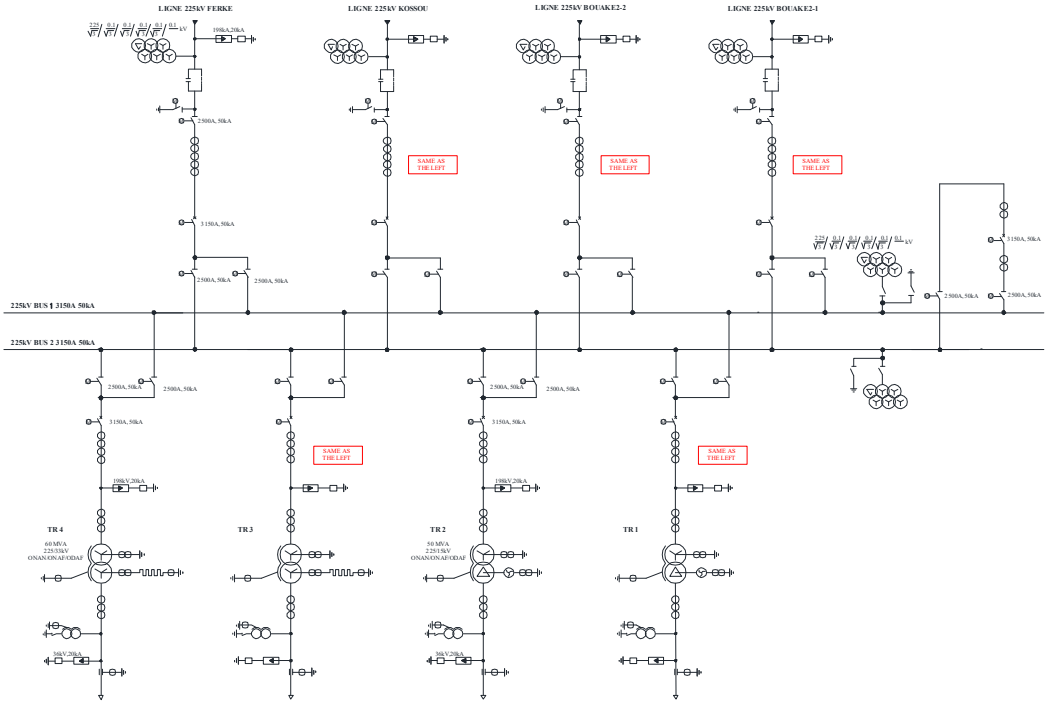


Fig. 6.3-6 Bouaké 3 substation single line diagram (225kV)

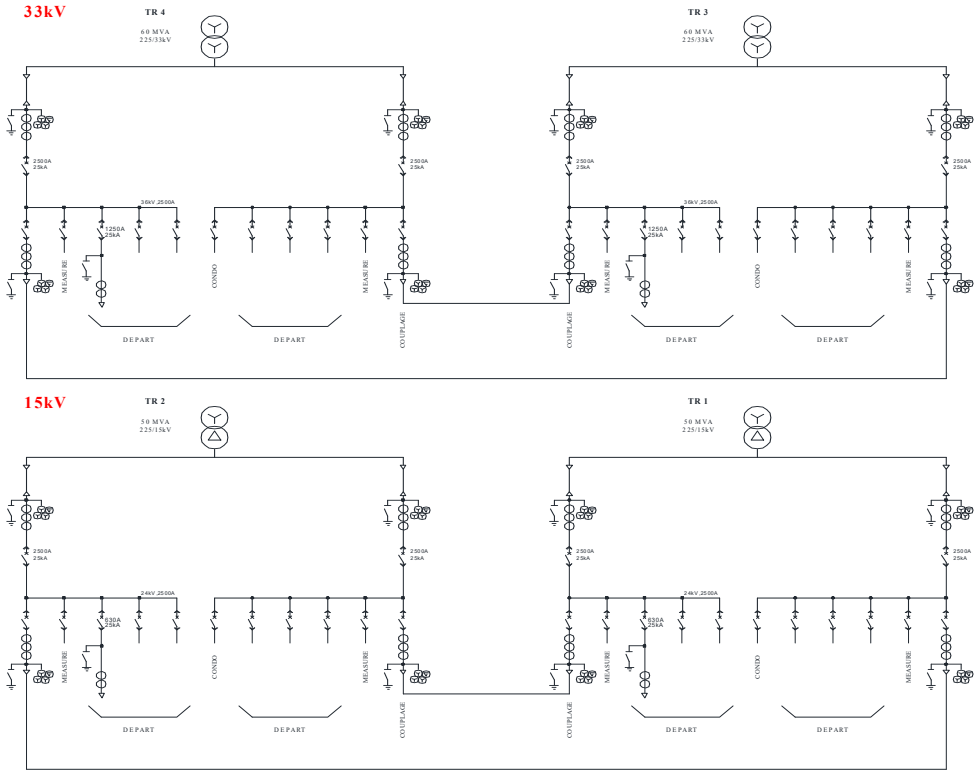


Fig. 6.3-7 Bouaké 3 substation single line diagram (33・15kV)

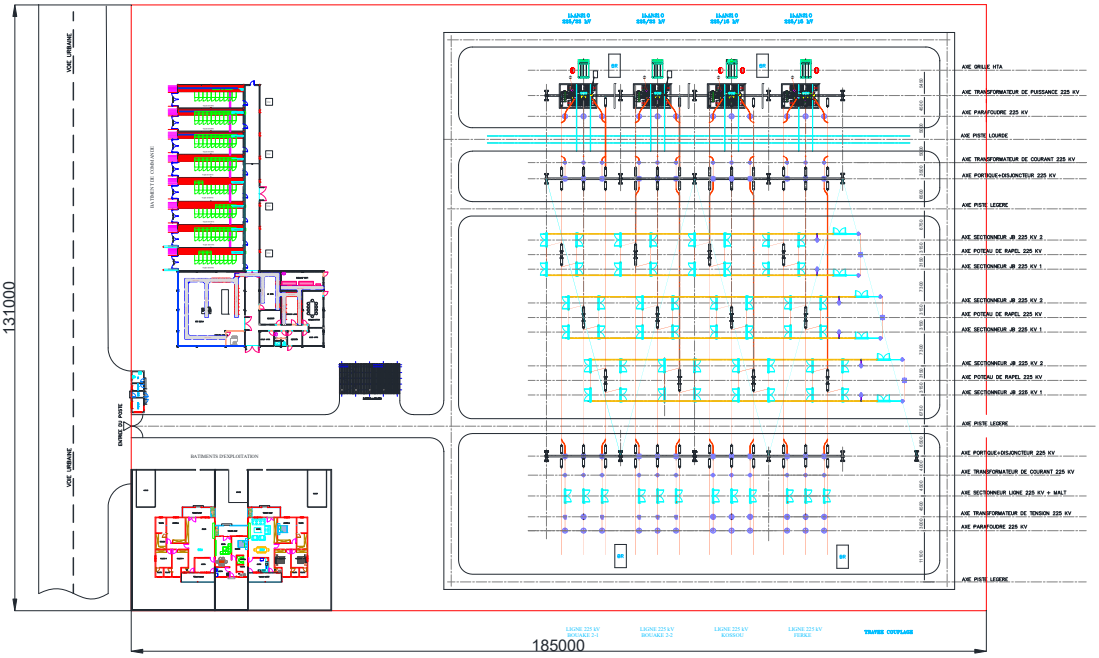


Fig. 6.3-8 Bouaké 3 substation layout

The number of units delivered and the basic specifications of each major component of the Bouaké

3 substation are shown below.

(1) Main switchgear

The AIS system will be installed with four (4) new transmission line bay unit.

- 225kV Circuit breaker 4 sets（single phase x 3 x 4）
- 225kV Disconnector with earthing switch 4 sets（single phase x 3 x 4）
- 225kV Disconnector 8 sets（single phase x 3 x 8）
- 225kV Lighting arrester 4 sets（single phase x 3 x 4）
- 225kV Voltage transformer 4 sets（single phase x 3 x 4）
- 225kV Current transformer 4 sets（single phase x 3 x 4）

The AIS system will be installed with four (4) new transformer bay units.

- 225kV Circuit breaker 4 set（single phase x 3 x 4）
- 225kV Disconnector with earthing switch 8 set（single phase x 3 x 8）
- 225kV Lighting arrester 4 set（single phase x 3 x 4）
- 225kV Voltage transformer 4 set（single phase x 3 x 4）

The AIS system will be installed with one (1) new bus coupler bay unit.

- 225kV Circuit breaker 1 set（single phase x 3 x 1）
- 225kV Disconnector 2 set（single phase x 3 x 2）
-225kV Current transformer 1 set（single phase x 3 x 1）

One (1) new voltage transformer bay for busbar will be installed.

- 225kV Voltage transformer 2 set（single phase x 3 x 2）
- 225kV Disconnector 2 set（single phase x 3 x 2）

- Description	- Basic specification
- GIS or AIS	AIS
- Rated Voltage	225kV
- Rated current	GCB:3150A, DS: 2500A
- Rated short time current	GCB: 50kA, DS: 50kA,

(2) Power transformer

Four (4) new units of transformer will be installed.

- 225/33kV Power transformer 2units
- 33kV Power cable and its accessories 1 lot

- Description	- Basic specification
- Rated Voltage	HV: 225kV, LV: 33kV
- Rated Capacity	50 MVA (ONAN) / 60MVA (ONAF)
- Winding Type	YNyn0

- 225/15kV Power transformer 2 units
- 15kV Power cable and its accessories 1 lot

- Description	- Basic specification
- Rated Voltage	HV: 225kV, LV: 15kV
- Rated Capacity	40 MVA (ONAN) / 50MVA (ONAF)
- Winding Type	YNd11

(3) Reactive power equipment

Four (4) new Capacitor bank will be installed.

- 33kV 7.2MVA (2.6MVA x 3) Capacitor bank 2 units
- 15kV 7.2MVA (2.6MVA x 3) Capacitor bank 2 units

(4) Metal-enclosed, medium voltage cubicles

The following new metal-enclosed, medium voltage cubicles will be installed.

- 33kV Cubicle for secondary of transformer 2 units
- 33kV Cubicle for distribution line 12 units
- 33kV Cubicle for 33kV voltage transformer 6 units
- 33kV Cubicle for 33kV capacitor bank 2 units
- 33kV Cubicle for busbar coupler 4 units
- 33kV Power cable and its accessories 1 lot

- Description		- Basic specification
- Rated Voltage		33 (36) kV
- Rated current	33kV	Transformer bay: 2500A Bus: 2500A Feeder: 1250A
- Rated short time current		25kA

- 15kV Cubicle for secondary of transformer 2 units
- 15kV Cubicle for distribution line 12 units
- 15kV Cubicle for 33kV voltage transformer 6 units
- 15kV Cubicle for 33kV capacitor bank 2 units
- 15kV Cubicle for busbar coupler 4 units
- 15kV Power cable and its accessories 1 lot

- Description		- Basic specification
- Rated Voltage		15 (24) kV
- Rated current	15kV	Transformer bay: 2500A Bus: 2500A Feeder: 630A
- Rated short time current		25kA

(5) Miscellaneous accessories

Aluminum pipe busbar, steel structure, etc. will be installed in accordance with the installation of 225kV busbar bay units, two (2) power transmission line bay units, and four (4) power transformer bay units.

-225kV Yard earthing system 1 lot
-225kV Conductor and electrical connections 1 lot
-225kV Insulators 1 lot
-225kV Aluminum tubular busbar 1 lot
-225kV Steel Structures 1 lot
-33kV Surge Arrester 2 sets (single phase x 3 x 2)
-33kV Insulators 1 lot
-15kV Surge Arrester 2 sets (single phase x 3 x 2)
-15kV Insulators 1 lot
-Low Voltage Control Cable 1 lot

(6) Low Voltage AC/DC system

For securing reliability, this new substation will consist of two (2) units of auxiliary transformer and two (2) units of charger (Rectifier). However, the battery unit will be only one unit.

- 33kV/400-230V Auxiliary transformer	2 units
- LVAC distribution panel	2 units
- 127V Charger (Rectifier)	2 units
- 48V Charger (Rectifier)	2 units
- DC127V battery unit	1 unit
- DC48V battery unit	1 unit
- Emergency generator	1 unit

(7) Control system and protection relay

The control system and protection relay of this new substation will be of Bay Control Unit (hereinafter called “BCU”) type based on IEC61850

- 225kV Transmission line bay control panel	4 units
- 225kV Transformer bay control panel	4 units
- 225kV Busbar coupler control panel	1 unit
- 225kV Transmission line protection relay	4 units
- 225kV Transformer protection relay	4 units
- 225kV Busbar protection relay	1 unit

(8) SCADA Telecommunication System

The SCADA system and the communication system of this new substation will be installed. Furthermore, the existing whole SCADA system was provided by Alstom and can be integrated with this system.

- SCADA system	1 lot
- MUX/SDH	1 lot
- Optical Fiber Cable	1 lot
- Optical Distribution Frame (ODF)	1 lot
- PBX system	1 lot

(9) Civil and building work

- Land preparation	1 lot
- Equipment foundation and oil pit	1 lot

- Control building 1 lot
- cable pit installation 1 lot

6.3.4 Budgetary Cost Estimate

Nonpublic Information

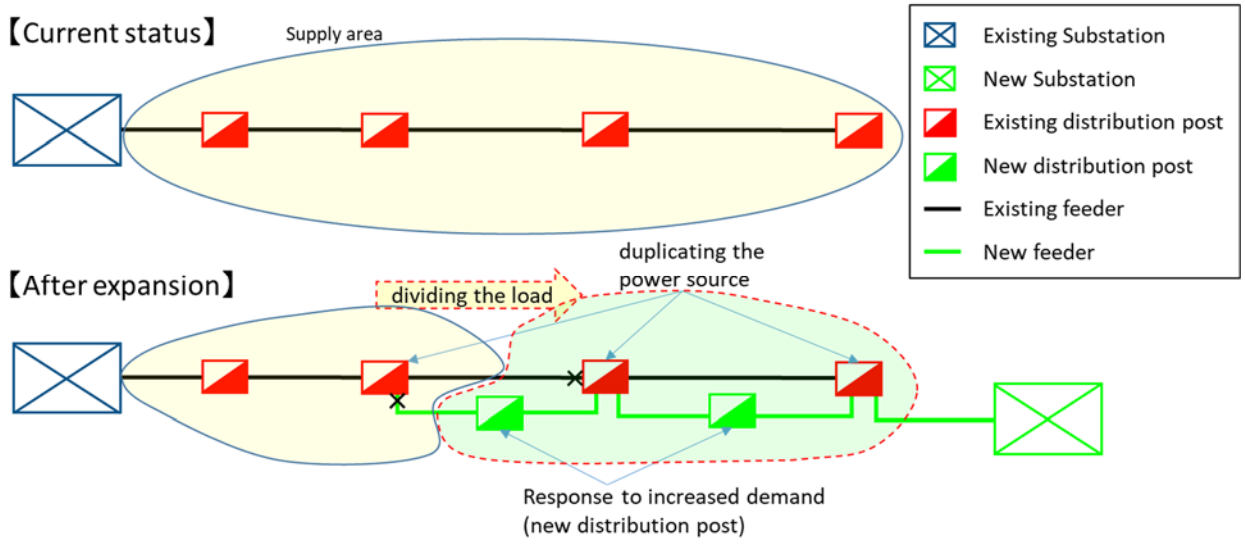
6.3.5 Construction Schedule

Nonpublic Information

6.4 DISTRIBUTION FACILITIES

6.4.1 Basic concept of distribution network expansion

The distribution network expansion project, which is the subject of this study, aims at installing new distribution lines from the Yamoussoukro 2 substation and Bouaké 3 substation, which will be newly constructed by separate components of this project, and connect them to the existing distribution network in the city. It aims to increase the supply capacity of the distribution network and improve reliability. The new distribution feeder will basically be constructed between the new substation and the existing interconnection switching station (Poste de réflexion) or the existing distribution post. In addition, it will be connected to the existing distribution posts on the route as well as the new distribution posts that will be constructed depending on the demand near the route. The new distribution feeder will contribute to the supply capacity by sharing the load of the existing distribution feeder, and improve reliability by duplicating the power source of the existing distribution post. Switchgear, which are necessary to connect the new distribution feeder, will be added to the existing switching station and the existing distribution posts. In addition, each distribution post will be equipped with automation equipment for remote monitoring and can be controlled from the distribution command center (BCC).



Source: JICA Study Team

Fig. 6.4-1 Conceptual image of distribution network expansion

6.4.2 Consideration of new distribution equipment

This distribution network expansion plan is based on the materials considered in the F/S conducted by CI-ENERGIES, however, the following amendments are done to the points found as a result of the field survey done by the JICA Study Team as mentioned in Chapter 4.

- Distribution feeder route optimization and addition or change of distribution posts to be connected
- Building renovation due to lack of space in the existing distribution posts
- Replacement of the existing switchgear and complete renovation due to incompatibility of the existing switchgear
- Relocation of existing distribution posts to reduce the risk of inundation

(1) Selection of connection point with existing distribution feeder

The new feeder will be connected to the existing distribution post or the existing switching station at a place where the load of the existing distribution feeder can be easily divided and where the reliability of supply can be improved.

(2) Consideration of power distribution system (overhead/underground)

Based on the planning criteria of CI-ENERGIES, as a principle the underground system will be adopted in Yamoussoukro and Bouaké. However, since most of Depart BELLE VILLE in Bouaké city passes through rural areas in the suburbs, the overhead distribution system will be adopted except for the substation lead-out area.

(3) Connection with distribution post (existing/new)

In order to improve the efficiency of recovery work when there is a fault in the cables, the distribution posts to be connected are designed in such a way that the length of underground cable between distribution posts is approximately 5 km or less. In addition, new distribution posts will be installed according to the demand of the distribution feeder route. When constructing a new distribution post, the following is prioritized— replacing the existing H61 (small-capacity type installed on a utility pole) with H59 and increasing the capacity of the post.

6.4.3 The City of Yamoussoukro

Table 6.4-1 shows the original plan of F/S implemented by CI-ENERGIES in Yamoussoukro City and the project plan revised by the JICA Study Team reflecting the results of the field survey. In Yamoussoukro city, seven 15kV distribution feeders and two 30kV distribution feeders will be newly constructed from the Yamoussoukro 2 substation, amounting to a total distance of about 80km. In addition, 8 new distribution posts will be installed and 26 existing distribution posts will be renovated. The detailed design of each distribution feeder is shown below.

Table 6.4-1 Outline of the distribution component in Yamoussoukro

City	Voltage (kV)	Feeder	Original plan			Revised plan					
			Length	Post		Length	New post	Exist. Post			
			(km)	New	Exisit.	(km)		Relocation, whole renovation	Building expansion	Replace exist. Swithcgear	Connection
Yamoussoukro	15	Aeroport	14.7	1	3	13.1	2	1			1
		Cafop	15.7	1	9	15.7	1	1	3	2	3
		Ville 4/1	3.8		1	3.8			1		
		Ville 4/2	3.8		1	3.8			(1)		
		Fondation 3	8.4	1	5	8.4	1		4	1	
		Kokrenou 1	13.8	2	8	13.8	2	1		4	3
		Kokrenou 2	9.3		2	9.3		1(1)			
	30	Zone Industrielle	9.5	2		9.5	2				
		Poste 30/15	0.2			0.2					
	合計		79.2	7	29	77.5	8	4	8	7	7

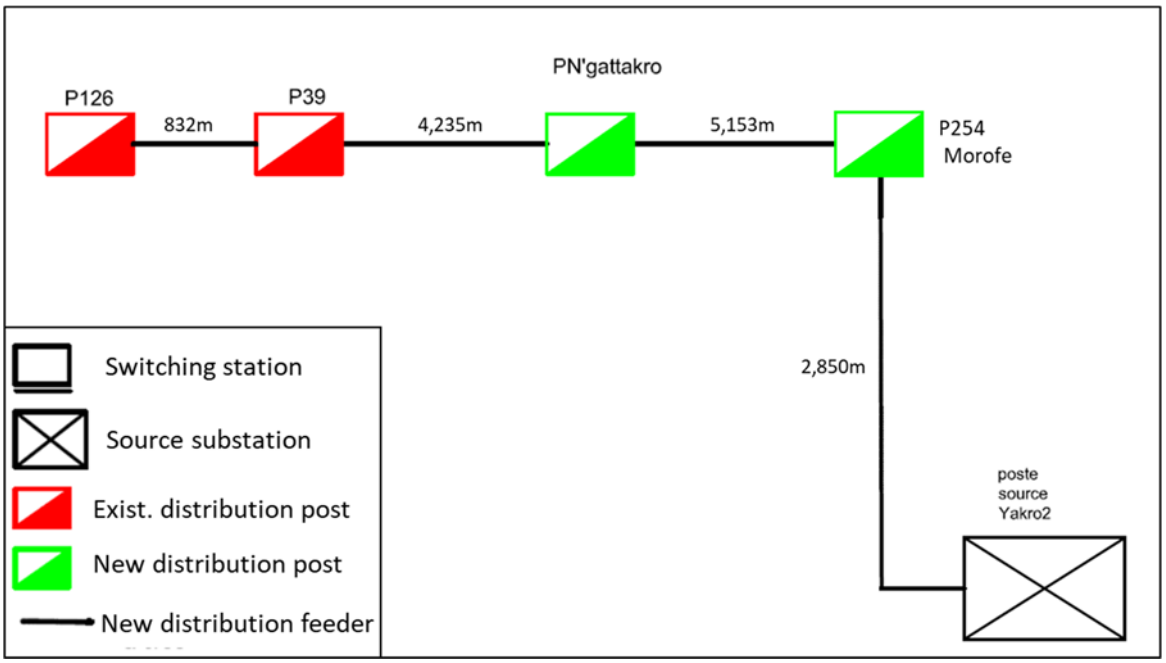
※The number in ( ) indicates the overlap with other distribution feeder.

Source: JICA Study Team

(1) Départ AÉROPORT

Départ AÉROPORT is a distribution feeder which will connect the Yamoussoukro 2 substation to the existing distribution post P126. Along the way to the P126, it will be connected to two existing distribution posts as well as the newly installed one. The existing distribution post P39 (Fig. 6.4-2) is an old-type distribution post that uses an air insulated switchgear, so it needs to be completely refurbished. This distribution feeder supplies to the northwestern part of the Yamoussoukro 2 substation and the area around the airport, which is located in the northwestern part of Yamoussoukro City. The feeder consists of an all-ground system, and the total length is about 15 km. Single line diagram and location map of Départ A ÉROPORT are shown in Fig. 6.4-3 and Fig. 6.4-4.

Fig. 6.4-2 Existing post P39



Source: JICA Study Team

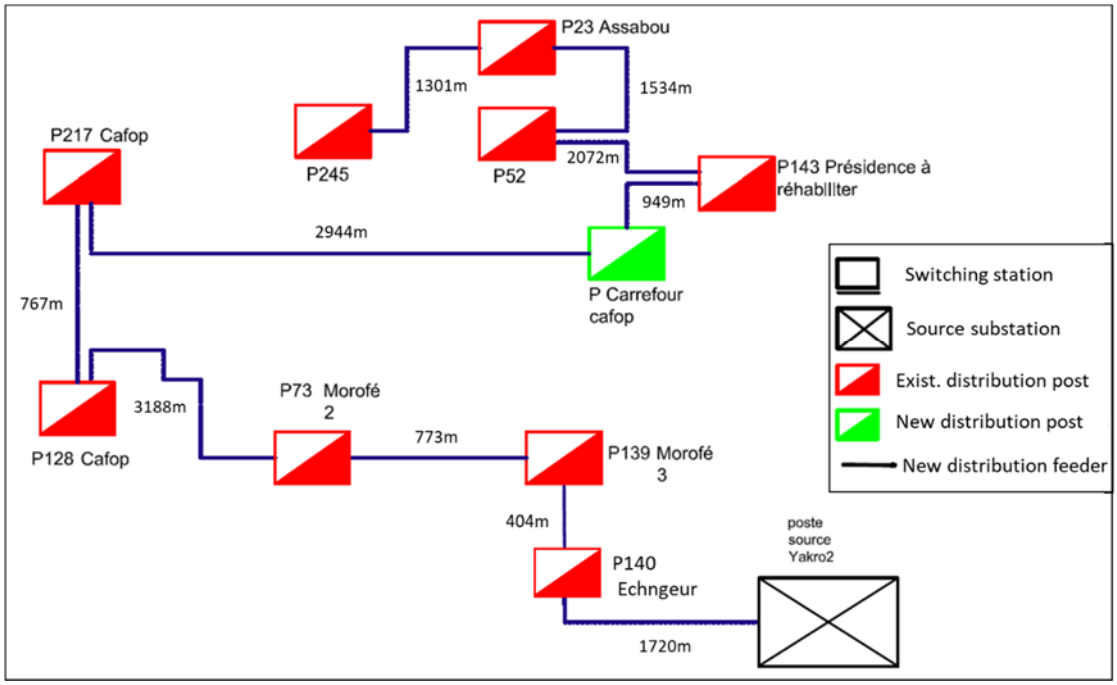
Fig. 6.4-3 Single line diagram of Départ Aéroport

Source: JICA Study Team

Fig. 6.4-4 Location map of Départ Aéroport

(2) Départ CAFOP

Départ CAFOP is an underground distribution feeder with a total length of about 18km that connects the Yamoussoukro 2 substation and the existing distribution post P245. It supplies to the northern area of Yamoussoukro city. On the feeder route, 8 existing distribution posts will be routed and a new distribution post will be installed. As for the existing distribution posts, the P140 Echcngeur has failed due to submersion in water, so it is necessary to relocate it to a highland with a low risk of inundation. P139, P143, and P23 require building renovation because there is no space to add a new switchgear within the building. P52 and P245 use an old switchgear that is not extendable, so it is necessary to replace the existing switchgear. Single line diagram and location map of Départ CAFOP are shown in Fig. 6.4-5 and Fig. 6.4-6.



Source: Report of the feasibility study carried out by CI-ENERGIES

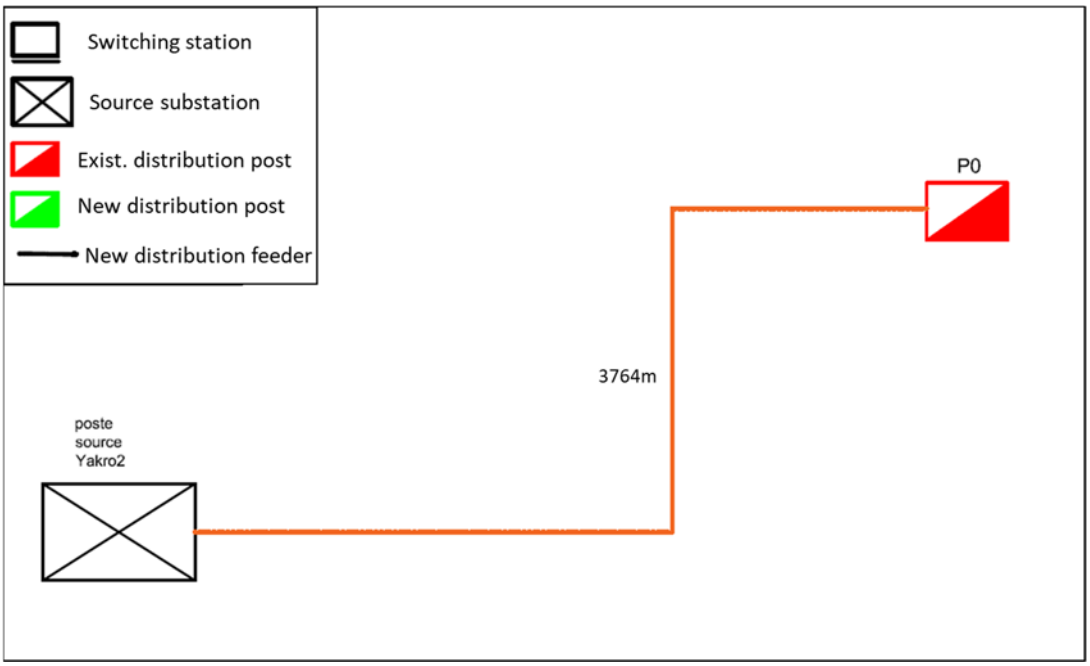
Fig. 6.4-5 Single line diagram of Départ CAFOP

Source: JICA Study Team

Fig. 6.4-6 Location map of Départ CAFOP

(3) Départ VILLE 4/1、4/2

Départ VILLE 4/1 and 4/2 are all-underground feeder with a total length of about 4 km that connect the Yamoussoukro 2 substation and Poste 0. VILLE 4/1 and 4/2 will be built on the same route. This distribution feeder contributes to the power supply to the city center through Poste 0. As mentioned in Section 4.3, the distribution board will be added to Poste 0, in order to add the two power sources, namely the VILLE 4/1 and 4/2. Single line diagrams and location map of Départ VILLE 4/1 and 4/2 are shown in Fig. 6.4-7 and Fig. 6.4-8.



Source: Report of the feasibility study carried out by CI-ENERGIES

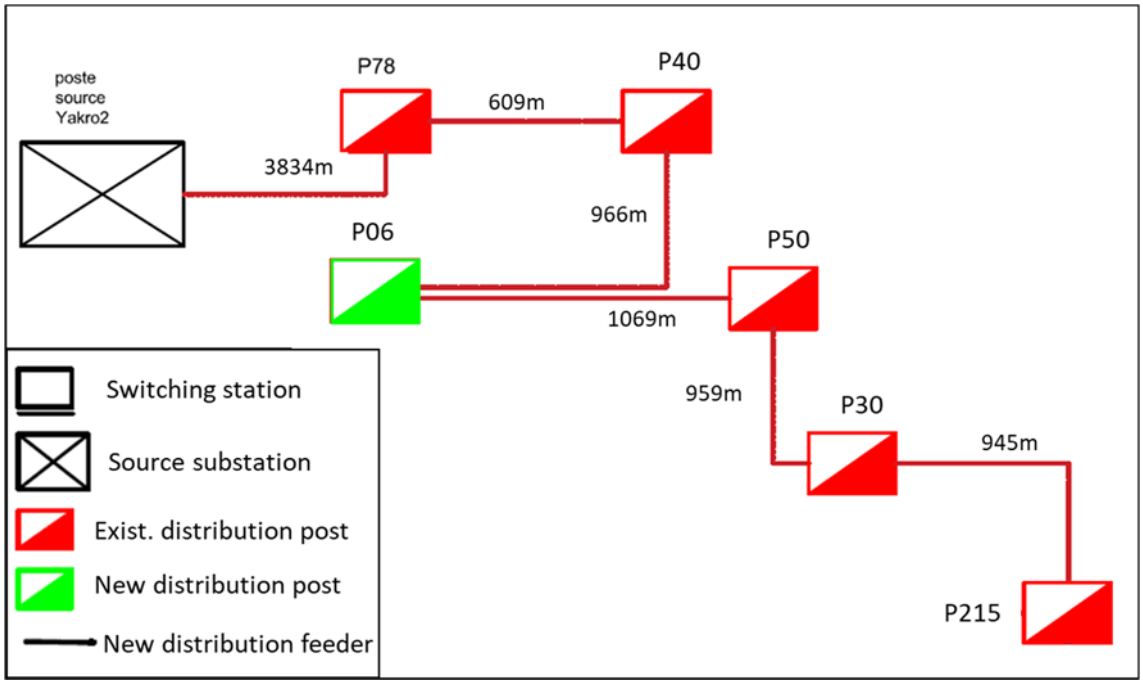
Fig. 6.4-7 Single line diagram of Départ VILLE 4/1, 4/2

Source: JICA Study Team

Fig. 6.4-8 Location map of Départ VILLE 4/1, 4/2

(4) Départ FONDATION 3

Départ FONDATION 3 is an all-underground distribution feeder with a total length of 8km that connects the Yamoussoukro 2 substation and the existing distribution post P215, and it mainly supplies power to the area around Foundation Street in the center of the city. Along the route, it passes through four existing distribution posts and one new distribution post. The existing distribution posts (P78, P40, P50, and P30) do not have any space for expansion, so it is necessary to remodel the building. In addition, P215 uses an old incompatible switchgear, so it is necessary to replace the existing switchgear. Single line diagram and location map of Départ FONDATION 3 are shown in Fig. 6.4-9 and Fig. 6.4-10.



Source : JICA Study Team

Fig. 6.4-9 Single line diagram of Départ FONDATION 3

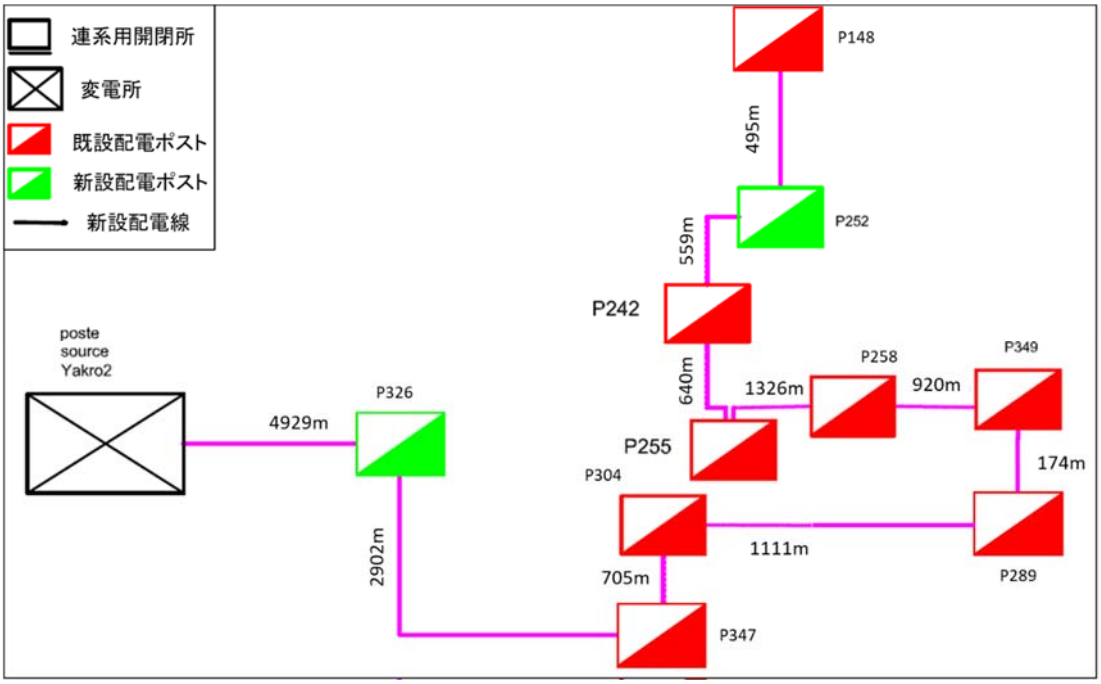
Source: JICA Study Team

Fig. 6.4-10 Location map of Départ FONDATION 3

(5) Départ KOKRÉNOU 1

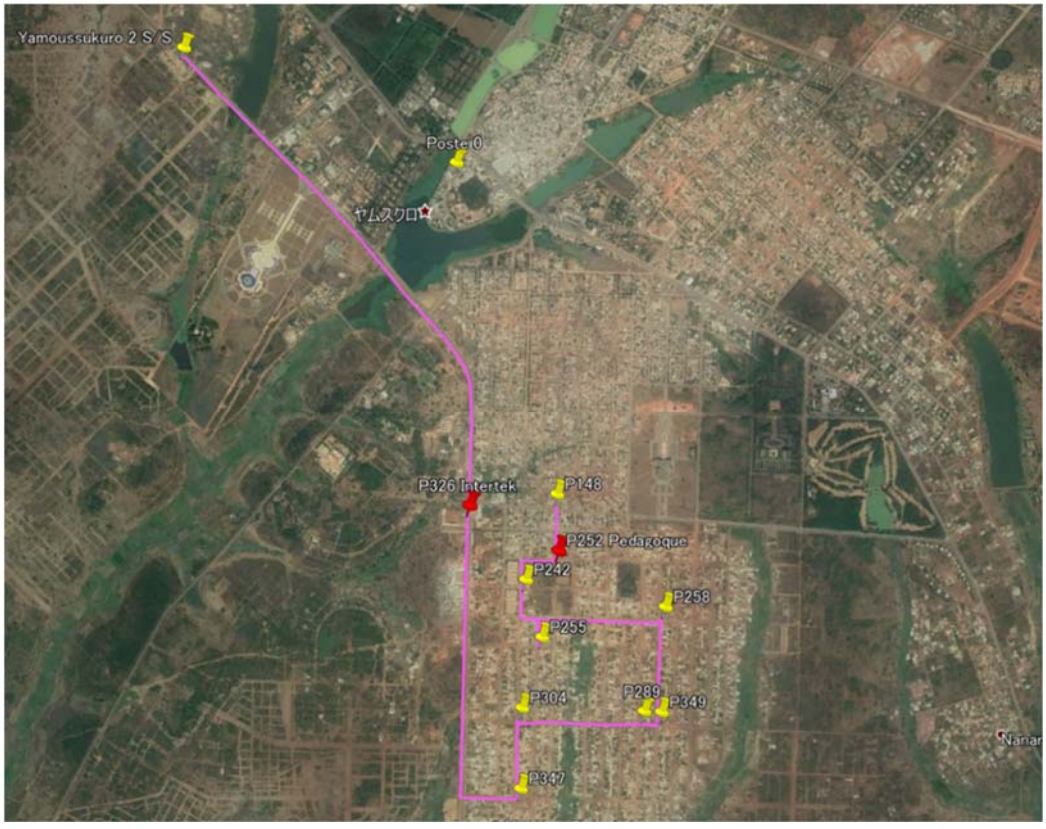
Départ KOKRÉNOU 1 is an all-underground distribution feeder with a total length of 14km that connects the Yamoussoukro 2 substation and the existing interconnection switching station P148, and it mainly supplies power to the southern area of the city. This feeder will be connected to two new distribution posts along the route, and it is already passing through seven existing distribution posts. Since the existing distribution post P148 is constructed on a land lower than the surrounding area and trace of inundation can be seen inside the building (Fig. 6.4-11), it should be relocated to a nearby higher ground. Also, among the existing distribution posts, P255, P347, P349, and P242 use old incompatible switchgear, so it is necessary to replace the existing switchgear. Single line diagram and location map of Départ KOKRÉNOU 1 are shown in Fig. 6.4-12 and Fig. 6.4-13.

Fig. 6.4-11 Existing post P148



Source : JICA Study Team

Fig. 6.4-12 Single line diagram Départ KOKRÉNOU 1

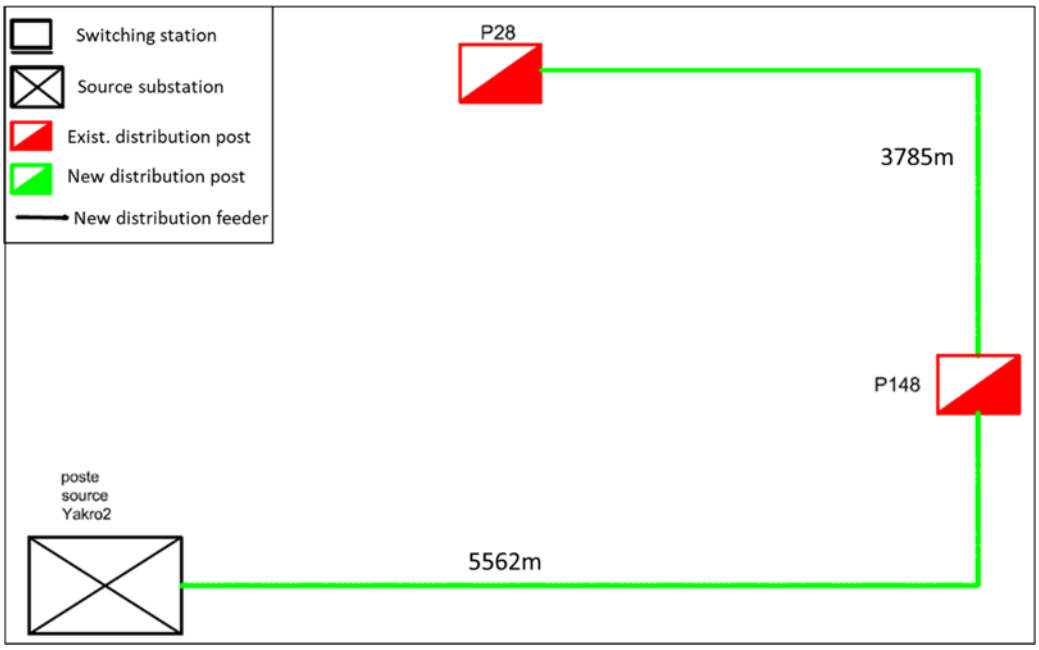


Source: JICA Study Team

Fig. 6.4-13 Location map of Départ KOKRÉNOU 1

(6) Départ KOKRÉNOU 2

Départ KOKRÉNOU 2 is an underground distribution feeder with a total length of approximately 14km that connects the Yamoussoukro 2 substation and the existing switching station P28, and it supplies to the central area of the city. There is one existing distribution post along the feeder route. The existing distribution post P148 needs to be relocated to a nearby higher ground as described in the section of Départ KOKRÉNOU 1. In addition, P28 is an old-type distribution post that uses an air insulated switchgear, therefore, it has to be fully renovated. Single line diagram and location map of Départ KOKRÉNOU 2 are shown in Fig. 6.4-14 and Fig. 6.4-15.



Source: Report of the feasibility study carried out by CI-ENERGIES

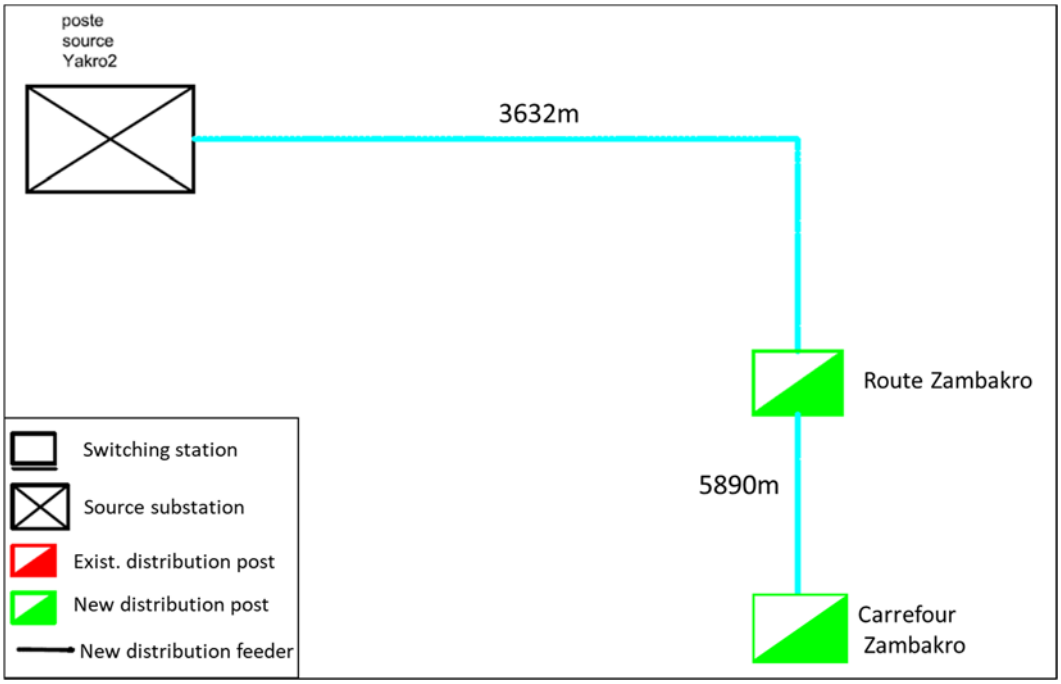
Fig. 6.4-14 Single line diagram of Départ KOKRÉNOU 2

Source: JICA Study Team

Fig. 6.4-15 Location map of Départ KOKRÉNOU 2

(7) Départ ZONE INDUSTRIELLE

Départ ZONE INDUSTRIELLE is an all-underground distribution feeder with a total length of approximately 10km that connects the Yamoussoukro 2 substation and the new distribution post, which is to be constructed in the industrial area located in the southwestern suburb of Yamoussoukro city. Another new distribution post will also be constructed on the feeder route. This feeder mainly supplies power to the industrial areas. Single line diagram and location map of Départ ZONE INDUSTRIELLE are shown in Fig. 6.4-16 and Fig. 6.4-17.



Source : JICA Study Team

Fig. 6.4-16 Single line diagram of Départ ZONE INDUSTRIELLE

Source: JICA Study Team

Fig. 6.4-17 Location map of Départ ZONE INDUSTRIELLE

(8) Départ POSTE30/15

Depart Poste 30/15 is an interconnection underground line with a total length of 200m and it connects the Yamoussoukro 2 substation with the existing 30/15kV post adjacent to the substation. The single line diagram and location map of the feeder are omitted.

6.4.4 The city of Bouaké

Table 6.4-2 shows the original plan of F/S implemented by CI-ENERGIES in Bouaké City and the project plan revised by the JICA Study Team reflecting the results of the field survey. In Bouaké city, eight 15kV distribution feeders and two 30kV distribution feeders will be newly constructed from the Bouaké 3 substation, amounting to a total distance of approximately 80km. In addition, four new distribution posts will be installed and twenty existing distribution posts will be renovated. The detailed design of each distribution feeder is shown below.

Table 6.4-2 Outline of the distribution component in Bouaké

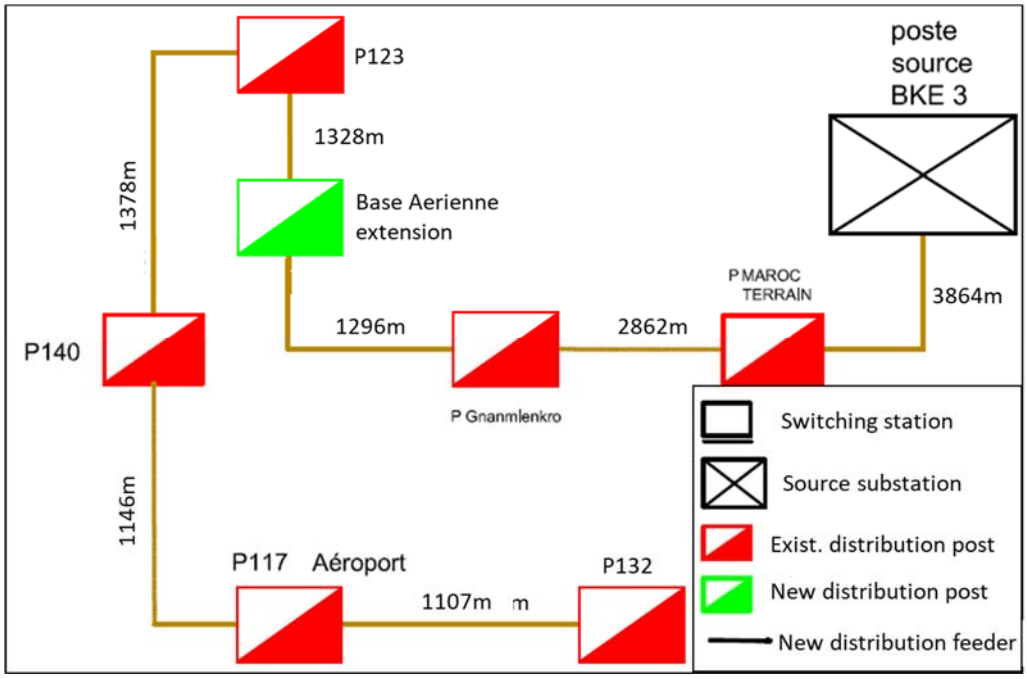
City	Voltage (kV)	Feeder	Original plan			Revised plan					
			Length	Post		Length	New post	Exist. Post			
			(km)	New	Exisit.	(km)		Relocation, whole renovation	Building expansion	Replace exist. Swithcgear	Connection
Bouake	15	Base Aerienne	13	3	4	13.0	1				6
		Hotel de l'Air	11.6	1	2	11.6	1				2
		EECI	12.3		3	12.3	(1)		1		2
		433	12.3		2	12.3	(1)				2
		401	8.8	1	1	8.8	1(1)				1
		345	12.9	1	3	12.9	1			1	2
		444	12.2		3	12.2					3
		Belle Ville	6.8			6.3					
	30	BKE 1	0.2			0.2					
		Katiola	0.2			0.2					
	合計		77.3	6	18	76.8	4		1	1	18

※The number in ( ) indicates the overlap with other distribution feeder.

Source: JICA Study Team

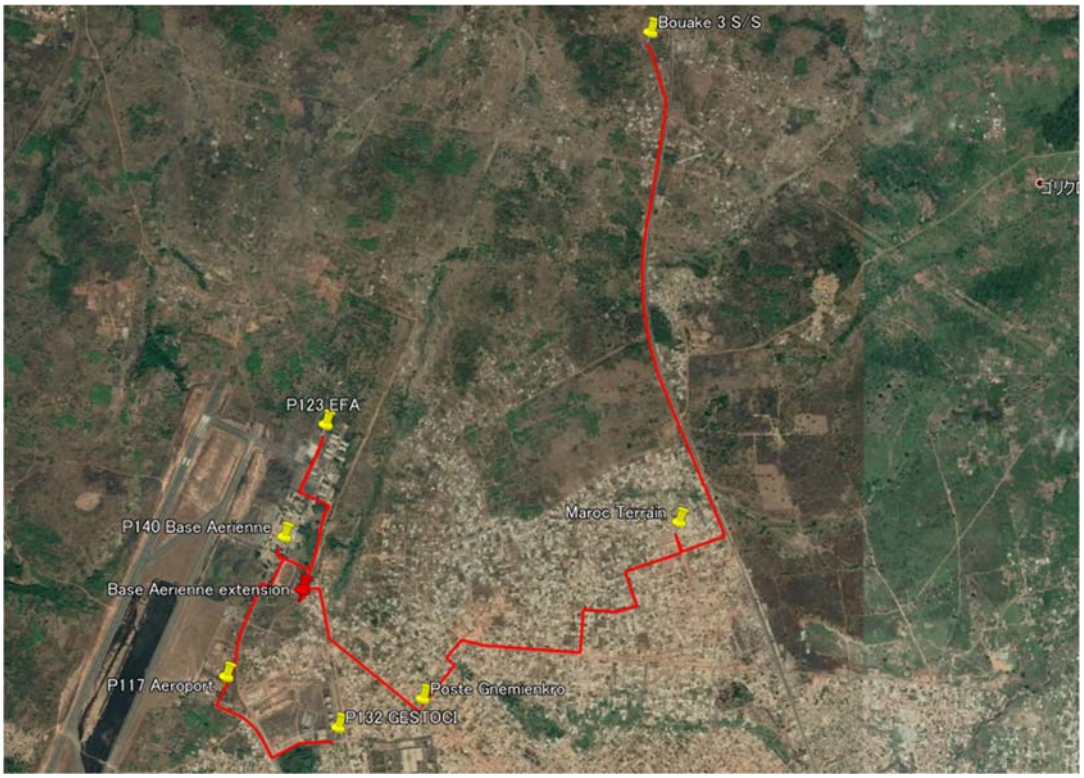
(1) Départ BASE AÉRIENNE

Départ BASE AÉRIENNE is an underground distribution feeder with a total length of approximately 13km that connects the Bouaké 3 substation with the existing switching station P132, near the air base located in the northwest of Bouaké city. This distribution feeder mainly supplies power to the area around the air base. Along the feeder route, it will pass through five existing distribution posts and one new distribution post, which is to be constructed. As for the existing distribution posts, Maroc Terrain, P140 and P123 are under construction by ENERGOS I project. Single line diagram and location map of Départ BASE AÉRIENNE are shown in Fig. 6.4-18 and Fig. 6.4-19.



Source : JICA Study Team

Fig. 6.4-18 Single line diagram of Départ BASE AÉRIENNE

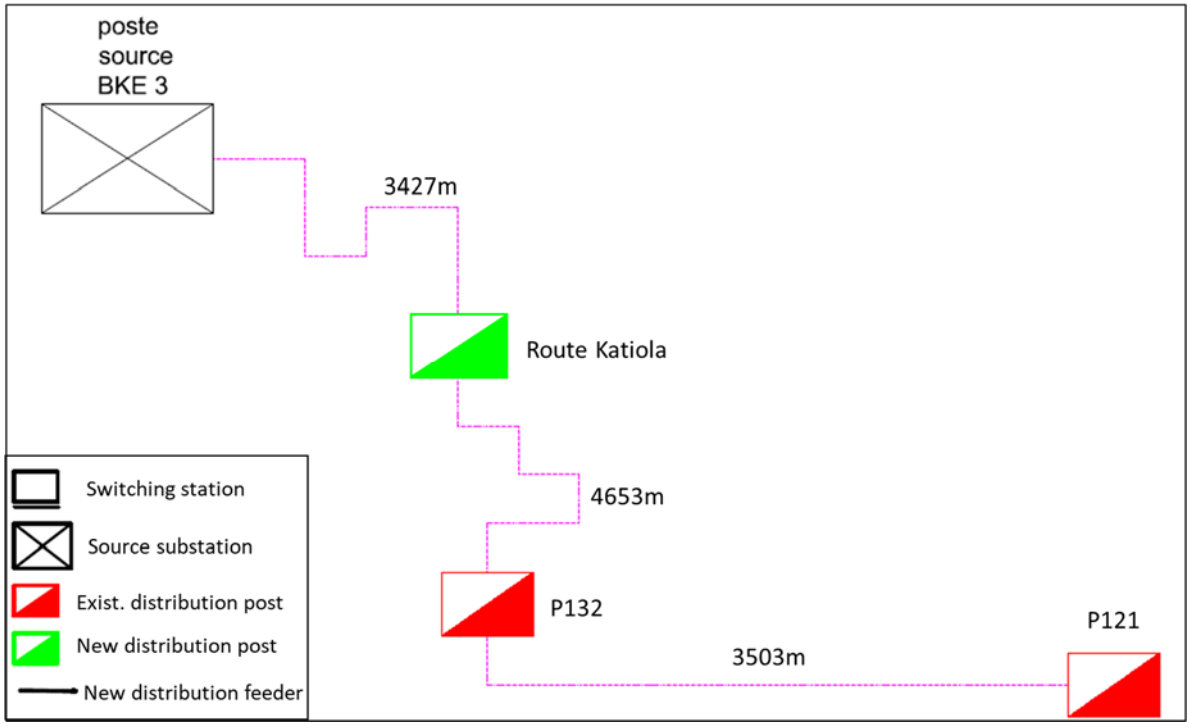


Source: JICA Study Team

Fig. 6.4-19 Location map of Départ BASE AÉRIENNE

(2) Départ HÔTEL DE L'AIR

Départ HÔTEL DE L'AIR is an all-underground distribution feeder with a total length of approximately 11km that connects Bouaké 3 substation with the existing distribution post P121, and it mainly supplies power to the northwestern area of Bouaké city. This feeder will pass through one new distribution post and one existing distribution post. Single line diagram and location map of Départ HÔTEL DE L'AIR are shown in Fig. 6.4-20 and Fig. 6.4-21.



Source : JICA Study Team

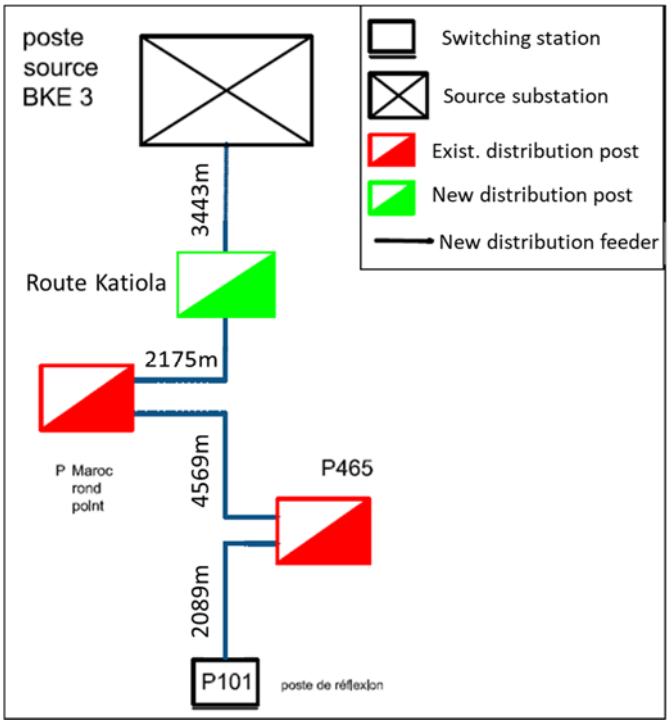
Fig. 6.4-20 Single line diagram of Départ HÔTEL DE L'AIR

Source: JICA Study Team

Fig. 6.4-21 Location map of Départ HÔTEL DE L'AIR

(3) Départ EECI 101

Départ EECI 101 is a distribution feeder that connects the Bouaké 3 substation with the existing switching station P101 near the Bouaké 1 substation, and it mainly supplies power to the central area of Bouaké city. This feeder has an all-underground system with a total length of approximately 12 km. There are two existing distribution posts and one new distribution post on the route of the feeder. The existing switching station P101 has an old-type equipment that uses air insulated switchgear, however, it is currently under rehabilitation work through the ENERGOS I project. In addition, the existing distribution post P465 does not have enough space to add the new switchgear to the building, therefore, the building needs to be renovated. Single line diagram and location map of Départ EECI 101 are shown in Fig. 6.4-22 and Fig. 6.4-23.



Source : JICA Study Team

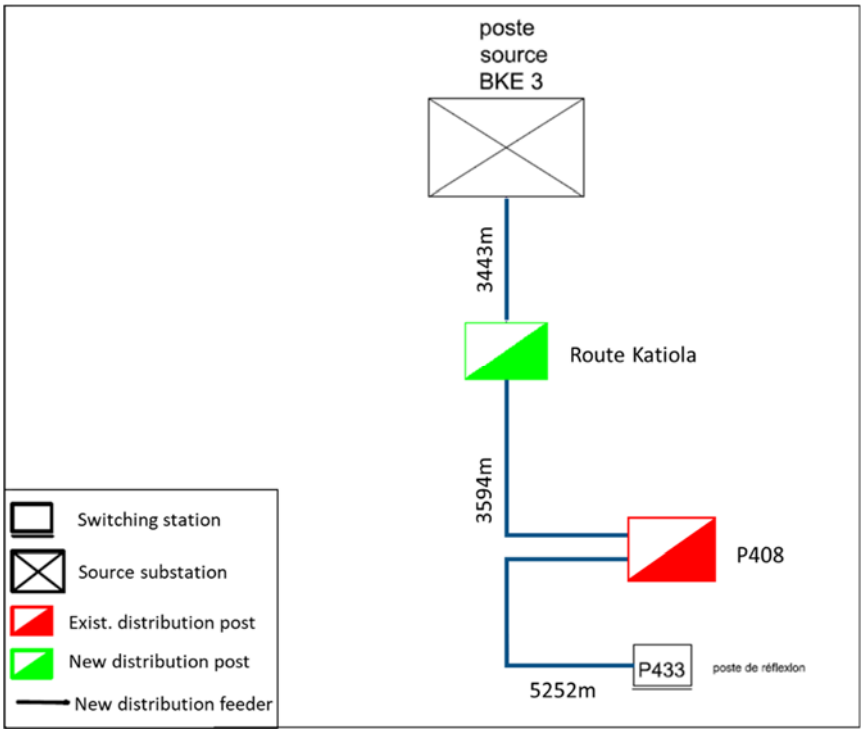
Fig. 6.4-22 Single line diagram of Départ EECI 101

Source : JICA Study Team

Fig. 6.4-23 Location map of Départ EECI 101

(4) Départ 433

Départ 433 is a distribution feeder that connects Bouaké 3 substation with the interconnection switching station P433 located at the southeast of Bouaké 1 substation, and it mainly supplies power to the central south area of Bouaké city. It has an all-underground system with a total length of approximately 13 km. There is one new distribution post and one existing distribution post on the feeder route. Single line connection diagram and route diagram of Départ 433 are shown in Fig. 6.4-24 and Fig. 6.4-25.



Source : JICA Study Team

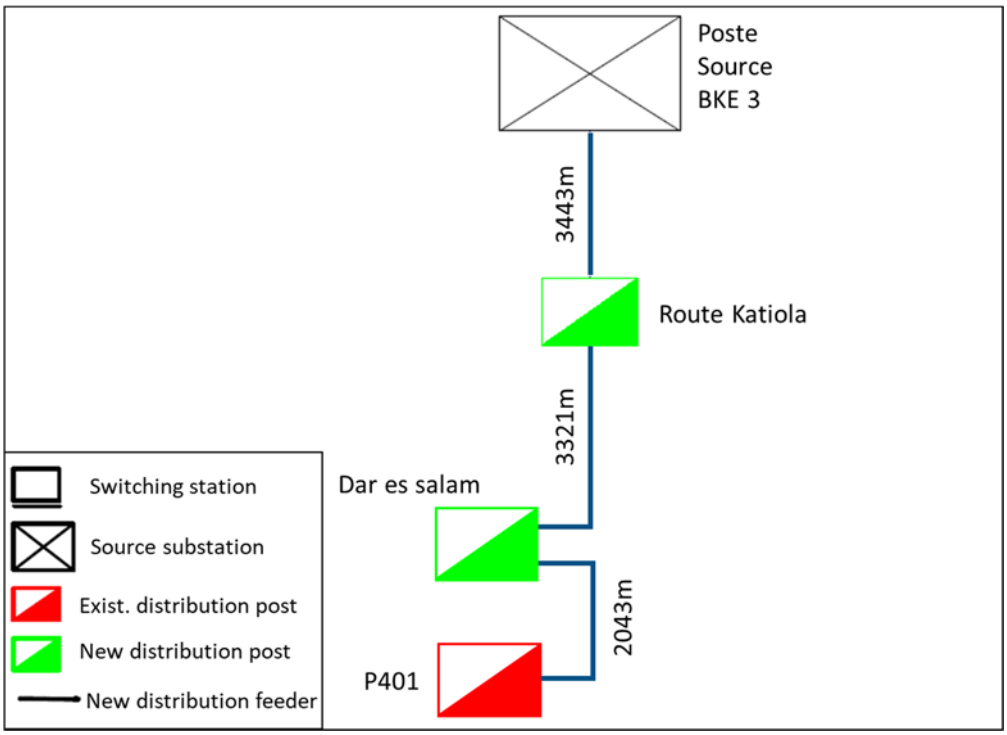
Fig. 6.4-24 Single line diagram of Départ 433

Source : JICA Study Team

Fig. 6.4-25 Location map of Départ 433

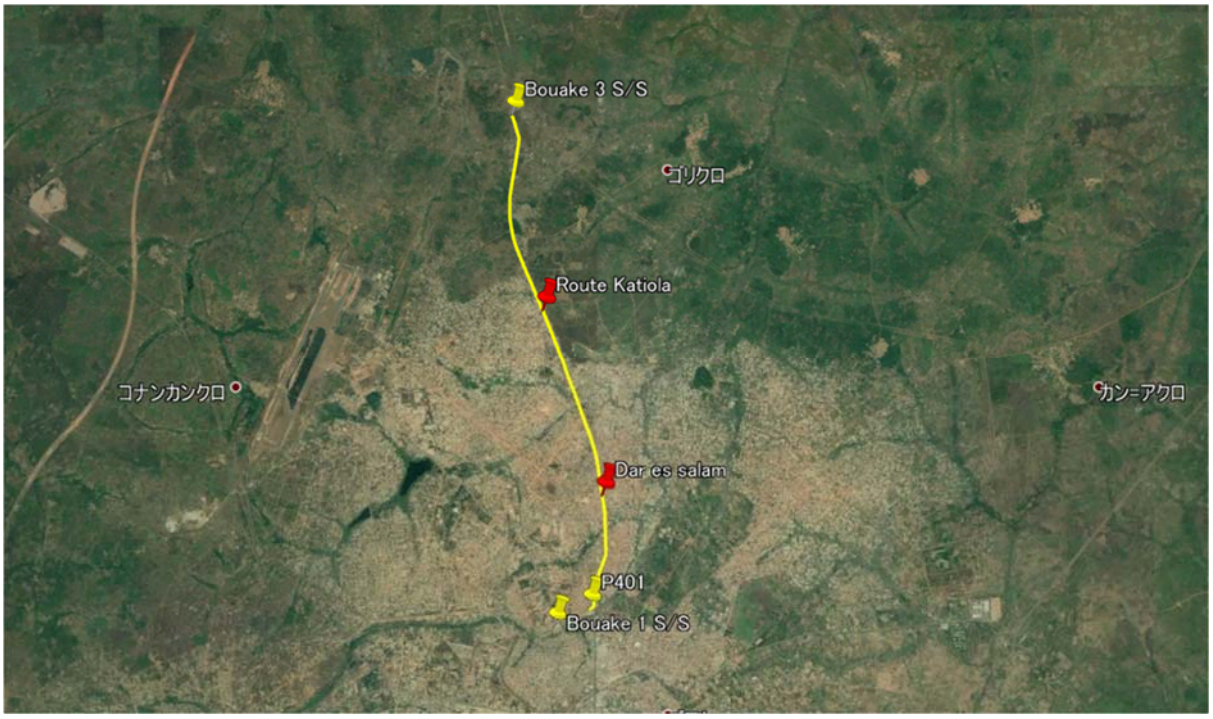
(5) Départ 401

Départ 401 is a distribution feeder that connects the Bouaké 3 substation with the existing distribution post P401 located in the northeast of Bouaké 1 substation, and it mainly supplies power to the central area of Bouaké city. It has an all-underground system with a total length of approximately 9 km, and routes to two new distribution posts in the middle of the line. Single line diagram and location map of Départ 401 are shown in Fig. 6.4-26 and Fig. 6.4-27.



Source : JICA Study Team

Fig. 6.4-26 Single line diagram of Départ 401

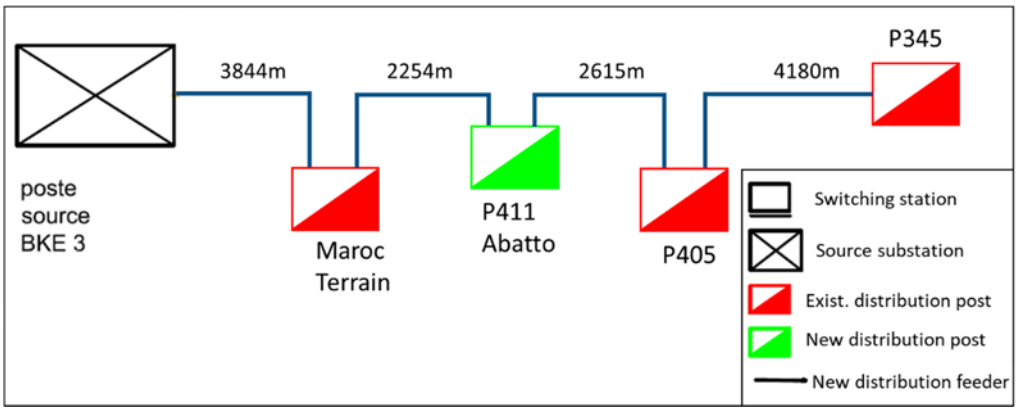


Source : JICA Study Team

Fig. 6.4-27 Location map of Départ 401

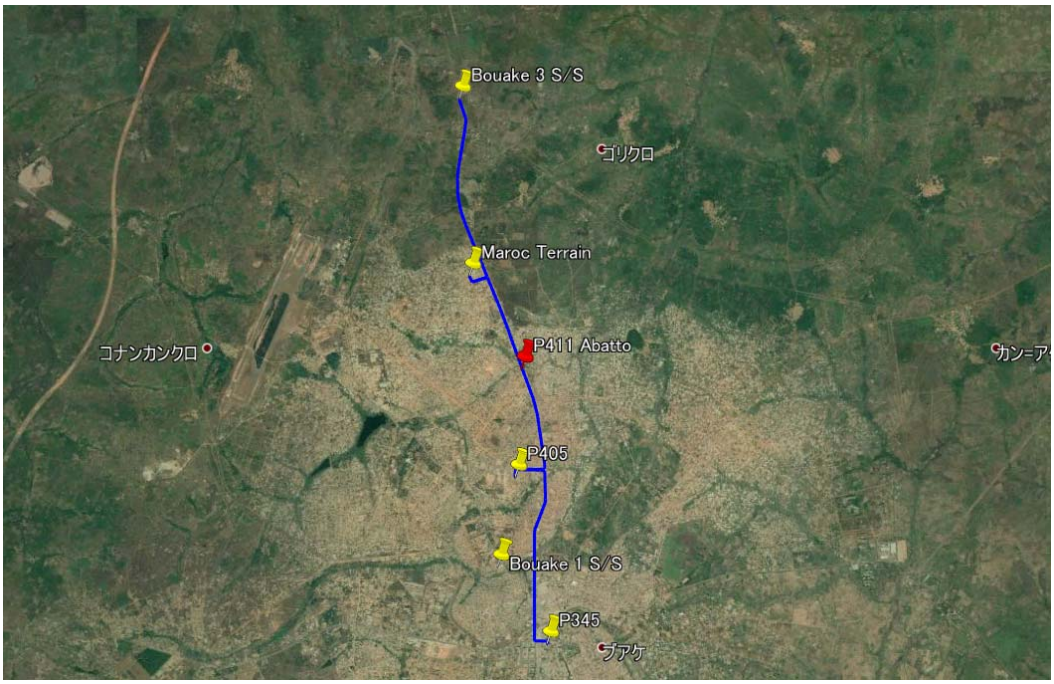
(6) Départ 345

Départ 345 is a distribution feeder that connects Bouaké 3 substation with the existing switching station P345, and it mainly supplies power to the central south area of Bouaké city. It has an all-underground system with a total length of approximately 11 km, and there are two existing distribution posts and one new distribution post on the feeder route. Single line diagram and location map of Départ 345 are shown in Fig. 6.4-28 and Fig. 6.4-29.



Source : JICA Study Team

Fig. 6.4-28 Single line diagram of Départ 345

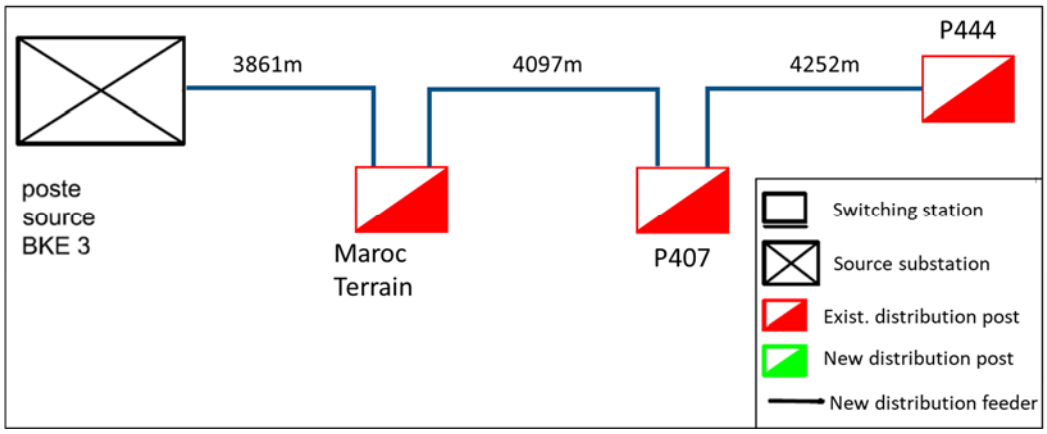


Source : JICA Study Team

Fig. 6.4-29 Location map of Départ 345

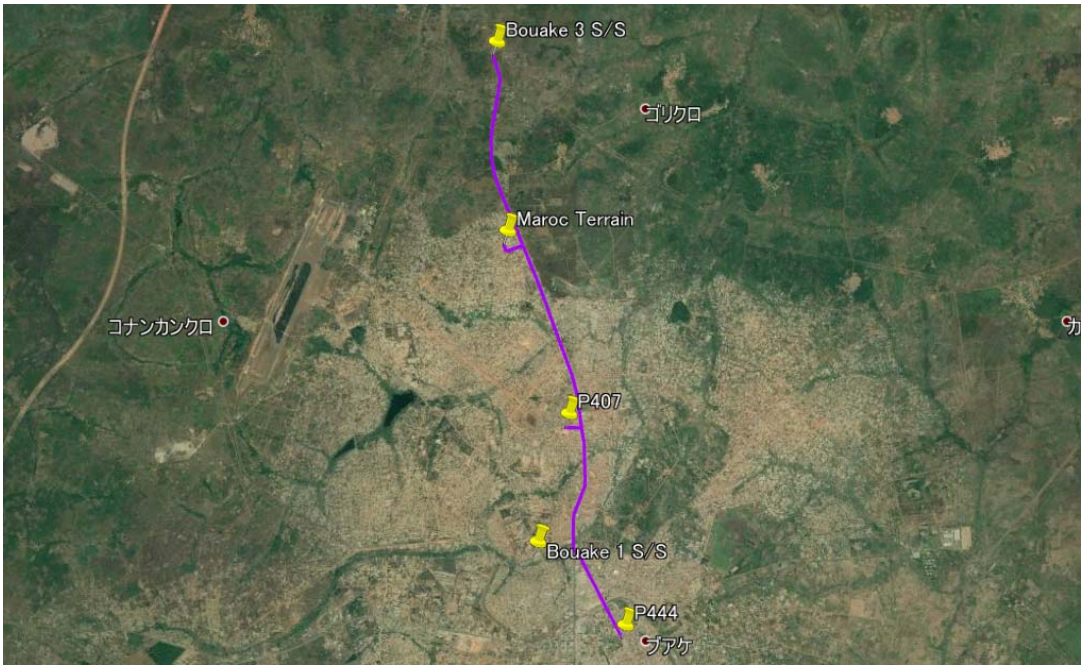
(7) Départ 444

Départ 444 is a distribution feeder that connects Bouaké 3 substation with the existing distribution post P444, and it mainly supplies power to the central south area of Bouaké city. It has an all-underground system with a total length of approximately 11 km, and there are two existing distribution posts on the feeder route. Single line diagram and location map of Départ 444 are shown in Fig. 6.4-30 and Fig. 6.4-31.



Source : JICA Study Team

Fig. 6.4-30 Single line diagram of Départ 444

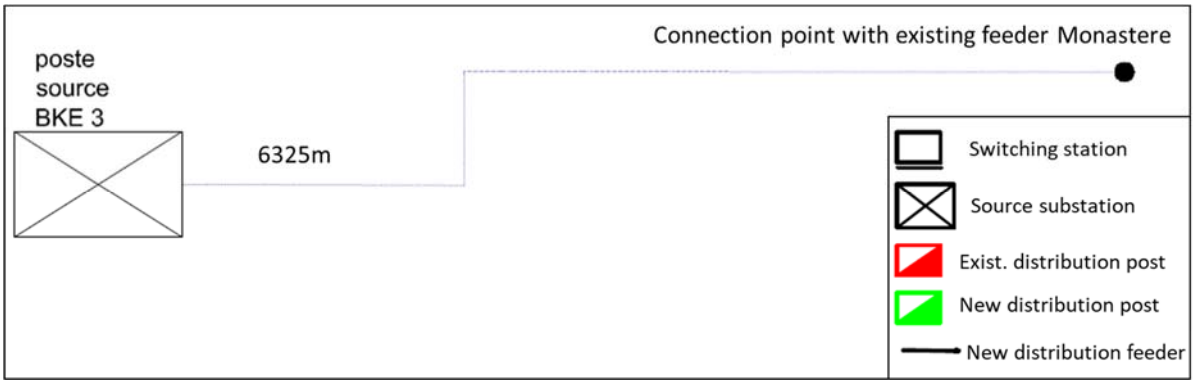


Source : JICA Study Team

Fig. 6.4-31 Location map of Départ 345

(8) Départ BELLE VILLE

Départ BELLE VILLE will be installed from Bouake 3 substation to the pole with switchgear (IACM), which is installed at the end of the existing feeder "Départ MONASTÉRE" that runs out from Bouake 2 substation. Most part of the feeder, except near the Bouake 3 substation, is made up of overhead facilities with a length of approximately 6km. Single line diagram and location map of Départ BELLE VILLE are shown in Fig. 6.4-32 and Fig. 6.4-33.



Source: Report of the feasibility study carried out by CI-ENERGIES

Fig. 6.4-32 Single line diagram of Départ BELLE VILLE

Source : JICA Study Team

Fig. 6.4-33 Location map of Départ BELLE VILLE

(9) Départ BKE 1, KAITOLA

These two (02) distribution feeders will be connected to two existing 30kV distribution feeders passing close to the Bouaké 3 substation. Each of these feeders have a 200m underground cable from the Bouake 3 substation and will connect to the existing overhead switchgear. The single line diagrams of these two (02) lines are not included.

6.4.5 Possibility of applying Japanese technology

6.4.6 Budgetary Cost Estimate

Nonpublic Information

6.4.7 Construction schedule

Nonpublic Information

CHAPTER 7

PROJECT PLAN

CHAPTER 7 PROJECT PLAN

7.1 CONSTRUCTION SCHEDULE

Nonpublic Information

7.2 PROJECT COST ESTIMATION

Nonpublic Information

7.3 STUDY OF PROCUREMENT

Nonpublic Information

7.4 TERMS OF REFERENCE (TOR)

Nonpublic Information

7.5 POSSIBILITY OF APPLYING JAPANESE TECHNOLOGY

7.5.1 Transmission Facilities

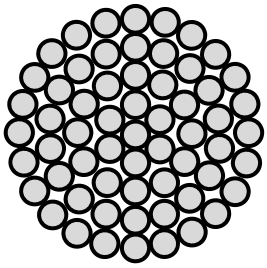
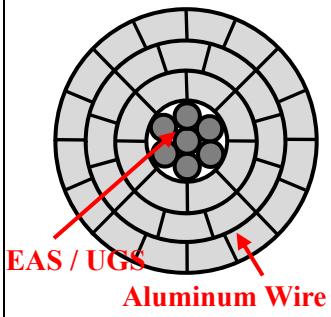
In Côte d'Ivoire, All Aluminum Alloy Conductor (AAAC) is applied as the standard conductor for 225kV overhead transmission lines. In Japan, Aluminum Conductor Steel Reinforced (ACSR) having steel wires with high tensile strength in the inner core is widely adopted.

Since the tensile strength is secured by steel wires in ACSR and by aluminum wires in AAAC, the risk of wire breakage due to lightning strikes and crane contacts is considered to be high in case of applying AAAC. On the other hand, when trying to obtain the same thermal capacity from conductors, AAAC without steel wires has an advantage as the outer diameter of conductor and the weight can be reduced.

Low loss conductors (LL-ACSR) have the following characteristics compared with ACSR.

- ✓ The inner core consists of EAS/UGS to reduce the cross-sectional area of the steel wire.
- ✓ The aluminum wire has a trapezoidal shape to increase the cross-sectional area of the aluminum wire.
- ✓ As the resistance value of the wire is reduced, the loss can be reduced.

Fig. 7.5-1 shows the structure of conductors.

Code Name	AAAC 570	LL-ACSR 633/637
Identification	AAAC	LL-ACSR
Cross Section		
Al [mm^2]	570.2	632.5/636.6
UTS [daN]	Approx. 18,50	
Dia [mm]	31.1	
Thermal Capacity	Approx. 840 A	Approx. 950 A

Source: JICA Study Team

Fig. 7.5-1 Structure of Conductors

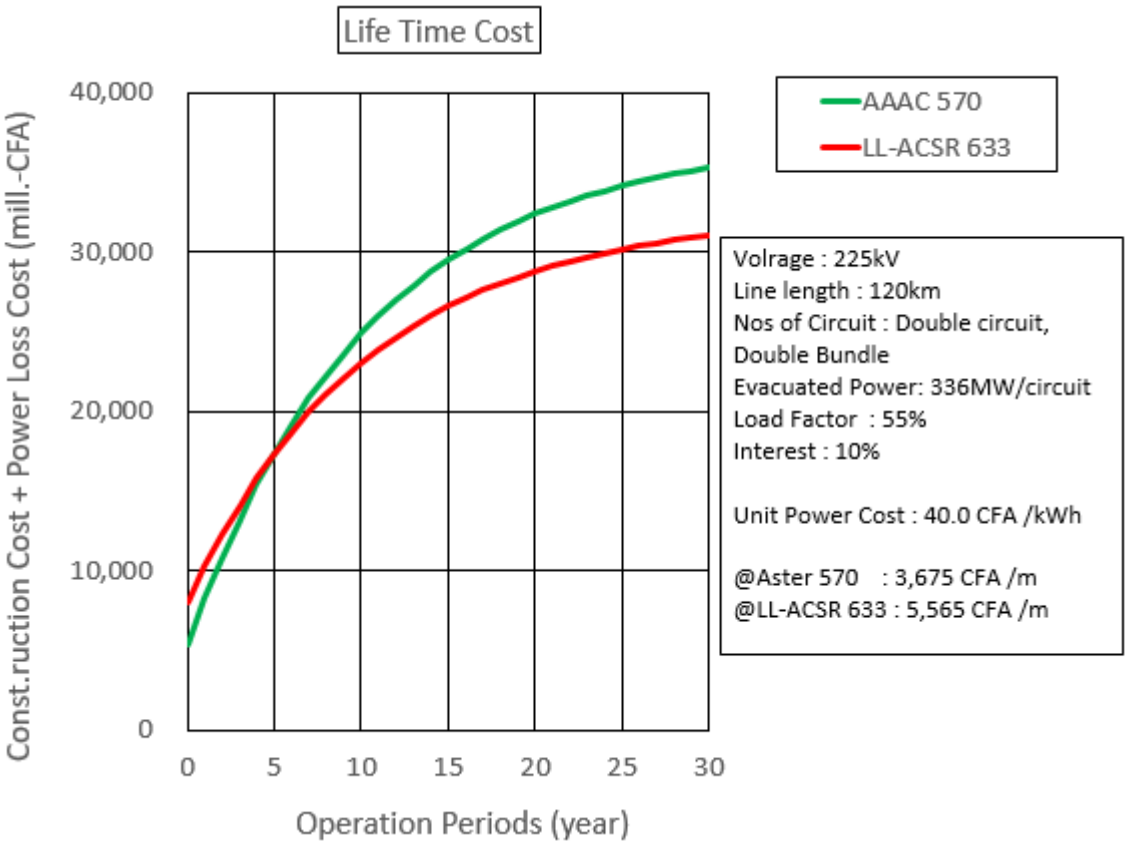
In case of the same outer diameter, the aluminum cross-sectional area of LL-ACSR is about 1.1 times larger than AAAC. Also, the continuous allowable current of LL-ACSR is also about 1.1 times larger than AAAC. Table 7.5-1 shows the continuous allowable current of conductors.

Table 7.5-1 Continuous Allowable Current

	AAAC 570	LL-ACSR 633/637
Continuous Allowable Current	Approx. 840 A	Approx. 950 A

Source: JICA Study Team

Fig. 7.5-2 shows the comparison of the life time cost of conductors (AAAC and LL-ACSR). If LL-ACSR is applied, the initial investment will become high. But the initial investment can be recovered in about 5 years.



Source: JICA Study Team

Fig. 7.5-2 Comparison of Life Time Cost

7.5.2 Distribution Facilities

In COTE D'IVOIRE, the CRGOT, one of the oil-immersed transformers which has a silicon steel sheet as the internal iron core, is used as the standard transformer for distribution. On the other hand, there is another option through which it is possible to realize energy saving and reduce the environmental impact, and the Japanese manufacturers have technical advantage in this respect. The AMT, which has an amorphous metal as an internal iron core, is highly efficient and has advantages in terms of running cost. As environmental awareness grows, the use of AMT is also increasing not only in Japan but also in China, India and in European countries.

There are two (02) types of loss incurred in the transformer. One is the load loss caused by the current flowing through the coils inside the transformer, and the other is the no-load loss which is generated in the iron core independent of the load current. The primary benefit of AMT is to greatly reduce the no-load loss that occurs in the iron core. This is achieved because of the excellent electric and magnetic characteristic of the amorphous raw material.

Table 7.5-2 compares the loss values of amorphous transformer, which is manufactured by a Japanese manufacturer and that which is used in COTE D'IVOIRE. The values of COTE D'IVOIRE have been obtained from CI-ENERGIES during this survey. It can be seen that the no-load loss of AMT is one fourth or fifth (1/4 to 1/5) compared to the CRGOT used in COTE D'IVOIRE.

Table 7.5-2 Comparison of loss value

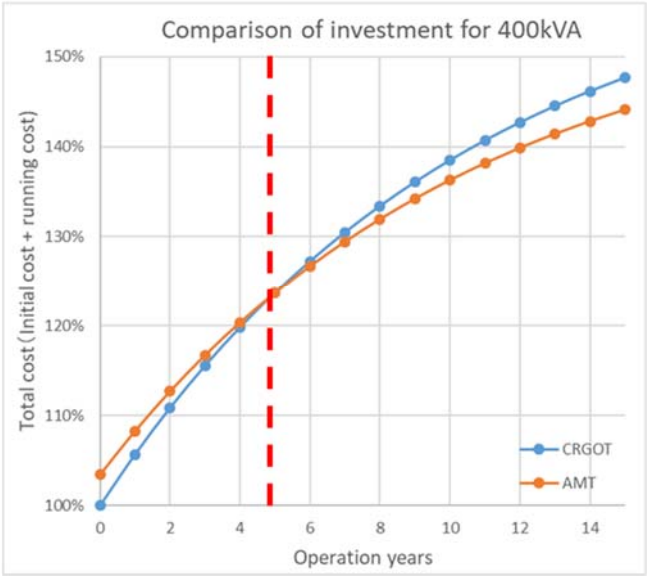
Capacity		CRGOT		AMT	
		No load loss(W)	Load loss(W)	No load loss(W)	Load loss(W)
15/0.4 kV	400kVA	930	4,600	215	3,250
	630kVA	1,300	6,500	295	4,600
33/0.4 kV	400kVA	1,050	6,250	260	3,575
	630kVA	1,800	8,800	340	5,060

Source: JICA Study Team

In general, the cost of AMT is higher than CRGOT in terms of initial costs, including purchase costs. However, the distribution transformers are usually used for twenty (20) years or more, therefore, it may seems to be uneconomical when the profitability of the transformer is decided based only the initial costs. It is important to consider the TOC (Total Owning Cost) including the operating costs, which are required during the operating period of more than twenty (20) years.

As an example, the TOC of AMT and CRGOT is compared in Fig. 7.5-3. In the case of this example, when the AMT is adopted, the initial costs are slightly expensive, however, the loss caused by the

initial costs can be overcome in approximately five (05) years, and it is advantageous to adopt AMT in terms of TOC.



Conditions for study

- Type of Transformer
  15/0.4kV 400kVA
- Load factor
  55%
- Interest
  10%
- Unit Generation Cost
  40.0 CFA/kWh

Source: JICA Study Team

Fig. 7.5-3 Comparison of Total owning cost

CHAPTER 8

PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE ORGANIZATION

CHAPTER 8 PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE ORGANIZATION

8.1 FINANCIAL SITUATION OF CI-ENERGIES

Nonpublic Information

8.2 PROJECT IMPLIMANTATION ORGANIZATION

8.2.1 Main activities and organizational structure of the executing agency

(1) Main activities of CI-ENERGIES

As mentioned above, the public electricity company CI-ENERGIES is mainly responsible for the management of the assets of the electric power sector and the implementation of new large-scale projects, apart from the public supply service. In electric power provided under the concession contract with CIE, the main activities under the laws and regulations are as follows:

【Main activities of CI-ENERGIES】

- Planning of supply and demand for electrical energy, in coordination with the ministry in charge of energy;
- Project management for the expansion, strengthening and renewal of the transport, distribution and rural electrification network;
- Ownership of assets relating to infrastructure, works and equipment in the electric power sector;
- The expansion and strengthening of existing works, installations and equipment in the public electricity sector on the basis of the concession agreement for the public electricity service;
- Monitoring the management of purchasing, transmission and distribution of electrical energy;
- Asset management of power sector components, accounting and financial management;
- Monitoring the management status of operations under the concession agreement;
- Collection of royalties offered under the concession agreement;
- Maintenance of consolidated accounts in the electricity sector and control of financial balance;
- The comprehensive review on the conversion of any energy source, including new and renewable energies, into electric power;
- The operation and maintenance of any electricity production infrastructure entrusted by third parties;

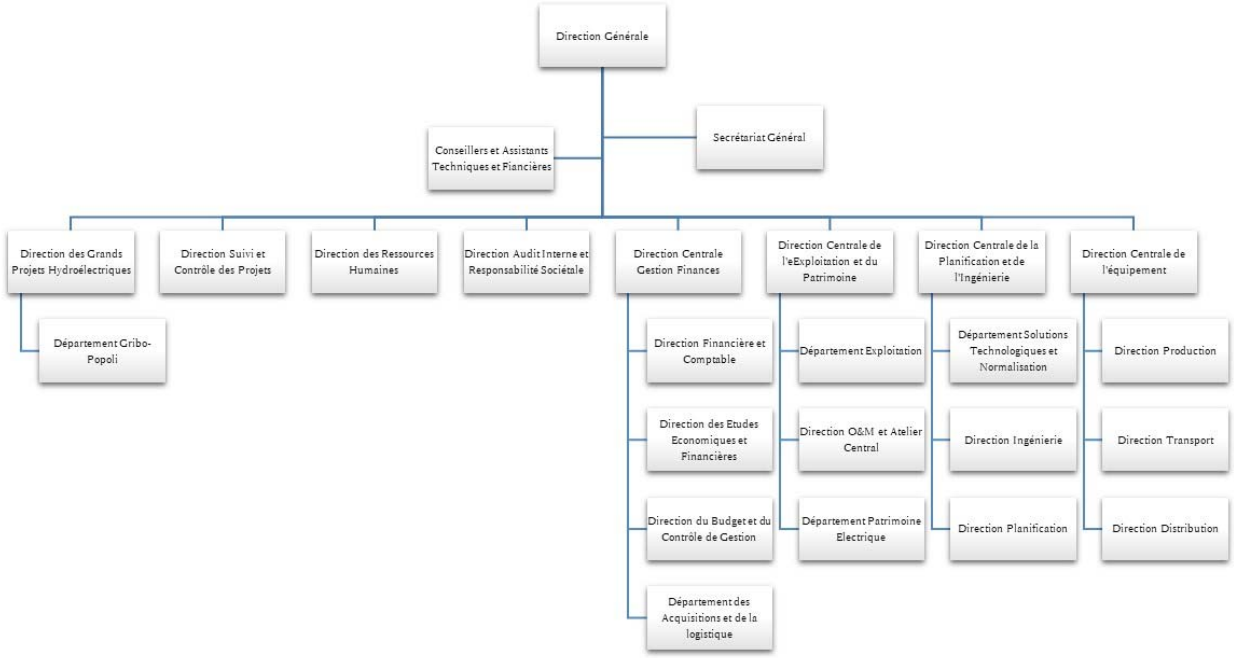
- The realization of investment programs approved by its board of directors by mobilizing with banking and financial institutions or technical and financial partners.

(2) Organizational structure

The organizational structure of the public company CI-ENERGIES, which carries out the aforementioned activities, had 315 people at the end of 2018, and the organizational chart of its management staff is shown in Fig. 8.2-1.

For the implementation of the projects, 7 regional technical centers (hereinafter referred to as "CRT") have been established, and the total workforce is 286 people. Table 8.2-1and Fig. 8.2-2 indicate the number of project teams, the number of staff and the allotment area for each CRT. Additional CRTs will be opened in Yamoussoukro and San Pedro.

It is planned to increase the number of staff to 360 by 2020 in order to respond to the various projects currently planned, and also to increase the number of project management units (hereinafter referred to as "PMUs"), which will be the main executing agencies for the projects as described in the following section, with 327 staff including regular employment consultants.



Source : CI-ENERGIES

Fig. 8.2-1 Management staff organization chart

Table 8.2-1 Staff assignment by CRT

No.	Regional technical centers（CRT）	Teams	Number of Staff
1	Abidjan	12	104
2	Bouaké	3	34
3	Bondoukou	1	10
4	Korhogo	2	19
5	Seguela	2	26
6	Man	3	34
7	Soubré	3	24
	Total	26	286

Source : prepared by the JICA Study Team based on data provided by CI-ENERGIES

Source : CI-ENERGIES

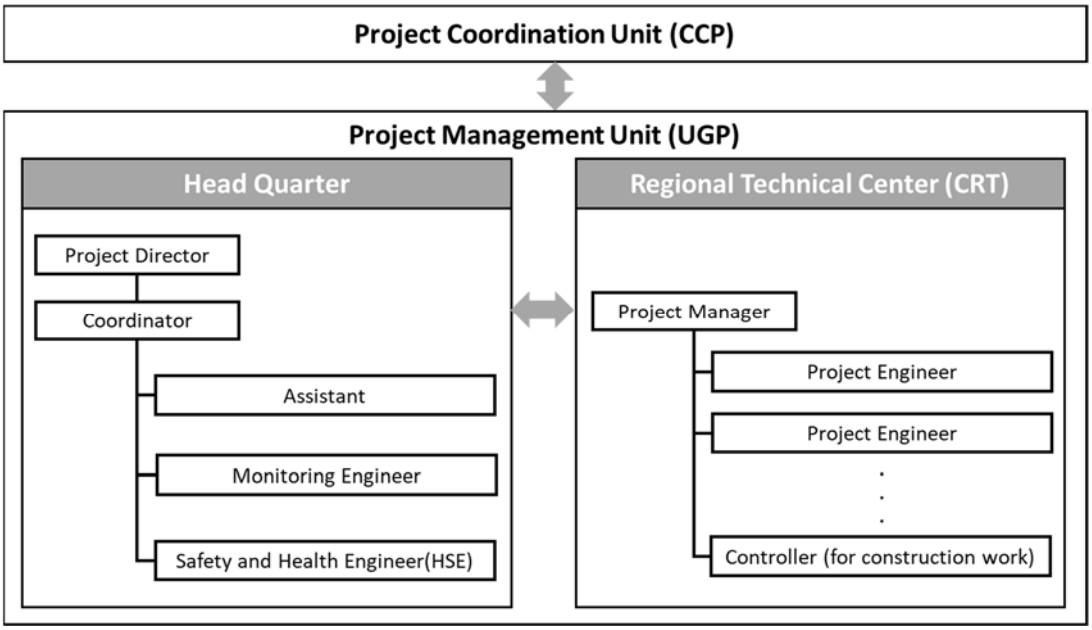
Fig. 8.2-2 Overview of CRTs

8.2.2 Structure of the implementation, supervision and responsibility of the executing agency in the project

(1) Structure of the implementation

Since the main activity of CI-ENERGIES is the implementation of projects, the PMU, which is the project implementation entity, has been integrated into the organization, and its main structure is shown in Fig. 8.2-3.

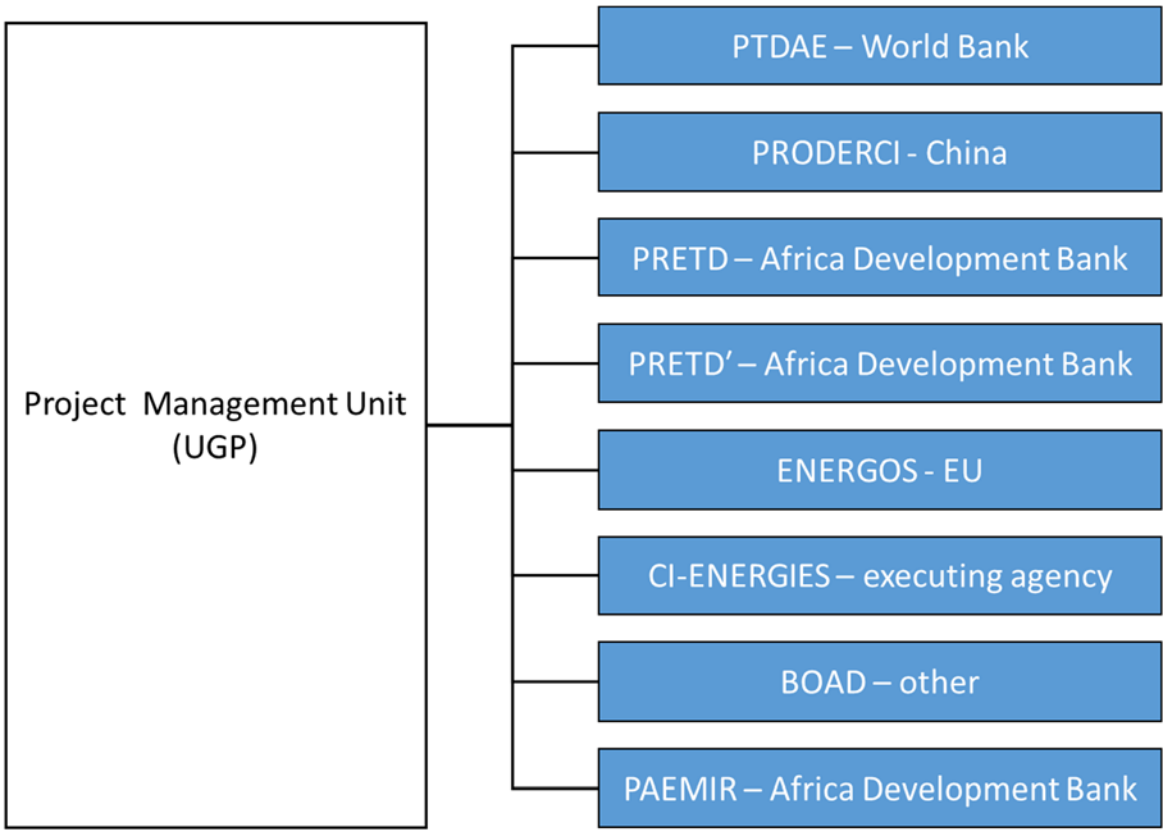
A project coordination unit, which controls all projects from the headquarters, is established to manage and support the various projects while the day-to-day operations of the project are carried out by the Project Coordinator in charge of communication with donors under the control of the Project Director, and the team assigned into the CRT. Engineers, technicians and assistants are assigned under project managers who are vested with a certain authority.



Source : prepared by the JICA Study Team based on data provided by CI-ENERGIES

Fig. 8.2-3 Basic organization of the PMU

The currently established PMUs are shown in the Figure below.

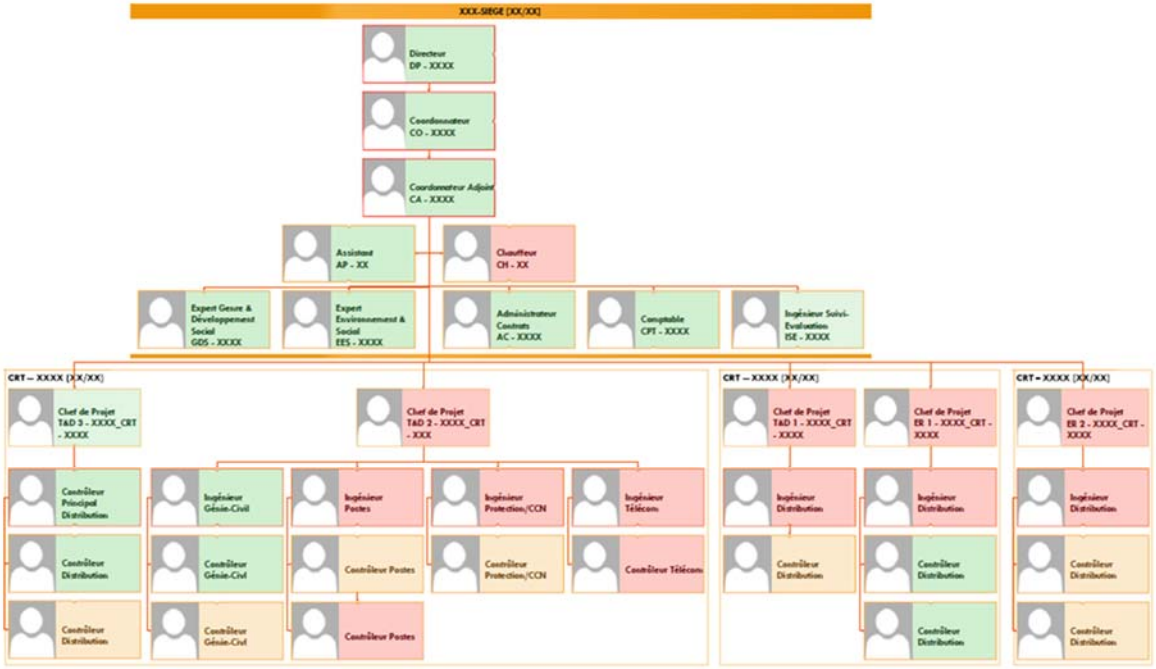


Source : prepared by the JICA Study Team

Fig. 8.2-4 Established PMUs

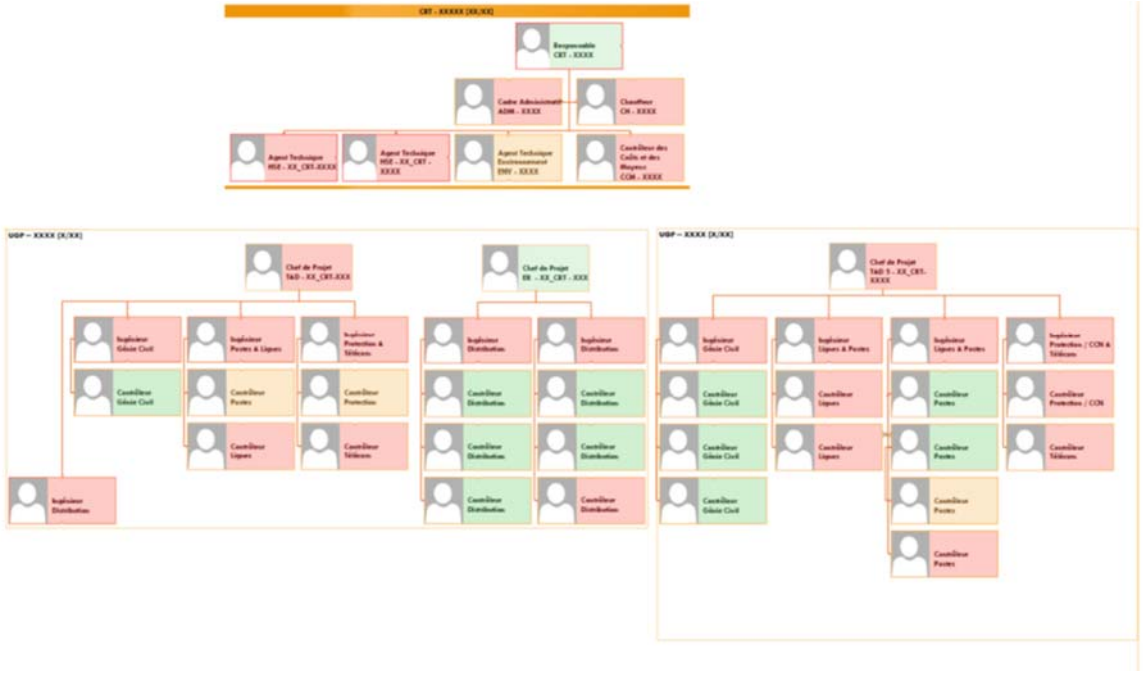
The composition of each PMU is flexibly configured depending on the size of the project.

Examples of staff planning at headquarters and CRT level are shown in the Figures below.



Source : CI-ENERGIES

Fig. 8.2-5 Example of organizational structure of the PMU at headquarters



Source : CI-ENERGIES

Fig. 8.2-6 Example of organizational structure from PMU to CRT

8.2.3 Quality control related to this project by the executing agency

CI-ENERGIES is implementing the Quality, Safety, and Environment Management System (QSE-SM) with the aim of improving the quality of services, and as shown in Table 8.2-2, it is expected that a total of 15 activity standards will be established for the 3 activity areas. This quality management system complies with ISO 9001, ISO 14001 and ISO 45001 standards.

In September 2018, the progress rate was 48%, but it is estimated that it is progressing steadily.

As the standardization of services, which is the basis of quality control in the power sector, is progressing steadily, it is considered that the required quality control will also be ensured during the implementation of the project.

Table 8.2-2 Standardization plan for activities in the QSE-SM

Activities	Activity Standard
Management process	1. Managing Management System 2. Audit and control activities 3. Managing the Communication 4. Leading enterprise
Process Direction	1. Planning the works 2. Realizing design studies 3. Achieving the works "Planning and preparing execution of works" "Achieving the execution of works Studies" "Run the works" "Transferring the works to exploitation" "Follow the exploitation of works" "Managing Heritage" 4. Harnessing the power generation works 5. Achieving the industrial mechanical work
Process Support	1. Managing People 2. Managing IT resources 3. Managing the legal activities and insurance 4. Monitoring and Controlling Projects 5. Managing the procurement purchases 6. Managing finances

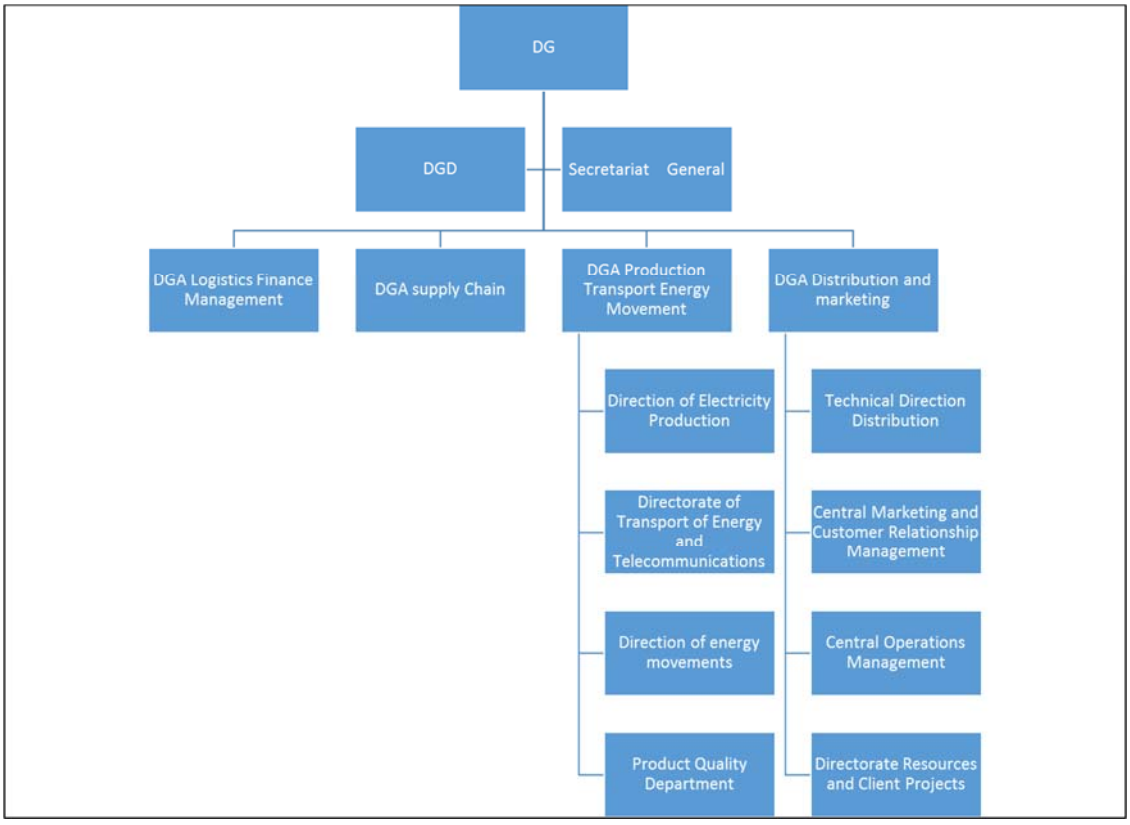
Source : CI-ENERGIES

8.3 ORGANIZATION OF OPERATION AND THE SERVICE

8.3.1 Structure of the operation and the service of the agency of execution

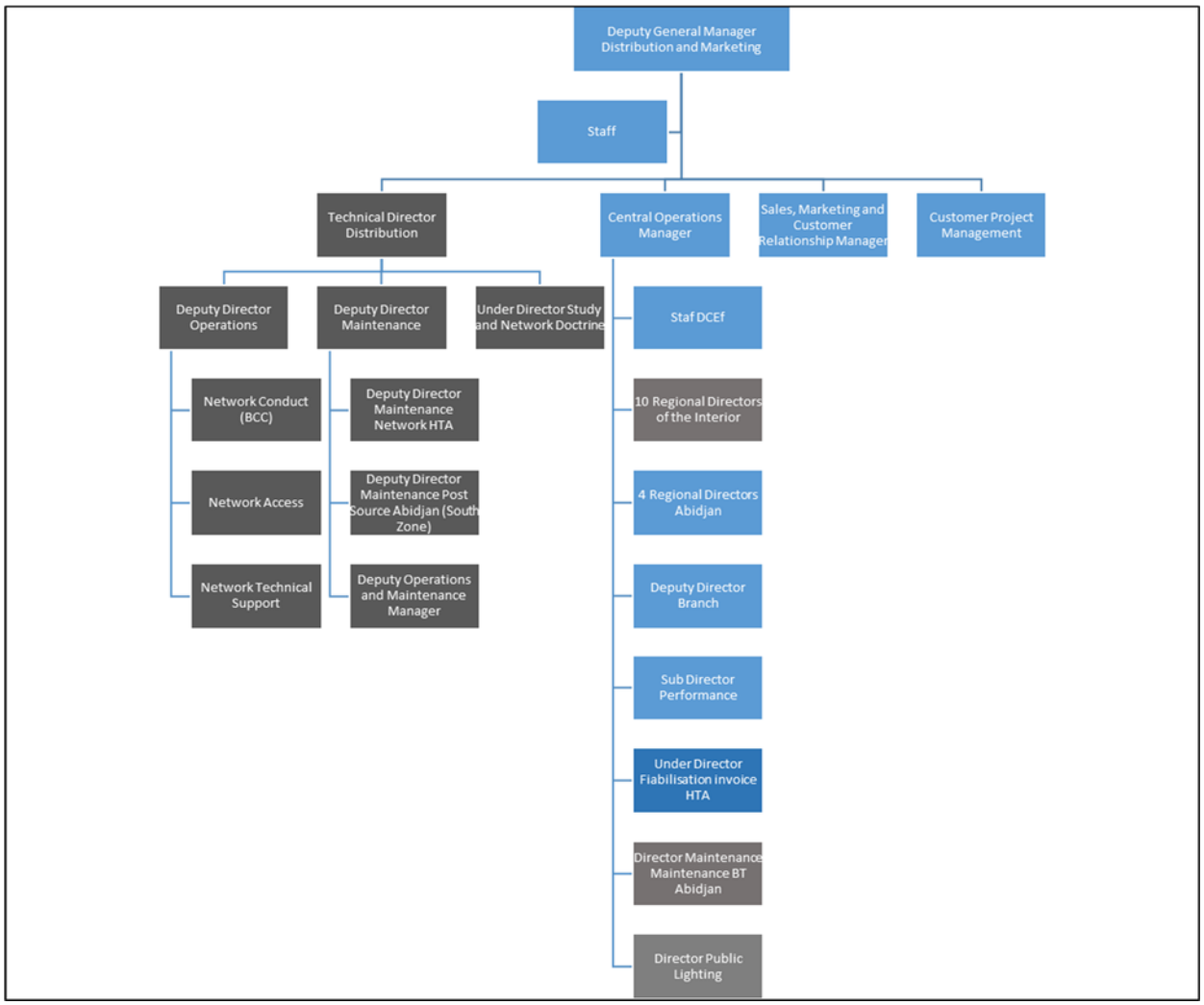
(1) Organizational structure of the CIE

CIE, a company that provides all the power utility services, had 4,733 employees at the end of 2018. Fig. 8.3-1 and Fig. 8.3-2 show the organization charts of the board and the field services.



Source：CIE

Fig. 8.3-1 Organizational chart of the board of directors of the CIE



Source : CIE

Fig. 8.3-2 Organizational chart of the CIE field service

(2) Organization of operation and maintenance

The details of the operation-maintenance organization are described below. The DRTETs (Regional Directorate of Energy Transport and Telecommunications) are maintenance bases for the transmission line and the substations. Regarding the distribution networks, the regional centers take care of the maintenance.

- Organization of the operation - maintenance of the transmission lines has 3 maintenance bases at Bouaké (north), Man (west) and Abidjan (east).
- Organization of the operation - maintenance of the substations has 4 teams in Abidjan (East), 1 team in Man (west) and the 2 teams in Bouaké (center-north).
- Organization of operation - maintenance of the distribution system has 10 regional centers and one

in Abidjan.

- SCADA monitoring by the dispatching center in Abidjan for the southern region (The construction of a new dispatching center in Yamoussoukro is planned, which covers the entire country).

- Assignment of technical staff in the major bases (DRTET) is as shown in the table below. It is considered that the technical staff are correctly allocated according to the size of the facilities in the jurisdiction areas.

Table 8.3-1 Assignment of personnel to the main maintenance bases

Regional Directorate			POST						
			Director	Deputy Director	Head of Division	Technical Manager / Chief of Substation	Technical Chief/ Technician	Administration	Total
ABIDJAN	Number of Personnel		1	2	10	50	51	3	117
	Speciality	Planning			1	4			5
		Communication			1	5	3		9
		Control			2	8	7		17
		Substation Maintenance			2	8	10		20
		Transmission Maintenance			1	4	14		19
		Substation Operation			1	20	14		35
		Administration	1	2	2	1	3	3	12
BOUAKE	Number of Personnel		1	3	10	29	28	3	74
	Speciality	Planning			1	2			3
		Communication			2	6	4		12
		Control			1	4	5		10
		Substation Maintenance			1	5	4		10
		Transmission Maintenance			1	3	6		10
		Substation Operation			1	9	7		17
		Administration	1	3	3		2	3	12
MAN	Number of Personnel		1	3	9	38	22	3	76
	Speciality	Planning			1	2			3
		Communication			2	7	1		10
		Control			1	3	5		9
		Substation Maintenance			1	5	3		9
		Transmission Maintenance			1	3	6		10
		Substation Operation			1	18	4		23
		Administration	1	3	2		3	3	12

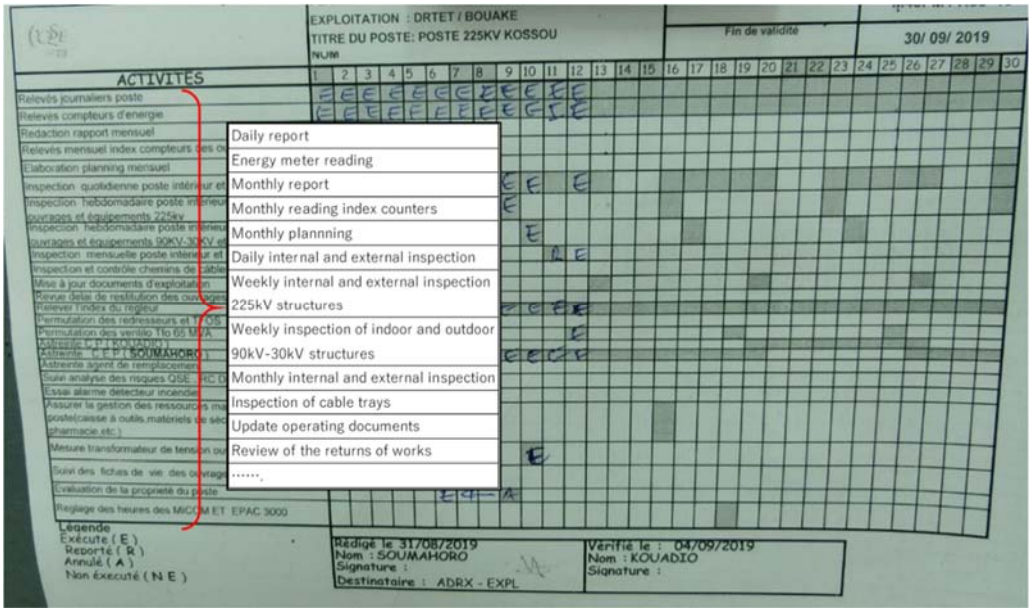
Source : prepared by the JICA Study Team based on data provided by CIE

1) Overhead transmission lines

The three 3 maintenance bases in charge of operation and maintenance of electricity transmission are Bouaké (north), Man (west) and Abidjan (east). Line inspections are carried out once a year by on foot or helicopter inspection and drone inspection have been tried recently. Under-line inspections are conducted twice a year (mainly to check trees), and inspection checklists exist.

2) Substations

4 teams in Abidjan (east), one team in Man (west) and 2 teams in Bouaké (center-north) are in charge of the operation and maintenance of the stations. Daily patrols, annual inspections and detailed inspections (transformer: 5 years, circuit breaker: 10 years) are carried out, and inspection checklists exist. The following figure confirmed by the study team shows a sample maintenance work plan and the result at the Kossou substation, which shows that the work plan is implemented correctly.



Source : prepared by the JICA Study Team

Fig. 8.3-3 Kossou substation operation and maintenance report

To respond to the incident at the substation, 2 resident technical staff intervened during the day and in the evening respectively. In the evening, the incident can be relayed by the alarm at the site's residence. A project to relocate the dispatching center, which controls only the southern zone of the country, is underway. The plan is to relocate it to Yamoussoukro to control all substations. Therefore, all substations are expected to be uninhabited in the future as the installation of the SCADA system progresses, and it is also expected that they will be fully maintained from the maintenance base. In the event of a transmission line or substation incident, all information is centralized at the dispatching center on the basis of the emergency contact list which is updated every week.

3) Distribution

The distribution operations-maintenance teams are located in 10 regional centers and in Abidjan.

The SCADA distribution system is installed at the dispatching center in Abidjan, and it allows remote control of the distribution system in Abidjan.

In the event of a distribution line or post incident, all information is centralized at the distribution dispatching center on the basis of the emergency contact list which is updated weekly.

8.3.2 Financial and budgetary situation of the operating and maintenance organization

Nonpublic Information

8.3.3 Quality control and technical level of the operating and maintenance organization

The CIE has been operating for a long period, since 1990, under the concession contract with Eranove, a French company, and as a result, the level of the company's activities is assumed to be very high. For example, the management of entrances to the premises of the substation and that of uniforms are quite strict, and no dangerous operations or unsecured equipment have been observed. The management of individual skills is also done using a skills assessment sheet shown in Fig. 8.3-4.

Regarding the standardization of operations, the standards and maintenance inspection methods have been standardized and daily operations are carried out according to the rules; there is therefore no particular point to raise in terms of quality control.

FICHE D'EVALUATION DES COMPETENCES

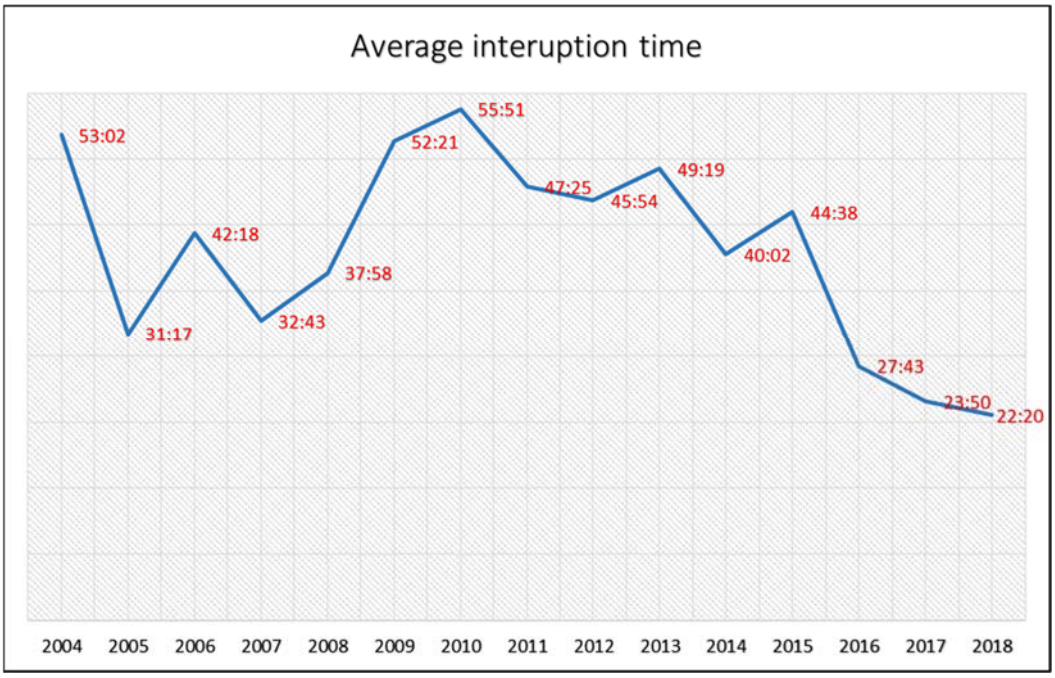
Pratiques Professionnelles	NIVEAU DE PROFESSIONNALISME ATTENDU	NIVEAU DE PROFESSIONNALISME REEL	ECART	REGULATE D'ACTIONS
Etablit l'état des clients à suspendre en exploitant le portefeuille clients à partir des données prédéfinies* en vue de garantir le paiement des factures	EXPERT			
Suit l'exécution des avis* édités en s'assurant de leur mise en œuvre effective par les agents d'intervention en vue d'améliorer le taux de recouvrement	CONFIRME			
Anime la réunion de recouvrement en commentant le rapport de la période précédente et la situation générale des impayés en vue d'améliorer le résultat du recouvrement	CONFIRME			
Oriente la demande vers le service concerné en transmettant les informations nécessaires en vue d'un meilleur suivi	CONFIRME			
Elabore le planning d'intervention en tenant compte des données prédéfinies en vue du respect des délais de recouvrement	MAITRISE			
Recueille la préoccupation du client en l'écoutant attentivement en vue de traiter efficacement sa demande	MAITRISE			

Source : CIE

Fig. 8.3-4 Individual skills assessment sheet

In addition, regarding the power quality which is the result of daily operation and maintenance activities, it is observed that the annual transition of the average power failure time, as shown in Fig. 8.3-5, although high during the country's crisis, has declined in recent years. It can be deduced that the daily operation-maintenance activities and the rehabilitation works of the facilities are

carried out in an appropriate and regular manner.



Source : CIE

Fig. 8.3-5 Transition of the mean time of power failure

8.4 ORGANIZATION OF PROJECT IMPLEMENTATION AND RECOMMENDATION

8.4.1 Organization of execution

To correspond to the allotment of the project contracts, the team in charge of the project will be established in the three CRTs- Abidjan, Yamoussoukro and Bouaké, as shown in the Figure below. The staff will come from the DCET (Central Directorate of Equipment and Works) of the headquarters. There is currently no problem with recruitment, as it will be dealt with as a part of Directorate's staff increase plan.

LOT	SCOPE	CRT
I	1.New Transmission Line 225 kV Taabo-Yamoussoukro	Abidjan
	Yamoussoukro-Kossou	Yamoussoukro
	2. Expansion of 225 kV Taabo Substation	Abidjan
	3. Expansion of 225 kV Kossou Substation	Yamoussoukro
	4. New Substation 225 kV Yamoussoukro 2	Yamoussoukro
II	1.New Transmission Line 225 kV Kossou-Bouaké 2-Bouaké 3	Bouake
	2.Expansion of 225 kV Bouaké 2 Substation	Bouake
	3.New Substation 225 kV Bouaké 3	Bouake
III	1.Distribution Line Expansion and Rehabiritation for Bouaké 3 Substation	Bouake
	2.Distribution Line Expansion and Rehabiritation for Yamoussoukro 2 Substation	Yamoussoukro

Source : prepared by the JICA Study Team

Activities at the detailed design stage are based at the PMU of the headquarters, as close

communication with the project manager and coordinator is required. On the other hand, activities at the construction and supervision stage will be based at each CRTs, while the entire project will be managed by the PMU at headquarters

8.4.2 Organization of operation and maintenance

The organization of the operation and maintenance of the CIE for substations and transmission structures within the framework of the project is as indicated in the table below, and the regional centers of each city are in charge of the maintenance and operation of distribution system. The operation and maintenance structures in the 2 bases of Abidjan and Bouaké are well established as mentioned above, and most of the transmission lines will be built along the existing lines; so there is no particular problem with the operation and maintenance of the project.

Table 8.4-1 Departments responsible for the operation and maintenance of facilities

Operation and Maintenance Center	Facilities
DRTET ABIDJAN	・225kV Taabo S/S
DRTET BOUAKE	・225kV Kossou S/S ・225kV Bouaké2 S/S ・225kV Bouaké3 S/S ・225kV Yamoussoukro2 S/S ・Tramsmission Lines of the project

Source : prepared by the JICA Study Team

8.4.3 Recommendation for the organization of the execution

While a sufficient number of employees of CI-ENERGIES, the executing agency of the project, are currently qualified and experienced in the planning and construction of the facilities, the personnel resources plan aims to increase contractual employees; and the strengthening of know-how within the organization and the training of young employees are seen as the challenges of the future. In particular, it is important for young, inexperienced employees to acquire the skills necessary to plan expansions and rehabilitations based on the precise knowledge and understanding of the condition of the equipment. From this point of view, sending inexperienced staff to the CIE in the short term, for example, should be considered in the future.

The maintenance executing agency has introduced a rational method of equipment management under a concession contract, and it is further planned to improve the efficiency of operating activities through the introduction of remote control by SCADA and inspection by drone. Taking into account that full operation by SCADA is not yet planned, appropriate staffing is necessary for substation operations. It goes without saying that it is also essential to maintain the required number of personnel for transmission lines and distribution networks under the appropriate personnel resources plan.

CHAPTER 9

EVALUATION OF PROJECT

CHAPTER 9 EVALUATION OF PROJECT

In this chapter, a project evaluation is carried out on the basis of quantitative indicators such as IRR (Internal Rate of Return) and CO_2 emissions, in order to examine the relevance of the implementation of the Project.

9.1 QUANTITATIVE EVALUATION

9.1.1 Project Benefit

With regard to "the power supply to domestic consumers and international connection by the reinforcement of transmission lines and substations", the Taabo, Kossou, Yamoussoukro, Bouaké 1, Bouaké 2, Bouaké 3 (new) and Yamoussoukro 2 (new) substations are considered as the target of the Project. Mali and Burkina Faso are considered for the interconnection of electricity export.

Table 9.1-1 shows the power demand forecasts for target substations and international interconnections in the Project up to 2040 provided by CI-ENERGIES.

Table 9.1-1 Power Demand Forecasts for Target Substations and International Interconnections until 2040

項目	対象	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
「コ」国変電所	BOUAKE 1	24.2	26.3	27.4	28.5	30.1	32.5	34.4	36.3	38.1	40.0	41.9	43.7	45.6	47.5	49.3
	BOUAKE 2	25.2	27.4	28.5	29.6	31.3	33.8	35.8	37.7	39.6	41.6	43.5	45.5	47.4	49.4	51.3
	KOSSOU	20.4	22.2	23.1	24.0	25.4	27.4	29.0	30.6	32.1	33.7	35.3	36.9	38.5	40.0	41.6
	TAABO	13.6	14.8	15.4	16.0	16.9	18.3	19.3	20.4	21.4	22.5	23.5	24.6	25.6	26.7	27.7
	YAMOUSS	40.9	44.4	46.2	48.1	50.9	54.9	58.0	61.2	64.3	67.5	70.7	73.8	77.0	80.1	83.3
	BOUAKE 3 (New)	16.0	18.2	20.1	22.0	24.1	26.4	28.6	30.7	32.9	35.1	37.2	39.4	41.5	43.7	45.8
	YAMOUSS 2 (New)	15.2	17.1	18.5	20.0	21.7	23.7	25.5	27.3	29.1	30.9	32.7	34.5	36.2	38.0	39.8
	Total (MW)	155.5	170.4	179.2	188.2	200.4	217.0	230.6	244.2	257.5	271.3	284.8	298.4	311.8	325.4	338.8
国際系統連系	Mali	270.0	270.0	270.0	270.0	270.0	370.0	370.0	370.0	370.0	370.0	470.0	470.0	470.0	470.0	470.0
	Burkina Faso	200.0	225.0	225.0	225.0	225.0	300.0	300.0	300.0	300.0	300.0	375.0	375.0	375.0	375.0	375.0
	Total (MW)	470.0	495.0	495.0	495.0	495.0	670.0	670.0	670.0	670.0	670.0	845.0	845.0	845.0	845.0	845.0

On the basis of these demand forecasts, the increase of transmitted electricity for the domestic supply and export by the Project will be calculated. It is necessary to distinguish between the benefits of the Project and those of the CI-ENERGIES self-financed project because the transmission lines between Taabo - Kossou - Bouaké is composed of the double circuits of the Project and the single circuit of the self-financed project. Here, 71.3% of the total increase is recorded as the profit by the Project on the basis of the power flow ratio calculated by the power system analysis. Table 9.1-2 shows the results of the increase in domestic electricity supply and electricity exports, which are the benefits of the Project. The load factor considered is set at 70%.

Table 9.1-2 Domestic electricity supply and electricity exports until 2040

Item	Category	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
(1) Demand Load（MW）	Domestic	155.5	170.4	179.2	188.2	200.4	217.0	230.6	244.2	257.5	271.3	284.8	298.4	311.8	325.4	338.8
	International	470.0	495.0	495.0	495.0	495.0	670.0	670.0	670.0	670.0	670.0	845.0	845.0	845.0	845.0	845.0
	Subtotal	625.5	665.4	674.2	683.2	695.4	887.0	900.6	914.2	927.5	941.3	1,129.8	1,143.4	1,156.8	1,170.4	1,183.8
(2) Total Supply（GWh）	Domestic	953.5	1,044.9	1,098.9	1,154.0	1,228.9	1,330.6	1,414.0	1,497.4	1,579.0	1,663.6	1,746.4	1,829.8	1,912.0	1,995.4	2,077.5
	International	2,882.0	3,035.3	3,035.3	3,035.3	3,035.3	4,108.4	4,108.4	4,108.4	4,108.4	4,108.4	5,181.5	5,181.5	5,181.5	5,181.5	5,181.5
	Subtotal	3,835.6	4,080.2	4,134.2	4,189.4	4,264.2	5,439.1	5,522.5	5,605.9	5,687.4	5,772.1	6,927.9	7,011.3	7,093.5	7,176.9	7,259.1
(3) Incremental Supply（GWh）	Domestic	953.5	1,044.9	1,098.9	1,154.0	1,228.9	1,330.6	1,414.0	1,497.4	1,579.0	1,663.6	1,746.4	1,829.8	1,912.0	1,995.4	2,077.5
	International	2,882.0	3,035.3	3,035.3	3,035.3	3,035.3	4,108.4	4,108.4	4,108.4	4,108.4	4,108.4	5,181.5	5,181.5	5,181.5	5,181.5	5,181.5
	Subtotal	3,835.6	4,080.2	4,134.2	4,189.4	4,264.2	5,439.1	5,522.5	5,605.9	5,687.4	5,772.1	6,927.9	7,011.3	7,093.5	7,176.9	7,259.1
(3) Benefits of the Project（GWh）	Domestic	680.2	745.4	783.9	823.3	876.6	949.2	1,008.7	1,068.2	1,126.4	1,186.8	1,245.8	1,305.3	1,363.9	1,423.4	1,482.1
	International	2,056.0	2,165.3	2,165.3	2,165.3	2,165.3	2,930.9	2,930.9	2,930.9	2,930.9	2,930.9	3,696.4	3,696.4	3,696.4	3,696.4	3,696.4
	Subtotal	2,736.2	2,910.7	2,949.2	2,988.6	3,042.0	3,880.1	3,939.6	3,999.1	4,057.3	4,117.6	4,942.2	5,001.7	5,060.3	5,119.8	5,178.4

9.1.2 Economic and financial analysis

Nonpublic Information

Fig. 9.1-1 Structures for Financial Analysis

1) Definition of financial costs and benefits

Following the calculation of the financial cost for the total project cost described in the previous chapter, the total financial cost of the Project is 312.7 million USD（Foreign :163.7 million USD and Domestic :82,925.0 million FCFA）.

With regard to the benefits of the project, as mentioned above, considering the structure of income and expenditure shown in Fig. 9.1-1, the revenues of the Project are assumed to come from wholesale to domestic consumers, and to Mali and Burkina Faso via international connection. Here, the benefits will be the increase in power supply to the domestic markets, Mali and Burkina Faso by the Project calculated in the previous section. As the demand forecasts provided by CI-ENERGIES are estimated up to 2040, the 2040 forecasts will be applied to demand and supply after 2040.

2) Results of the analysis

The results of financial analysis for the Project are presented in Table 9.1-3 and the results of the sensitivity analysis are presented in Table 9.1-4. The FIRR for the base case is 22.4%. The results of the sensitivity analysis also exceed the 6% level of government bonds issued by the Central Bank of the Republic of Côte d'Ivoire, and it is expected that the Project will also have financial benefits.

Table 9.1-3 Results of FIRR

Commissioning Year		-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	total
Year		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	#	
1. Income Statement																																							
1.1 Incom Schedule																																							
Energy Sold	GWh						2,672.7	2,843.2	2,881.0	2,919.6	2,971.9	3,789.9	3,848.3	3,906.6	3,963.6	4,022.7	4,827.5	4,885.8	4,943.3	5,001.6	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0	5,059.0		139,481.0
Applied Rate	USD/kWh						0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123	0.123		-
1.2 Capital Expenses																																							
(1) Investment Cost	Mil USD	0.0	4.9	5.9	109.4	132.3	52.2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		312.8
(2) VAT	Mil USD																																						
Total Capital Expenses	Mil USD	0.0	4.9	5.9	109.4	132.3	52.2	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		312.8
1.3 Operating Revenue																																							
(1) Revenue from Power Sales Increase	Mil USD						82.1	90.0	94.6	99.4	105.8	114.6	121.8	128.9	136.0	143.2	150.4	157.5	164.6	171.8	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9	178.9		4,801.6
(2) Revenue from Interconnection Increase	Mil USD						237.7	250.3	250.3	250.3	250.3	338.8	338.8	338.8	338.8	338.8	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4	427.4		11,907.8
(3)	Mil USD																																						0.0
(4)	Mil USD																																						
Total Operating Revenue	Mil USD						319.8	340.3	345.0	349.7	356.2	453.4	460.6	467.8	474.8	482.1	577.7	584.9	592.0	599.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2		16,709.4
1.4 Operating Expenses																																							
(1) O&M Cost	Mil USD						32.5	35.5	37.0	38.5	40.5	49.5	51.8	54.2	56.6	59.2	68.7	71.5	74.3	77.2	80.1	81.3	82.6	83.9	85.1	86.5	87.8	89.1	90.5	91.9	93.3	94.8	96.2	97.7	99.2	100.7	102.3		2,289.8
(2) Power Purchase Cost	Mil USD						207.4	220.6	223.6	226.7	230.8	294.0	298.6	303.2	307.7	312.4	374.6	379.2	383.7	388.3	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8	392.8		10,829.3
(3)	Mil USD																																						0.0
(4)	Mil USD																																						0.0
(5)	Mil USD																																						
(6) Depreciation	Mil USD						9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8		303.9
Total Operating Expenses	Mil USD						249.7	265.9	270.4	275.0	281.1	353.3	360.3	367.2	374.1	381.3	453.1	460.5	467.8	475.3	482.7	484.0	485.2	486.5	487.8	489.1	490.4	491.8	493.2	494.5	496.0	497.4	498.9	500.3	501.8	503.4	504.9	13,423.0
1.5 Earnings before Interest and Tax (EBIT)							70.1	74.4	74.6	74.7	75.1	100.1	100.3	100.5	100.7	100.7	124.6	124.4	124.2	123.9	123.5	122.3	121.0	119.7	118.4	117.1	115.8	114.5	113.1	111.7	110.3	108.8	107.4	105.9	104.4	102.9	101.3	3,286.4
1.6 Non-Operating Expenses																																							
(1) Interest payment	Mil USD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	2.8	2.7	2.5	2.4	2.2	2.1	1.9	1.8	1.6	1.5	1.3	1.2	1.0	0.9	0.7	0.6	0.4	0.3	0.1	31.3
(2) Commitment Fee	Mil USD	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.5
Total Non-Operating Expenses		0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	2.8	2.7	2.5	2.4	2.2	2.1	1.9	1.8	1.6	1.5	1.3	1.2	1.0	0.9	0.7	0.6	0.4	0.3	0.1	31.332
1.7 Earnings before Tax	Mil USD	-0.5	0.0	0.0	0.0	0.0	70.1	74.4	74.6	74.7	75.1	100.1	100.3	100.5	100.7	100.7	124.6	121.4	121.3	121.2	121.0	119.9	118.8	117.6	116.5	115.3	114.2	113.0	111.7	110.5	109.2	107.9	106.6	105.3	103.9	102.6	101.2		3,255.0
1.8 Sales Additional Tax																																							
(1)																																							
(2)																																							
Total Sales Additional Tax		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
1.9 Taxable Income	Mil USD	-0.5	0.0	0.0	0.0	0.0	70.1	74.4	74.6	74.7	75.1	100.1	100.3	100.5	100.7	100.7	124.6	121.4	121.3	121.2	121.0	119.9	118.8	117.6	116.5	115.3	114.2	113.0	111.7	110.5	109.2	107.9	106.6	105.3	103.9	102.6	101.2		3,255.0
1.10 Income Tax	Mil USD	0.0	0.0	0.0	0.0	0.0	17.5	18.6	18.6	18.7	18.8	25.0	25.1	25.1	25.2	25.2	31.1	30.4	30.3	30.3	30.2	30.0	29.7	29.4	29.1	28.8	28.5	28.2	27.9	27.6	27.3	27.0	26.7	26.3	26.0	25.6	25.3		813.8
1.11 NET INCOME	Mil USD	-0.5	0.0	0.0	0.0	0.0	52.6	55.8	55.9	56.0	56.3	75.1	75.3	75.4	75.5	75.6	93.4	91.1	91.0	90.9	90.7	89.9	89.1	88.2	87.4	86.5	85.6	84.7	83.8	82.9	81.9	81.0	80.0	79.0	78.0	76.9	75.9		2,441.3
Commissioning Year	**unit**	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	total
Year		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	#	
2. CASH FLOW																																							
2.1 Operating Cash Flow																																							
(1) Operating Income	Mil USD	0.0	0.0	0.0	0.0	0.0	319.8	340.3	345.0	349.7	356.2	453.4	460.6	467.8	474.8	482.1	577.7	584.9	592.0	599.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2	606.2		16,709.4
(2) Operating Expenses	Mil USD	0.0	0.0	0.0	0.0	0.0	-249.7	-265.9	-270.4	-275.0	-281.1	-353.3	-360.3	-367.2	-374.1	-381.3	-453.1	-460.5	-467.8	-475.3	-482.7	-484.0	-485.2	-486.5	-487.8	-489.1	-490.4	-491.8	-493.2	-494.5	-496.0	-497.4	-498.9	-500.3	-501.8	-503.4	-504.9		-13,423.0
(3) Taxes and duties	Mil USD	0.0	0.0	0.0	0.0	0.0	-17.5	-18.6	-18.6	-18.7	-18.8	-25.0	-25.1	-25.1	-25.2	-25.2	-31.1	-30.4	-30.3	-30.3	-30.2	-30.0	-29.7	-29.4	-29.1	-28.8	-28.5	-28.2	-27.9	-27.6	-27.3	-27.0	-26.7	-26.3	-26.0	-25.6	-25.3		-813.8
2.2 Financing Activities																																							
(1) Interest payment	Mil USD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.0	-2.8	-2.7	-2.5	-2.4	-2.2	-2.1	-1.9	-1.8	-1.6	-1.5	-1.3	-1.2	-1.0	-0.9	-0.7	-0.6	-0.4	-0.3	-0.1	-31.3
(2) Commitment Fee Payment	Mil USD	-0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0
(3) Principal repayment	Mil USD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0	-13.0		-259.5
2.3 Investment Activities																																							
(1) Own Capital Expenditure	Mil USD	0.0	-1.0	-1.2	-21.9	-26.5	-10.4	-1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		-62.5
(2) Capital Expenditure by Loan	Mil USD	0.0	-3.9	-4.7	-87.6	-105.8	-41.8	-6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		-250.2
2.4 Cash Flow for Project FIRR	FIRR=22.35%	0.0	-4.9	-5.9	-109.4	-132.3	10.2	57.6	65.7	65.8	66.1	84.9	85.1	85.2	85.3	85.4	103.2	103.9	103.6	103.4	103.1	102.1	101.1	100.1	99.1	98.1	97.1	96.0	94.9	93.9	92.8	91.7	90.5	89.4	88.2	87.0	85.8		2,463.8

Table 9.1-4 Results of Sensitivity Analysis on FIRR

Case	FIRR
Base Case	22.4%
Project cost (+10%)	20.7%
Unit price of electricity sales (-10%)	14.0%
Not achieved at the assumed increase in power at the end of the transmission line (-10%)	20.5%

9.1.3 Estimation of CO2 Emission

One of the benefits brought about by implementing this project is the reduction of transmission loss. The following difference can be expected in the year 2026.

without Project	Energy Loss p.a,＝	2,749,334 MWh
with Project	Ditto	2,736,200 MWh

The difference in the amount of electricity saved by implementing the project is 13,134 MWh. The amount of CO2 emission that was supposed to be emitted by generating 5,890 MWh electricity, is the amount of CO2 emission reduced by implementing this project.

Under these conditions, the effect of CO2 emission reduction, taking into consideration the reduction of CO2 emission due to the improvement of distribution efficiency, is estimated to be 103,976 t-CO2 per year as shown in the below table.

Table 9.1-1 Reduction of CO2 Emission by the Project (as of 2026)

		Value	Unit
Emission reduction		21,310	tCO_2/year
Baseline emission		88,790	tCO_2/year
Amount of electricity to the transmission system in the project in year y		2,736,200	MWh/year
Transmission loss rate of the baseline transmission system in a year y		5	%
CO_2 emission factor of electricity		0.649	tCO_2/MWh
Project emission		67,480	tCO_2/year
Electricity loss of the project transmission system in a year y		103,976	MWh/year
CO_2 emission factor of electricity		0.649	tCO_2/MWh

https://www.jica.go.jp/activities/issues/climate/mitigation_j.html

Source: JICA Study Team

9.2 PROPOSAL OF OPERATION AND EFFECT INDICATOR

9.2.1 Transmission Facility, Substation Facility and Distribution Facility

The three operation and effect indicators proposed for performing a post-evaluation are shown in Table 9.2-1.

Table 9.2-1 Proposed Operation and Effect Indicators

Indicator	Function	Purpose	
		As Operation Indicator	As Effect Indicator
a) Electricity supply for transmission and substation ［GWh］	Electricity supply per year by the expanded transformer capacity	To check that the expanded transformer is utilized efficiently	To evaluate the increased energy
b) Substation outage frequency [number of times in a year]	Frequency of substation outage for over ten minutes caused by a transmission line fault	To evaluate whether reliability is kept proper	To evaluate whether reliability has been improved to a proper value after the Project
c) Electricity supply for distribution ［GWh］	Electricity supply per year by the expanded transformer capacity	To check that the expanded distribution network (MV) is utilized efficiently	To evaluate the increased energy

Source: JICA Study Team

As for the electricity supply, it can be checked if the expanded facilities are used effectively or not using index such as the increased electricity supply from transmission line including export power and the expanded transformer capacity of substation brought by this project.

As for the substation's outage frequency, it can be checked if the expanded facilities are reliable or not by index such as the number of outages in the substation's expanded incoming transmission line.

9.3 TARGET VALUES OF OPERATION AND EFFECT INDICATORS

9.3.1 Transmission Facility, Substation Facility and Distribution Facility

The values aimed for the year 2026, two years after the completion of project, are set as target values. The target values of operation and effect indicators are shown in Table 9.3-1.

Table 9.3-1 Target Values of Operation and Effect Indicators

Indicator	Facility	Standard Value	Target Value	Remark
a) Electricity supply［GWh］	Yamoussoukro2 substation 225/33kV 2 units 225/15kV 2 units	-	123 GWh	two-year after project completion (2026)
	Bouake3 substation 225/33kV 2 units 225/15kV 2 units	-	113 GWh	
	Electricity supply from Bouake3 substation (Ferke side:225kV)	2,056 GWh	2,165 GWh	
b) Substation Outage Frequency ［Time per year］	Yamoussoukro 2 substation	-	0	
	Bouake 3 substation	-	0	
c) Electricity supply［GWh］	9 distribution feeders at Yamoussoukro 2 substation	-	123 GWh	
	10 distribution feeders at Bouake 3	-	113 GWh	

Source: JICA Study Team

APPENDICES

APPENDIX-1

LIST OF PARTIES

赤字は英語表記

	Nom (Name)	Organization (Organisation)	Département (Department)	Titre (Position)
1	KONE Moussa	Direction Générale de l'Energie / MPEER Directorate General of Energy / Ministry of Petroleum, Energy and Renewable Energies	Direction Générale de l'Energie Directorate General of Energy	Directeur des Suivi et de la Règlementation de l'Energie Director of Energy Monitoring and Regulation Department
2	DIARRASOUBA Nagaky	CI-ENERGIES	Direction Centrale Equipements et Travaux Central Directorate of Equipment and Works	Directeur Central Equipement et Travaux Central Director of Equipment and Works
3	BONI Adipoh	CI-ENERGIES	Secrétariat Général General Secretariat	Assistant Assistant
4	ANOH Angaman	CI-ENERGIES	Direction Centrale Planification et Ingénierie Central Direction of Planning and Engineering	Assistant du Directeur Central Planification et Ingénierie Assistant to the Central Director of Planning and Engineering
5	BORGET Jean-François	CI-ENERGIES	Direction Centrale Planification et Ingénierie Central Direction of Planning and Engineering	Ingénieur SIG GIS Engineer
6	TCHA Camille	CI-ENERGIES	Direction Centrale Planification et Ingénierie Central Direction of Planning and Engineering	Ingénieur Planification Planning Engineer
7	OUATTARA Dognymé	CI-ENERGIES	Direction Centrale Planification et Ingénierie Central Direction of Planning and Engineering	Ingénieur Planification Planning Engineer
8	AFFAINIE Marie-Emmanuelle	CI-ENERGIES	Direction de la Planification Planning Department	Ingénieur Planification / Distribution Planning Engineering/Distribution
9	ABOUA Flora	CI-ENERGIES	Direction de la Planification Planning Department	Economiste Economist
10	SYLLA Vame	CI-ENERGIES	Département Patrimoine Electrique Electrical Patrimony Department	Chef de Département Head of Department
11	GILBERNAIRE Pascaline	CI-ENERGIES	Département Patrimoine Electrique Electrical Patrimony Department	Chef de Service Foncier Head of Land Department
12	MAMERY Serifou	CI-ENERGIES	DCGF/DEEF Direction Centrale de Gestion Finances/Direction des Etudes Economiques et Financières Central Direction of Management and Finance / Economic and Financial Studies Department	DEEF/Directeur des Etudes Economiques et Financières Director of Economic and Financial Studies Department
13	BILE Hervé	CI-ENERGIES	DCGF/DEEF Direction Centrale de Gestion et Finances/Direction des Etudes Economiques et Financières Central Direction of Management and Finance / Economic and Financial Studies Department	CSEE/Chef de Service Etudes Economiques Head of Economic Studies Service
14	N'GUESSAN Kouadio Simplice	CI-ENERGIES	Exploitation Operations	Chef Service Suivi Conventions et Contrats Head of Monitoring Conventions and Contracts Service
15	OUATTARA Oumar	CI-ENERGIES	DCPI/DIN Direction Centrale Planification et Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Chef de Service Etudes Environnementales et Sociales Head of Environmental and Social Studies Service
16	SAKHO Aidatou	CI-ENERGIES	DCPI/DIN Direction Centrale Planification et Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Ingénieure en Environnement Environmental Engineer
17	KARIN Aurélie	CI-ENERGIES	DCPI/DIN Direction Centrale Planification et Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Ingénieure en Environnement Environmental Engineer
18	Adon Yves Marie Florence	CI-ENERGIES	DCPI/DIN Direction Centrale Planification et Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Environnementaliste Environmentalist
19	AFFAIRMIE Marie Emmanuelle	CI-ENERGIES	DPI (Direction Planification et Ingénierie) Planning and Engineering Department	Ingénieur Planification Planning Engineer
20	SYLLA Vame	CI-ENERGIES	DPE (Département Patrimoine Electrique) Electrical Patrimony Department	Chef de département Head of Department
21	Gnama Badi Guy	CI-ENERGIES	DCET/DTR (Direction Centrale Equipements et Travaux/Direction des Travaux) Central Direction of Equipment and Works/ Works Department	Controleur-Expert Ligne HTB Controller-High Voltage Line Expert

	Nom (Name)	Organization (Organisation)	Département (Department)	Titre (Position)
22	ADJEI Jean Mavc Kouakou Odi	CI-ENERGIES	Direction de la Planification/Service Planification-Programmation-Production-Transport-Téléconduite Planning Department/ Planning-Programming-Production-Transport-Telecontrol Service	CS (Chef de Service) Head of Service
23	M'bea Yao Syllas	CI-ENERGIES	DIN (Direction de l'Ingénierie) Engineering Department	CS (Chef de Service) Head of Service
24	Sidibe Noumaolike Germain Joseph	CI-ENERGIES	DIN (Direction de l'Ingénierie) Engineering Department	Ingénieur Engineer
25	Serge-Pacôme ABLINGUE	CI-ENERGIES	Departement Achat et Logistique Purchase and Logistic Deprtment	Chef du Service Acquisition Head of Purchasing Service
26	BROU Koissi Louis	CI-ENERGIES	Direction de la Planification Planning Department	Directeur Director
27	AMARI EDLEMS A. STEPHANE	CI-ENERGIES	PDSSIG (Prevision de la Demande Statistique et Systeme D'information Geographique) (Statistical Demand Forecast and Geographical Information System)	Chef de service Head of Service
28	COULIBALY Mohamed	CI-ENERGIES	DCPI/DPL(Direction Centrale Planification et Ingénierie / Direction de la Planification) Central Direction of Planning and Engineering/ Planning Department	Chargé d'Etudes In charge of Studies
29	Wihon Jean KONE	CI-ENERGIES	DCPI/DIN Direction Centrale Planification et Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Chef de Service Ingenierie Production-Transport-Teleconduite Engineering-Production-Transport-Telecontrol service
30	Mathie Neri AHOSSOU	CI-ENERGIES	DCET/SVCG (Direction Centrale Equipements et Travaux/Service Génie Civil) Central Direction of Equipment and Works/ Civil Engineering Service	Chef de Service Genie Civil Head of Civil Engineering Service
31	Aka Ammyua	CI-ENERGIES	Secrétariat Général General Secretariat	Ingenieur Génie Civil Civil Engineer
32	AHOUSSOU Serge	CI-ENERGIES	Diection Centrale de la Planification et de l'Ingénierie Central Direction of Planning and Engineering	Directeur Central de Planification et de l'Ingenierie Central Director of Planning and Engineering
33	DIARRA Daouda	CI-ENERGIES	PTDAE (Programme de Transport, de Distribution et d'Accès à l'Electricité) Transport, Distribution and Access to Electricity Program	Coordinateur Cordinator
34	KONIN Aiddarou	CI-ENERGIES	DCPI/DIN Direction Centrale de la Planification et de l'Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Ingénieure en Environnement Environmental Engineer
35	SYLLA Mohamed Salim Bambo	CI-ENERGIES	DCPI/DPL/SPP-PTT Direction centrale de la Planificatio et de l'Ingénirie/Direction de la Planification / Service Programmation Production-Planification-Transport-Télé communications Central Direction of Planning and Engineering/Planning Department – Production Programming Service-Planning-Transport-and Telecommunications	Agent Technique Technical Agent
36	OUTTARA Abou	CI-ENERGIES	DCPI/DIN Direction Centrale de la Planification et de l'Ingénierie/Direction de l'Ingénierie Central Direction of Planning and Engineering/Engineering Department	Ingénieur en Environnement Environmental Engineer
37	KASSI Euloge Koutoua	CI-ENERGIES		Directeur de l'Ingenierie Director of Engineering
38	KARAMOKO Vazoumana	CIE/DRTET(Compagnie Ivoirienne d'Electricité) Direction Régionale Transport Electrique et Télé communications) / BOUAKE Ivorian Electricty Company/Electric Transport and Telecommunications Regional Department/ BOUAKE	DRTET(Direction Régionale Transport Electrique et Télécommunications) / BOUAKE Regional Direction of Electric Transport and Telecommunications/ BOUAKE	CP (Chef de poste) Head of Post
39	COULIBALY Bakari	CIE / DTET (Direction Transport Electrique et Télécommunications) Electric Transport and Telecommunications Department	CSX (Service Exploitation) CSX (Operation Service)	Chef de Service Exploitation Head of Operation Service
40	ALLA SANHOU	CIE / DTET (Direction Transport Electrique et Télécommunications) Electric Transport and Telecommunications Department	DRTET(Direction Régionale Transport Electrique et Télécommunications) / ABIDJAN (Electric Transport and Telecommunications Regional Department) / ABIDJAN	Chef de poste /TAABO Head of Post /TAABO

	Nom (Name)	Organization (Organisation)	Département (Department)	Titre (Position)
41	SOUMAHORO Ladji	CIE / DTET (Direction Transport Electrique et T élécommunications) Electric Transport and Telecommunications Department	DRTET(Direction Régionale Transport Electrique et Télécommunications) / BOUAKE Electric Transport and Telecommunications Regional Department) / BOUAKE	Intérimaire Chef de poste / KOSSOU Acting Head of Post/ KOSSOU
42	ANAM Sylvain	CIE	DCIR Direction Centrale Ingenierie et Realisation Center direction for engineering realization	Directeur Adjoint Deputy Director
43	AHOUSSOU Kouadio Jacques	CIE	DTET (Direction Transport Electrique et Télecom.) Electric Transport and Telecommunications Department	Directeur Adjoint Deputy Director
44	DJE KACOU Jean	CIE / DME	DME (Direction Mouvements d'Energie) Energy Movements Department	Sous Directeur Etudes et Exploitation Assistant Director in charge of Studies and Operations
45	GNADRO Désiré Okou	CIE	(DTD)Direction Technique Distribution Distribution Technical Department	Directeur Technique Distribution Director of Distribution Technical Department
46	NIANGORA Pierre	CIE	(DTD)Direction Technique Distribution Distribution Technical Department	Sous Directeur Etudes et Doctrine Assistant Director for Studies and Doctrine Department
47	AKA N'dah	CIE	DTET (Direction Transport Electrique et Télecom.) Electric Transport and Telecommunications Department	Chef Service Etudes et Travaux Head of Studies and Works Service
48	Ernet Didier ELIAKA	CIE	DME (Direction Mouvements d'Energie) Energy Movements Department	Sous-Directeur Moyens Techniques Deputy Director of Technical Ressources Department
49	KOFFI Roland	CIE	Direction Regionale du Centre Direction of the Central Region	Directeur Director
50	BEHI Baya	CIE	Centre Regional de Yamoussokro Yamoussoukro Regional Center	Directeur Director
51	Amadou Bassirou DIALLO	African Development Bank	Direction Regionale de Development de Prestations de Service pour l'Afrique de l'Ouest Regional Diretcion of Service Development for West Africa	Chef de Division Head of Division
52	Lamia NOUROUDINE HASSANALY	Agence Francaise de Developpemnt French Devolpment Agency		Chargée de Projets Infrastructures In charge of Infrastructure Project
53	SORO Dotehé Jérome	CF OPTINUM		Technicien-Responsable Technique et Etudes Technician Technical and Studies Manager
54	COILIBALY Foungnigué	CF OPTINUM		Directeur Général General Manager
55	KAKOU KANDE Charles	POWERCOM	POWERCOM	Directeur Director
56	DIALLO BAKARY	POWERCOM	TOPOGRAPHIE SURVEYING	Géometre Surveyor
57	BEDA Akichi	POWERCOM	Distribution/ LHT Distribution / High Voltage Line	Expert Etudes Studies Expert
58	AKATCHI Dominique	POWERCOM	TOPOGRAPHIE SURVEYING	Géometre Surveyor
59	N'GUESSAN Diby	POWERCOM	INGENIERIE ET TRAVAUX ENGINEERING AND WORKS	Expert Electromécanique Electromechanical Expert
60	Mone Ariko Faustin	H&B Consulting	Études Sociales Social Studies	Socio-économiste Socio-economist
61	Gode Gnanzojc	H&B Consulting	Environnement Environment	Environnementaliste Environmentalist
62	Gnahore Frowok	BRL	Environnement Environment	Environnementaliste Environmentalist
63	Fokouo Raoul	BURGEAP		Chef de Projet Project Manager
64	Kouame Marie Cecile	BURGEAP		Ingénieur Socio-économiste Socio-economist Engineer
65	Gbegbo Fulzen	CSI	Qualité, Hygiène, Sécurité, Environnement Quality, Hygiene, Safety, Environment	Directeur Général General Manager

	Nom (Name)	Organization (Organisation)	Département (Department)	Titre (Position)
66	藤野　浩次郎	JICA	コートジボワール事務所	所長
67	碓井　祐吉	JICA	コートジボワール事務所	次長
68	田中　亜依	JICA	コートジボワール事務所	
69	佐藤 昌弘	JICA	コートジボワール事務所	
70	瀬川　俊治	JICA	コートジボワール事務所	
71	BILE Arnaud	JICA	コートジボワール事務所	
72	岡本　浩治	三菱商事株式会社	アビジャン駐在事務所	事務所長
73	BRETT HYSKA	三菱商事株式会社	Battery Service Business Team Environmental Energy Dept Environmental Business Div	
74	谷本　正文	住友商事株式会社	アクラ事務所	所長
75	金森　健司	cfao		Project General Manager

APPENDIX-2

LIST OF COLLECTED DATA

No.	Nom	Type
P-1	Liste de consultants	WORD
P-2	Publication des résultats de l'appel d'offres (poste et transpo	WORD
P-3	Publication des résultats de l'appel d'offres (distribution)	WORD
P-4	Dossier d'appel d'offres (poste et transport)	WORD
P-5	Dossier d'appel d'offres (distribution)	WORD
P-6	Lois relatifs au marché public	PDF
P-7	Tarif de la grue	WORD
P-8	Devis quantitatif	EXCEL
P-9	Liste de sociétés 2015	
T-1	CAHIER DES CHARGES GENERAL Lignes Aériennes HTB - Ouvrages Neufs (CCG - LA Ouvrages Neufs)	PDF
T-2	CONDITIONS TECHNIQUES AUXQUELLES DOIVENT SATISFAIRE LES DISTRIBUTIONS D'ÉNERGIE ÉLECTRIQUE	PDF
T-3	VISITE OU PATROUILLE ANNUELLE	EXCEL
T-4	RAPPORT ETUDE D' AVANT PROJET DETAILLE	WORD
T-5	ESTIMATION LIGNE MONOTERNE 225 KV EN TREILLIS TAABO KOSSOU LOT 2A PHASE A	EXCEL
T-6	ESTIMATION LIGNE MONOTERNE 225 KV EN TREILLIS KOSSOU BOUAKE3 LOT 3A PHASE A	EXCEL
T-7	EDF Tower Catalog	PDF
T-8	Lignes empruntant les même couloirs	WORD
E-1	Rqpport provisoire de l'etude d'impact environnemental et social (mai 2019)	WORD
E-2	Rapport provisoire du plan abrégé de réinstallation (mai 2019)	WORD, PDF
E-3	Attestation d'acquisition de terrain (Yamoussoukro 2)	PDF
E-4	Organigramme CI Energies	PDF
D-1	Choix techniques et doctrine(norme d'installations de distribu	PDF
D-2	Guide technique réseau de distribution parties_1: Poste HTA/BT	PDF
D-3	Guide technique réseau de distribution parties_2: Reseaux HTA	PDF
D-4	Guide technique réseau de distribution parties_3: Reseaux BTA	PDF
D-5	Compte rendu technique annuel	PDF
D-6	Rapport Annuel Qualité du Produit	PDF
D-7	Rapport relatifs au plan de renforcement des réseaux de distribution dans les villes de Yamoussoukro et Bouaké	WORD
D-8	Devis quantitatif du plan de renforcement des réseaux de distribution dans les villes de Yamoussoukro et Bouaké	EXCEL
D-9	Tracés relatifs au plan de renforcement des réseaux de distribution dans les villes de Yamoussoukro et Bouaké	PDF
D-10	Tracés relatifs aux réseaux de distribution dans les villes de Yamoussoukro et Bouaké	PDF, GIS
D-11	Rapport de l'étude de faisabilité du projet ENERGOS I	WORD, PDF
D-12	Dossier d'appel d'offres du projet ENERGOS 1	WORD
D-13	Prix unitaire standard pour les travaux des réseaux de distribution	EXCEL
S-1	Plan de conception du poste Taabo par consultant local	PDF
S-2	Plan de conception du poste Kossou par consultant local	PDF
S-3	Plan de conception du poste Yamoussoukro2 par consultant local	PDF
S-4	Plan de conception du poste Bouak3 par consultant local	PDF
S-5	Plan de conception du poste Bouake2 par consultant local (schéma unifilaire)	PDF
S-6	Plan de conception de communication par consultant local	PDF
S-7	Devis quantitatif par consultant local	Excel
S-8	Plan de conception du poste Kossou dans le projet de la Banque Mondiale (plan de disposition)	PDF
S-9	Liste de contrôle de la tournée d'inspection CIE(exemplaire du disjoncteur)	Excel

No.	Nom	Type
S-10	Plan de disposition et schéma unifilaire du poste Taabo	PDF
S-11	Plan de disposition, schéma unifilaire et plan du système SCADA du poste Kossou etc.	PDF
S-12	Plan de disposition, schéma unifilaire et plan du système SCADA du poste Bouaké 2 etc.	PDF
S-13	Plan de disposition du poste Ferké	PDF
S-14	Plan du poste Anani （référence pour la nouvelle construction)	PDF
S-15	Plan du poste Gagnoa (référence pour la nouvelle construction)	PDF
S-16	Plan de disposition du centre de dispatching	PDF
S-17	Standard des travaux aux postes	PDF
S-18	Attestation d'acquisition de terrain (Yamoussoukro 2) devisée	PDF
S-19	Document concerné à l'acquisition du terrain (Bouaké 3)	PDF
EF-1	Statistiques 2010-2018	Excel
EF-2	Plan directeur de l'EEEAO 2018 Dec	PDF
EF-3	Plan directeur de CI 2014	PDF
EF-4	Plan directeur d'électrification rurale (français)	PDF
EF-5	CI-ENERGY ANNUAL REPORT	PDF
EF-6	ANARE ANNUAL REPORT	PDF
EF-7	CIE ANNUAL REPORT	PDF
EF-8	CI-ENERGY Financial Statement	papier
EF-9	CIE Financial Statement	papier
EF-10	Organigramme CI-ENERGY	papier
PS-1	Limitation de l'exploitation	WORD
PS-2	Liste d'installations de poste et de transport (2019-2030)	EXCEL
PS-3	Energie électrique de l'échange international (2019-2030)	EXCEL
PS-4	Réseau HTB(2030)	JPEG
PS-5	Image du réseau+carte d'installations solaires(2030)	JPEG
PS-6	Données réelles des charges de l'énergie électrique (2019)	EXCEL
PS-7	RapIncid N° 3 du 23_01_2016	PDF
L-1	Données réelles de la demande totale (2014-2018)	EXCEL
L-2	Prévision de la demande de l'énergie électrique (-2040) (par poste)	EXCEL
L-3	Plan de développement des centrales (-2030)	EXCEL
L-4	Courbe de charge du jour	PPT
C-1	Rapport de l'étude géologique (poste Bouaké 2)	PDF
C-2	Rapport de l'étude géologique (poste Kossou)	PDF
C-3	Rapport du sondage électrique (poste Kossou)	PDF

APPENDIX-3

RECORD OF LOAD AT SUBSTATION

POINTES NATIONALES ET POINTES SYNCHRONES DES POSTES SOURCES (MW)

ANNEE : 2014

POSTES	Janv	Févr	Mars	Avr	Mai	Juin	Juil	Août	Sept	Oct	Nov	Déc
ABENGOUROU	4.40	4.30	4.30	2.40	4.10	4.20	4.32	3.86	4.31	3.65	4.35	4.59
ABOBO	96.00	94.00	95.00	89.00	95.00	90.00	87.00	86.00	82.00	99.00	99.00	94.00
ABROBAKRO	15.11	16.20	14.60	15.60	16.50	14.70	15.00	14.40	13.20	16.00	15.00	17.10
AGBAOU	5.47	5.18	4.61	4.76	4.88	4.86	4.69	4.85	5.02	4.41	4.35	4.83
AGBOVILLE	10.90	11.10	11.80	10.90	11.80	9.70	10.50	10.20	10.50	10.60	11.10	11.50
AGNIBILEKRO	12.20	13.10	13.10	12.60	13.20	13.67	13.24	13.19	13.43	13.03	13.70	13.59
ATTAKRO	19.90	22.00	21.40	19.50	19.10	20.70	18.60	18.00	21.00	19.80	21.90	21.80
AYAME	5.10	5.10	4.50	5.10	4.60	4.50	4.40	4.30	4.20	4.60	4.90	3.90
BIA-NORD	60.50	71.90	53.50	56.30	54.40	53.60	45.00	43.10	48.20	51.90	53.50	54.40
BIA-SUD	108.50	107.60	105.10	103.60	107.10	107.80	99.60	89.00	101.10	97.00	110.30	116.90
BONGO	5.60	5.30	4.80	6.10	5.20	5.30	4.90	4.10	5.80	6.30	8.20	6.10
BOUAKE 1	23.36	22.22	21.67	19.39	20.46	18.60	19.85	19.42	16.65	20.62	21.31	20.34
BOUAKE 2	10.50	9.20	10.10	13.10	10.00	10.60	9.80	9.20	10.10	8.50	8.60	10.10
BOUNDIALI	9.20	9.00	8.86	8.75	8.60	6.41	6.85	6.08	6.20	6.39	7.80	8.60
BUYO	1.53	1.37	1.44	1.47	1.43	1.16	1.34	1.37	1.44	1.28	1.47	1.52
DABOU	23.60	22.80	23.20	21.20	22.40	21.00	19.20	20.80	17.60	21.60	22.20	24.10
DALOA	22.14	21.66	22.47	22.19	22.42	22.93	21.43	21.45	21.46	21.57	22.73	22.75
DANANE	6.27	6.28	6.26	5.92	6.30	6.54	5.82	4.23	5.40	5.85	6.27	6.15
DIMBOKRO	7.23	6.68	7.24	7.49	7.67	7.00	7.17	4.41	2.65	7.44	7.68	6.70
DIVO	19.08	18.90	16.10	19.80	19.50	20.50	19.80	18.70	20.40	21.00	21.25	21.15
FERKE	16.00	16.40	21.30	19.10	21.30	17.80	15.40	8.70	8.90	8.50	17.80	12.90
GAGNOA	18.95	16.54	21.78	15.86	18.43	18.27	18.07	17.70	18.74	18.71	19.04	18.69
GD BASSAM	9.01	8.87	8.92	8.39	8.96	8.86	7.42	7.38	7.84	8.48	9.27	9.12
HIRE	6.76	7.09	6.71	1.32	6.83	6.66	6.80	6.71	7.03	7.01	6.77	6.50
KORHOGO	18.60	18.70	18.00	15.40	13.70	14.50	13.60	14.50	14.10	15.90	16.60	19.50
KOSSOU	7.90	7.90	9.40	9.60	9.60	9.40	8.90	9.10	10.00	8.80	8.50	10.30
LABOA	2.12	2.28	1.90	1.42	1.42	3.30	3.55	2.92	2.85	3.62	4.06	4.04
MAN	20.51	20.34	19.27	20.86	20.63	19.54	19.85	19.65	18.80	22.15	20.48	21.70
MARABA	2.13	2.11	2.86	2.86	3.16	3.11	2.25	3.12	3.15	2.34	3.04	3.09
ODIENNE	3.09	3.08	3.42	3.35	3.33	2.73	8.99	3.30	3.60	3.42	3.70	3.42
PLATEAU	19.80	21.40	20.60	21.40	21.80	20.60	17.90	17.80	18.70	19.40	20.30	19.40
RIVIERA	62.00	58.90	59.90	60.10	60.10	64.60	54.00	51.00	50.20	54.50	65.80	66.10
SAN-PEDRO	29.80	27.30	29.90	28.10	27.80	28.90	28.20	25.60	28.00	29.30	30.10	30.40
SEGUELA	5.64	5.19	5.05	5.74	4.85	4.64	4.69	4.47	4.39	4.46	4.60	4.40
SEREBOU	2.80	2.70	2.80	5.10	5.20	3.00	5.10	5.00	4.40	4.30	4.60	5.20
SOUBRE	11.32	11.47	11.43	9.95	10.08	10.88	11.42	11.10	10.96	11.65	11.17	11.60
TAABO	6.10	3.29	3.98	7.10	6.40	5.80	6.80	7.82	6.72	7.12	7.60	9.09
TONGON	15.10	20.90	21.80	23.30	26.50	25.00	28.30	23.80	24.60	24.00	21.30	25.70
TREICHVILLE	54.00	51.30	55.50	58.60	48.30	5.54	46.90	46.20	48.20	46.80	47.50	53.80
VRIDI	45.50	45.30	48.40	44.20	43.00	41.80	43.00	42.00	42.00	46.60	43.80	43.30
YAMOUSS	19.81	18.54	20.34	19.25	19.57	19.22	18.22	21.96	22.95	19.59	19.32	20.75
YOPOUGON 1	123.80	120.90	120.10	127.30	123.40	126.90	114.40	109.70	115.80	116.30	119.40	127.00
YOPOUGON 2	37.20	39.20	37.10	40.00	40.70	36.10	39.20	38.60	34.50	40.00	39.80	40.10
ZUENOULA	3.90	4.10	4.00	4.00	5.20	5.72	5.40	4.94	5.07	5.16	4.19	4.75
Total postes	1008.43	1007.69	1004.51	997.47	1004.92	946.64	946.87	899.73	922.16	968.65	1014.35	1040.97
Réseau interco	1108.50	1116.33	1148.20	1147.70	1129.50	1108.70	1035.20	984.90	1040.81	1086.50	1105.90	1124.60
Ecarts	100.07	108.64	143.69	150.23	124.58	162.06	88.33	85.17	118.65	117.85	91.55	83.63
Date réseau inter	9/01/2014- 21H45	10/02/2014-21h45	25/03/2014-22h00	02/04/2014-22h00	07/05/2014-22h00	04/06/2014 -22h00	15/07/2014 -21h00	25/08/2014 -21h00	26/09/2014 -20h45	30/10/2014 -21h00	12/11/2014 -21h00	19/12/2014 -21h00

POINTES NATIONALES ET POINTES SYNCHRONES DES POSTES SOURCES (MW)

ANNEE : 2015

POSTES	Janv	Févr	Mars	Avr	Mai	Juin	Juil	Août	Sept	Oct	Nov	Déc
ABENGOUROU	3.65	4.71	3.90	4.24	3.93	3.56	4.23	3.08	4.47	4.54	3.99	4.28
ABOBO	109.00	90.00	113.70	104.00	110.00	105.00	98.00	95.00	100.00	97.00	99.00	102.00
ABROBAKRO	17.40	17.40	18.00	18.20	15.80	10.90	12.80	12.90	12.70	12.20	15.00	15.30
AGBAOU	1.38	4.39	4.43	3.45	4.25	4.28	4.64	4.89	5.46	4.64	4.47	4.55
AGBOVILLE	10.80	11.60	10.80	11.50	11.40	9.70	10.50	11.02	11.50	11.40	12.30	8.50
AGNIBILEKRO	14.23	14.66	14.23	13.88	14.28	11.50	14.08	14.10	14.34	14.54	15.06	14.10
ATTAKRO	23.60	22.90	24.90	22.70	21.10	8.30	20.40	22.80	22.90	23.50	22.00	23.90
AYAME	5.80	5.40	5.30	4.50	9.80	8.50	8.20	7.80	7.90	8.00	8.20	9.40
BIA-NORD	56.30	60.80	60.00	61.30	57.00	50.40	48.60	48.60	53.40	56.10	64.00	64.50
BIA-SUD	107.00	116.70	118.70	116.20	89.60	108.50	98.50	95.22	106.00	104.70	109.30	115.00
BONGO	5.80	5.50	6.50	8.30	4.40	0.00	7.40	5.80	6.50	8.00	5.50	8.00
BOUAKE 1	19.68	21.28	24.70	21.60	20.65	22.00	20.20	17.56	22.00	23.26	22.67	21.22
BOUAKE 2	11.00	10.50	10.30	12.30	11.40	9.60	9.30	9.10	9.00	10.10	10.00	9.30
BOUNDIALI	8.40	8.05	8.60	7.90	9.10	6.90	6.60	5.00	6.40	6.80	9.10	9.60
BUYO	1.54	1.52	1.48	1.50	1.50	1.44	1.37	1.02	1.44	1.53	1.45	1.48
DABOU	22.80	23.10	25.50	20.10	20.10	19.80	22.20	22.60	23.40	20.40	21.30	24.30
DALOA	23.02	23.84	23.45	20.59	22.35	22.39	16.98	22.00	21.93	23.66	22.88	21.41
DANANE	6.27	5.60	6.31	7.04	2.41	5.18	5.69	4.75	6.36	5.68	5.57	5.50
DIMBOKRO	6.75	6.56	6.87	6.31	7.90	7.98	7.68	7.46	8.48	8.77	8.09	8.70
DIVO	15.55	22.20	22.20	21.30	21.00	14.20	19.20	19.70	21.35	23.40	22.60	22.15
FERKE	16.50	18.40	16.50	15.70	10.90	20.50	22.60	10.80	24.20	13.80	18.20	19.20
GAGNOA	18.27	19.14	20.04	19.85	18.79	16.39	18.41	16.82	19.97	20.86	23.05	22.80
GD BASSAM	9.04	9.41	10.86	11.03	9.14	8.85	8.52	7.56	9.31	10.25	10.06	10.94
HIRE	7.25	6.61	6.67	7.03	6.87	7.08	6.42	6.59	6.61	6.68	6.36	6.43
KORHOGO	17.60	19.20	20.70	20.50	21.00	16.50	15.60	14.40	16.00	17.50	19.40	19.10
KOSSOU	10.10	9.30	9.00	10.60	10.10	1.47	9.94	7.80	10.52	11.06	10.80	10.84
LABOA	3.53	3.96	3.74	3.72	1.64	4.42	3.15	2.59	3.17	2.62	2.68	2.46
MAN	25.09	26.22	25.34	25.05	23.53	22.23	22.32	22.08	23.21	21.90	21.78	20.61
MARABA	3.28	3.20	3.19	3.28	3.24	3.40	3.13	2.60	3.2	3.47	3.35	3.22
ODIENNE	3.75	3.99	3.53	3.64	4.59	4.58	4.52	4.37	4.46	5.04	4.68	4.79
PLATEAU	20.20	20.80	21.10	23.50	19.50	18.10	18.00	16.90	18.8	19.00	24.11	21.10
RIVIERA	63.50	64.80	65.10	65.00	58.20	54.90	51.00	51.50	50.20	60.00	66.30	66.50
SAN-PEDRO	34.00	33.60	31.90	34.10	26.70	22.60	28.90	27.70	28.9	31.00	31.40	29.60
SEGUELA	5.48	5.49	5.33	5.85	5.45	5.13	5.46	4.63	5.21	5.52	5.33	5.18
SEREBOU	5.50	5.20	5.20	5.20	4.00	3.60	3.70	3.50	3.9	4.00	3.90	3.70
SOUBRE	11.80	12.50	12.98	11.90	11.50	12.00	10.20	10.15	12.00	8.40	7.33	6.90
TAABO	6.80	6.89	5.78	7.52	7.50	6.20	3.03	9.40	9.07	8.70	8.69	9.10
TONGON	23.70	23.60	12.70	11.70	23.70	4.10	5.57	21.76	24.28	25.26	24.37	25.80
TREICHVILLE	55.40	56.70	59.60	55.80	49.30	51.90	48.80	47.00	50.8	52.60	51.10	59.40
VRIDI	49.70	45.20	46.20	45.30	46.00	41.60	43.00	40.00	43.00	47.50	40.00	45.20
YAMOUSS	20.97	21.96	21.28	21.21	22.57	20.93	19.08	18.40	19.73	21.81	21.43	21.28
YOPOUGON 1	131.80	139.40	136.40	124.70	126.70	109.40	122.50	111.00	123.80	136.10	138.10	139.00
YOPOUGON 2	32.00	41.30	40.30	37.80	33.30	34.20	42.60	39.9	36.40	43.40	37.00	28.90
ZUENOULA	6.84	6.22	5.52	5.77	4.27	0.22	5.31	5.90	5.42	6.35	5.88	5.49
Total postes	1052.07	1079.80	1098.83	1062.66	1006.46	920.43	958.33	933.75	1017.69	1051.04	1067.78	1080.73
Réseau interco	1178.47	1177.43	1169.80	1158.06	1151.00	1093.60	1060.60	1096.40	1098.40	1165.09	1182.20	1193.04
Ecarts	126.40	97.63	70.97	95.40	144.54	173.17	102.27	162.65	80.71	114.05	114.42	112.31
Date réseau inter	0/01/2015- 20H45	04/02/2015-20h15	09/03/2015-21h00	01/04/2015-21h45	02/05/2015-22h00	12/06/2015-22h00	27/07/2015-21h00	14/08/2015-19h15	28/09/2015-20h00	27/10/2015-21h15	30/11/2015-22h	09/12/2015-21h30

POINTES NATIONALES ET POINTES SYNCHRONES DES POSTES SOURCES (MW)

ANNEE : 2016

POSTES	Janv	Févr	Mars	Avr	Mai	Juin	Juil	Août	Sept	Oct	Nov	Déc
ABENGOUROU	4.45	4.65	8.19	4.63	3.96	3.99	3.88	4.54	4.85	4.58	5.05	4.78
ABOBO	104.00	117.00	112.00	118.00	110.00	111.00	100.00	90.00	97.00	110.00	101.00	100.00
ABROBAKRO	14.00	15.30	15.50	17.20	15.30	14.30	14.70	15.10	14.70	15.30	16.10	15.60
AGBAOU	4.28	4.20	4.99	4.54	4.60	4.75	4.56	4.85	5.34	4.82	4.75	4.12
AGBOVILLE	11.30	11.50	11.80	12.10	12.12	12.10	13.00	13.20	16.00	14.40	10.00	15.00
AGNIBILEKRO	14.65	15.15	14.61	14.34	14.53	14.95	15.32	14.78	14.35	16.07	14.49	14.48
ANOUMABO	0.00	0.00	24.50	23.50	34.50	37.70	34.20	32.60	38.60	43.80	51.30	53.50
ATTAKRO	22.60	23.90	26.80	21.30	18.40	20.30	23.60	20.90	20.60	18.80	19.90	19.60
AYAME	10.20	11.10	9.80	9.80	9.60	8.70	8.80	7.90	8.30	8.80	9.60	9.90
AZITO									11.40	22.30	28.40	24.70
BIA-NORD	62.30	63.30	67.80	62.30	61.60	56.20	50.50	51.80	51.20	56.40	62.10	64.40
BIA-SUD	124.20	125.00	101.00	97.60	100.00	89.00	80.00	77.00	70.40	90.40	81.60	76.20
BONGO	7.90	7.90	6.70	8.30	7.10	7.50	6.60	5.20	6.60	5.60	5.80	5.00
BOUAKE 1	22.50	23.93	24.71	24.46	23.37	23.46	18.97	19.95	18.11	22.03	20.87	20.58
BOUAKE 2	10.00	10.00	10.00	9.80	9.20	11.00	11.10	10.70	10.80	11.02	12.53	12.59
BOUNDIALI	7.90	8.20	8.70	7.40	7.40	7.70	7.70	7.30	7.60	7.70	9.70	8.00
BUYO	1.50	1.51	1.51	1.45	1.50	1.37	1.42	1.29	1.34	1.39	1.46	1.51
DABOU	23.10	22.00	21.60	21.00	18.60	18.90	17.40	17.40	18.30	20.70	18.30	19.50
DALOA	22.58	24.00	23.94	23.98	23.45	23.40	21.95	21.80	22.49	21.97	23.97	23.69
DANANE	6.67	6.73	6.53	7.06	7.05	6.23	6.10	5.89	5.24	6.69	7.14	6.84
DIMBOKRO	8.12	8.46	6.24	7.81	5.43	8.28	5.11	8.05	8.44	7.92	7.69	7.67
DIVO	21.20	21.75	22.40	21.20	18.80	22.05	20.38	19.45	20.65	16.80	16.95	16.55
DJIBI											18.50	19.00
FERKE	12.70	13.20	13.60	22.30	24.10	23.50	12.60	12.40	9.70	14.10	15.90	19.20
GAGNOA	22.20	21.04	20.69	20.01	19.21	19.42	19.60	17.91	10.00	24.08	24.57	23.28
GD BASSAM	9.37	11.34	11.38	11.68	10.93	11.20	9.96	9.46	10.00	12.15	12.07	12.75
HIRE	6.94	7.05	6.89	6.51	7.05	7.30	6.62	6.71	6.87	6.65	6.04	6.93
KORHOGO	20.20	21.20	22.80	18.80	18.00	18.80	18.00	17.10	18.50	18.30	22.90	23.00
KOSSOU	9.52	10.04	9.86	9.36	10.04	11.00	9.95	6.40	10.00	9.30	9.22	11.52
LABOA	2.90	2.45	3.68	1.70	1.90	3.40	3.34	3.24	3.23	3.85	3.05	3.14
MAN	22.74	23.63	23.50	25.20	25.20	22.70	21.40	20.40	21.00	22.75	23.70	22.70
MARABA	3.42	3.40	3.11	3.35	3.58	3.52	3.28	3.81	2.51	3.60	3.62	3.46
ODIENNE	4.88	5.02	5.42	5.63	5.61	5.47	5.02	4.57	4.88	4.86	5.25	4.08
PLATEAU	21.10	21.50	31.40	21.60	21.70	20.60	18.90	17.10	18.2	19.90	21.20	21.10
RIVIERA	65.30	79.30	62.10	69.50	69.90	64.50	54.10	43.30	54.40	63.40	54.10	57.20
SAN-PEDRO	31.20	31.90	33.85	31.02	32.14	27.13	30.66	26.27	31.2	34.65	34.47	32.14
SEGUELA	6.88	6.94	6.60	5.93	5.90	5.96	5.64	5.42	5.36	5.98	5.92	6.05
SEREBOU	3.70	3.80	4.00	4.20	6.10	6.50	6.00	6.30	6.3	6.40	6.10	6.20
SOUBRE	7.52	12.66	12.55	12.80	12.60	12.62	11.50	11.10	12.20	12.50	13.34	3.40
TAABO	10.85	10.70	10.56	10.50	9.31	8.33	8.85	8.33	7.49	7.68	7.66	8.80
TONGON	25.77	24.07	23.78	11.79	17.79	25.19	25.28	26.68	26.27	26.39	25.88	24.08
TREICHVILLE	52.10	57.90	47.40	43.90	47.60	43.00	44.90	43.10	41.6	48.30	53.00	55.50
VRIDI	30.60	52.00	40.20	41.90	44.50	40.25	37.00	34.00	39.30	41.50	43.60	40.00
YAMOUSS	21.75	23.05	24.85	22.85	24.81	21.74	24.87	23.85	19.73	19.07	22.41	23.02
YOPOUGON 1	138.20	136.30	138.30	138.40	141.90	131.50	118.70	108.70	117.60	111.20	114.20	115.90
YOPOUGON 2	46.70	49.80	40.70	50.40	49.60	50.90	46.60	58.10	53.60	55.00	56.70	54.00
ZUENOULA	6.01	4.90	6.50	7.08	6.72	5.91	5.76	5.59	5.66	6.20	9.25	6.54
Total postes	1086.00	1158.77	1133.04	1114.18	1122.70	1093.32	1013.82	969.54	1007.91	1105.30	1141.35	1127.20
Réseau interco	1252.50	1288.22	1264.50	1284.50	1280.63	1243.70	1188.87	1118.09	1138.92	1229.49	1278.30	1275.20
Ecarts	166.50	129.45	131.46	170.32	157.93	150.38	175.05	148.55	131.01	124.19	136.95	148.00
Date réseau inter	19/01/2016- 22H00	19/02/2016- 21H45	10/03/2016- 22H00	25/04/2016- 22H00	11/05/2016- 22H30	02/06/2016- 22H00	05/07/2016-19H45	26/08/2016-21H30	23/09/2016-21H00	25/10/2016-21H30	30/11/2016-21H00	01/12/2016-21H30

POINTES NATIONALES ET POINTES SYNCHRONES DES POSTES SOURCES (MW)

ANNEE : 2017

POSTES	Janv	Févr	Mars	Avr	Mai	Juin	Juil	Août	Sept	Oct	Nov	Déc
ABENGOUROU	4.44	5.05	4.78	5.15	4.97	4.04	4.50	6.81	4.24	4.08	4.95	4.75
ABOBO	109.00	108.00	114.00	111.00	119.00	106.00	89.00	88.00	95.00	110.00	102.00	100.00
ABROBAKRO	14.70	16.70	14.20	16.70	16.90	16.40	17.00	15.20	17.70	17.60	17.80	17.00
AGBAOU	4.45	4.90	5.66	5.96	5.76	2.05	5.78	6.23	5.91	6.50	6.07	6.28
AGBOVILLE	13.60	14.10	14.80	12.10	15.00	14.70	13.30	16.40	15.60	14.40	14.12	14.50
AGNIBILEKRO	16.19	15.92	16.19	16.49	16.99	14.42	16.31	15.93	15.47	16.56	16.85	17.18
ANOUMABO	48.20	54.30	48.10	51.10	45.90	48.20	38.20	34.20	36.60	35.60	35.60	40.90
ATTAKRO	21.40	20.10	21.40	20.05	21.80	22.80	21.10	22.15	21.03	21.70	20.20	21.50
AYAME	11.10	10.63	10.70	11.50	10.24	10.53	9.03	9.30	10.24	10.04	10.20	10.30
AZITO	35.20	30.80	29.70	34.50	35.40	32.10	27.60	26.40	23.70	24.00	37.00	24.50
BIA-NORD	54.90	64.70	63.70	65.30	64.50	78.40	50.10	49.30	55.00	60.00	58.00	59.00
BIA-SUD	85.40	83.00	79.00	83.00	88.00	92.00	76.00	81.80	75.20	88.20	87.14	82.20
BONGO	5.90	4.10	6.40	7.30	5.40	6.40	6.20	5.50	5.80	5.90	4.00	6.50
BOUAKE 1	22.06	22.21	24.58	23.50	24.81	23.22	20.50	20.92	20.22	23.34	23.96	23.48
BOUAKE 2	10.80	12.06	10.65	10.02	10.17	10.62	8.52	9.48	11.50	9.70	9.88	11.19
BOUNDIALI	9.80	8.40	10.00	9.00	8.80	9.30	6.10	8.20	7.70	8.80	8.90	10.10
BUYO	1.47	1.47	1.49	1.49	1.51	1.55	1.36	1.36	1.28	1.38	1.43	1.53
DABOU	21.60	23.70	27.60	22.70	26.70	25.20	24.10	24.70	25.20	28.10	25.20	25.90
DALOA	24.53	24.42	24.60	23.55	24.94	24.50	22.25	21.64	22.85	23.55	23.70	23.64
DANANE	7.39	7.35	7.63	3.40	7.32	6.18	6.50	6.71	5.76	6.60	6.88	7.30
DIMBOKRO	6.98	9.02	8.40	8.24	8.08	8.32	8.25	7.28	8.29	7.56	8.46	7.88
DIVO	17.80	19.35	23.00	22.45	21.80	16.35	20.85	19.85	20.25	21.65	21.55	22.90
DJIBI	20.50	9.80	21.90	24.70	29.94	24.60	19.00	14.20	18.53	21.90	33.50	34.20
FERKE	18.91	19.18	19.54	19.55	21.80	11.40	14.50	8.80	9.60	13.10	12.90	15.40
GAGNOA	25.72	25.61	22.03	20.16	22.47	19.73	20.75	21.18	21.65	20.88	21.79	22.34
GD BASSAM	12.22	12.66	9.16	11.62	13.40	6.10	10.10	10.28	10.81	12.76	12.37	12.18
HIRE	6.91	2.85	7.32	6.14	6.98	6.80	7.78	7.77	7.21	7.70	7.87	7.71
KORHOGO	23.80	21.70	22.30	18.90	19.10	19.40	17.90	17.80	18.80	20.00	20.60	25.00
KOSSOU	11.60	17.56	11.42	10.26	11.68	9.28	12.02	6.08	10.48	9.62	12.90	11.00
LABOA	4.58	4.16	3.62	3.12	3.70	2.23	5.76	3.26	3.5	5.85	6.48	4.10
MAN	21.20	23.20	25.10	21.90	17.50	24.50	22.00	21.60	22.40	23.20	23.93	24.50
MARABA	3.62	2.74	2.95	4.29	3.98	4.10	4.20	3.80	3.9	3.90	4.05	3.99
ODIENNE	5.24	5.46	5.79	5.57	5.99	6.02	5.55	5.82	5.77	6.16	5.64	6.31
PLATEAU	20.40	20.60	21.10	20.90	21.90	20.40	20.80	10.70	17.6	23.40	19.20	19.60
RIVIERA	64.60	65.00	57.50	60.80	60.30	54.60	50.60	54.80	55.80	58.70	55.70	50.70
SAN-PEDRO	36.80	37.89	36.20	33.28	34.80	34.72	35.78	32.73	35.87	32.58	31.44	42.45
SEGUELA	6.14	6.97	6.98	5.91	6.65	6.76	6.10	5.88	6.09	6.27	6.49	7.19
SEREBOU	7.30	6.70	7.60	8.10	7.20	6.60	6.60	6.00	6.8	2.70	6.90	7.10
SOUBRE	13.00	13.30	11.70	12.80	12.30	12.10	11.10	10.58	10.80	11.40	11.50	7.50
TAABO	10.80	11.30	6.97	12.67	6.79	9.82	9.20	8.16	5.68	6.87	6.85	5.77
TONGON	26.38	24.98	27.09	26.70	27.59	13.60	25.88	28.29	28.89	13.79	27.40	28.79
TREICHVILLE	48.40	50.90	48.20	54.40	48.10	47.80	48.20	42.40	44.6	28.00	50.20	53.10
VRIDI	36.40	37.80	38.10	37.70	43.20	29.00	27.00	37.00	44.70	43.40	42.40	43.40
YAKRO	22.53	15.70	22.54	22.91	23.27	22.17	20.10	22.76	21.78	22.44	18.46	22.96
YOPOUGON 1	99.20	105.40	113.20	108.00	103.40	107.50	99.00	103.70	106.60	98.60	100.03	110.30
YOPOUGON 2	61.40	54.90	57.00	54.00	65.30	55.70	39.80	52.20	54.10	54.10	60.10	61.40
ZUENOULA	7.70	5.45	9.23	7.81	4.58	6.37	6.33	5.89	5.67	6.60	6.23	6.06
Total postes	1,162.26	1,162.09	1,181.12	1,176.69	1,205.91	1,134.58	1,038.60	1,039.04	1,082.17	1,099.18	1,148.82	1,171.58
Réseau interco	1,285.02	1,303.42	1,327.60	1,328.08	1,341.75	1,274.10	1,162.50	1,147.57	1,199.02	1,260.77	1,295.11	1,322.60
Ecarts	122.76	141.33	146.48	151.39	135.84	139.52	123.90	108.53	116.85	161.59	146.29	151.02
Date réseau inter.	18/01/2017-21h45	07/02/2017- 22H15	08/03/2017- 23H00	24/04/2017-22H30	10/05/2017-22H45	02/06/2017-22H45	21/07/2017-22H00	28/08/2017-20H30	21/09/2017-20H45	26/10/2017-21H30	14/11/2017-21H00	18/12/2017-22H00

POINTES NATIONALES ET POINTES SYNCHRONES DES POSTES SOURCES (MW)

ANNEE : 2018

POSTES	Janv	Févr	Mars	Avr	Mai	Juin	Juillet	Août	Septembre	Octobre	Novembre	Décembre
ABENGOUROU	4.94	5.19	5.96	4.49	5.57	3.35	4.06	4.47	4.62	4.89	5.15	5.09
ABOBO	101.00	94.00	102.00	103.00	99.00	92.00	86.00	90.00	81.00	88.00	89.00	87.40
ABROBAKRO	18.00	22.00	19.20	19.30	18.00	13.30	16.60	17.40	17.80	19.70	19.30	20.20
AGBAOU	6.83	6.08	5.98	5.81	6.18	5.43	5.85	6.18	6.30	5.09	5.15	5.51
AGBOVILLE	15.50	15.70	18.40	16.90	12.30	16.20	13.80	19.40	14.00	20.68	21.61	16.84
AGNIBILEKRO	16.62	17.09	17.50	17.88	16.57	18.83	15.77	16.71	16.55	17.76	17.98	17.97
ANOUMABO	42.50	38.80	42.50	44.60	46.30	45.23	38.60	36.60	30.90	34.10	37.60	41.30
ATTAKRO	22.40	23.67	22.30	21.60	21.10	22.40	20.90	21.50	22.00	22.10	21.60	22.30
AYAME	7.35	7.66	10.90	10.47	10.07	10.02	10.45	10.97	10.80	10.59	11.96	10.40
AZITO	17.50	23.50	19.10	18.78	8.50	13.70	11.19	15.10	19.30	26.40	13.20	19.70
BIA-NORD	60.00	61.00	61.00	61.00	60.00	42.00	67.00	45.00	50.12	60.00	77.50	59.20
BIA-SUD	86.20	89.60	81.80	91.40	77.90	78.90	68.70	69.60	77.10	87.20	90.10	99.00
BONGO	6.70	5.00	6.20	6.20	5.90	5.80	6.10	5.60	5.30	6.10	6.50	6.40
BOUAKE 1	22.56	27.10	23.50	23.57	24.24	24.27	20.63	22.46	23.70	22.04	23.97	30.60
BOUAKE 2 (*)	9.31	8.85	10.32	10.52	11.94	10.06	8.79	9.61	9.32	11.54	11.15	-
BOUNDIALI	10.20	11.10	10.10	9.90	9.90	9.80	8.40	8.50	8.00	8.70	9.90	11.20
BUYO	1.54	1.72	1.57	1.61	1.50	1.48	1.46	1.46	1.38	1.48	1.51	1.45
DABOU	28.30	28.70	26.90	24.30	20.90	23.40	22.40	22.80	21.50	20.80	20.20	22.00
DALOA	24.20	26.60	7.53	24.00	25.20	22.30	22.92	23.00	23.20	23.60	24.29	23.88
DANANE	7.44	7.98	6.72	8.07	7.74	5.20	7.22	7.61	6.84	6.62	7.42	5.35
DIMBOKRO	8.29	7.22	4.88	9.45	8.69	9.58	8.88	9.21	8.57	9.39	9.98	5.60
DIVO	22.56	23.32	23.14	23.34	23.23	22.61	20.26	22.29	20.76	21.71	22.08	22.63
DJIBI	34.80	38.00	37.60	36.10	34.90	30.00	32.70	31.10	34.60	32.12	32.50	33.00
FERKESSEDOUGOU	12.00	17.20	17.40	27.00	24.70	23.10	14.20	10.30	13.10	13.80	18.90	19.00
GAGNOA	14.42	22.28	21.29	21.24	22.16	20.27	19.72	20.33	19.84	20.09	20.69	22.11
GD BASSAM	12.77	14.20	13.17	13.66	14.93	12.73	12.03	12.04	11.94	13.45	14.90	14.17
HIRE	7.69	7.63	7.43	7.80	6.81	6.96	7.02	6.70	7.22	7.40	7.89	6.36
KORHOGO	23.80	7.22	23.30	22.80	22.80	21.19	19.10	21.00	21.10	22.00	22.50	22.46
KOSSOU	10.54	10.36	9.70	11.40	9.68	9.66	8.96	9.60	9.22	13.38	9.82	11.48
LABOA	3.68	5.08	2.63	-	5.46	7.59	3.33	4.14	3.71	2.33	5.44	0.79
MAN	24.60	25.50	26.35	23.43	26.70	25.91	23.60	24.25	23.20	25.50	26.10	27.00
MARABADIASSA	3.93	4.10	4.21	4.34	4.27	4.12	3.79	4.12	3.71	3.83	3.94	3.81
ODIENNE	6.20	6.36	7.39	4.52	7.51	7.21	7.08	6.99	6.24	7.31	7.39	7.25
AKOUPE-ZEUDLI_PK 24	-	5.30	5.27	5.32	7.16	7.16	4.80	5.18	12.40	15.20	19.10	18.00
PLATEAU	20.40	21.00	27.60	25.30	19.40	17.30	23.70	17.50	16.70	18.70	17.60	19.60
RIVIERA	60.80	61.00	67.71	63.90	61.60	51.40	45.50	44.60	43.60	49.90	55.00	57.90
SAN-PEDRO	36.56	36.50	39.61	37.29	32.46	33.51	29.11	33.85	32.50	33.91	34.96	33.00
SEGUELA	7.48	7.92	8.19	7.08	7.19	6.73	6.22	6.41	6.13	6.64	7.31	92.00
SEREBOU	7.20	7.70	7.90	8.30	8.10	8.00	7.60	7.30	7.70	8.20	8.00	7.70
SOUBRE	7.50	12.10	13.60	9.30	12.70	11.30	10.50	11.50	11.25	12.80	12.13	9.10
TAABO	6.78	9.16	5.32	9.17	7.97	10.30	7.10	9.39	7.40	8.56	11.51	10.43
TONGON	28.80	8.40	27.00	9.00	29.11	26.30	27.89	3.18	28.54	14.19	7.81	12.39
TREICHVILLE	55.50	51.10	80.20	51.00	55.10	44.30	52.20	53.00	51.40	47.60	59.40	57.70
VRIDI	44.00	40.40	46.40	45.00	41.00	44.20	44.12	37.60	36.30	48.90	41.70	43.60
YAMOUSSOUKRO	22.30	29.34	27.71	25.19	24.22	22.96	20.84	15.06	20.89	21.87	23.29	27.20
YOPOUGON 1	111.00	115.60	111.70	117.90	115.10	104.50	101.80	97.60	87.80	91.50	105.20	104.50
YOPOUGON 2	68.80	65.20	60.80	69.80	72.50	71.40	67.00	60.30	66.40	68.90	68.50	71.30
ZUENOULA	6.49	9.97	6.13	6.57	6.77	6.50	5.96	6.08	6.16	3.14	5.96	5.51
Total postes	**1177.98**	**1190.50**	**1233.11**	**1218.60**	**1201.03**	**1130.46**	**1091.85**	**1044.59**	**1068.11**	**1139.71**	**1194.69**	**1271.38**
Réseau interco	**1354.72**	**1379.40**	**1386.50**	**1377.90**	**1388.12**	**1308.00**	**1201.86**	**1160.30**	**1181.90**	**1262.10**	**1318.60**	**1313.53**
Ecarts	**176.74**	**188.90**	**153.39**	**159.30**	**187.09**	**177.54**	**110.01**	**115.71**	**113.79**	**122.39**	**123.91**	**42.15**
Date réseau inter.	**09/01/2018-21h15**	**16/02/2018-22h15**	**20/03/2018-22h30**	**24/04/2018-23h00**	**03/05/2018-23h15**	**07/06/2018-22h45**	**02/07/2018-22h15**	**16/08/2018-22h00**	**10/09/2018-21h30**	**15/10/2018-22h00**	**13/11/2018-20h45**	**18/12/2018-20h45**

(*) Explosion du disjoncteur du départ 15 kV Assèkro de BOUAKE 2 le 18 décembre 2018 à 18h36. Cette explosion a affecté le jeu de barre 15 kV, suivi d'un déclenchement du transformateur 15 kV-36 MVA 1 .

APPENDIX-4

DEMAND FORECAST FOR EACH SUBSTATION

EVOLUTION DE LA CHARGE DES POSTES SOURCES DE 2020 à 2040

N°	POSTE SOURCE	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
1	ABATTA	0.0	22.1	23.4	27.1	28.6	32.5	38.2	41.5	43.2	44.9	47.6	51.3	54.3	57.2	60.2	63.1	66.1	69.0	72.0	74.9	77.9
2	ABENGOUROU	3.0	3.3	3.5	4.0	4.2	4.8	5.6	6.1	6.4	6.6	7.0	7.6	8.0	8.4	8.9	9.3	9.7	10.2	10.6	11.1	11.5
3	ABOBO	92.0	56.0	58.9	67.6	71.1	80.4	94.7	102.5	106.3	110.3	116.5	125.5	132.6	139.6	146.7	153.7	160.7	167.8	174.8	181.9	188.9
4	ABOBO-ANYAMA	0.0	36.5	38.6	44.6	47.2	53.5	63.0	68.4	71.2	74.1	78.4	84.6	89.5	94.3	99.2	104.1	108.9	113.8	118.7	123.5	128.4
5	ABROBAKRO	20.4	22.0	23.3	26.9	28.4	32.2	38.0	41.2	42.9	44.6	47.3	51.0	53.9	56.8	59.8	62.7	65.6	68.6	71.5	74.4	77.4
6	ADZOPE	0.0	12.2	13.0	15.0	15.8	17.9	21.1	23.0	23.9	24.9	26.3	28.4	30.0	31.6	33.3	34.9	36.5	38.2	39.8	41.4	43.1
7	AGBAOU	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
8	AGBOVILLE	13.9	10.5	11.1	12.9	13.6	15.4	18.2	19.7	20.5	21.4	22.6	24.4	25.8	27.2	28.6	30.0	31.4	32.8	34.2	35.6	37.0
9	AGNIBILEKRO	3.4	3.6	3.9	4.5	4.7	5.3	6.3	6.8	7.1	7.4	7.8	8.4	8.9	9.4	9.9	10.4	10.9	11.4	11.8	12.3	12.8
10	AKOUPE ZEUDJI (PK 24)	20.9	29.9	31.7	36.6	38.7	43.9	51.7	56.1	58.4	60.7	64.3	69.3	73.3	77.3	81.3	85.3	89.3	93.3	97.3	101.3	105.3
11	ANANI	36.2	39.0	41.3	47.7	50.4	56.7	66.4	71.7	74.1	76.7	80.8	86.9	91.7	96.4	101.1	105.8	110.5	115.2	119.9	124.6	129.3
12	ANANI 2	0.0	0.0	0.0	0.0	0.0	2.9	3.8	4.6	5.2	5.8	6.5	7.3	8.0	8.7	9.5	10.2	10.9	11.6	12.3	13.1	13.8
13	ANOUMABO	51.5	54.1	55.9	63.7	66.1	74.4	87.7	94.6	97.4	100.3	105.5	113.6	119.7	125.7	131.7	137.8	143.8	149.9	155.9	162.0	168.0
14	ATTAKRO	23.9	18.0	19.1	22.1	23.3	26.5	31.2	33.8	35.2	36.6	38.8	41.8	44.2	46.6	49.0	51.5	53.9	56.3	58.7	61.1	63.5
15	AYAME 2	11.4	11.1	11.7	13.5	14.3	16.2	19.1	20.8	21.6	22.5	23.8	25.7	27.1	28.6	30.1	31.6	33.0	34.5	36.0	37.5	39.0
16	AYEBO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	AZITO	22.7	48.1	50.9	58.8	62.1	63.4	74.7	81.1	84.4	87.8	93.0	100.3	106.1	111.8	117.6	123.4	129.1	134.9	140.7	146.4	152.2
18	BAKRE	0.0	0.0	0.0	0.0	0.0	14.4	17.0	18.4	19.2	19.9	21.1	22.8	24.1	25.4	26.7	28.0	29.3	30.6	31.9	33.2	34.5
19	BIA-NORD	57.6	46.3	48.9	56.3	59.4	67.3	79.3	86.0	89.4	92.9	98.2	105.9	112.0	118.0	124.0	130.1	136.1	142.1	148.1	154.2	160.2
20	BIA-SUD	39.7	42.8	45.3	52.4	55.4	62.8	74.0	80.3	83.6	86.9	92.0	99.3	105.0	110.7	116.4	122.1	127.8	133.5	139.3	145.0	150.7
21	BINGERVILLE	29.3	31.6	33.5	38.6	40.9	46.3	54.6	59.3	61.7	64.2	67.9	73.3	77.5	81.7	85.9	90.1	94.3	98.6	102.8	107.0	111.2
22	BONDOUKOU	5.0	7.3	9.5	12.0	14.2	16.8	19.7	22.2	24.4	26.7	29.0	31.6	34.0	36.5	38.9	41.4	43.8	46.2	48.7	51.1	53.5
23	BONGO	6.7	7.2	7.6	8.8	9.3	10.6	12.5	13.5	14.1	14.6	15.5	16.7	17.7	18.6	19.6	20.6	21.5	22.5	23.4	24.4	25.4
24	BOUAKE 1	17.6	19.0	14.8	17.1	18.1	20.6	24.2	26.3	27.4	28.5	30.1	32.5	34.4	36.3	38.1	40.0	41.9	43.7	45.6	47.5	49.3
25	BOUAKE 2	13.5	14.6	15.4	17.8	18.9	21.4	25.2	27.4	28.5	29.6	31.3	33.8	35.8	37.7	39.6	41.6	43.5	45.5	47.4	49.4	51.3
26	BOUAKE 3	0.0	0.0	6.7	9.0	10.9	13.2	16.0	18.2	20.1	22.0	24.1	26.4	28.6	30.7	32.9	35.1	37.2	39.4	41.5	43.7	45.8
27	BOUNA	2.8	3.3	3.7	4.4	4.9	5.6	6.6	7.2	7.7	8.2	8.8	9.5	10.1	10.7	11.3	12.0	12.6	13.2	13.8	14.5	15.1
28	BOUNDIALI	11.2	7.3	7.7	8.9	9.4	10.6	12.5	13.6	14.2	14.7	15.6	16.8	17.8	18.8	19.7	20.7	21.7	22.6	23.6	24.6	25.5
29	BOUTOUBRE	0.0	0.0	0.0	0.0	1.0	1.1	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6
30	BUYO	1.7	1.8	1.9	2.2	2.4	2.7	3.2	3.4	3.6	3.7	3.9	4.2	4.5	4.7	5.0	5.2	5.5	5.7	6.0	6.2	6.4
31	DABAKALA	2.4	2.8	3.1	3.7	4.1	4.7	5.5	6.0	6.4	6.8	7.3	7.9	8.4	8.9	9.4	10.0	10.5	11.0	11.5	12.0	12.5
32	DABOU	20.6	18.9	19.0	21.9	23.2	26.3	31.0	33.6	35.0	36.4	38.5	41.6	44.0	46.4	48.8	51.1	53.5	55.9	58.3	60.7	63.1
33	DALOA	24.6	26.5	28.0	32.4	34.2	38.8	45.7	49.7	51.7	53.7	56.9	61.4	64.9	68.4	72.0	75.5	79.0	82.6	86.1	89.6	93.2
34	DANANE	4.7	5.1	5.4	6.2	6.6	7.5	8.8	9.6	10.0	10.4	11.0	11.8	12.5	13.2	13.9	14.6	15.2	15.9	16.6	17.3	18.0
35	DAOUKRO	0.0	0.0	0.0	0.0	0.0	4.2	5.1	5.8	6.2	6.7	7.2	7.9	8.5	9.1	9.7	10.4	11.0	11.6	12.2	12.8	13.4
36	DIMBOKRO	9.8	10.6	11.2	13.0	13.7	13.5	16.0	17.3	18.0	18.7	19.8	21.4	22.6	23.9	25.1	26.3	27.6	28.8	30.0	31.3	32.5
37	DIVO	26.3	28.4	21.0	24.3	25.7	29.1	34.3	37.3	38.8	40.3	42.7	46.0	48.7	51.3	54.0	56.6	59.3	61.9	64.6	67.2	69.9
38	DIVO 2	0.0	0.0	6.0	6.9	7.3	8.3	9.8	10.6	11.1	11.5	12.2	13.2	13.9	14.7	15.4	16.2	16.9	17.7	18.5	19.2	20.0
39	DJIBI	54.3	69.0	70.7	80.0	82.5	92.5	108.8	117.0	119.9	123.1	129.2	138.9	146.0	153.1	160.2	167.3	174.4	181.5	188.6	195.7	202.8
40	DUEKOUE	3.0	3.3	3.5	4.0	4.2	4.8	5.6	6.1	6.4	6.6	7.0	7.6	8.0	8.4	8.9	9.3	9.7	10.2	10.6	11.0	11.5
41	EBOUE	0.0	1.7	2.3	3.0	3.6	4.3	5.1	5.8	6.4	7.0	7.6	8.4	9.0	9.7	10.3	11.0	11.7	12.3	13.0	13.7	14.3
42	FERKE	16.5	17.8	18.8	21.8	23.0	26.1	30.8	33.4	34.7	36.1	38.3	41.3	43.6	46.0	48.4	50.8	53.1	55.5	57.9	60.3	62.6
43	GAGNOA	20.1	21.7	20.6	23.8	25.2	28.6	33.7	36.6	38.0	39.6	41.9	45.2	47.8	50.4	53.0	55.6	58.2	60.8	63.4	66.0	68.6
44	GAGNOA 2	5.0	5.4	5.7	6.6	7.0	7.9	9.4	10.2	10.6	11.0	11.6	12.6	13.3	14.0	14.7	15.4	16.2	16.9	17.6	18.3	19.1
45	GD BASSAM	15.2	16.4	17.4	20.1	21.2	21.7	25.5	27.7	28.8	30.0	31.7	34.2	36.2	38.2	40.2	42.1	44.1	46.1	48.0	50.0	52.0
46	GD BASSAM 2	14.1	15.2	16.0	18.5	19.6	22.2	26.2	28.4	29.6	30.8	32.6	35.1	37.1	39.2	41.2	43.2	45.2	47.2	49.3	51.3	53.3
47	GNAGO	0.0	0.0	2.1	2.4	2.6	2.9	3.4	3.7	3.9	4.0	4.3	4.6	4.9	5.1	5.4	5.7	5.9	6.2	6.4	6.7	7.0
48	GRAND LAHOU	0.0	0.0	4.0	4.6	4.9	5.5	6.5	7.1	7.4	7.7	8.1	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3
49	GRIBOPOPOLI	0.0	0.8	0.8	0.9	1.0	1.1	1.3	1.5	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7
50	HIRE	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
51	ITY	12.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
52	JACQUEVILLE	0.0	3.3	3.5	4.1	4.3	4.9	5.8	6.2	6.5	6.8	7.2	7.7	8.2	8.6	9.1	9.5	9.9	10.4	10.8	11.3	11.7
53	KATIOLA	7.7	8.3	8.8	10.1	10.7	12.2	14.3	15.6	16.2	16.8	17.8	19.2	20.3	21.4	22.5	23.6	24.8	25.9	27.0	28.1	29.2
54	KONG	11.5	12.4	13.1	15.1	16.0	18.1	21.4	23.2	24.1	25.1	26.6	28.7	30.3	32.0	33.6	35.3	36.9	38.6	40.2	41.9	43.5
55	KORHOGO	25.8	27.9	29.5	34.1	36.0	40.8	48.1	52.2	54.3	56.5	59.9	64.6	68.3	72.0	75.7	79.4	83.1	86.9	90.6	94.3	98.0
56	KOSSOU	11.0	11.8	12.5	14.5	15.3	17.3	20.4	22.2	23.1	24.0	25.4	27.4	29.0	30.6	32.1	33.7	35.3	36.9	38.5	40.0	41.6
57	KOSSOU MINE	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
58	LABOA	6.2	6.7	7.1	8.2	8.6	9.8	11.5	12.5	13.0	13.5	14.3	15.5	16.4	17.2	18.1	19.0	19.9	20.8	21.7	22.6	23.5
59	MAN	15.7	17.0	18.0	20.7	21.9	24.9	29.3	31.8	33.1	34.4	36.4	39.3	41.6	43.8	46.1	48.4	50.6	52.9	55.2	57.4	59.7
60	MANKONO	4.7	5.1	5.4	6.3	6.6	7.5	8.8	9.6	10.0	10.4	11.0	11.9	12.5	13.2	13.9	14.6	15.3	16.0	16.6	17.3	18.0
61	MARABA	4.8	5.2	5.5	6.4	6.7	7.6	9.0	9.8	10.2	10.6	11.2	12.1	12.8	13.5	14.2	14.9	15.6	16.3	17.0	17.7	18.4
62	MEAGUI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	ODIENNE	8.5	9.2	9.7	11.2	11.9	13.5	15.8	17.2	17.9	18.6	19.7	21.3	22.5	23.7	24.9	26.2	27.4	28.6	29.8	31.1	32.3
64	PLATEAU	22.0	23.7	25.1	29.0	30.6	34.7	40.9	44.5	46.2	48.1	50.9	54.9	58.1	61.3	64.4	67.6	70.7	73.9	77.1	80.2	83.4
65	RIVIERA	54.6	58.4	61.8	71.4	75.4	85.6	100.8	109.5	113.9	118.5	125.4	135.3	143.1	150.9	158.6	166.4	174.2	182.0	189.8	197.6	205.3
66	SAN-PEDRO	36.8	39.7	31.5	36.4	38.4	41.4	48.8	53.0	55.1	57.4	60.7	65.5	69.3	73.0	76.8	80.6	84.3	88.1	91.9	95.6	99.4
67	SAN-PEDRO 2	0.0	0.0	8.4	9.7	10.3	11.6	13.7	14.9	15.5	16.1	17.0	18.4	19.4	20.5	21.6	22.6	23.7	24.7	25.8	26.8	27.9
68	SEGUELA	5.7	6.2	6.5	7.5	7.9	9.0	10.6	11.5	12.0	12.5	13.2	14.3	15.1	15.9	16.7	17.5	18.4	19.2	20.0	20.8	21.6
69	SEREBOU	9.2	9.9	10.5	12.1	12.8	12.6	14.9	16.1	16.8	17.5	18.5	20.0	21.1	22.3	23.4	24.5	25.7	26.8	28.0	29.1	30.3
70	SINFRA	0.0	0.0	2.3	2.6	2.8	3.2	3.7	4.1	4.2	4.4	4.7	5.0	5.3	5.6	5.9	6.2	6.5	6.8	7.0	7.3	7.6
71	SINGROBO	0.0	0.0	0.9	1.1	1.1	1.3	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.6	2.7	2.8	3.0	3.1
72	SONGON	5.1	7.3	9.5	12.1	14.3	16.9	19.7	22.2	24.5	26.7	29.1	31.7	34.1	36.6	39.0	41.5	43.9	46.4	48.8	51.2	53.7
73	SOUBRE	14.4	14.7	15.6	18.0	18.1	20.5	24.2	26.3	27.3	28.4	30.1	32.5	34.3	36.2	38.1	39.9	41.8	43.7	45.5	47.4	49.3
74	TAABO	9.0	8.8	8.4	9.6	10.2	11.6	13.6	14.8	15.4	16.0	16.9	18.3	19.3	20.4	21.4	22.5	23.5	24.6	25.6	26.7	27.7
75	TANDA	13.0	14.1	14.9	17.2	18.2	20.6	24.3	26.4	27.4	28.6	30.2	32.6	34.5	36.4	38.2	40.1	42.0	43.9	45.7	47.6	49.5
76	TENGRELA	0.0	4.8	5.1	5.9	6.3	7.1	8.4	9.1	9.4	9.8	10.4	11.2	11.9	12.5	13.2	13.8	14.4	15.1	15.7	16.4	17.0
77	TIASSALE	0.0	2.0	3.0	4.2	5.3	6.4	7.7	8.8	9.9	11.0	12.1	13.3	14.4	15.5	16.6	17.8	18.9	20.0	21.2	22.3	23.4
78	TIBOTO	0.0	0.0	0.0	0.0	0.0	2.2	2.6	2.8	2.9	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2
79	TONGON	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
80	TOUBA	4.8	5.2	5.5	6.4	6.7	7.7	9.0	9.8	10.2	10.6	11.2	12.1	12.8	13.5	14.2	14.9	15.6	16.3	17.0	17.7	18.4
81	TOULEPLEU	4.0	4.4	4.6	5.3	5.6	6.4	7.5	8.2	8.5	8.8	9.3	10.1	10.7	11.2	11.8	12.4	13.0	13.6	14.1	14.7	15.3
82	TREICHVILLE	60.9	63.8	65.8	74.8	77.5	87.2	102.8	110.8	113.8	117.2	123.2	132.5	139.5	146.5	153.5	160.5	167.4	174.4	181.4	188.4	195.3
83	VAVOUA	4.0	4.3	4.6	5.3	5.6	6.3	7.4	8.1	8.4	8.7	9.3	10.0	10.6	11.1	11.7	12.3	12.9	13.4	14.0	14.6	15.2
84	VRIDI	46.5	50.1	53.0	61.2	64.7	66.1	77.9	84.6	88.0	91.5	96.9	104.5	110.5	116.5	122.5	128.5	134.6	140.6	146.6	152.6	158.6
85	YAMOUSS	27.5	29.6	25.1	28.9	30.6	34.7	40.9	44.4	46.2	48.1	50.9	54.9	58.0	61.2	64.3	67.5	70.7	73.8	77.0	80.1	83.3
86	YAMOUSS 2	0.0	0.0	7.3	9.2	10.6	12.7	15.2	17.1	18.5	20.0	21.7	23.7	25.5	27.3	29.1	30.9	32.7	34.5	36.2	38.0	39.8
87	YOPOUGON 1	87.7	55.8	59.0	68.2	72.1	81.7	96.3	104.6	108.8	113.2	119.8	129.2	136.7	144.1	151.5	159.0	166.4	173.8	181.3	188.7	196.2
88	YOPOUGON 2	61.5	62.1	64.0	72.6	75.2	84.0	98.4	105.7	108.4	111.3	116.8	125.4	131.7	138.1	144.4	150.8	157.1	163.5	169.8	176.2	182.5
89	YOPOUGON 3	37.4	40.3	42.6	49.2	52.1	59.1	69.6	75.5	78.6	81.8	86.5	93.4	98.7	104.1	109.5	114.8	120.2	125.6	131.0	136.3	141.7
90	ZAGNE	6.7	7.2	7.6	8.8	9.3	10.5	12.4	13.5	14.0	14.6	15.4	16.6	17.6	18.5	19.5	20.5	21.4	22.4	23.3	24.3	25.2
91	ZUENOULA	5.4	5.8	6.1	7.1	7.5	8.5	10.0	10.9	11.3	11.8	12.4	13.4	14.2	15.0	15.7	16.5	17.3	18.1	18.8	19.6	20.4
	Total (MW)	1,391	1,501	1,584	1,816	1,915	2,161	2,531	2,741	2,848	2,959	3,128	3,367	3,556	3,745	3,933	4,122	4,311	4,500	4,689	4,878	5,067

APPENDIX-5

POWER DEVELOPMENT PLAN

Planification des ouvrages de prodution 2019 - 2030

Scénario de Référence avec 80% des projets aurifères :

Développement du parc de production avec la prise en compte du développement des centrales thermiques Gas to Power (180 MW), Songon (369 MW) et Charbon (700 MW)

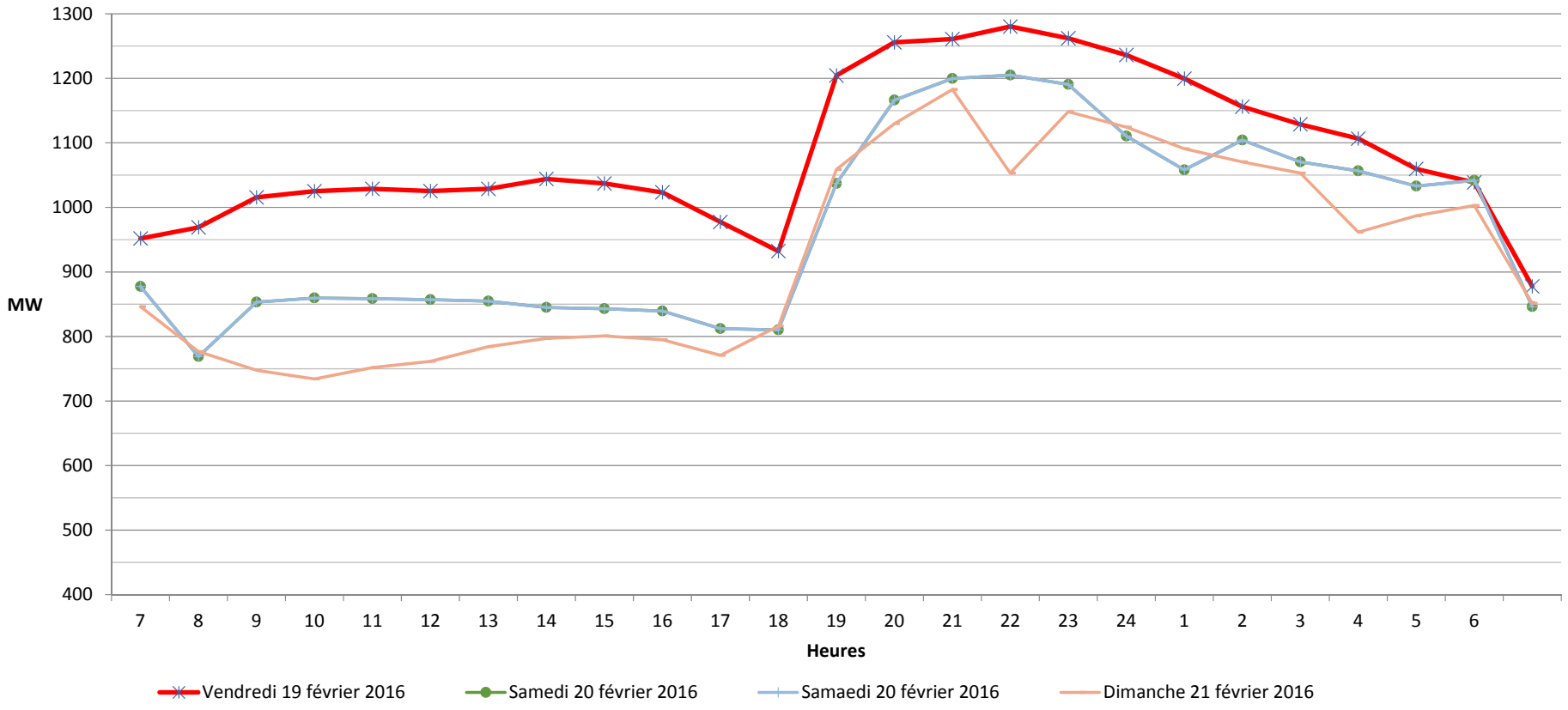
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Puissance installée 2019 - 2030			**2229**	**2438**	**3009**	**3064**	**3332**	**3715**	**4014**	**4393**	**4513**	**4592**	**4942**	**5317**
Augmetation anuelle			**30**	**209**	**571**	**55**	**268**	**383**	**299**	**379**	**120**	**79**	**350**	**375**
Hydraulique	Hydro		**879**	**879**	**991**	**1035**	**1035**	**1185**	**1311**	**1340**	**1460**	**1489**	**1489**	**1499**
Ayamé 1	Hydro	1959/1/1	20	20	20	20	20	20	20	20	20	20	20	20
Ayamé 2	Hydro	1965/1/1	30	30	30	30	30	30	30	30	30	30	30	30
Buyo	Hydro	1980/1/1	165	165	165	165	165	165	165	165	165	165	165	165
Kossou	Hydro	1972/1/1	174	174	174	174	174	174	174	174	174	174	174	174
Taabo	Hydro	1979/1/1	210	210	210	210	210	210	210	210	210	210	210	210
Fayé	Hydro	1983/1/1	5	5	5	5	5	5	5	5	5	5	5	5
Soubré	Hydro	2017/5/25	275	275	275	275	275	275	275	275	275	275	275	275
Singrobo G1	Hydro	2022/6/1	0	0	0	**22**	22	22	22	22	22	22	22	22
Singrobo G2	Hydro	2022/8/1	0	0	0	**22**	22	22	22	22	22	22	22	22
Gribopopoli G1	Hydro	2021/1/30	0	0	**37**	37	37	37	37	37	37	37	37	37
Gribopopoli G2	Hydro	2021/9/21	0	0	**37**	37	37	37	37	37	37	37	37	37
Gribopopoli G3	Hydro	2021/12/21	0	0	**37**	37	37	37	37	37	37	37	37	37
Boutoubre	Hydro	2024/6/30	0	0	0	0	0	**150**	150	150	150	150	150	150
Louga 1	Hydro	2025/12/31	0	0	0	0	0	0	**126**	126	126	126	126	126
Louga 2	Hydro	2027/12/31	0	0	0	0	0	0	0	0	**120**	120	120	120
Ferké	Hydro	2026/7/1	0	0	0	0	0	0	0	**8**	**8**	**8**	8	8
Haut Bandaman	Hydro	2028/7/1	0	0	0	0	0	0	0	0	0	**12**	12	12
Man	Hydro	2028/7/1	0	0	0	0	0	0	0	0	0	**3**	3	3
Marabadiassa	Hydro	2028/7/1	0	0	0	0	0	0	0	0	0	**15**	15	15
Zégbéry	Hydro	2026/7/1	0	0	0	0	0	0	0	**13**	13	13	13	13
Mankono	Hydro	2026/7/1	0	0	0	0	0	0	0	**8**	8	8	8	8
Téhini	Hydro	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**4**
Aboisso	Hydro	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**6**
Thermique	**Thermique**		**1350**	**1529**	**1858**	**1783**	**2026**	**2209**	**2332**	**2332**	**2332**	**2332**	**2332**	**2332**
Vridi 1	Thermique	1984/1/1	100	100	100	100	100	100	100	100	100	100	100	100
CIPREL	Thermique	1995/2/1	569	569	569	569	569	569	569	569	569	569	569	569
Azito	Thermique	1999/1/1	471	471	471	471	471	471	471	471	471	471	471	471
Aggreko	Thermique	2010/1/1	210	210	210	0	0	0	0	0	0	0	0	0
AZITO IV TAG	Thermique	2020/12/15	0	**179**	179	179	179	179	179	179	179	179	179	179
AZITO IV TAV	Thermique	2021/12/15	0	0	**74**	74	74	74	74	74	74	74	74	74
Ciprel V - 1er Tranche TAG	Thermique	2021/12/31	0	0	**255**	255	255	255	255	255	255	255	255	255
Ciprel V - 2eme Tranche TAV	Thermique	2022/12/31	0	0	0	**135**	135	135	135	135	135	135	135	135
Songon TAG 1	Thermique	2023/12/31	0	0	0	0	**123**	123	123	123	123	123	123	123
Gas to Power TAG	Thermique	2023/12/31	0	0	0	0	**120**	120	120	120	120	120	120	120
Songon TAG 2	Thermique	2024/12/31	0	0	0	0	0	**123**	123	123	123	123	123	123
Gas to Power TAV	Thermique	2024/12/31	0	0	0	0	0	**60**	60	60	60	60	60	60
Songon TAG 3	Thermique	2025/12/31	0	0	0	0	0	0	**123**	123	123	123	123	123
Biomasse	Boimasse		**0**	**0**	**0**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**46**	**311**
BIOKALA 1.1	Boimasse	2022/5/30	0	0	0	**23**	23	23	23	23	23	23	23	23
BIOKALA 1.2	Boimasse	2022/11/30	0	0	0	**23**	23	23	23	23	23	23	23	23
Biomasse 1	Boimasse	2030/12/25	0	0	0	0	0	0	0	0	0	0	0	**10**
Biomasse 2	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**10**
Biomasse 3	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**20**
Biomasse Coton	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**25**
Biomasse Cacao	Boimasse	2030/12/21	0	0	0	0	0	0	0	0	0	0	0	**20**
Yakro 1.1	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**40**
Yakro 1.2	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**40**
Boundiali	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**25**
Abidjan 1.2	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**50**
San-Pédro 1.1	Boimasse	2030/12/31	0	0	0	0	0	0	0	0	0	0	0	**25**
Solaire	Solaire		**0**	**30**	**160**	**200**	**225**	**275**	**325**	**325**	**325**	**375**	**375**	**475**
KORHOGO SOLAIRE (RECA)	Solaire	2021/12/31	**0**	0	**20**	20	20	20	20	20	20	20	20	20
PORO POWER (GALILEA)	Solaire	2021/12/31	0	0	**50**	50	50	50	50	50	50	50	50	50
Centrale solaire FERKE (BIOTHERM)	Solaire	2022/12/31	0	0	0	**20**	20	20	20	20	20	20	20	20
Centrale solaire BOUNDIALI (CI-ENERGIES)	Solaire	2020/9/1	0	**30**	30	30	30	30	30	30	30	30	30	30
Scaling Solar	Solaire	2021/12/31	0	0	**60**	60	60	60	60	60	60	60	60	60
Odiénné Solaire (AVAADA)	Solaire	2022/12/31	0	0	0	**20**	20	20	20	20	20	20	20	20
Centrale solaire 1	Solaire	2023/12/31	0	0	0	0	**25**	25	25	25	25	25	25	25
Centrale solaire 2	Solaire	2024/12/31	0	0	0	0	0	**50**	50	50	50	50	50	50
Centrale solaire 3	Solaire	2025/12/31	0	0	0	0	0	0	**50**	50	50	50	50	50
Centrale solaire 4	Solaire	2026/12/31	0	0	0	0	0	0	0	0	0	**50**	50	50
Centrale solaire 5	Solaire	2027/12/31	0	0	0	0	0	0	0	0	0	0	0	0
Centrale solaire 6	Solaire	2028/12/31	0	0	0	0	0	0	0	0	0	0	0	**100**
Charbon	Charbon		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**350**	**350**	**350**	**700**	**700**
Centrale à charbon-Tranche TAC1	Charbon	2026/12/31	0	0	0	0	0	0	0	**350**	350	350	350	350
Centrale à charbon-Tranche TAC2	Charbon	2029/12/31	0	0	0	0	0	0	0	0	0	0	**350**	350

			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Grosse hydraulique			39%	36%	33%	34%	31%	32%	33%	30%	32%	31%	29%	27%
EnR hors grosse hydraulique			0%	1%	5%	8%	8%	9%	9%	9%	9%	10%	10%	16%
Petite hydraulique			0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%
Solaire			0%	1%	5%	7%	7%	7%	8%	7%	7%	8%	8%	9%
Biomasse			0%	0%	0%	2%	1%	1%	1%	1%	1%	1%	1%	6%
Energie renouvelable			39%	37%	38%	42%	39%	41%	42%	39%	41%	42%	39%	43%
Thermique			61%	63%	62%	58%	61%	59%	58%	53%	52%	51%	47%	44%
Charbon			0%	0%	0%	0%	0%	0%	0%	8%	8%	8%	14%	13%
TOTAL Mix énergétique			**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

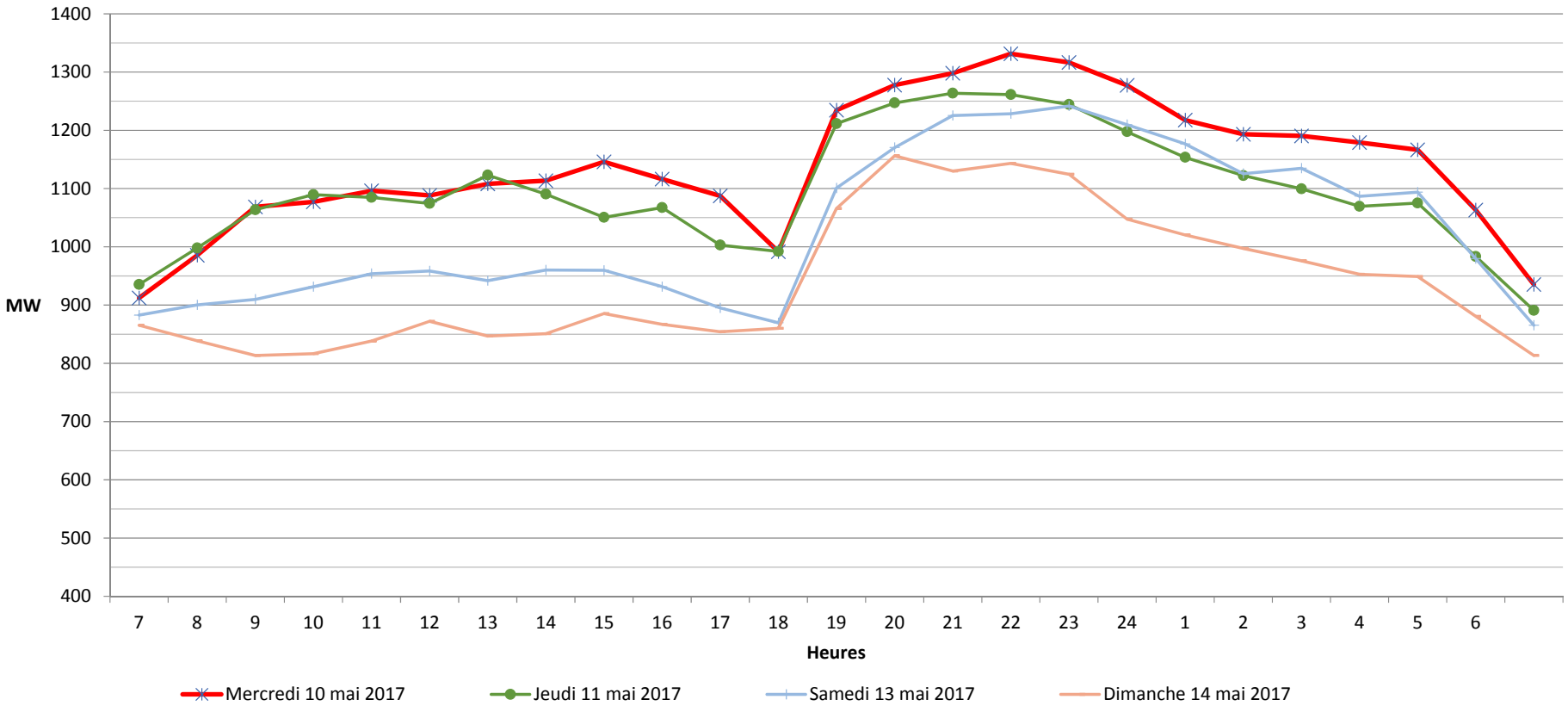
APPENDIX-6

DAILY LOAD CURVE (2016 / 2017)

Courbes de charge nationales du jour le plus chargé de 2016, du jour suivant, du samedi et du dimanche de la même semaine

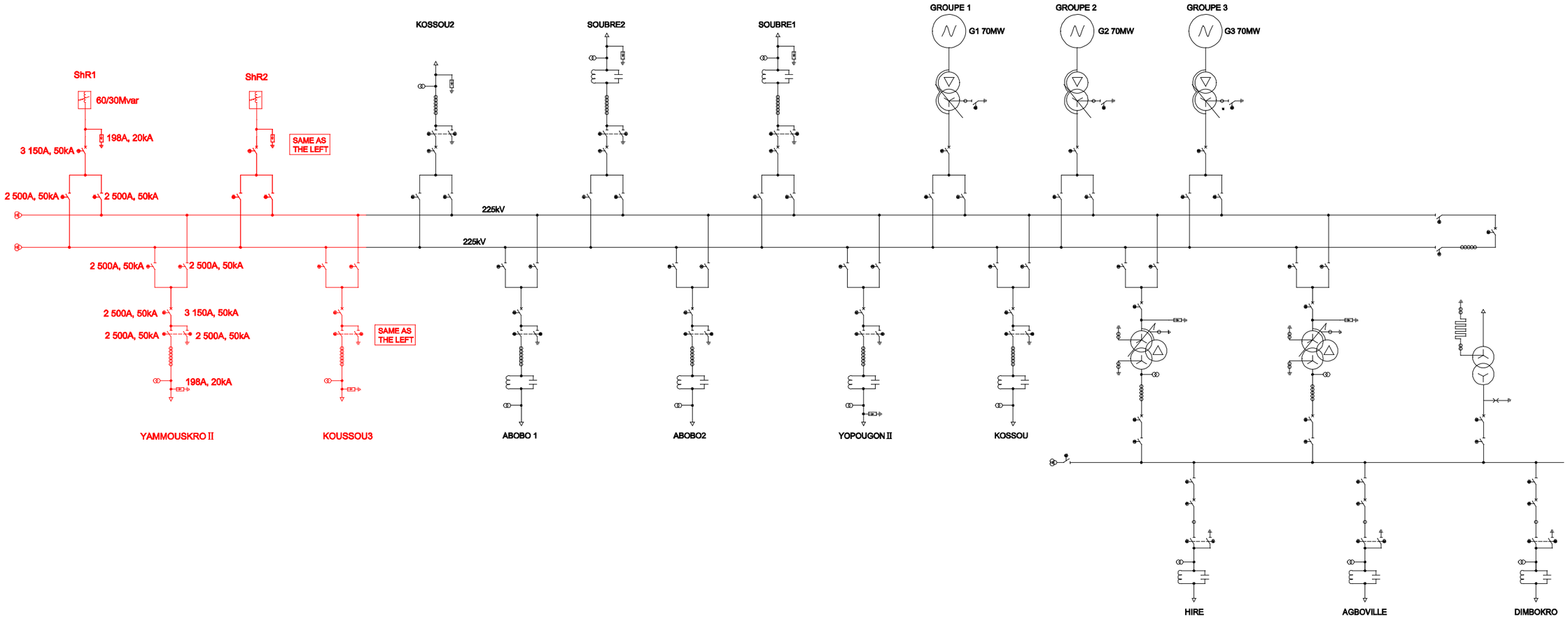


Courbes de charge nationales du jour le plus chargé de 2017, du jour suivant, du samedi et du dimanche de la même semaine

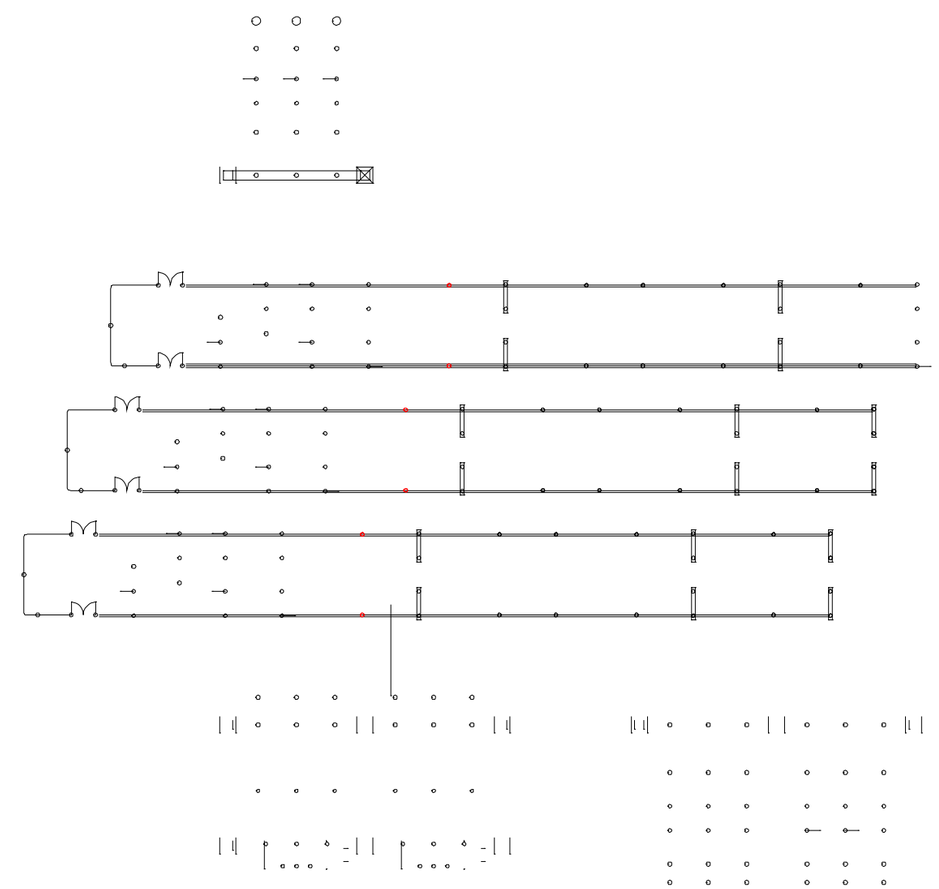


APPENDIX-7

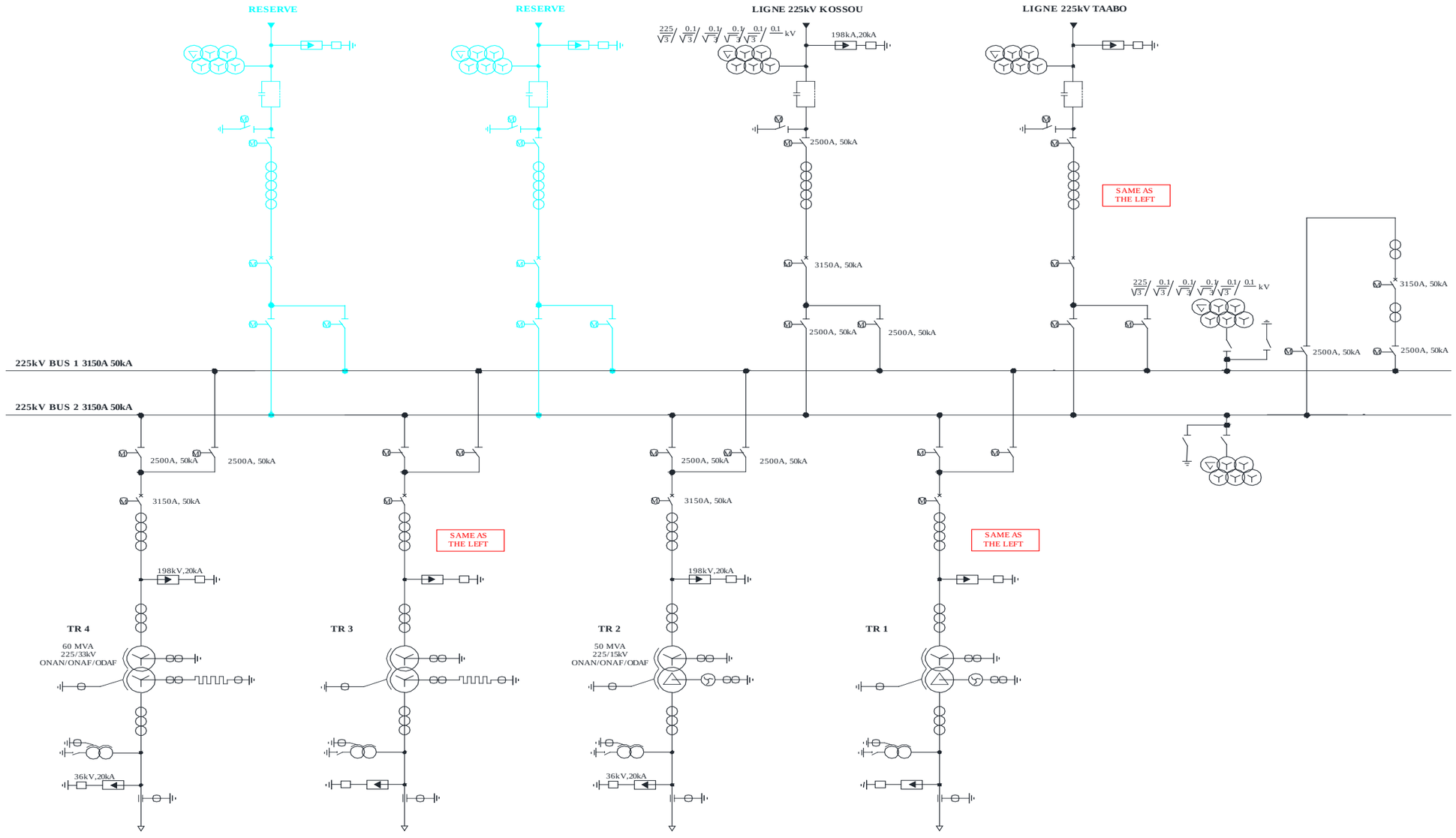
DRAWINGS OF SUBSTATION



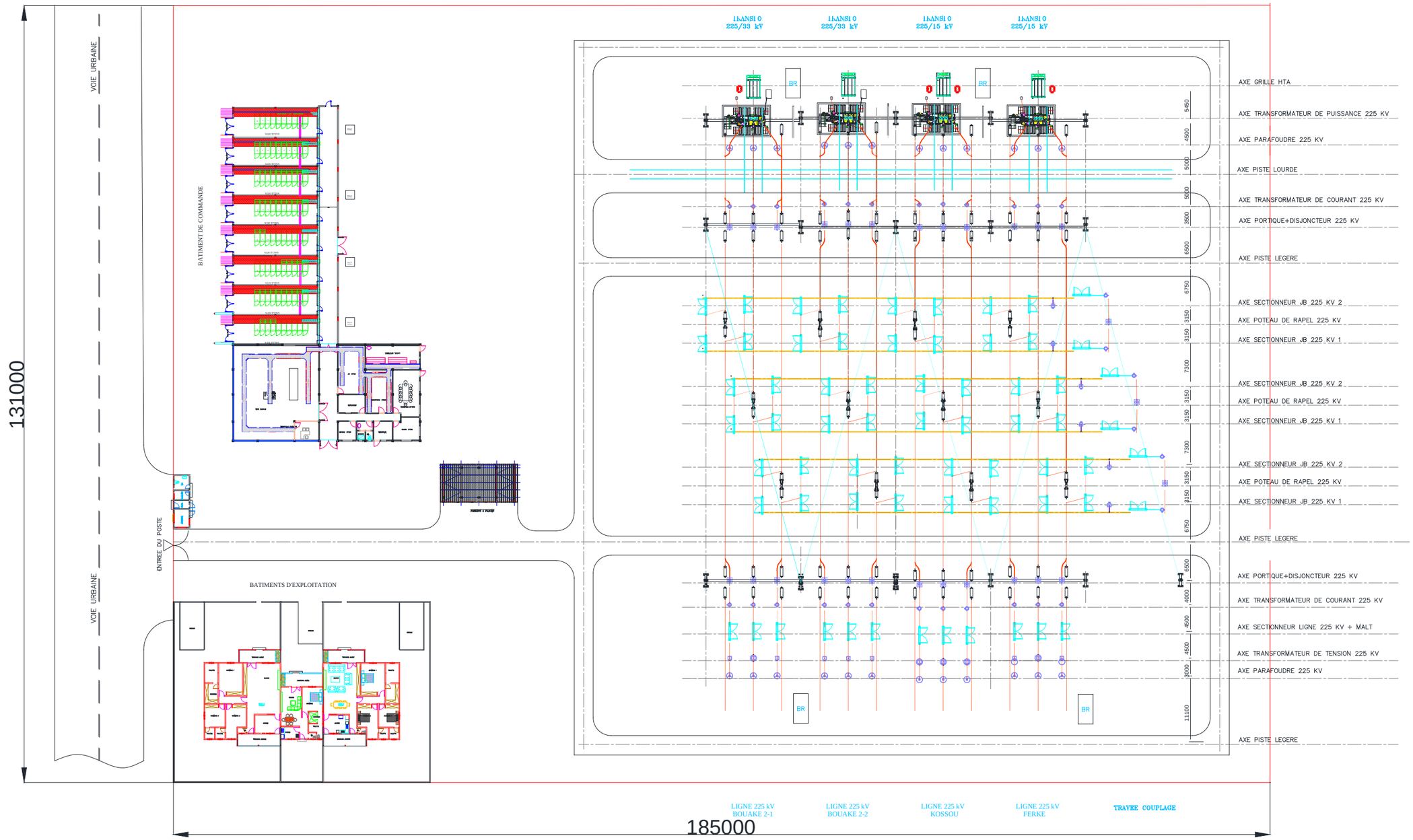
Single line diagram of Taabo substation



Layout of Bouake 2 substation



Single line diagram of Yamoussoukro 2 substation (225kV)



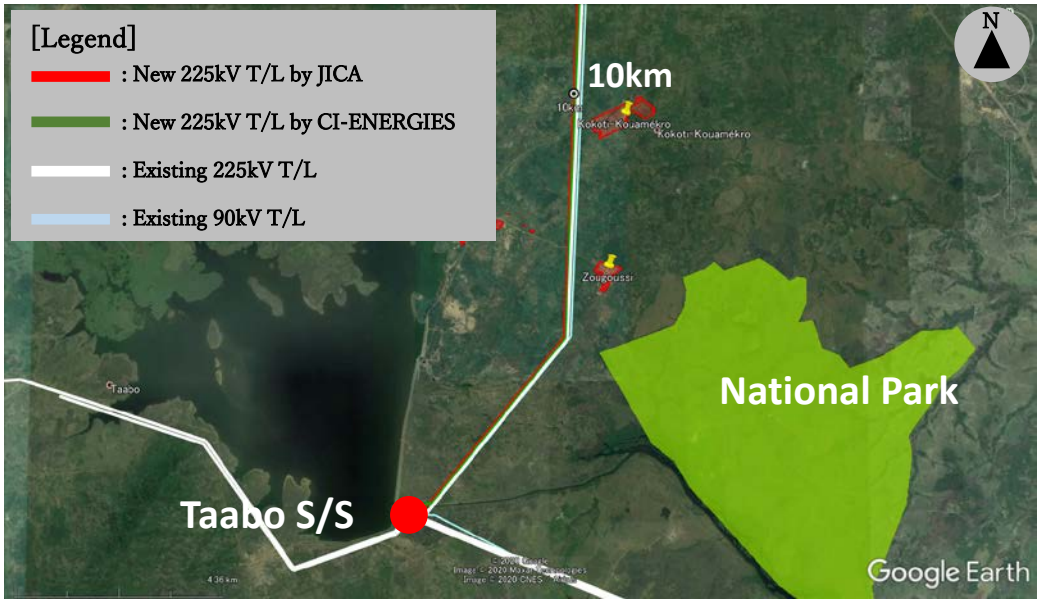
Layout of Bouaké 3 substation

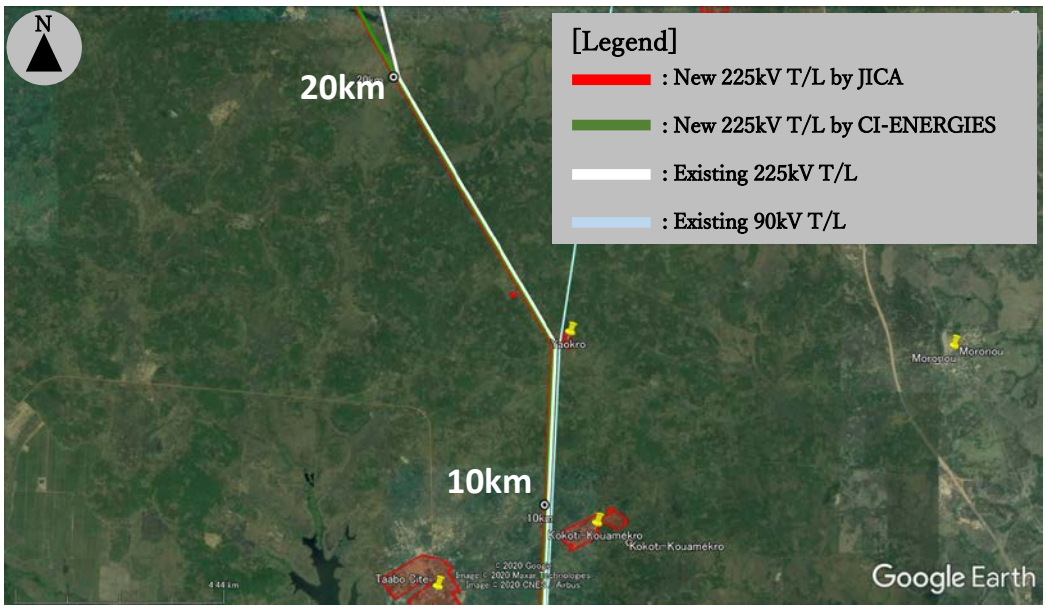
APPENDIX-8

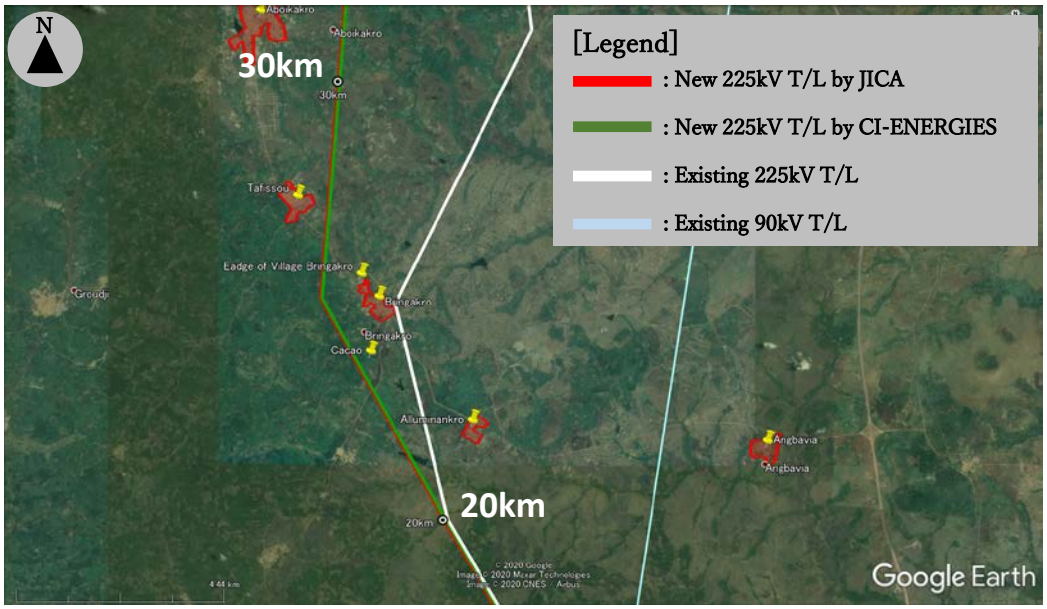
TRANSMISSION NETWORKS

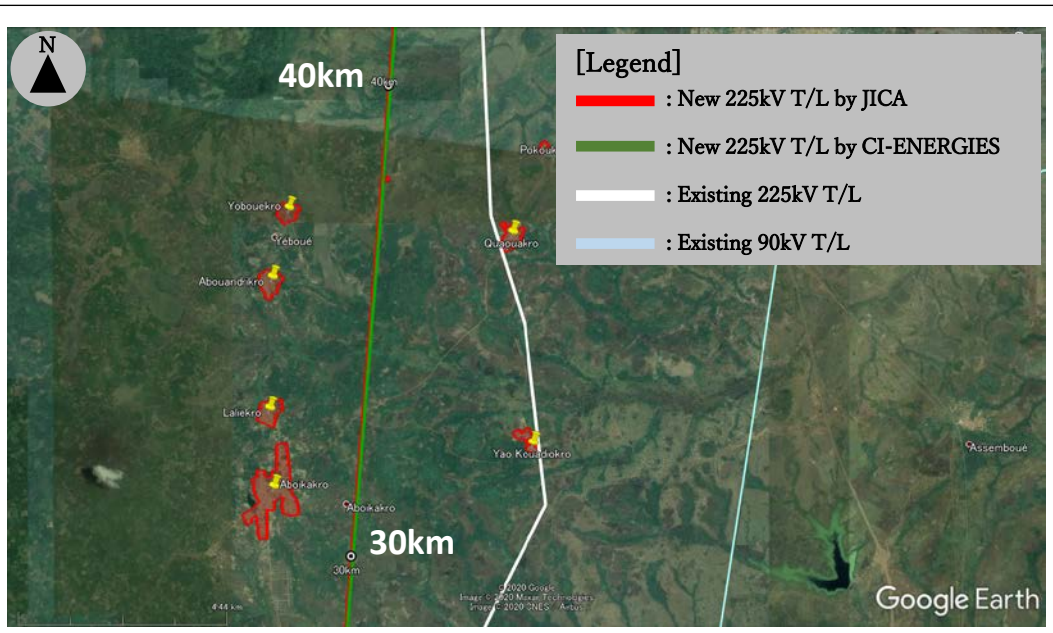
以下に架空送電線の平面図を示す。

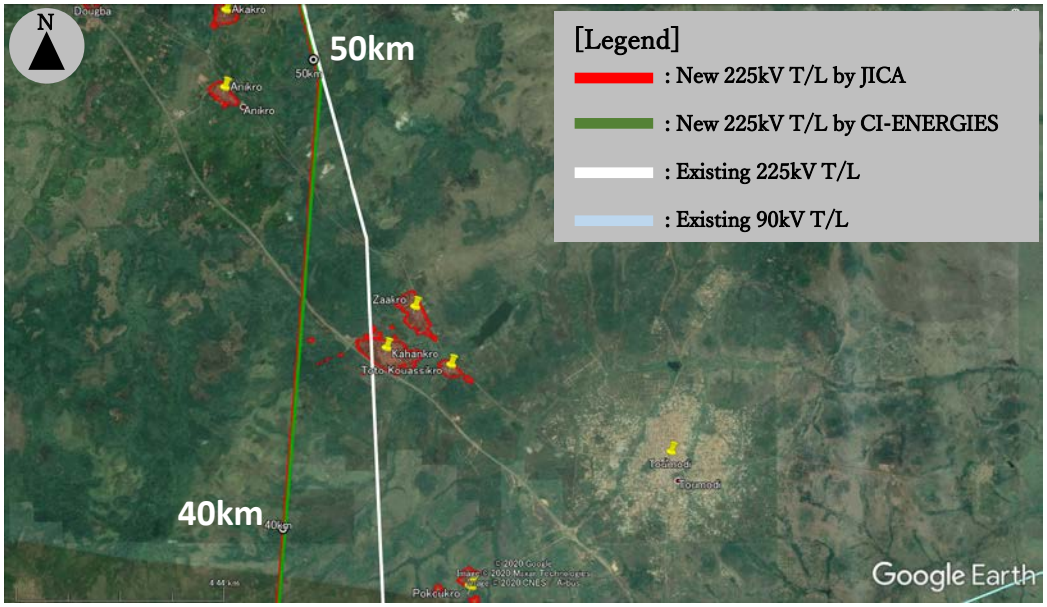
(1) Taabo S/S - Kossou S/S

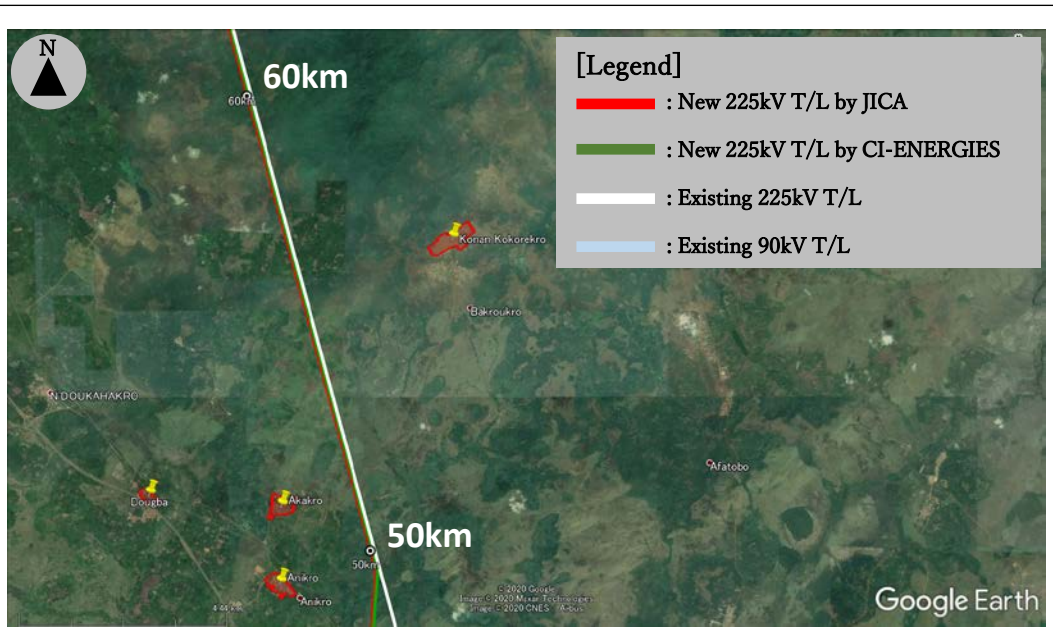


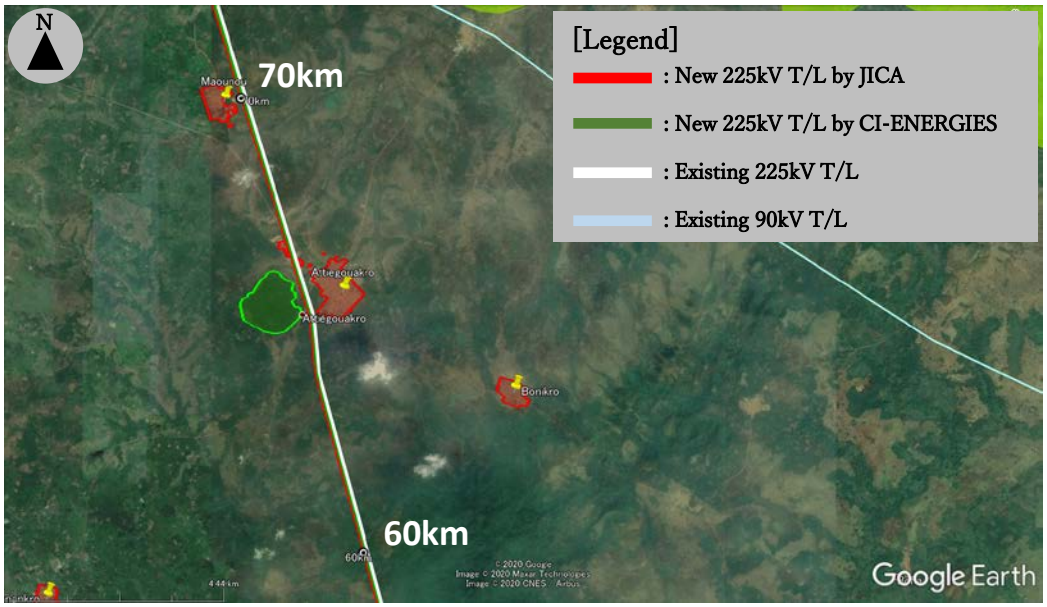


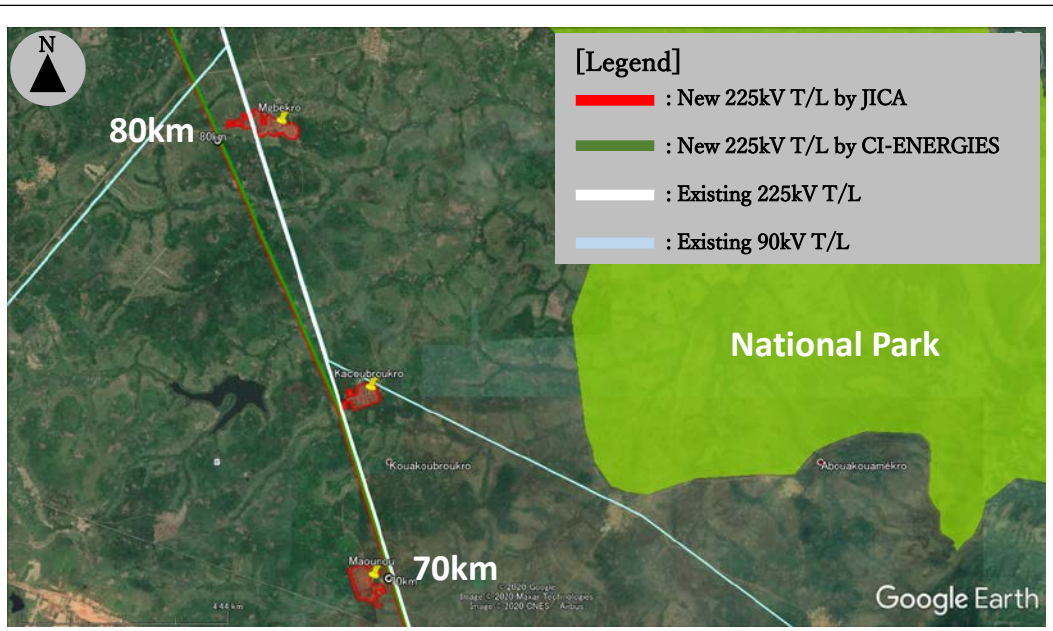

N
30km
20km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

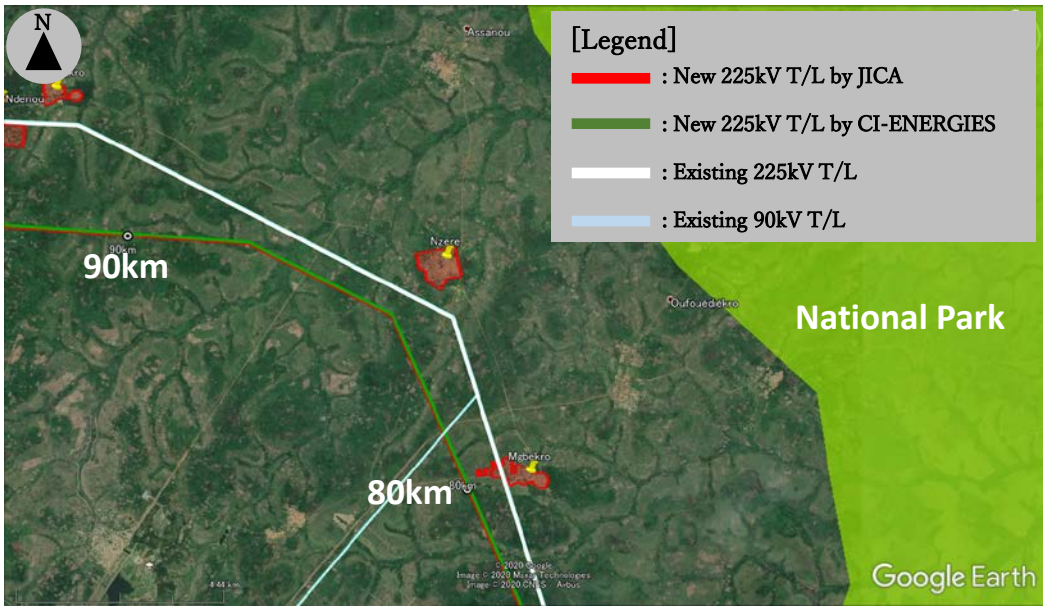

N
40km
30km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

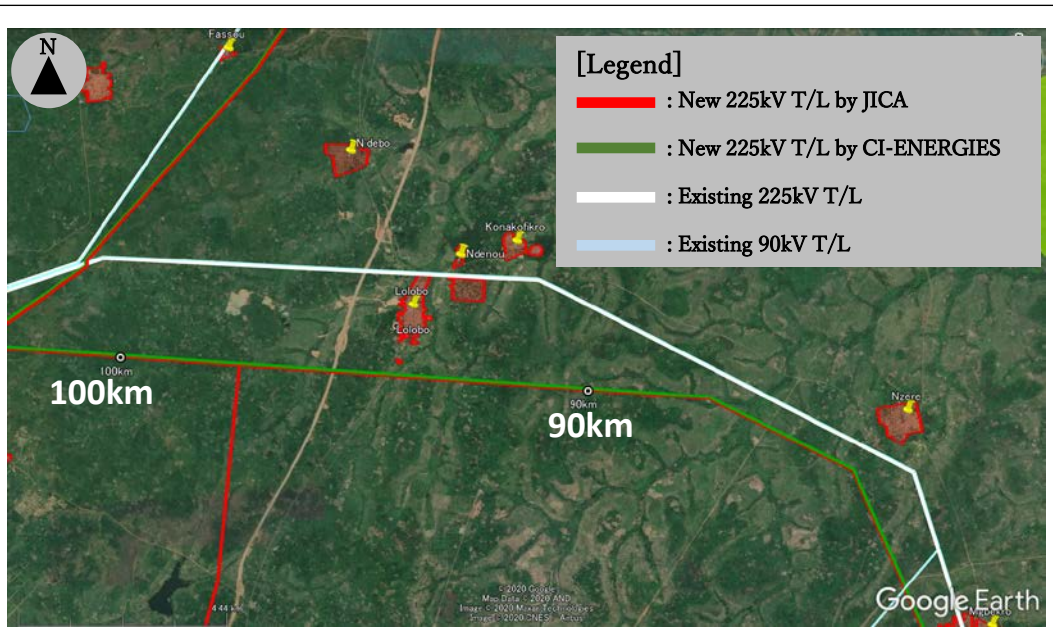

N
50km
40km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

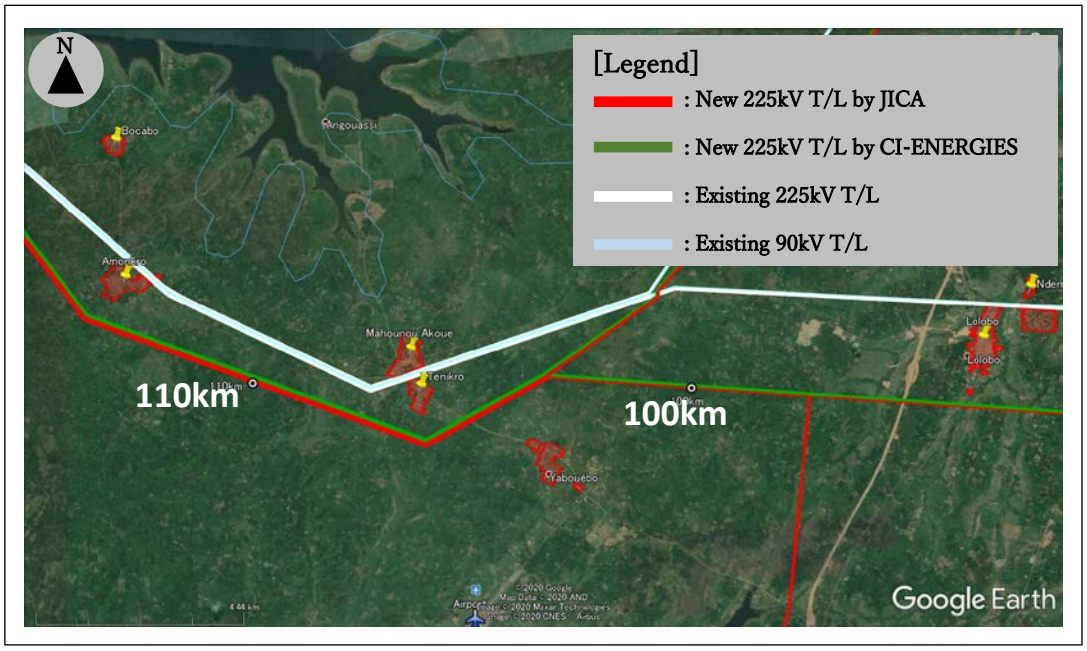

N
60km
50km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

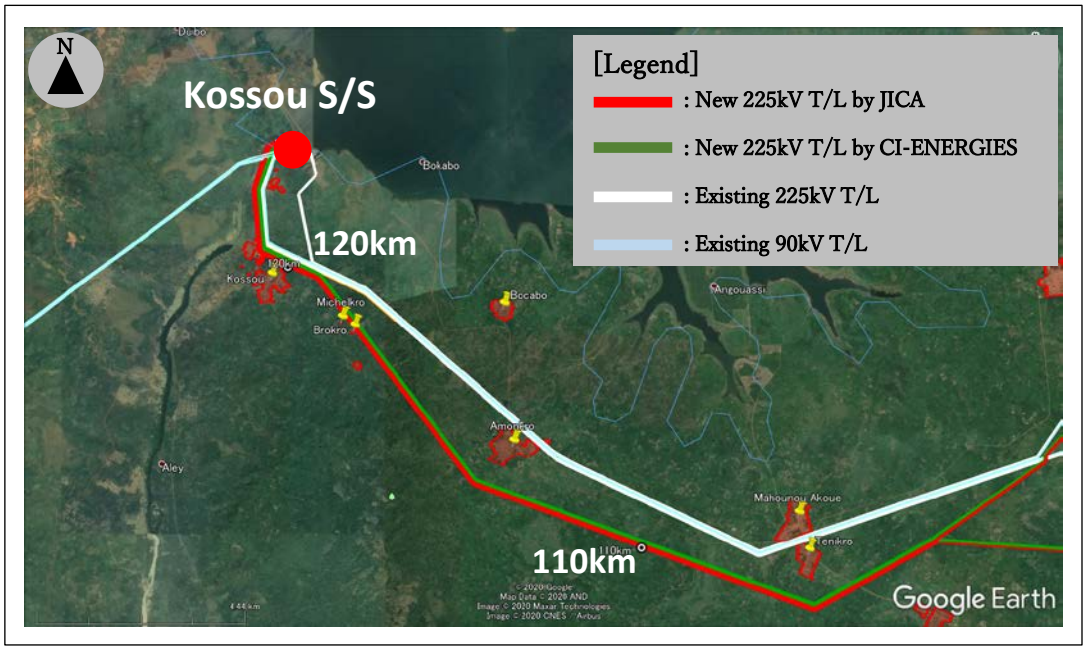

N
70km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Maounoy
0km
Akégouakro
Bonikro
60km
Google Earth


N
80km
Mbékro
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
National Park
Kouakoubroukro
Abouakouamékro
Maounoy
70km
Google Earth

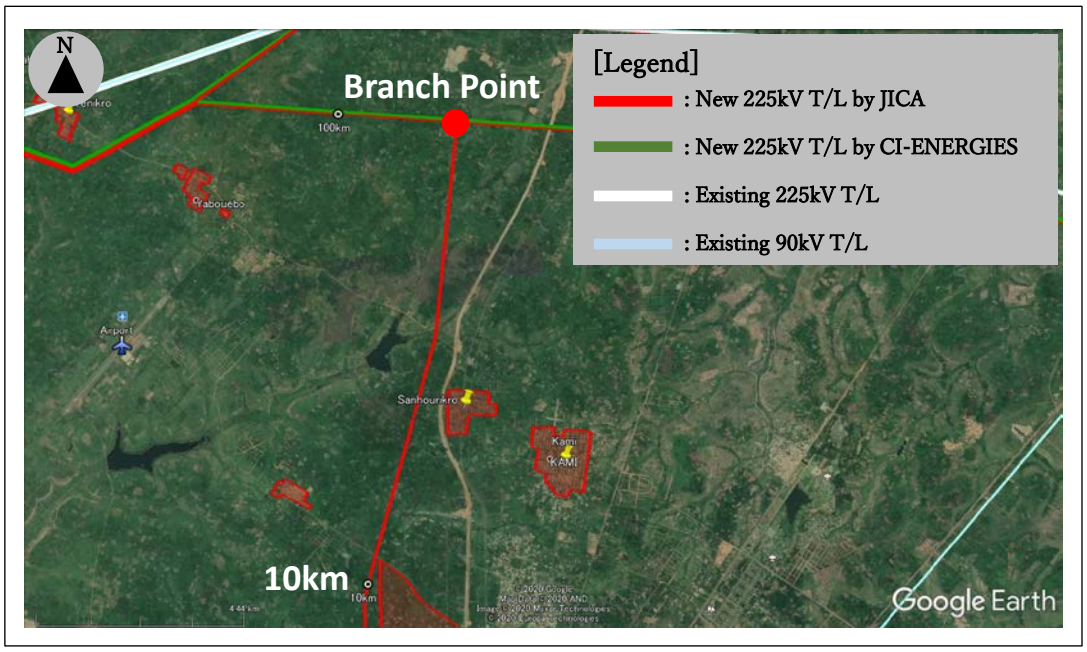

N
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
National Park
90km
80km
Google Earth

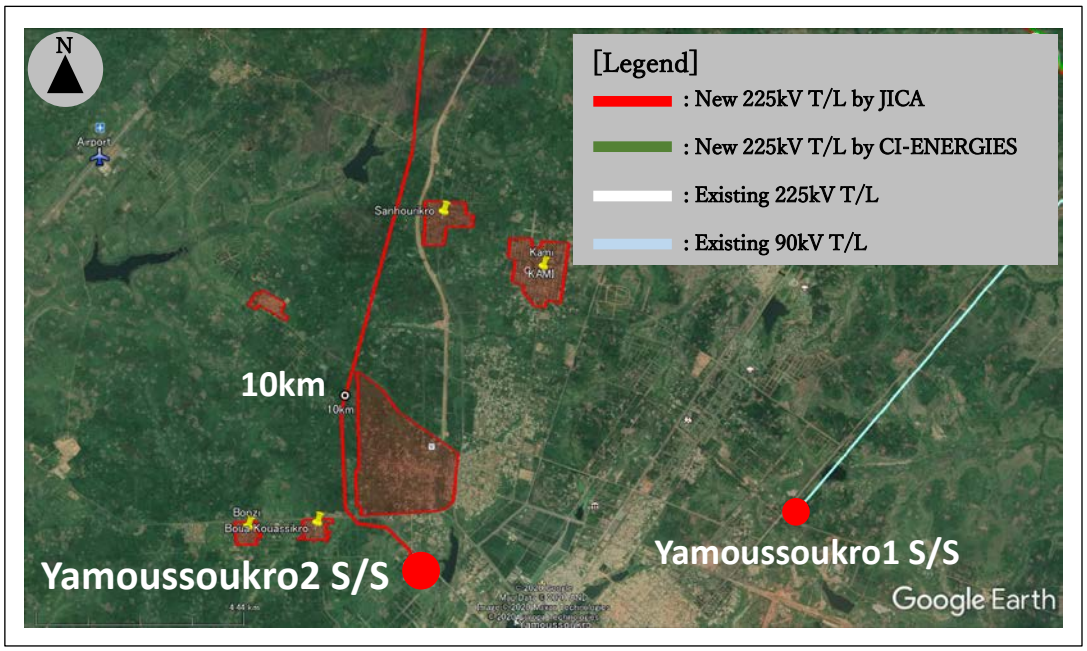

N
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
100km
90km
Google Earth


N
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Bocabo
Angouassi
Mahounou Akoue
Tenikro
Lolobo
Yaboueba
110km
100km
Google Earth

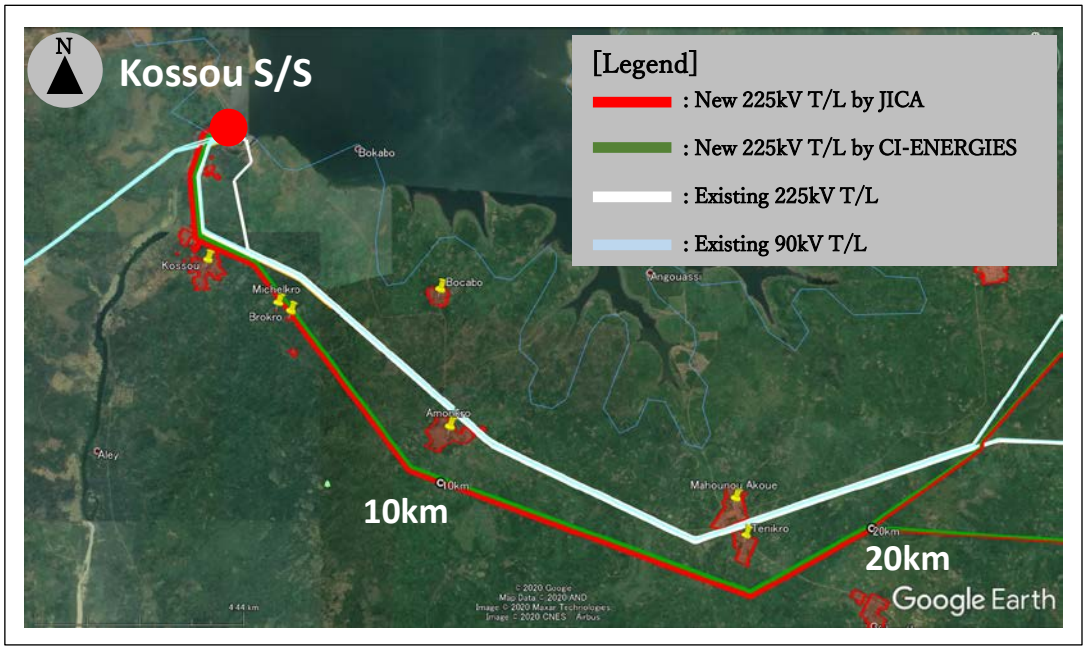

N
Kossou S/S
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Bokabo
120km
Kossou
Michekro
Brokro
Bocabo
Angouassi
Aley
Mahounou Akoue
Tenikro
110km
Google Earth

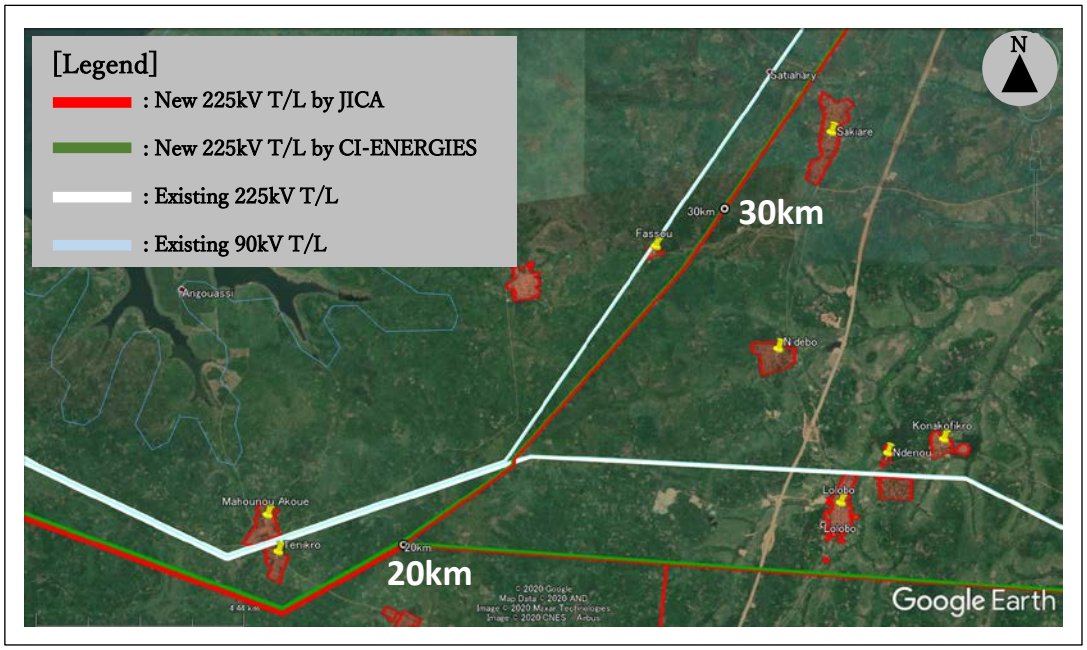
(2) Branch Point - Yamoussoukro2 S/S

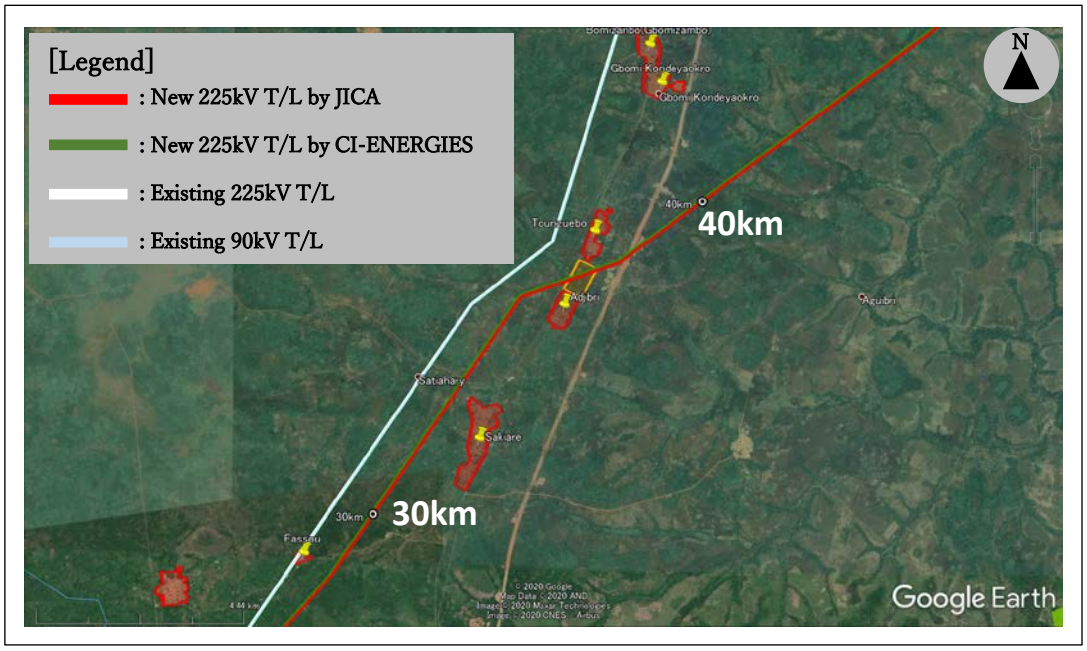


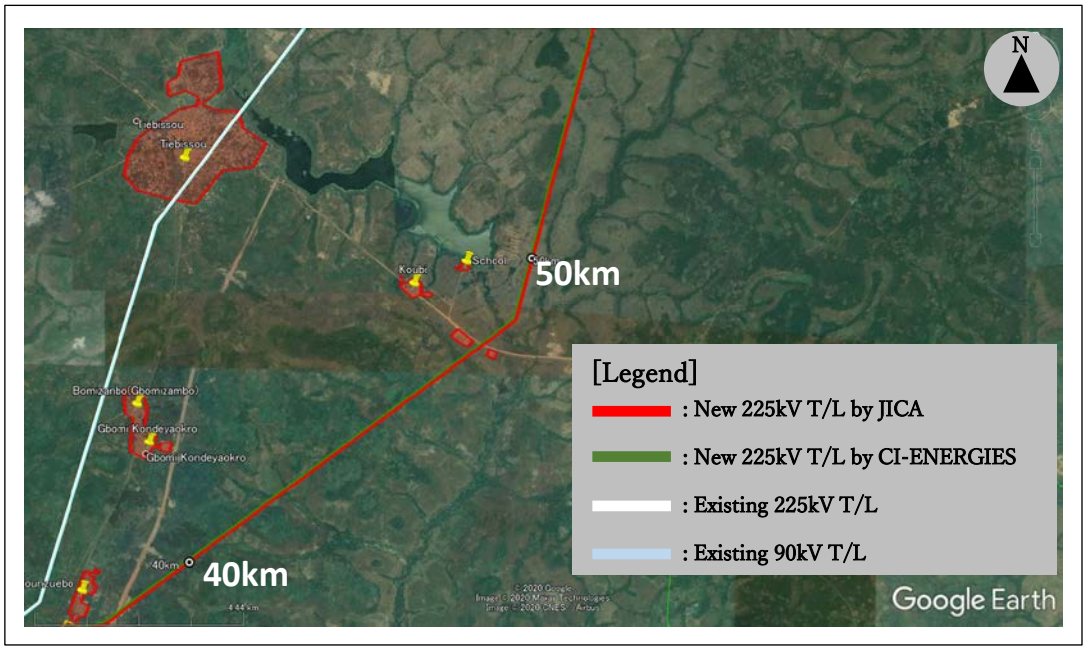


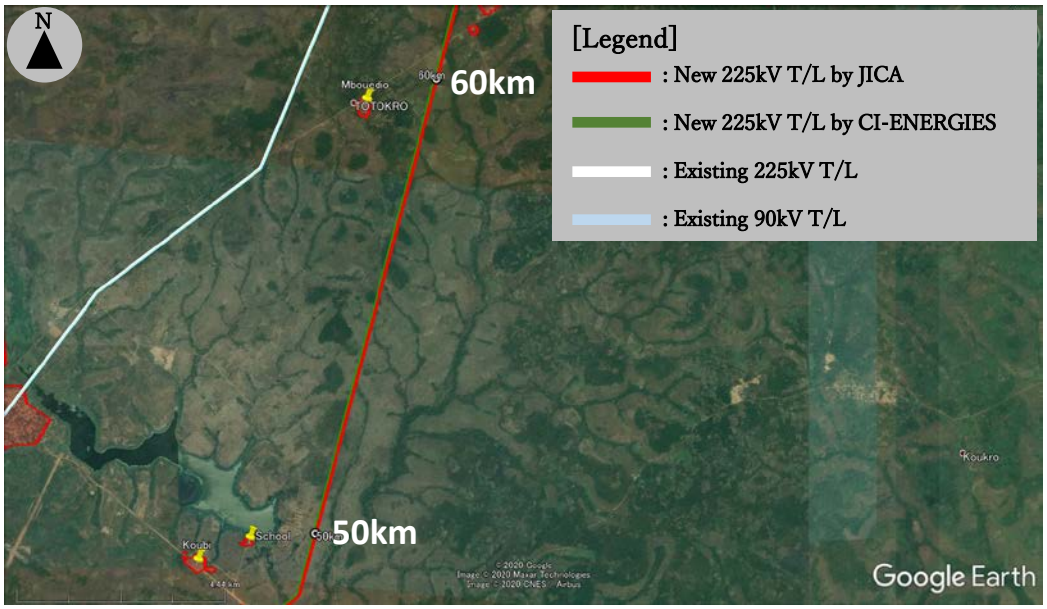
(3) Kossou S/S - Bouake3 S/S

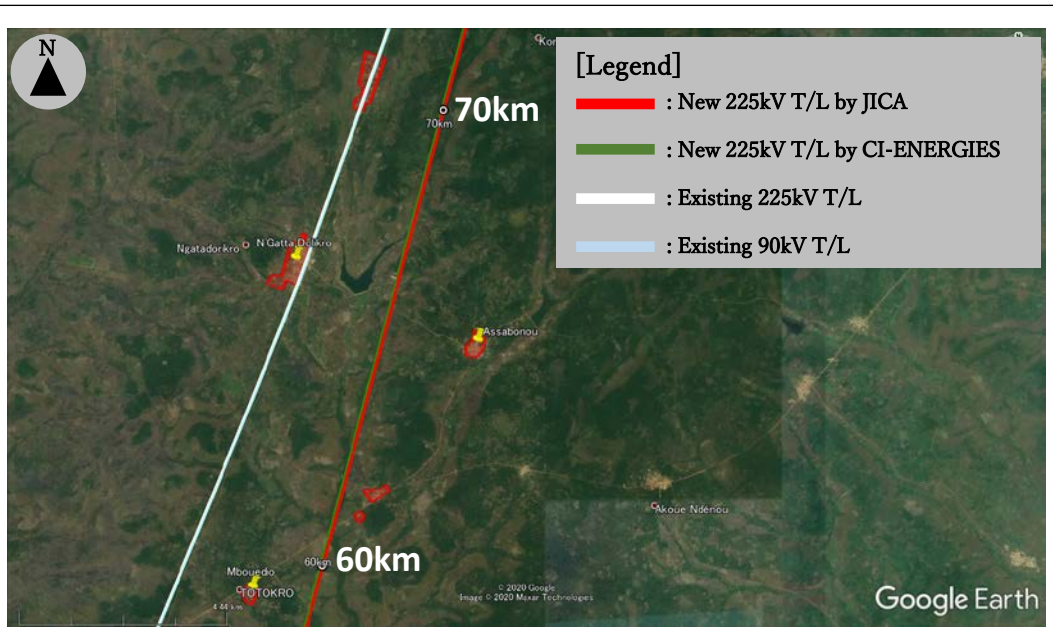


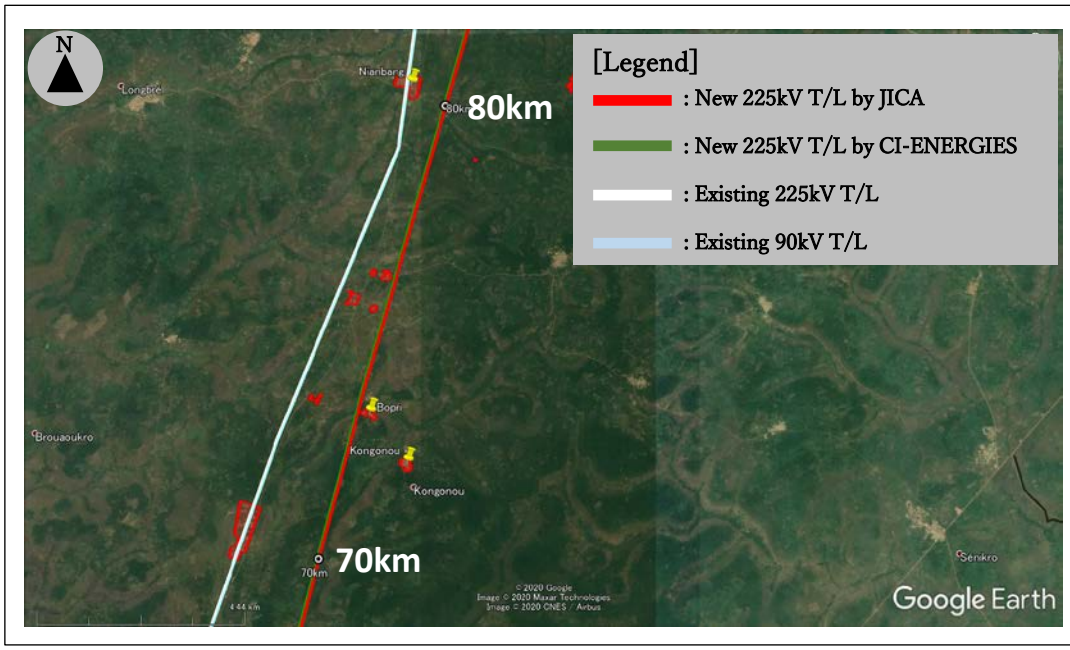


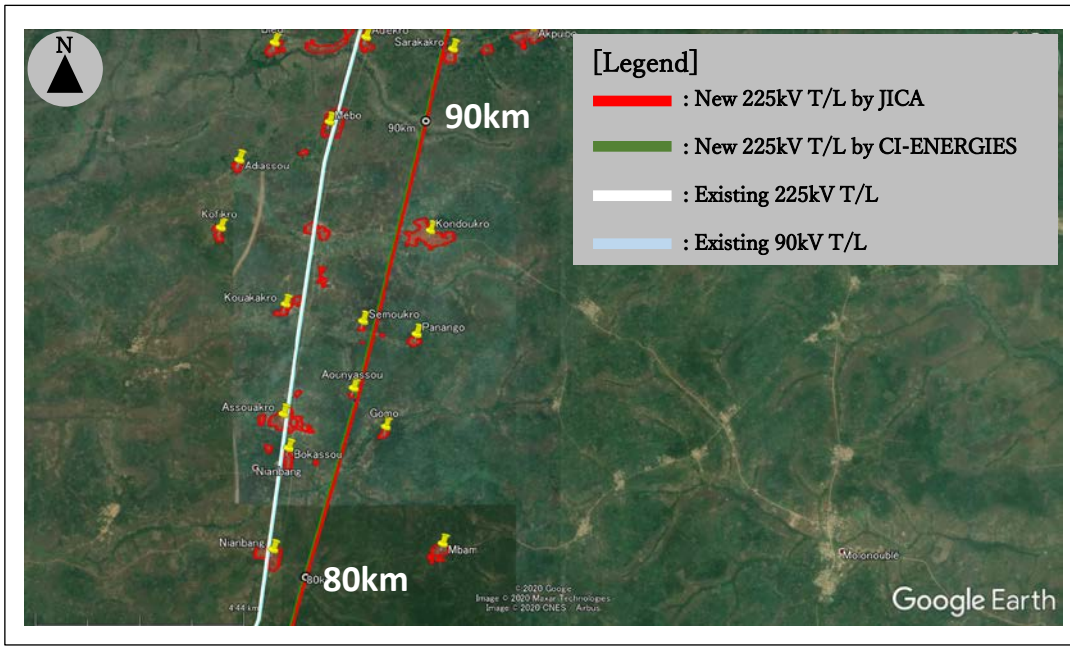

[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
N
40km
30km
Google Earth

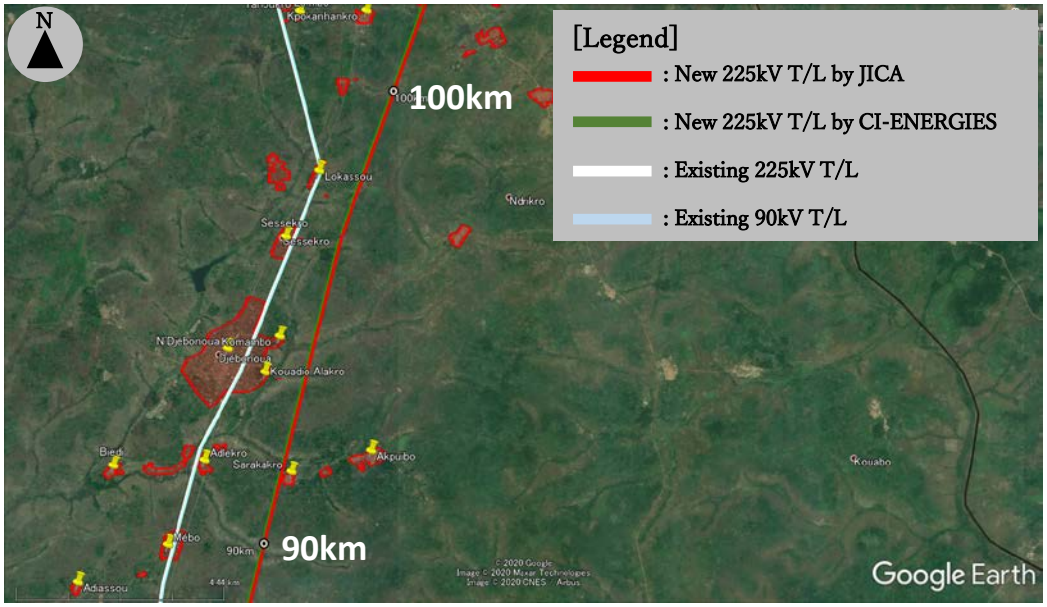

N
50km
40km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

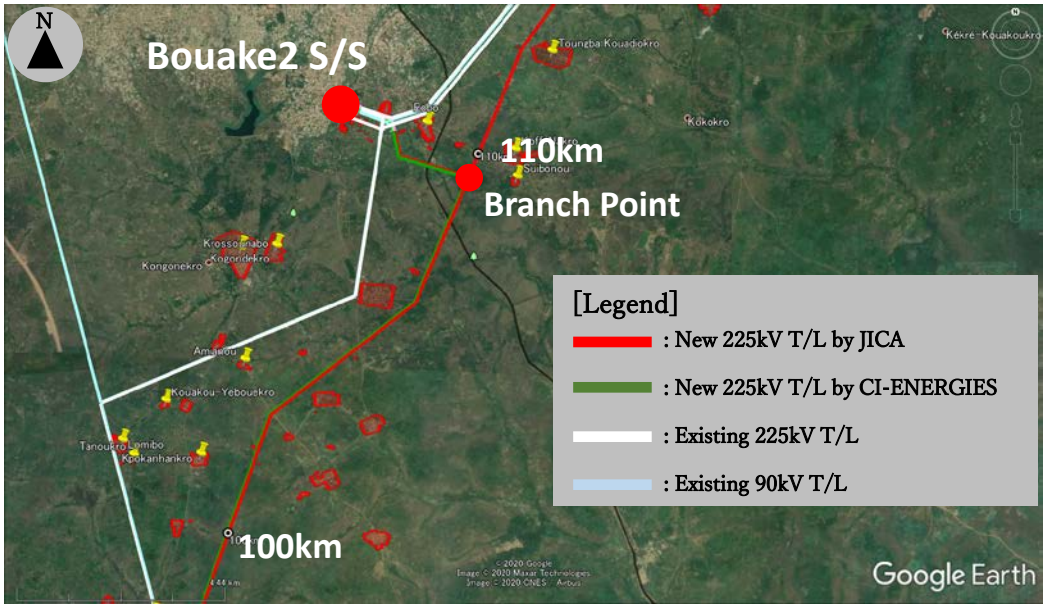

N
60km
50km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

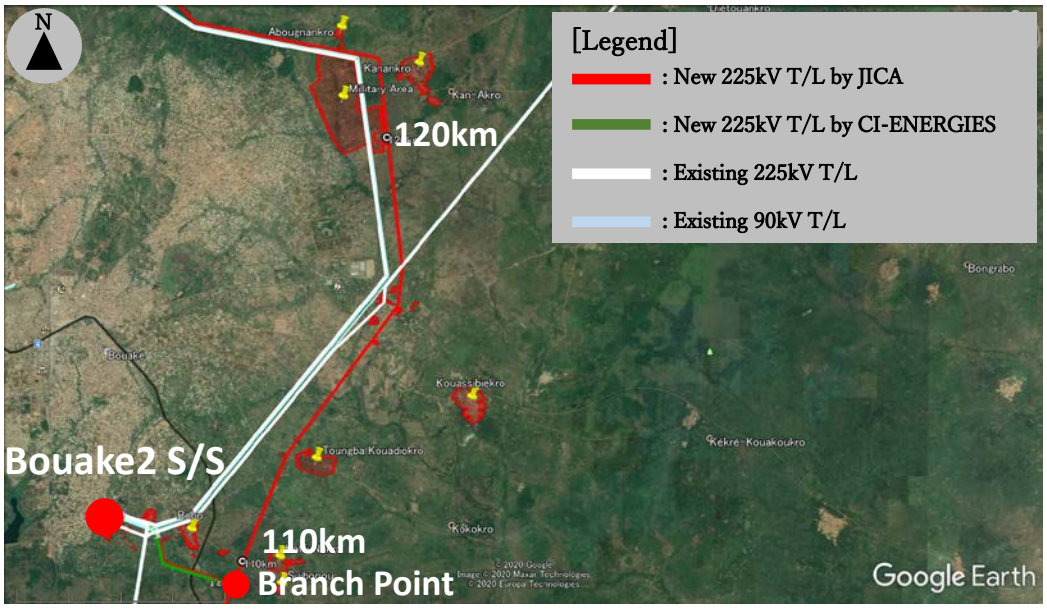

N
70km
60km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

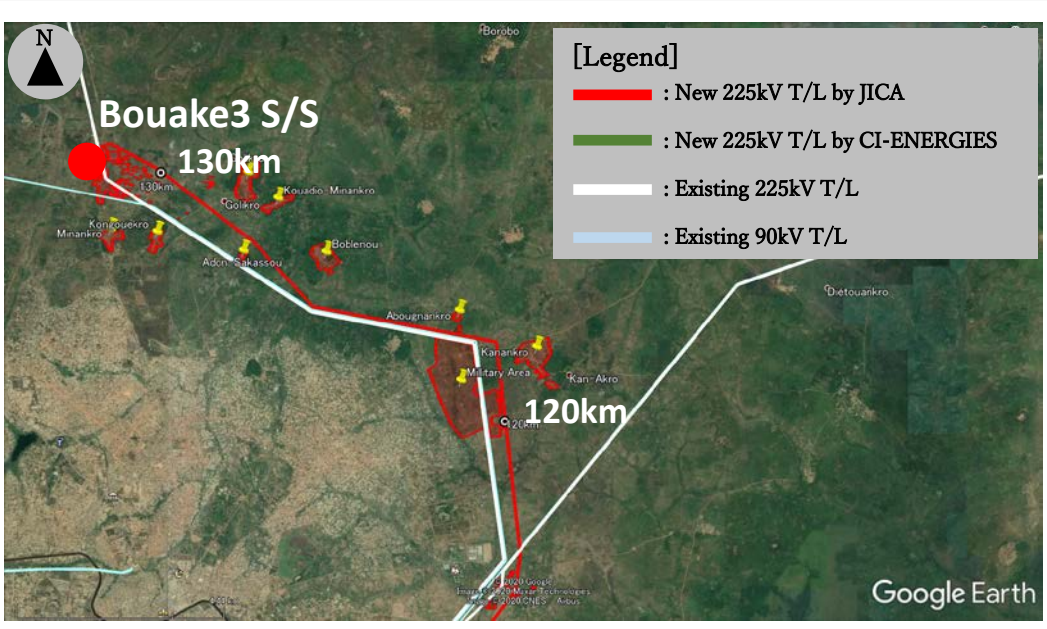

N
Niaribang
80km
Bopri
Brouaoukro
Kongonou
Kongonou
70km
70km
Sénikro
Google Earth
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L


N
Sarakakro
Mebo
90km
90km
Adaoussou
Kondoukro
Kouakakro
Semoukro
Panarigo
Aounyassou
Assouakro
Gomo
Bokassou
Niaribang
Niaribang
Mbam
80km
Google Earth
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L


N
100km
90km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth

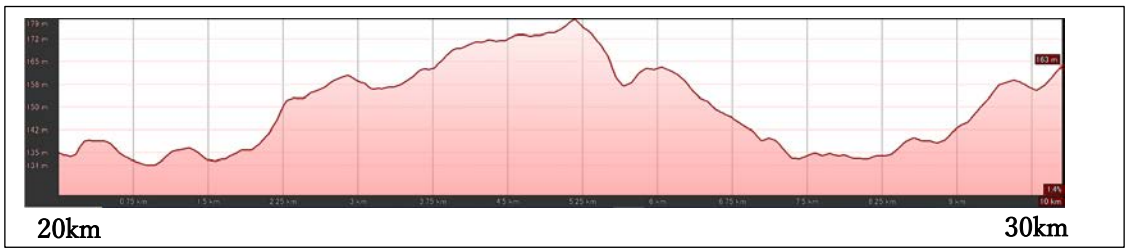

N
Bouake2 S/S
110km
Branch Point
100km
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Google Earth


N
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
120km
Bouake2 S/S
110km
Branch Point
Google Earth


N
[Legend]
: New 225kV T/L by JICA
: New 225kV T/L by CI-ENERGIES
: Existing 225kV T/L
: Existing 90kV T/L
Bouake3 S/S
130km
120km
Google Earth

以下に架空送電線の縦断図を示す。

(1) Taabo S/S - Kossou S/S



50km 60km

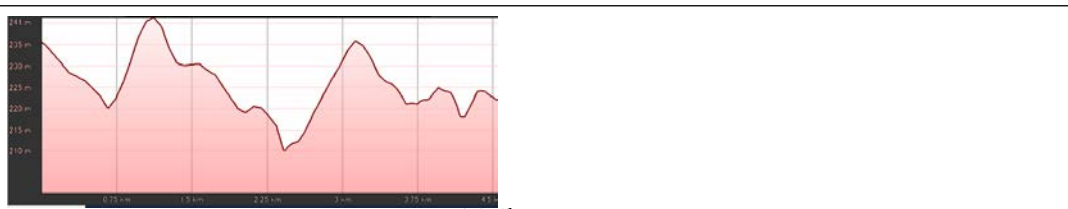
60km 70km

70km 80km

80km 90km

90km 100km

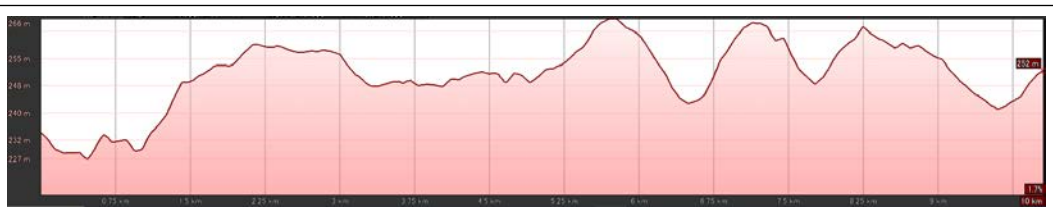
(2) Branch Point - Yamoussoukro2 S/S



(3) Kossou S/S - Bouake3 S/S

50km 60km

60km 70km

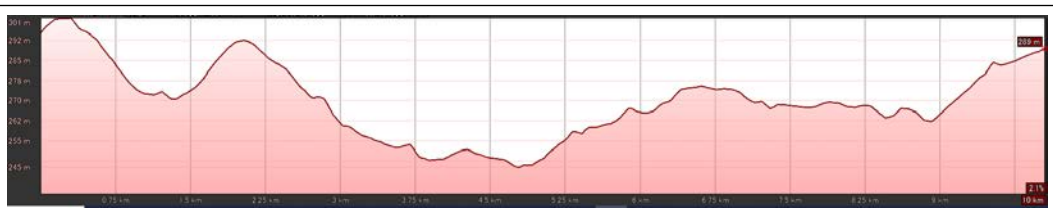


70km 80km

80km 90km

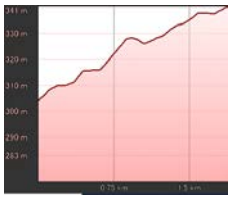
90km 100km

100km 110km



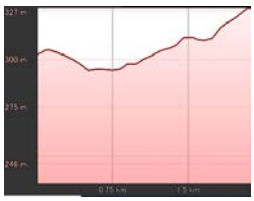
110km 120km

120km 130km



120km 131.9km

(4) Branch Point - Bouake2 S/S



0km 2.1km