CHAPTER 6

ENVIRONMENTAL AND SOCIAL CONSIDERATION

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6.1 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

6.1.1 Description of Project Components and Environmental and Social Impacts

The description of project components is shown in Table 6.1-1.

Table 6.1-1 Description of project components

No.	Project components	Contents (required land etc.)
1	Addis Center Substation	The change of land use registration has been completed (No land acquisition is required). Two households are located within the site; however, the compensation task had been completed at the time of cut-off date.
2	Kaliti I Substation	Gas insulated switchgears will be modified.
3	Black Lion Substation	Gas insulated switchgears will be modified.
4	Addis North Substation	Transformers will be replaced.
5	Weregenu Substation	Expansion of the existing substation site is required; however, the land acquisition has been completed by EEP.
6	Construction of 132kV transmission line (Addis Center Substation - Kaliti I Substation/Gofa Substation)	Underground transmission lines and overhead transmission lines will be constructed. The ROW of the existing transmission lines and roads will be utilized.
7	Construction of 132kV transmission line (Addis Center Substation - Black Lion Substation)	Underground transmission lines will be constructed. The ROW of the existing transmission lines and roads will be utilized.
8	Construction of 132kV transmission line (Weregenu Substation - Connection point)	Underground transmission lines will be constructed. The ROW of the existing roads will be utilized.
9	Rehabilitation of 15V/ 33 kV distribution line	Medium voltage distribution lines will be constructed. The ROW of the existing distribution lines will be utilized.

Source: JICA Study Team

6.1.2 Status of Environmental and Social Baseline

(1) Natural Environment

The proposed project site is located within the city of Addis Ababa and at a high altitude of approximately 2,300 meters. The city center of Addis Ababa has commercial and residential areas, surrounded by residential and agricultural areas.

1) Meteorology

Addis Ababa City is characterized by a highland climate and categorized as "Dry-winter highland climate" (CwB) for Köppen climate classification. It has three seasons: a) *Belg* (short rainy season from February to May), b) *Kiremt* (main rainy season from June to September) and c) *Bega* (dry season from October to January). The meteorological data in Addis Ababa are as follows: annual precipitation (1,200mm); annual average temperature (18.5ºC); annual maximum temperature (18.5 ºC); annual minimum temperature (12.8 ºC)[1].

[1] Source: Statistics from National Metrology Agency of Ethiopia (2015)

2) Air/ Water Quality

In Addis Ababa City, air pollution is serious due to exhaust gas from vehicles. The level of CO, SO_2, NO_2 satisfies the World Health Organization (WHO) standards, while that of PM2.5 exceed the WHO standard level[2]. The City is located in the basin of Awash river, and the tributary crosses over the project site. Addis Ababa Water and Sewerage Authority operates and maintain two wastewater treatment plants; however, untreated wastewater is directly discharged into the tributary in most of the city areas.

3) Flora and Fauna

Since Addis Ababa City is already developed through the expansion of houses and agricultural lands, no wild animals are identified, except birds and wild pigs etc. The main vegetation is Dry Evergreen Montane forest and grassland. The plants categorized as "VU (Vulnerable)" and "LC (Least Concern)"[3] in International Union for Conservation of Nature (IUCN) Red List were identified around the project site (See Table 6.1-2).

Table 6.1-2 Plants listed in IUCN red list

	Family name	Scientific name	Category in IUCN red list	Notes
1	Apocynaceae	*Nerium oleander*	LC	Introduced ornamental shrub
2	Araucariaceae	*Araucaria heterophylla*	VU	Introduced ornamental tree
3	Arecaceae (Palmae)	*Phoenix canariensis*	LC	Introduced ornamental tree
4	Bignoniaceae	*Jacaranda mimosifolia*	VU	Introduced ornamental tree
5	Poaceae	*Arundo donax*	LC	Indigenous grass
6	Poaceae	*Eleusine floccifolia*	LC	Indigenous grass
7	Poaceae	*Cenchrus purpureus*	LC	Indigenous grass
8	Poaceae	*Pennisetum sphacelatum*	LC	Indigenous grass

Source: JICA Study Team based on "IUCN Red List of Threatened Species. Version 2018-1"

4) Flora and Fauna

Ethiopia has 20 national parks, 2 wildlife sanctuaries, 3 wildlife reserve, 17 controlled hunting areas and 3 community conservation areas, which are under the jurisdiction of Ethiopian Wildlife and Conservation Authority (EWCA) and the corresponding regional authorities; and these areas have been designated as 'protection areas' by local laws and regulations.

[2] Source: Environmental and Social Impact Assessment Report (prepared by JICA Study Team)

As of October, 2018, there are no environmental standards for air and water in Ethiopia.

[3] IUCN Red List is an inventory of species under the risk of extinction. According to the risk level, the categories are determined as follows: Extinct (EX), Extinct in Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) etc.

These 'protection areas' are not located in and around the city of Addis Ababa. In addition, there are no ecological, historical and culturally important habitats designated by the laws, both within and around the project site.

(2) Social Environment

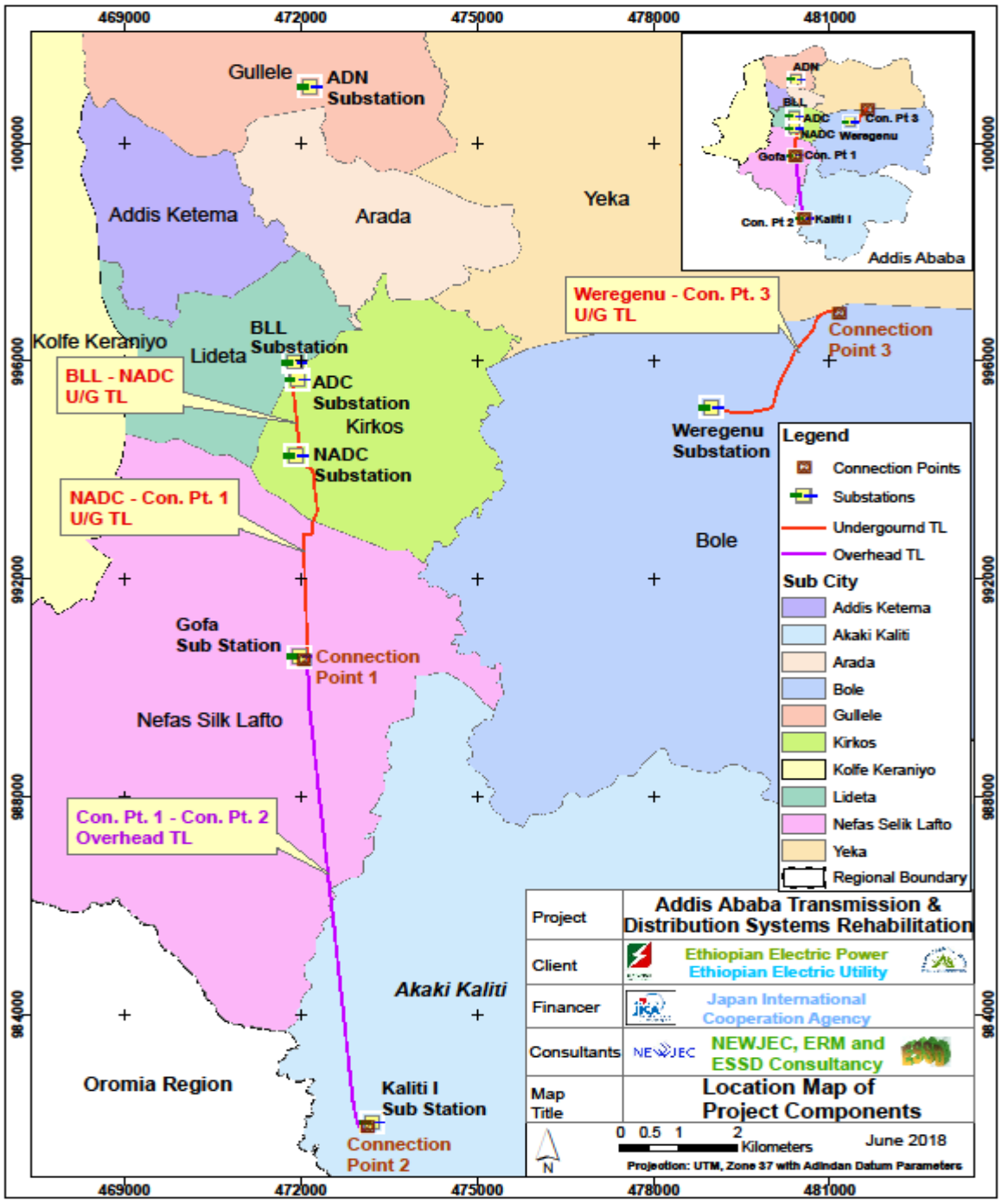
1) Administrative divisions

The Addis Ababa City Administration is structured into 10 sub-cities and 116 Woreda (district) administrations. The Woredas are further subdivided into Sub-woredas and Sefers. Finally, the Sefers are partitioned into 9,009 blocks. The administrative divisions of Addis Ababa are shown in Table 6.1-3 and Fig. 6.1-1.

Table 6.1-3 Administrative divisions of Addis Ababa

No.	Sub City	Woreda	Sub-Woreda	Sefer	Block
1	Akaki Kaliti	11	135	683	1,660
2	Nefas Silk Lafto	12	128	397	1,059
3	Kolfe Keraniyo	15	103	392	1,385
4	Gulele	10	73	200	546
5	Lideta	10	27	75	228
6	Kirkos	11	41	146	474
7	Arada-Sub City	10	31	100	316
8	Addis Ketema	10	28	84	302
9	Yeka	13	124	394	1,344
10	Bole	14	152	532	1,695
Total		**116**	**842**	**3,003**	**9,009**

Source: Addis Ababa City Administration (2015), Addis Ababa Atlas



Source: JICA Study Team

Fig. 6.1-1 Administrative divisions of Addis Ababa (location map)

2) Land use

17.5 % of Addis Ababa City is classified as residential area. Other land uses include green (22.0%), field crop (18.5%) and agriculture (10.0%). The land use in Addis Ababa is shown in Table 6.1-4.

Table 6.1-4 Land use in Addis Ababa (in 2012)

No	Land use	Area (ha)	Percentage (%)
1	Administration	894.85	1.2
2	Commercial	761.38	1.0
3	Cultural and social welfare	120.15	0.2
4	Education	856.61	1.1
5	Agricultural land	21,435.91	28.5
6	Green	16,569.48	22.0
7	Health	198.19	0.3
8	Infrastructure and utilities	38.61	0.1
9	Manufacturing and storage	1,758.57	2.3
10	Mixed residential	880..26	1.2
11	Municipality service	552.65	0.7
12	Open space	4,675.23	6.2
13	Recreation	5,227.65	7.0
14	Religious institutions	558.71	0.7
15	Residential	13,130.73	17.5
16	River	1,186.02	1.6
17	Road network	5,413.52	7.2
18	Special use	369.77	0.5
19	Transport terminal	530.11	0.7
Total		75,158.4	100

Source: Addis Ababa City Authority (2015): Addis Ababa City Atlas

3) Population

The estimated population of Addis Ababa City in total is 3,433,999 as of 2017, of which 1,624,999 is male (i.e. 47.3%), and the rest 1,809,000 (i.e. 52.7%) is female. The city has an annual population growth rate of 2.5%[4]. Table 6.1-5 depicts the population distribution in the sub-city of Addis Ababa.

Table 6.1-5 Population distribution in Sub-city (2017)

Sub-city	Male	Female	Total population	Percentage (%)	Area (km^2)	Population density (person/km^2)
Akaki Kaliti	110,435	116,747	227,182	6.6	126.3	1,798.74
Nefas Silk-Lafto	185,461	211,025	396,486	11.5	63.59	6,235.03
Kolfe-Keraniyo	258,480	279,081	537,561	15.6	65.10	8,257.46
Gulele	161,078	174,356	335,434	9.8	32.73	10,248.52
Lideta	119,843	132,999	252,842	7.4	12.40	20,390.48
Kirkos	128,841	148,505	277,346	8.1	16.26	17,056.95
Arada	123,445	141,696	265,141	7.7	11.56	22,936.07
Addis Ketema	155,478	164,575	320,053	9.3	9.98	32,069.44
Yeka	201,156	233,443	434,599	12.7	82.30	5,280.66
Bole	180,782	206,573	387,355	11.3	120.93	3,203.13
Total	1,624,999	1,809,000	3,433,999	100	541.15	6, 345.74

Source: Central Statistical Agency (2013): Population Projection of Ethiopia for All Regions at Woreda Level from 2014 – 2017; and Parsons Brinckerhoff and Tropics Consulting Engineers (2016)

Kolfe-Keraniyo and Yeka sub-cities contribute more to the total population of the city, whereas Akaki Kaliti and Lideta sub-cities contribute less to the total population. The

[4] This annual population growth rate is based on the results of the latest national census conducted in 2007.

population density of the city is 6,346 people per km^2. The population densities of the sub-cities vary between 3,203 people/km^2 and 32,069 people per km^2. Accordingly, Addis Ketema and Arada sub-cities are densely populated, while Akaki Kaliti and Bole have lower population density.

In the year 2012, the total number of households in Addis Ababa was estimated to be about 827,364 with a total population of 3,295,206. At that time, the average household size was calculated to be four.

4) Poverty

The absolute poverty line in Ethiopia is determined as 3,781 birr/person/year[5], and those under this line are defined as poor. The poverty rate in Addis Ababa is shown in Table 6.1-6.

Table 6.1-6 Poverty rate in Addis Ababa City

	Poverty rate (%)			
	1996	2000	2005	2011
Addis Ababa	30.2%	36.1%	32.5%	28.1%

Source: WB (2015) Ethiopia: Poverty Assessment Report.

5) Worship Places/Religious Sites

There are 682 worship places/ religious sites in Addis Ababa City. The number of worship places/ religious sites by religion is shown in Table 6.1-7.

Table 6.1-7 Number of worship places/ religious sites by religion

	Worship places/ religious sites					
	Protestant Church	Orthodox Christian Church	Protestant Church	Mosque	Others	Total
Addis Ababa	305	179	25	151	22	**682**

Source: Addis Ababa City Authority (2015): Addis Ababa City Atlas, Page 85

[5] 15,178 JPY/person/year (JICA rate as of May, 2018 (1Birr = 4.014390 JPY))

6.1.3 Legal and Institutional Frameworks for Environmental and Social Considerations

(1) Legal Framework for Environmental and Social Considerations in Ethiopia

1) Environmental laws and regulations

As a comprehensive environment policy, the Environmental Policy of Ethiopia was issued in 1997 to provide overall guidance in the conservation and sustainable utilization of the country's environmental resources, in general. The overall objective of the environmental policy is to promote a sustainable social and economic development of the country through, *inter alia*, sustainable management and utilization of the natural resources of the country. In section 4.9, the environment policy stipulates the country's policies regarding Environmental and Social Impact Assessment (hereinafter called "ESIA"). It provides for the enactment of a law, which enforces an appropriate ESIA to be undertaken on private and state development projects; and the development of detailed technical guidelines that direct the undertaking of ESIA in the various sectors. It also stipulates the establishment of institutions responsible for approving ESIA.

Following the provisions of the environment policy, the Ethiopian government introduced the Environmental Impact Assessment Proclamation (Proclamation No.299 of 2002). It gives the regional environmental agencies the responsibility to evaluate the ESIA reports on projects that are licensed, executed or supervised by regional states. In addition, the Environmental Protection Organs Establishment Proclamation (Proclamation No. 295/2002) established institutions, which are responsible for regulating the ESIA; these include the Environmental Protection Authority, Regional Environmental Agencies and the Sectoral Environmental Units.

2) Environmental standards in Ethiopia

No environmental standards have been established in Ethiopia[6].

3) ESIA System in Ethiopia

(a) Projects subject to ESIA

According to the ESIA Procedural Guidelines, projects are categorized into three schedules (there is no provision to specify the requirements regarding project scale):

6 The Guidelines for Ambient Environment Standards for Ethiopia were drafted in 2003, but not approved by Environmental Protection Authority (later upgraded to the Ministry of Environment, Forest & Climate Change) and United Nations Industrial Development Organization.

- Schedule-1: Projects, which may have adverse and significant environmental impact and therefore require a full Environmental Impact Assessment.

- Schedule-2: Projects whose type, scale or other relevant characteristics have potential to cause some significant environmental impact but are not likely to warrant a full ESIA study.

- Schedule-3: Projects which would have no impact and do not require environmental impact assessment

The Schedule of activities that may be required to undergo an ESIA process is detailed in the Environmental Impact Assessment Guideline Document (Table 6.1-8 – 6.1-10). High power transmission line projects are categorized as Schedule-1, because negative impacts during construction and operation phase are predicted such as noise, air pollution, resettlement and land acquisition. Other than high power transmission lines, electricity transmission and distribution lines are categorized as Schedule-2.

This project is categorized as Shedule-1 and 2, and requires implementation of ESIA. The ESIA report of this project was approved on October 30, 2018.

Table 6.1-8 Projects Categorized into Schedule 1

Sector	Requirements
A. Social infrastructure and service	
1. Rural and Urban water supply and sanitation	Construction of dams with a surface area of 100 hectors, Ground water development for industrial, agricultural or urban water supply of greater than 4000 m3 /day, etc.
2. Waste Disposal	Waste disposal installations for the incineration, chemical treatment of toxic, hazardous and dangerous wastes, Land fill site for waste disposal in major urban center
3. Urban Development	Hospital and educational facilities (large scale), Housing development covering an area of 50 hectares or more, Establishment of industrial estates, etc.
B. Economic infrastructure and services	
4. Transport	Major urban roads, Rail infrastructure and railways, etc.
5. Energy	**High power transmission line**, Large bio-mass energy using plants, Thermal power stations and other combustion installations with a heat output of 100 Mega Watts or more
C. Production Sector	
6. Agriculture	Land reclamation (large scale), Agricultural Projects necessitating the resettlement of 100 families or more, Introduction of new breed, species of crops, seeds or animals
7. Irrigation and Drainage	Construction of dams and man-made lakes with surface area of 250 hectares or more, Surface water fed irrigation projects covering more than 100 hectares, etc.
8. Forestry	Conversion of hill forest land to other land use, Logging with special emphasis for endangered tree species, Conversion of mangrove swamps for industry, housing or agricultural use covering an area of more than 10 hectares, etc.

9. Livestock	Large scale livestock production in Urban area, Large scale slaughter house construction, etc.
10. Fisheries	Commercial fisheries, Introduction of exotic species
11. Minerals extraction and processing	Large scale Mining Operation
12. Petroleum	Oil and gas fields development, Construction of oil and gas separation, processing, handling and storage facilities, Construction of off shore pipe lines in excess of 50 km in length, etc.
13. Industry	Petrochemicals, Manufacture of rubber and plastic products (large scale), Manufacture or transport of pesticides or other hazardous and/or toxic materials, etc.

Source: EIA Guidelines

Table 6.1-9 Project Categorized into Schedule 2

Sector	Requirements
A. Social infrastructure and services	
1. Rural and Urban water supply and sanitation	Rural water supply and sanitation, Sewerage system, etc.
2. Waste disposal	Recycling plant (small scale)
3. Urban development	Housing and commercial projects, Cemetery site and establishment of religious institutions
B. Economic Infrastructure and Services	
4. Transport	Upgrading or rehabilitation of major rural roads, Airports with basic runway length less than 2,100m
5. Energy	**Electricity lines,** Hydropower projects having dam height less than 15 meters and reservoirs with a surface area less than 250 hectares, etc.
C. Production sector	
6. Agriculture	Wide spread introduction of fertilizers, Pest control programs (large scale)
7. Irrigation	Surface water fed irrigation projects covering less than 100 hectares, etc.
8. Forestry	Agro forestry (large scale), etc.
9. Livestock	Establishment of animal feed (large scale), Bee keeping projects (large scale), etc.
10. Fisheries	Introduction of new harvesting technology, etc.
11. Minerals extraction and processing	Small scale mining operations
12. Industry	Manufacture, packing and canning of animal, fish and vegetable products, Industries utilizing hazardous materials (small scale), etc.

Source: EIA Guidelines

Table 6.1-10 Projects Categorized into Schedule 3

Sector	Requirements
A. Social infrastructure and services	Educational facilities (small scale), Training, Family planning, etc.
B. Economic Infrastructure and Services	Telecommunication, Research, etc.
C. Production Sector	Surface water fed irrigation projects covering less than 50 hectares, All small scale agricultural activities, Bees keeping projects (small scale), Food aid, Assistance to refugee returned and displaced person, etc.

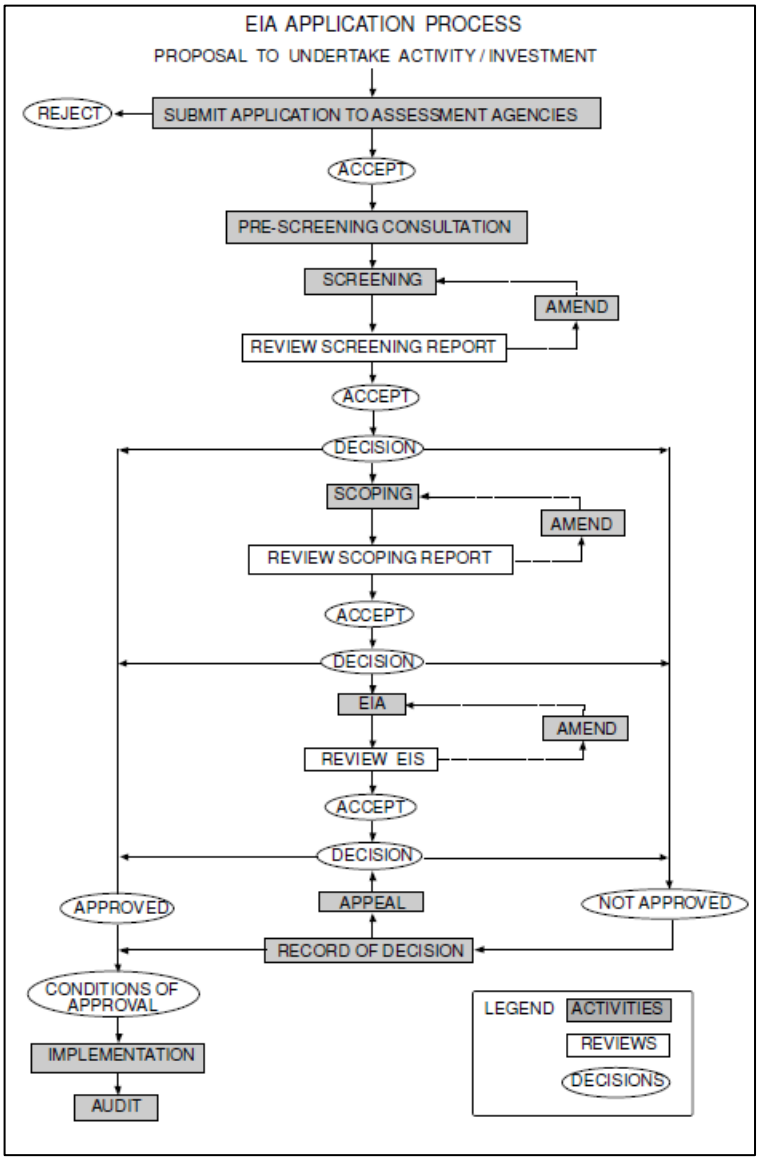
Source: EIA Guidelines

(b) ESIA Procedure

The regulatory process for conducting an environmental impact assessment in Ethiopia is shown in Figure 6.1-2.

Ministry of Environment, Forest & Climate Change (hereinafter called "MEFCC") is the Competent Agency at the federal level in Ethiopia. Therefore, this authority is responsible for the following in the ESIA process:

- Ensure that the proponent complies with the requirements of ESIA process;
- Maintain co-operation and consultation between the different sectoral agencies throughout the ESIA process;
- Maintain a close relationship with the proponent and to provide guidance on the process; and
- Evaluate and take decisions on the documents that arise from the ESIA process.



Source: EIA Guidelines

Fig. 6.1-2 ESIA Procedure

(c) Requirement of ESIA Description

As a minimum, the following descriptions shall be presented in ESIA reports.

- The nature of the project, including the technology and processes to be used and their physical impacts;
- The content and amount of pollutants that will be released during implementation as well as during operation;
- Source and amount of energy required for operation such as electricity;
- Characteristics and duration of all the estimated direct or indirect, positive or negative impacts on living things and the physical environment;
- Measures proposed to eliminate, minimize, or mitigate negative impacts;
- Contingency plan in case of accidents;
- Procedures of internal monitoring and auditing during implementation and operation.
- Environment related standards and limit values

(d) Gap analysis of EIA

The results of gap analysis between the JICA Guidelines for Environmental and Social Considerations (April, 2010) (JICA Guidelines) and the Ethiopian laws/regulations, and the policies to be taken by this project are shown in Table 6.1-11.

Table 6.1-11 Results of gap analysis and policies to be taken by this project

Items	JICA Guidelines	Relevant laws/ regulations in Ethiopia	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 order to predict and manage impacts caused by the project, EIA shall be implemented and shall include the analysis of alternatives and mitigation measures, which shall be taken into consideration in the decision making of the project. It will promote sustainable development. (EIA Proclamation (No.299/2002))	・ 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	・ There is no directive regarding the language to be used in the EIA report. ・ The access to EIA report by residents shall be secured. (EIA Proclamation (No.299/2002) Article 15) ・ EIA report shall be distributed and be available at libraries and schools etc., but there is no directive regarding	・ EIA report will be prepared in the officially used language, or English. ・ EIA report will be available at Addis Ababa City Administration, and it will be also disclosed on the

Items	JICA Guidelines	Relevant laws/ regulations in Ethiopia	Gaps/ Policies to be taken by this project
	must be available at all times for perusal by project stakeholders such as local residents, and copying must be permitted. (JICA guidelines, Appendix 2)	copying of the report. (EIA Guideline Document)	website of EEP.
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)	・It is recommended to collect public opinions through public consultations etc. At the scoping stage, and the results shall be reflected in the scoping report. (EIA Guideline Document) ・At the preparation stage of draft EIA reports, the comments from stakeholders including residents (especially people affected by the project) shall be reflected in the report. (EIA Proclamation (No.299/2002) Article 15)	・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 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)	・In the process of EIA, the impacts caused during construction and operation shall be examined. (EIA Proclamation (No.299/2002) Article 8) ・In EIA reports, the impacts on the following items shall be assessed: flora and fauna, ecosystem, soil, water, air, cultural heritages, socio-economic impacts and health. (EIA Guideline Document) ・There is no description about derivative, secondary and cumulative impacts, as well as the impacts of projects that are indivisible from the project. (EIA Guideline Document)	・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 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	・It is recommended to conduct internal audits and it shall be the responsibility of project proponents, and the results shall be open to the public. (EIA Guideline Document)	・Monitoring results will be open to the public, and will be available to the stakeholders. ・Any person is

Items	JICA Guidelines	Relevant laws/ regulations in Ethiopia	Gaps/ Policies to be taken by this project
	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)	・ Any person is allowed to submit his/her grievances. Project proponents shall disclose the response to the grievances within 30 days after the receipt. (EIA Proclamation (No.299/2002) Article 17)	allowed to submit his/her grievances. Project proponents shall disclose the response to the grievances within 30 days after the receipt.

Source: JICA Study Team

4) Legislation related to the resettlement and land acquisition

The Constitution of Ethiopia stipulates that the right to ownership of rural and urban land is exclusively vested in the State and in the peoples of Ethiopia, and the land is a common property of the Nation. It also describes that the land shall not be subject to sale or other means of exchange.

Regulations No. 135/2007 came into effect in July 2007 and they deal with payment of compensation for property situated on landholdings expropriated for public purposes. Since the land is considered as a common property of the Nation, compensation is paid for land use right (crops etc.)[7]. These Regulations were issued by the Council of Ministers pursuant to Article 14(1) of the Proclamation No. 455/2005 with an objective of not only paying compensation, but also to assist displaced persons to restore their livelihood. The Regulations contain provisions on assessment of compensation for various property types (including buildings, fences, crops, trees) and the formula for calculating the amount of compensation. In addition, it has provisions for replacement of displacement compensation for land used for crops or grazing, and provisional expropriation of rural land. According to this Regulation and other relevant government laws, EEP or the Addis Ababa City Administration has the responsibility to pay compensation or provide replacement land, house etc.

Pursuant to Article 14(2) of /2005, the Addis Ababa City Council issued an amended directive (No.19/2014) on compensation of assets and replacement of land for expropriation of landholdings for public purposes. The amended directive was issued in April 2014 and is divided into 6 sections and 36 articles, as well as, 7 attachments. The directive mainly

[7] The procedure to obtain land use right is as follows: a) Sub-city Land Administration and Urban Renewal Office and Woreda Administration conduct survey. 2) Sub-city Land Administration and Urban Renewal Office issues land use certificates to the applicants. Land use right holders are obliged to pay annual land use tax.

focuses on the legal rights of landholdings and compensation payment for various properties lost from the expropriated land, and valuation of assets.

Resettlement Action Plan (hereinafter called "RAP") and Abbreviated Resettlement Action Plan ((hereinafter called "ARAP") are not stipulated in the Ethiopian regulations. However, when projects cause resettlement and loss of livelihood, project proponents need to submit RAP or ARAP and obtain approvals from the relevant local authorities, which is the requirement for project implementation. Since this project does not incur a large scale of resettlement, ARAP was developed and approved on October 30, 2018.

Table 6.1-12 Laws and regulations related to Environmental and Social Considerations

No.	Title	Enacted year	Summary
Environmental aspects			
1	Environmental Policy of Ethiopia	1995	The overall policy goal is to improve and enhance the health and quality of life of all Ethiopians, to promote sustainable social and economic development through sound management and use of natural, human and cultural resources and their environment as a whole, so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.
2	Environmental Impact Assessment Guideline Document	2000	It stipulates the ESIA procedure. It is necessary to categories projects as: require full ESIA, not full ESIA or no ESIA required.
3	Environmental Impact Assessment Proclamation (No.299/2002)	2002	Primary aim of this Proclamation is to make ESIA mandatory for specified categories of activities, undertaken either by the public or private sectors, and possibly, the extension of ESIA to policies, plans and programs, in addition to, projects.
4	Environmental Pollution Control Proclamation (No.300/2002)	2002	The primary objective of this law is to provide the basis from which the relevant ambient environmental standards applicable to Ethiopia can be developed, and to make the violation of these standards a punishable act.
5	Environmental Protection Organs Establishment Proclamation (No.295/2002)	2002	The objective of this Proclamation is to formally lay down the institutional arrangements necessary to ensure environmentally sustainable development or ensure sustainable use of environmental resources, both at Federal and at Regional level.
Social aspects			
1	Electricity Operations Council of Ministers Regulations (No49/1999)	1999	This regulation stipulates the requirement of distance between electrical lines and structures/crops etc. It is the superior regulation of the "Directive on overhead electric lines and quality of supply (No.EEA/1/2005)"
2	Directive on overhead electric lines and quality of supply (No.EEA/1/2005)	2005	The objective of this directive is to set standards for the clearance of spaces associated with transmission and distribution lines for the purpose of the protection of persons from risk and property from damage, as well as to specify the quality of supply voltage.
3	Trade Registration and Business Licensing Proclamation (No.67/1997)	1997	The proclamation subjects the undertaking of commercial activities in the country and the required business license.
4	Investment Proclamation (No.375/2003) Investment Regulation (No. 84/2003)	2003	At present, these regulate the investment activities in the country.

Source: JICA Study Team

Table 6.1-13 Legislation related to the resettlement and land acquisition

No.	Title	Enacted year	Summary
1	Ethiopian Constitution	1994	It provides the overriding principles and legal provisions for all legislative frameworks in the country. The constitution provides for the right of investors to obtain land for investment purpose on lease in accordance to the conditions specified by subsidiary laws (Art. 40).
2	Rural Land Administration and Use Proclamation(No.455/2005)	2005	It stipulates the detail procedure such as expropriation process and compensation standard.
3	Rural Land Administration and land Use Proclamation (No.456/2005)	2005	It stipulates rural land management (including expropriation).
4	Regulations on Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes (No. 135/2007)	2007	It provides detail standard such as compensation standard for the each expropriating asset for public purposes.
5	Addis Ababa City Administration Directive on Compensation of Assets and Replacement of Land for Expropriation of Landholdings for Public Purposes (No.19/2014)	2014	It stipulates how to calculate the amount of compensation, caused by land expropriation in Addis Ababa City.

Source: JICA Study Team

(2) Institutional Framework for Environmental and Social Considerations in Ethiopia

1) EEP

EEP has an Environment, Health, Safety & Quality Department, which has 21 staff members as of 2018. The department consists of three sections: 1) Environmental monitoring & control, 2) Quality assurance and 3) Health & safety. This department is in charge of preparation, review and monitoring of ESIA and RAP (including the development of ToR) for transmission line projects, as well as, power generation projects.

2) EEU

EEU has an Investment, Environment & Social Department, which has 7 staff members as of 2018. The department is responsible for preparing, reviewing and monitoring ESIA and RAP (including the development of ToR) for distribution line projects. This department also has jurisdiction over the preparation of investment planning related to electrical distribution network and conducts environmental and social examinations of investment plans.

3) Ministry of Environment, Forest & Climate Change

The ministry in charge of environment in Ethiopia is MEFCC. It was established in 2015, and is in charge of conserving natural resources and setting up environmental standards etc. The role to review and approve ESIA in several specific sectors has been delegated to the relevant ministries of each sector.

4) Ministry of Water, Irrigation and Electricity

MEFCC delegated the roles of reviewing and approving ESIA in water and energy sectors to the Ministry of Water, Irrigation and Electricity (hereinafter called "MOWIE"). Hence, MOWIE has an Environmental and Climate Directorate, which in charge of (a) Review and approval of ESIA reports and RAP, (b) Monitoring of environmental management plan and RAP (reporting to MEFCC as necessary), (c) Measures for climate change and green economy. Since this project falls into power transmission and distribution lines, EEP and EEU shall submit an ESIA report and RAP to MOWIE, and then MOWIE shall issue an environmental permit.

6.1.4 Comparison of the Alternatives

The analysis of the alternatives is shown in Table 6.1-14. The alternatives were comprehensively examined from the viewpoints of city planning, environment, social and project cost.

With no-project alternative (Zero-option), resettlement and land acquisition can be avoided. However, the power transmission and distribution facilities will not be improved to meet the increasing demand for power in the capital city of Addis Ababa, and a stable power supply cannot be expected. The situation of unstable power supply will hinder economic development and improvement of living standards of people.

Table 6.1-14 Comparison of the alternatives (132 kV transmission lines from New Addis Center to Kaliti I Substation)

Item	Alternative 1	Alternative 2	Alternative 3	Zero option
Outline	Overhead transmission line (8.7km) and Underground transmission line (4.2km) are combined: underground transmission line between New Addis Center and the connection point at Gofa substation, plus overhead transmission line between the connection point at Gofa substation and Kaliti I substation	Overhead transmission line (11km) is applied for all sections between New Addis Center and Kaliti I substation	Underground transmission line (13km) is applied for all sections between New Addis Center and Kaliti I substation	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 city planning.	According to the Addis Ababa City Planning, it is not allowed to newly construct overhead transmission lines in the center of Addis Ababa City.	Alternative 3 is consistent with the city planning.	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 (8.7km) 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 (11km) will be cut down.	Temporary impact on the surrounding environment is expected during the construction such as noise and vibration. On the other hand, no impact is expected during the operation.	No negative impacts are expected.
Impact on social environment	No involuntary resettlement and land acquisition is expected because the construction is done within the existing ROW. Impact on traffic is predicted during the construction. In the operation stage, the landscape is maintained in the city area by applying underground cable.	No involuntary resettlement and land acquisition is expected because the construction is done within the existing ROW. In case some residents live within the site of the existing tower base, then resettlement is required. Since the overhead line passes the densely populated areas, some illegal residents will be temporarily affected. Impact on traffic is also predicted during the construction.	No involuntary resettlement and land acquisition is expected because the construction is done within the existing ROW. Impact on traffic is predicted during the construction. In the operation stage, the landscape is maintained by applying underground cable.	No negative impacts are expected.
Project cost	The project cost is lower than Alternative 3, because the distance of underground transmission line is shorter.	Compared with Alternative 1, the project cost is relatively low, because Alternative 2 does not include the construction of underground cable.	Compared with Alternative 1 and 2, the project cost is very high, because the construction of underground transmission line is much more expensive than that of overhead transmission line.	No project cost
Benefits	◎	◎	◎	×
City planning	◎	×	◎	×
Natural environment	○	△	◎	◎
Social environment	◎	×	◎	◎

Item	Alternative 1	Alternative 2	Alternative 3	Zero option
Project cost	○	◎	×	◎
Evaluation	◎ (Alternative 1 is recommended from the viewpoints of environmental impacts and project cost.)	× (Alternative 2 is NOT recommended from the viewpoints of city planning and social impacts.)	× (Alternative 3 is NOT recommended from the viewpoint of project cost.)	× (Zero option is NOT recommended from the viewpoints of benefits to the local communities)

Source: JICA Study Team

6.1.5 Scoping

The scoping was conducted as shown in Table 6.1-15, in consideration of the impacts caused by this project.

Table 6.1-15 Scoping

	No.	Item	Planning Construction	Operation	Expected Impacts
Social Environment	1	Involuntary Resettlement	B-	D	Planning/Construction Phase: No involuntary resettlement is expected, because the construction work is done within the existing sites and ROW. Operation Phase: No impact is expected.
	2	Poverty	B-	D	Planning/Construction Phase: There may be poor people among the Project Affected Persons (PAPs) for resettlement. Operation Phase: No impact is expected.
	3	Indigenous/Minorities	D	D	There are no indigenous people or minorities within the project sites.
	4	Economic activities, living and livelihood	B+/-	A+	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: Positive impacts on socio-economic aspects of residences and industries due to the stable power supply are expected.
	5	Land Use and Utilization of local resources	D	D	No land acquisition is expected, because the construction work is done within the existing sites and ROW. Therefore, there will be no significant adverse impacts on land use and utilization of local resources.
	6	Water Use and Water Right	D	D	A river crosses the route of overhead transmission lines. However, since the project does not utilize river water, no impact on water use and water right is predicted,
	7	Existing social infrastructure and services	B-	A+	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: Positive impacts are expected due to the stable power supply.
	8	Social institutions such as social infrastructure and local decision-making institutions	D	D	No impacts are predicted as the project requires limited area. 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	D	D	The project will contribute to the improvement of public service in power sector; hence will not cause any misdistribution
	10	Local conflicts of interest	D	D	The project will contribute to the improvement of public service in power sector; hence will not cause any conflict

	No.	Item	Planning Construction	Operation	Expected Impacts
	11	Heritage	B	D	There are five churches around the project site, which might be affected by the construction work. Apart from these churches, there are no heritage or culturally important sites near the project sites.
	12	Landscape	D	D	There are no naturally or culturally important landscapes near the project sites.
	13	Gender	D	D	No adverse impact on gender issues is expected by the project.
	14	Children's right	D	D	Child labor is not predicted for electrical line projects in Ethiopia. Since the purpose of the project is to secure stable electricity supply, no adverse impact on children's right is expected by the project.
	15	Infectious Disease (HIV/AIDS, etc.)	D	D	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).
	16	Occupational health hazards	B-	D	Construction Phase: It is necessary to protect workers from the hazards and risk of accidents.
Natural Environment	17	Protected Areas	D	D	No protected areas are present near the project sites
	18	Ecosystem	B-	B-	The project sites are within a built-up area of Addis Ababa city and there is no important fauna and flora which will be affected by the project. However, some trees along the electrical lines may be removed, which can cause some impact on ecosystem. There is a possibility of bird strike against overhead transmission lines during the operation.
	19	Hydrology	D	D	There are no major rivers or streams near the project sites.
	20	Geological Features	B-	D	Construction Phase: Levelling of the land at a newly constructed substation as well as the tower base, so some impact may be caused such as soil erosion.
Pollution Control	21	Air Pollution	B-	D	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.
	22	Water Pollution	D	D	No activity that may cause water pollution is expected. No water bodies are present near the project sites.
	23	Soil Pollution	B-	B-	Construction/Operation Phase. Insulating oil will be used for transformers. It may cause soil pollution if leaked.
	24	Waste	B-	D	Although the leveling is planned, waste soil will not be generated. Dismantling of existing towers may generate waste materials.

	No.	Item	Planning Construction	Operation	Expected Impacts
	25	Noise/Vibration	B-	B-	Construction Phase: Temporary impacts are expected due to the operation of heavy machineries. Operation Phase: Transformers at the substation may cause noise. However, these will be located away from the boundaries of the site. There are no sensitive receptors such as residential area, hospitals or schools nearby. Strong wind might cause some noise.
	26	Ground subsidence	D	D	No impact is expected.
	27	Odor	D	D	No impact is expected.
	28	Bottom sediment	D	D	There is no river or swamp near the project site, hence no impact is expected.
	29	Electromagnetic field	D	C	Operation Phase: There may be some impact on the residents living nearby.
Others	30	Accidents	B-	B-	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	D	D	The project will not cover a large area; hence global warming or impacts across the boarders are not expected.

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)

Source: JICA Study Team

6.1.6 TOR for Environmental and Social Considerations Study

Based on the above scoping results, the TOR for EIA study was determined as shown in Table 6.1-16.

Table 6.1-16 TOR for Environmental and Social Considerations Study

No.	Item	Evaluation	Study Item	Methods
2	Poverty	Planning Phase B- Construction Phase B-	• Confirming the magnitude of impacts caused by the project	• Socio-economic study by local consultant
4	Economic activities, living and livelihood	Planning Phase B- Construction Phase B-	• Confirming the magnitude of impacts caused 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
7	Existing social infrastructure and services	Construction Phase B-	• Social infrastructures nearby	• Site visit • Interview with EEP, EEU and other stakeholders

No.	Item	Evaluation	Study Item	Methods
11	Heritage	Construction Phase B-	• Distribution of churches around the project site	• Site visit • Interview with EEP, EEU and other stakeholders
16	Occupational health hazards	Construction Phase B-	• Labor Safety measures	• Review of existing documents and data (relevant labor regulations, EEP health and safety policy, etc.)
18	Ecosystem	Planning Phase B- Operation Phase B-	• 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	Construction Phase B-	• 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	Construction Phase B-	• Operation of heavy machineries	• Review of existing documents and data (relevant labor regulations, EEP health and safety policy, etc.)
23	Soil Pollution	Construction Phase B- Operation Phase B-	• Setting of transformer and insulating oil pipe	• Review of existing documents and data (EEP health and safety policy, examples from other substations, etc.)
24	Waste	Construction Phase B-	• Disposal of wastes generated from the dismantling of the existing towers and lines	• Review of existing documents and data (EEP health and safety policy, examples from other substations, etc.)
25	Noise/ Vibration	Construction Phase B- Operation Phase B-	• Noise level • Situation of the project site	• Review of existing documents and data • Construction methods and design of electrical lines and a substation
29	Electric magnetic fields	Operation Phase B-	• Distance between the power line and buildings	• Review of existing documents and data (report from international organization, etc.) • Site visit
30	Accident	Construction Phase B- Operation Phase B-	• Situation of the project site • Accident prevention measure during construction phase	• Review of existing documents and data (contract manual for construction, etc.) • Interview with EEP, EEU and other stakeholders

Source: JICA Study Team

6.1.7 Results of Environmental and Social Consideration Study

The results of the Study based on the above TOR are summarized in Table 6.1-17.

Table 6.1-17 Results of Environmental and Social Consideration Study

No.	Item	Results
2	Poverty	• According to the socio-economic survey, it was confirmed that there are no households below the Ethiopian poverty line (3,781Birr/person/year) (according to the results of the socio-economic survey, the average income of PAPs was approximately 9,500 Birr/person/year). Hence, no impact on poor people is expected.
4	Economic activities, living and livelihood	• Planning/Construction Phase: Some temporary impacts on living and livelihood are expected due to the loss of crops (total area: 1,988 m^2). Based on the ARAP, the compensation will be paid. • 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. • Operation Phase: Positive impacts on socio economic aspects of residences and industries are expected, due to the stable power supply.
7	Existing social infrastructure and services	• Planning/Construction Phase: 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	• Five churches were found along the planned transmission lines. However, the distance between the routes and the churches are sufficiently secured, and no negative impact 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	• Planning Phase: Some trees along the electrical lines will be removed: trees along the underground transmission lines will be removed by the roots. • Planning/ Operation Phase: Trees close to the overhead transmission and distribution lines will be pruned. • An apple tree will be cut down and compensated. Some negative impacts on road-side trees (487 trees and shrubs) in the median of underground transmission lines are predicted. Among these trees, two tree species categorized as VU of IUCN Red List are included (*Araucaria heterophylla* (92 trees) and *Jacaranda mimosifolia* (3 trees)). • Birds were observed around the project site. However, since the electrical routes of this project follow the existing overhead transmission lines, no impacts on birds are expected. The existing overhead transmission lines will be replaced by underground transmission lines (from Black Lion Substation to Addis Center Substation and Gofa Substation), which will mitigate the impact on bird such as bird strike.
20	Geological Features	• Planning Phase: 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	• Planning/Construction Phase: Due to the land leveling work and the operation of heavy machineries during the construction works, temporary impacts on air pollution are expected. However, these impacts may be mitigated largely by general measures that are required to be carried out by the contractor.
23	Soil Pollution	• Planning/Construction/Operation Phase. Insulating oil will be used for transformers. It may cause soil pollution if it is leaked.
24	Waste	• Construction work includes removal of existing towers and construction of tower base. 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. • Dismantling of existing towers will generate wasted materials, which will be treated and disposed by licensed companies (the license will be issued by Addis Ababa Land Development & Urban Renewal Agency).

No.	Item	Results
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	• Construction Phase: General accidents related to construction activities such as erection of towers and rewiring of power line may happen. • Operation Phase: 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

6.1.8 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 6.1-18.

Table 6.1-18 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	D	D	N/A	N/A	
	2	Poverty	B-	D	D	N/A	No impact due to the absence of the poor among PAPs.
	3	Indigenous/Minorities	D	D	N/A	N/A	
	4	Economic activities, living and livelihood	B+/-	A+	B+/-	A+	The Impacts are limited to planning and construction phase only and their scope is also limited.
	5	Land Use and Utilization of local resources	D	D	N/A	N/A	
	6	Water Use and Water Right	D	D	N/A	N/A	
	7	Existing social infrastructure and services	B-	A+	B-	A+	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	8	Social institutions such as social infrastructure and local decision-making institutions	D	D	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	
	9	Misdistribution of benefits & damages	D	D	N/A	N/A	
	10	Local conflicts of interest	D	D	N/A	N/A	
	11	Heritage	B-	D	D	N/A	No impact on churches because enough distance is secured between the churches and the electrical line routes.
	12	Landscape	D	D	N/A	N/A	
	13	Gender	D	D	N/A	N/A	
	14	Children's right	D	D	N/A	N/A	
	15	Infectious Disease (HIV/AIDS, etc.)	D	D	N/A	N/A	
	16	Occupational health hazards	B-	D	B-	N/A	The impact is only during construction phase and can be mitigated with general measures.
Natural Environment	17	Protected Areas	D	D	N/A	N/A	
	18	Ecosystem	B-	B-	B-	D	The impact on trees is predicted. However, these are artificially planted road-side trees. Hence, the impact will be mitigated by setting the routes avoiding the median and if unavoidable, by replanting trees in another location.
	19	Hydrology	D	D	N/A	N/A	
	20	Geological Features	B-	D	D	D	Leveling will not cause any impact.
Pollution Control	21	Air Pollution	B-	D	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	22	Water Pollution	D	D	N/A	N/A	
	23	Soil Pollution	B-	B-	B-	B-	Impact is expected during construction and operation phase, however it is limited only to the inside of the substation and can be mitigated by general measures.

	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	
	24	Waste	B-	D	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	25	Noise/Vibration	B-	B-	B-	D	The impact is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	26	Ground subsidence	D	D	N/A	N/A	
	27	Odor	D	D	N/A	N/A	
	28	Bottom sediment	D	D	N/A	N/A	
	29	Electromagnetic field	D	C	N/A	D	No significant impact is expected because enough distance is secured between the electrical lines and houses.
Others	30	Accidents	B-	B-	B-	B-	Impacts such as electrocution and fire is limited during construction phase. It is temporary and locally limited and can be mitigated by general measures.
	31	Global warming	D	D	N/A	N/A	

(*1) For the items evaluated as “D” at Scoping, “N/A” was applied in the Impact Evaluation.

Source: JICA Study Team

6.1.9 Mitigation Measures

Mitigation measures towards the items with adverse impacts are summarized in Table 6.1-19.

Table 6.1-19 Mitigation Measures

No.	Item	Impact	Mitigation Measures	Implementation/Responsible Body	Cost (ETB)
	Construction Phase				
4	Economic activities, living and livelihood	Loss of crops due to the construction work	• In accordance with JICA guidelines and WB OP4.12, an ARAP was prepared based on the consensus with project affected people, compensation at full replacement cost and support will be provided. • PAPs will have priority for the project related employment opportunities.	EEP	871,059.97
7	Existing social infrastructure and services	Impacts on traffic during construction works Power Cut during construction works	• By announcing construction plans to nearby residents and collaborating with local police, enforcement of traffic safety and mitigation of traffic congestion[§§] • Preparation of power cut plan and sharing the plan with affected communities	EEP/EEU	Included in construction costs
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. • Construction site (especially the storage site) will be fenced, lighted and guarded by security guards to prevent intruders and theft.	EEP/EEU/ Contractor	Included in construction costs
18	Ecosystem	Cutting trees along the electrical lines	• The routes of transmission lines are designed to minimize tree cutting. Replanting trees as necessary.	EEP/EEU	2,968,625.00
21	Air Pollution	Air pollution by heavy machineries during leveling and construction works	• Conducting inspection of vehicles • Sprinkling water at the site to avoid dust • Controlling vehicle speed in unpaved roads • Installing the cover of trucks transporting soils or construction debris from the site	Contractor	N/A
23	Soil 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

[§§] A construction plan and a power cut plan will be shared with the relevant Sub-city/ Woreda with official letters from EEP/EEU. Then, prior to the commencement of construction work, these plans will be disseminated among the public through community meetings etc. The construction plan will be submitted to the local police, and any meetings will be organized as necessary, to discuss mitigation measures for traffic congestion and safety.

No.	Item	Impact	Mitigation Measures	Implementation/Responsible Body	Cost (ETB)
24	Waste	Dismantling of the existing towers, Waste during construction	• Reusing any materials saved from dismantling the existing towers and unusable materials will be properly handled over to licensed waste management companies (the license will be issued by Addis Ababa Land Development & Urban Renewal Agency). • Regular disposal of solid waste to a damp site or have a contract with a licensed waste disposal company.	Contractor	Included in construction costs
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	• Same as for occupational health hazards • When wiring or removing power lines, fall prevention net will be used.	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.	EEP/EEU	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. • EEP/EEU will check house wiring carefully. • Ground wires with enough capacity will be set.	EEP/EEU	N/A

Source: JICA Study Team

6.1.10 Environmental Monitoring Plan

Monitoring plan for each item is described in Table 6.1-20.

Table 6.1-20 Monitoring Plan

No.	Monitoring items	Monitoring methods	Monitoring location	Frequency	Implementation body	Responsible body	Cost (ETB)
	Construction Phase						
4	Economic activities, living and livelihood (Loss of crops)	Checking compensation records, Conducting interview with PAPs	Project affected communities	Once every 2 months	EEP	EEP	85,000
7	Existing social infrastructure and services (Road to be affected by the project)	Visual observation, Conducting interview with contractors and relevant governmental agencies	Construction site, roads around the project site	Once a month	EEP EEU	EEP EEU	90,000
13	Gender (Employment of women, installation of toilets for women)	Visual observation, Checking employment records, Conducting interview with experts and female workers	Construction site	Quarterly	EEP EEU	EEP EEU	25,000
16	Occupational health hazards (Training and provision of protective gears etc.)	Visual observation, Checking employment records, Conducting interview with contractors and workers	Construction site	Daily	EEP EEU	EEP EEU	70,000
18	Ecosystem (Trees to be affected by the project)	Checking number of cut down trees, Confirming the status of planting and growing conditions, Conducting interview with contractors and relevant governmental agencies	Transmission line routes	Daily	EEP EEU	EEP EEU	60,000
21	Air Pollution (Dust etc.)	Conducting interview with surrounding communities, Record of grievance, Checking contractors' monthly reports (results of vehicle inspection)	Project affected communities, construction site	Once every 2 months (Interview), Monthly (Records of grievance, monthly reports)	Contractor EEP EEU	EEP, EEU	50,000
23	Soil 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	EEP EEU	EEP, EEU	40,000
24	Waste (Type and amount of waste)	Checking record of waste type, amount (quantity and volume) and disposal conditions, Visual observation	Construction site	Once every 2 weeks or once a month	Contractor	Contractor, EEP, EEU	50,000

No.	Monitoring items	Monitoring methods	Monitoring location	Frequency	Implementation body	Responsible body	Cost (ETB)
25	Noise/ Vibration	Measurement of noise level	Construction site, access roads, sensitive receptors such as schools	Daily (at the construction sites and along the access roads), Once a week (around sensitive receptors, if any)	EEP EEU	EEP, EEU	150,000
30	Accidents (Safety management provision of safety gears, training, traffic conditions)	Visual observation, Conducting interview with contractors, workers and surrounding communities etc.	Construction site, project affected communities	Once a week	EEP EEU	EEP, EEU	110,000
	Operation Phase						
23	Soil pollution	Visual observation (confirming leakage of insulating oil from transformers as well as the amount of the insulating oil), Photographic records	Project site	Once a year	EEP EEU	EEP, EEU	-
30	Accidents (Contact with electrical lines, cutting trees etc.)	Visual observation, Interview with facility managers	Project site	Quarterly	EEP EEU	EEP, EEU	-

Source: JICA Study Team

6.1.11 Stakeholder Meetings

Stakeholder meetings with the officials of affected sub-cities and Woredas were held from April 10 to 12, 2018 as shown in Table 6.1-21. In the meetings the overview of the project, expected impacts and mitigation measures were discussed. Also consultations with representatives of communities which could be potentially affected were conducted at four different villages in three Woredas. These four villages were selected for the consultation because they contain a large number of structures and households which could be potentially affected. Potential impacts, concerns from participants and mitigation measures of the project discussed in stakeholder meetings are described in Table 6.1-22.

Table 6.1-21 Outline of stakeholder meetings

Affected area	Dates	Venue	Participants
Akaki Kaliti Sub-city and affected Woredas (Woreda 4 &Woreda 7)	April 10, 2018 from 9:00 to 10:40 am	Sub-city administration office	Head of the Sub-city Chief Executive Office, the Land Devt & Urban Renewal Office and the Plan Commission Office, Chief Executive of Woreda 4 and Representative of the Chief Executive of Woreda 7
Nifas Silk Lafto Sub-city	April 10, 2018 from 2:30 to 4:20 pm	Sub-city administration office	Head of the Sub-city Chief Executive Office, Land Devt & Urban Renewal Office, Beatification and Parks Adm. Office, Sanitation Office, and Community Participation Office
Affected Woredas of Nifas Silk Lafto Sub-city (Woreda 6, 11 & 12)	April 11 and 12, 2018	Respective administration office of the Woredas	Chief & Deputy Chief Executive of the Woredas Administration, Head/Experts of Building License & Control Offices, Environmental Protection Offices, and Community Participation Offices
Project Affected Communities (Salo Mebrat Hail & Wello Sefer villages (Woreda4)、Cheri village (Woreda7) Mender 2 (Ketena 2) (Woreda11))	April 9 to 13, 2018	Affected Communities	Representatives of communities which could be potentially affected, PAPs

Source: JICA Study Team

Table 6.1-22 Details of Discussion during Stakeholder Meetings

Locations	Impacts and worries raised by participants	Proposed mitigation measures etc.
Akaki Kaliti Sub-city and Affected Woredas	・Safety risks and health impacts on local people both during construction and operation phases ・Potential displacement of people due to demolishment of housing units from ROW of the transmission line – there are many houses, most of which are of low standard and illegally constructed. (*1) ・The existing laws and regulations on compensation and land replacement matters apply only for people who have legal entitlement of landholding and properties. Therefore, as the majority of the potential PAP do not have land or property certificate, the local government and the project would face a major problem in relocating the people and keeping the ROW free of settlements, unless some special considerations were undertaken.	・Implementing compensation, land replacement and/or restoration measures for the PAP who are eligible for compensation as per the relevant government laws and regulations. ・Provision of special consideration and support for the PAP who have no legal rights of land ownership and properties located within the ROW. For the poor households, elders and female headed households who don't have the capacity to arrange alternative residential houses or means of living, the officials suggested that the city government/ the sub-city and Woreda authorities to arrange resettlement sites or construct replacement houses, and the EEP to provide financial support for this.
Nifas Silk Lafto Sub-city	・Potential displacement of the people living or making their livelihood within the ROW of the transmission line. (*1) ・Damages to internal roads due to operation of heavy equipment and vehicles during construction of the transmission line, and this situation may affect the economic and social activities of the road users. ・Potential health impacts on people residing or working along the transmission line resulting from exposure to electromagnetic fields.	・EEP to contact and discuss with the relevant authorities, as soon as possible, to avoid conflicts between road construction and the transmission line due to the overlap of ROW. ・Considering configuration of towers to occupy much less space than the normal tower. ・Conducting a detail survey of the PAP and the properties located within the ROW of the transmission lines to have complete data on the number of PAP and properties affected as well as the status of entitlement.

Locations	Impacts and worries raised by participants	Proposed mitigation measures etc.
	・Disruption of social and economic interactions of the PAP if they were relocated to places far from the current location or community.	
Affected Woredas of Nifas Silk Lafto sub-city	・Potential displacement of the people residing within the ROW of the transmission line. (*1) ・Several of the people who have houses or other structures within the ROW have legal documents of entitlement (34%). In addition, there are many people who have built structures before 2004/2005 and currently the city government is providing legal certificate of landholding for these (51%). Therefore, the majority of the households who have houses or other structures within the ROW might have legal rights for compensation and land replacement. ・Excavation works for construction of the transmission line, particularly for the installation of the underground cables, may cause damages to water supply lines and interruption of water supply.	・The project proponent shall take precautions to protect people and properties from traffic and other accidents during the project construction phase. ・The need to take precautions to minimize damage of underground structures such as water supply pipelines, telephone lines and sewerage/drainage lines, and disruption of traffic flows during construction of underground transmission line.
Project Affected Communities	・We do not oppose the project since it is a development project. However, if the project brings us displacement problem, it will affect our life. Therefore, we request and express our need for the government to consider our problems and support us to continue our life. ・Loss of employment, income generation activities or other sources of livelihood. ・Inadequate compensation payments for eligible properties and land. Inadequate Land replacement for the PAP to restore the affected houses or other assets. ・The relocated people may not be able to restore their livelihood or the current living standard if infrastructure (like road, water supply, market) and social services (schools, health) development in the new settlement area is poor or inadequate.	・The city/sub-city government to provide replacement land for the displaced people in areas where adequate infrastructure is already in place. They also will be provided with a land holding certificate even for the people who don't have certificate for their current holdings. ・Provision of additional support for the affected vulnerable groups to help them to reconstruct replacement houses and to restore their livelihood. ・Finally the participants of the meetings expressed that they would fully support the proposed project as far as they would be provided with adequate compensation for what they would loss and are supported in restoration of their means of living.

(*1) During the above stakeholder meetings, there were some concerns on houses settled under the existing transmission lines. According to the discussion with EEP etc., it was determined that those under transmission lines would not be required to be resettled in line with local laws and regulations. In the coming stakeholder meetings, the resettlement policy was explained and agreed with stakeholders.

Source: JICA Study Team

6.2 LAND ACQUISITION/ RESETTLEMENT

6.2.1 Necessity of Land Acquisition and Resettlement

The necessity of land acquisition and resettlement was examined during the visit to Ethiopia. A detail study was conducted by an environmental sub-contractor, and ARAP was developed. In the course of this study, the scope of land acquisition and resettlement, compensation and assistance policy, grievance mechanism and cost were analyzed.

Table 6.2-1 Necessity of land acquisition and resettlement

	Items	Land acquisition	Resettlement
1	Addis Center Substation	Change of land use registration has been completed.	Two households are located within the site; however, the compensation task has been completed. (See Table 6.2-2)
2	Kaliti I Substation	Land acquisition and resettlement is not expected, because all the work is done within the site of the existing substation.	
3	Black Lion Substation	Land acquisition and resettlement is not expected, because all the work is done within the site of the existing substation.	
4	Addis North Substation	Land acquisition and resettlement is not expected, because all the work is done within the site of the existing substation.	
5	Weregenu Substation	The expansion of the existing substation site is required; however, the land acquisition has been completed by EEP.	No houses are found in the site.
6	Gofa Substation	Land acquisition and resettlement is not expected, because all the work is done within the site of the existing substation.	
7	Construction of 132kV transmission line (Addis Center Substation – Kaliti I Substation/Gofa Substation)	Underground transmission line: No land acquisition is expected at this moment. Overhead transmission line: No land acquisition is expected, because the towers are constructed within the ROW of the existing transmission line.	Underground transmission line: No resettlement is expected at his moment. Overhead transmission line: Resettlement will be required for at least 3 areas (For example, there are several houses around the transmission tower No.24, 25 and 26; one clinic was found near the tower No. 31. Detail study will be conducted by an environmental sub-contractor.)
8	Construction of 132kV transmission line (Addis Center Substation – Black Lion Substation)	No land acquisition and resettlement is expected at this moment.	
9	Construction of 132kV transmission line (Weregenu Substation- Connection point)	No land acquisition and resettlement is expected at this moment.	
10	Rehabilitation of 15V/ 33 kV distribution line	No land acquisition and resettlement is expected at this moment, because all the work is planned within the ROW of the existing distribution lines.	

Source: JICA Study Team

Table 6.2-2 Status of compensation at Addis Center Substation

Household No.	Type of compensation	Contents
88/19	Provision of condominium	The condominium was provided for the affected people, and the receipt of compensation (at full replacement cost or equivalent) was signed on December 26, 2013. In discussion with Woreda 6 on December 29, 2013, they agreed that they would leave the site within 30 days after the signing day.
105/19	Provision of condominium	The condominium was provided for the affected people, and the receipt of compensation (at full replacement cost or equivalent) was signed on November 8, 2014. In discussion with Woreda 6 on November 8, 2014, they agreed that they would leave the site within 30 days after the signing day.

Source: JICA Study Team

The ROW of electrical lines in Ethiopia is stipulated in "Directives on Overhead Electric Line Clearances and Quality Supply (2005) and Electricity Operations Council of Ministers Regulations No49/1999." Based on these directives/regulations, the following conditions were applied for 132 kV Transmission Lines of this project.

Table 6.2-3 Conditions Applied for 132 kV Transmission Lines

Items	Criteria
ROW	30m width (15m + 15m)
Land acquisition	No land acquisition is expected, because the construction work is completed within the existing ROW.
Structures to be resettled	Structures located within the above ROW and with vertical distance of less than 8m from electrical lines are subject to resettlement.
Trees	Trees grown within 17m width (8.5m +8.5m) are subject to removal. Fruit trees grown within 22m width (11m +11m) are subject to removal.

(*1) The size of tower base is: 144m^2 (12m x 12m) for each lattice tower and 25m^2 (5m x 5m) for each tubular tower

Source: JICA Study Team

6.2.2 Legal Framework on Land Acquisition and Resettlement

(1) Legal Framework in Ethiopia

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

1) Proclamation No. 455/2005 to Provide for the Expropriation of Land Holdings for Public Purposes and Payment of Compensation

The procedures of land expropriation and compensation for public purposes are stipulated. Any implementing agency should inform land owners in writing. The land owners should hand over their land within 90 days after the completion of compensation payment (within 30 days if there are no houses and crops to be displaced).

All the compensation should be paid at full replacement cost, and the valuation should be conducted by a certified private or public institution or individual consultants.

2) Council of Ministers Regulations No. 135/2007 on the Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes

This regulation describes the valuation method of houses, trees and crops to be expropriated, as well as livelihood restoration programs.

3) Addis Ababa City Administration Directive No. 19/2014 on Compensation of Assets and Replacement of Land for Expropriation of Landholdings for Public Purposes

This directive was issued in accordance with "Proclamation No. 455/2005 to Provide for the Expropriation of Land Holdings for Public Purposes and Payment of Compensation". The eligibility and compensation methods of compensation are stipulated, and the compensation should be paid at full replacement cost.

(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 Ethiopia

Table 6-2.4 below shows the gap analysis between the JICA Guidelines and laws of Ethiopia, as well as the policies applied to fulfill the gaps.

Table 6.2-4 GAP Analysis between the JICA Guidelines and Laws of Ethiopia

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines& Laws of the Country	Policies applied 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. (Proclamation No. 455/2005)	Yes (There is no directive regarding the avoidance of land acquisition and resettlement)	・ Alternative analysis, including no project option, was conducted 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. (Proclamation No. 455/2005) ・ The necessity of consensus building is emphasized. (Ethiopian constitution)	Yes (There is no directive regarding the minimization of land acquisition and resettlement)	・ Consensus was made with PAPs in line with World Bank Safeguard Policy and JICA Guidelines.
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 the livelihood restoration. (Proclamation No. 455/2005)	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 amount should be based on full replacement cost. (Proclamation No. 455/2005)	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)	・ There is no directive regarding the timing of compensation and support. (Proclamation No. 455/2005, Council of Ministers Regulations No. 135/2007)	Yes (There is no directive regarding the timing of compensation and support)	・ The compensation and support will be provided prior to the resettlement.

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines& Laws of the Country	Policies applied to the Project
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 description about RAP. However, the approval of RAP by MOWIE is required for the implementation of project.	No gap	・ ARAP was 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. (Proclamation No. 455/2005)	Yes (There is no directive regarding public consultations at the stage of RAP preparation.)	・ Information about the project and ARAP was shared with PAPs and their communities in advance, and their opinions were reflected on ARAP.
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 languages etc., but in general local language (*Amharic*) is used for consultations.	No gap	・ Amharic is used for public consultations. ・ Documents are prepared in an officially used language, English.
Public participation	・ Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	・ The importance of public participation is described including the methods and timing. (EIA Guidelines (2000))	No gap	・ Public consultation was promoted in the process of ARAP preparation, in line with local EIA Guidelines and JICA Guidelines.
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. (Proclamation No. 455/2005)	No gap	・ The procedure of grievance mechanism was described in ARAP 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. (Addis Ababa City Administration Directive No. 19/2014)	No gap	・ The cut-off date was set as the commencement date of census survey. It was informed that those who encroach after the cut-off date were not eligible for compensation and support.

No.	JICA Guidelines	Laws of the Country	Gap between JICA Guidelines& Laws of the Country	Policies applied to the Project
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 Para.15)	・ The persons who are eligible for compensation and support should have legal rights. (Proclamation No. 455/2005)	Yes (There is no directive regarding the PAPs without legal rights.)	・ In line with the OP4.12 guidelines and principles, eligibility to benefits includes both formal and informal owners of land and owners of other assets affected by the project.
Compensation type	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are ・ Land-based. (WB OP4.12 Para.11)	・ There is no specific directive regarding the PAPs depending on land. (Proclamation No. 455/2005)	Yes (There is no specific directive regarding the PAPs depending on land.)	・ Due to the fact that the PAPs opted for full payment compensation as opposed to land to land, monetary based compensation will be generally applied.
Support during resettlement	・ Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	・ There is no directive regarding the support for transition period. (Proclamation No. 455/2005, Council of Ministers Regulations No. 135/2007)	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.
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 Para.8)	・ There is no directive regarding vulnerable groups. (Proclamation No. 455/2005, Council of Ministers Regulations No. 135/2007)	Yes (There is no directive regarding vulnerable groups.)	・ Additional support for vulnerable groups will be given.
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 Para.25)	・ There is no directive regarding ARAP. (Proclamation No. 455/2005, Council of Ministers Regulations No. 135/2007)	Yes (There is no directive regarding ARAP.)	・ ARAP was prepared, because the project does not require physical resettlement.

Source: JICA Study Team

(4) Policies Applied to the Project

This project will be implemented on the basis of the Ethiopian laws/regulations, World Bank safeguard policy and the JICA Guidelines. In case there are any gaps between these policies and guidelines, the gaps will be fulfilled by referring to the similar RAPs/ ARAPs prepared in Ethiopia under the support of World Bank and JICA.

This section discusses the principles of the Project Policy based on the type and degree of their losses, which will bridge the gaps between the policy and guideline. Where there are gaps between Ethiopian 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.

I. 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.

II. 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.

III. 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.

IV. 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.

V. 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.

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

VII. 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.

VIII. The resettlement plans will be designed in accordance with Ethiopian expropriation law No. 18/2007 and JICA's Policy on Involuntary Resettlement.

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

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

XI. 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.

XII. 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.

XIII. 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.

XIV. 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.

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

XVI. 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.

XVII. 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.

XVIII. 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.)

XIX. 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.

XX. 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

In the Project, the Cut-off date was set as July 13, 2018. This date was disclosed to the PAPs during preliminary meetings with PAPs and local authorities. The establishment of eligibility cut-off date is intended to prevent the influx of ineligible non-residents who might take advantage of project entitlement.

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 replacement cost. Replacement cost for this project is calculated as shown in Table 6.2-5.

Based on the above policies, the ARAP was prepared.

Table 6.2-5 Calculation methods of full replacement cost

Loss of asset	Calculation methods
Crops/ Trees	(Total area of the land in square meters) x (Value of the crops/ trees per kilo gram) x (Amount of crops to be obtained per square meter) + (Cost of permanent improvement on land)

Note: The calculation methods are based on "Addis Ababa City Administration Directive No. 19/2014 on Compensation of Assets and Replacement of Land for Expropriation of Landholdings for Public Purposes". The above compensation amount is calculated based on the unit price annually updated by Addis Ababa City Administration Land Development and Urban Renewal Agency. The "Value of the crops/ trees" is based on average market price. The "cost of permanent improvement on land" include the cost for fertilizer, labor cost and soil erosion preventive measures etc.

Source: JICA Study Team

(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 6.2-6. This project does not require involuntary resettlement and land acquisition. However, 21 households will be affected by the construction of overhead and underground transmission lines.

Table 6.2-6 Number of PAHs and PAPs

Displacement	Impact	Unit	Magnitude of Displacement				Total
			Overhead transmission lines	Underground transmission lines	Substations	Distribution lines	
Loss of Residential Houses	Physical Displacement	PAH	0	0	0	0	**0**
		PAP	0	0	0	0	**0**
Loss of Agricultural Land	Economic Displacement	PAH	0	0	0	0	**0**
		PAP	0	0	0	0	**0**
Loss of Crops/ Trees		PAH	13	8	0	0	**21**
		PAP			0	0	**100**

Source: JICA Study Team

1) Census Survey

According to the census survey, 21 households (100 persons) will be economically affected by the project. The number of PAHs and PAPs for overhead and underground transmission lines is shown in Table 6.2-7 and 6.2-8.

Table 6.2-7 Number of PAHs and PAPs for overhead transmission lines

Type of loss	No of PAHs			No of PAPs		
	Legal	Illegal	Total	Legal	Illegal	Total
Required for displacement						
1 HH (Structure owner on Gov. land)	0	0	0	0	0	0
2 HH (Structure on Private land)	0	0	0	0	0	0
3 HH (Tenants)	0	0	0	0	0	0
4 CBEs (Structure owner Gov. land)	0	0	0	0	0	0
5 CBEs (Structure owner on Private land)	0	0	0	0	0	0
6 CBEs (Tenants)	0	0	0	0	0	0
7 Community owned structures including physical cultural resources	0	0	0	0	0	0
Not required for displacement						
8 Land use right holders	0	13	13	0	63	63
9 Wage earners	0	0	0	0	0	0

Note: HH: Household, CBEs: Commercial and Business Enterprises

Source: JICA Study Team

Table 6.2-8 Number of PAHs and PAPs for underground transmission lines

Type of loss	No of PAHs			No of PAPs		
	Legal	Illegal	Total	Legal	Illegal	Total
Required for displacement						
1 HH (Structure owner on Gov. land)	0	0	0	0	0	0
2 HH (Structure on Private land)	0	0	0	0	0	0
3 HH (Tenants)	0	0	0	0	0	0
4 CBEs (Structure owner Gov. land)	0	0	0	0	0	0
5 CBEs (Structure owner on Private land)	0	0	0	0	0	0
6 CBEs (Tenants)	0	0	0	0	0	0
7 Community owned structures including physical cultural resources	0	0	0	0	0	0
Not required for displacement						
8 Land use right holders	0	8	8	0	37	37
9 Wage earners	0	0	0	0	0	0

Note: HH: Household, CBEs: Commercial and Business Enterprises

Source: JICA Study Team

2) Asset Inventory

The implementation of this project will not cause the loss of buildings, but will cause loss of crops and trees, because of the illegal agricultural activities. In total, 1,988 m^2 of the farmland will be affected. Table 6.2-9 shows the outline of the affected area and the land use category.

Table 6.2-9 Land use and area affected by the project

No.	Items	Land use	Affected area (m^2)	Total (m^2)
1	Overhead and underground transmission lines	Farm Land	1,988	1,988
2		Housing Land	0	
合計				**1,988**

Source: JICA Study Team

Crops and trees affected by the project are shown in Table 6.2-10.

Table 6.2-10 Crops and trees affected by the project

Crop Type	
a. Annual crops	Area affected (m^2)
Spinach	869
Wheat	738
Kale	189
Tomato	128
Grass	64
Total area	**1,988**
b. Perennial crops	Number of affected crops
Ensete（*Ensete ventricosum*）	32
Sugarcane	8

Crop Type	
Hop（*Humulus lupulus L.*）	7
Tree Type	Number of affected trees
Apple	1

Source: JICA Study Team

3) Socio-Economic Baseline of PAHs

The socio-economic information of PAHs is shown in Table 6.2-11. Out of 21 PAHs, 2 households are headed by females; 1 household head is physically impaired and another household head is seriously ill.

Table 6.2-11 Socio-Economic Information of PAHs

Gender of Head s of Households	Male: 19 households, Female: 2 households
Age of Heads of Households	0 – 20 years old: 0 household 21-40 years old: 8 households 41-60 years old: 9 households More than 61 years old : 4 households
Employment status of Heads of Affected Households	Agriculture: 16 households Trade/ Service: 1 household Pension: 1 household Others: 2 households
Number of persons of each household	2 persons: 2 households 3 persons: 3 households 4 persons: 4 households 5 persons: 6 households 6 persons: 3 households 7 persons: 1 household 8 persons: 2 households (Average household size: 4.7 persons)
Ownership of houses	Privately owned: 15 households Rented: 6 households
Typical House Type	Wall: Wood, mud (17 households), Bricks (4 households) Roof: Corrugated iron sheet. Floor: Concrete (14 households), Sand (7 households) Toilet: House with private toilets (13 households), House without private toilets (8 houses)
Main income sources	Agriculture, Livestock production, House rent etc. (Average annual income: 45,833 Birr)

Source: JICA Study Team

4) Vulnerable Groups

According to the results of the census survey and socio-economic survey, there are two (2) households headed by women, one (1) household headed by a physically impaired person, and one (1) household headed by a seriously ill person. Additional compensation will be paid for these four households (socially vulnerable groups).

5) 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
- 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 July 13, 2018. Losses caused by the Project and compensation toward them are as summarized below.

Loss of land

No loss of land is expected by the project[***].

Loss of houses

No loss of houses is expected by the project.

Loss of agricultural crops

Loss of agricultural crops is expected by the project (Table 6.2-10). The amount of compensation is calculated based on full replacement cost (Table 6.2-5).

Loss of trees

Loss of trees is expected by the project (Table 6.2-10). The amount of compensation is calculated based on full replacement cost (Table 6.2-5).

[***] Since the construction of transmission lines follows the existing ROW, the project does not require land acquisition. Economically displaced households illegally cultivate the land.

(b) Livelihood Restauration

The loss of crops and trees 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 labors during the construction period. They will also be hired as skilled and unskilled labors to work during the maintenance of towers and clearing trees within the ROW and access roads. The cultivation along underground transmission line routes is allowed during the operation.

(c) Entitlement Matrix

In line with the Ethiopian laws and regulations, 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 6.2-12.

Table 6.2-12 Entitlement Matrix

Type of Loss	Eligible Groups	Impact		Entitlement	Responsible Bodies
Seasonal crops	Crop owner	- Loss of seasonal crops used for subsistence - Loss of livelihood	Permanent loss (loss caused by the construction of tower base for the overhead transmission lines)	• Cash compensation based on prices of such crops keeping in view the stage, size, area coverage and type of crop	EEP
			Temporary loss (loss caused by the construction of underground transmission lines)	• Cash compensation based on prices of such crops keeping in view the stage, size, area coverage and type of crop • Planting of seasonal crops may be continued even after the erection of towers, as long as they do not grow tall and interfere with the power lines	EEP
Perennial crops, Trees (apple)	Crop and tree owner	- Loss of perennial crops and trees used for subsistence - Loss of livelihood		• Cash compensation based on prices of such crops keeping in view the stage, size, area coverage and type of crop and trees	EEP
Waged employment (Day laborers/ traders)	Employee	- Loss of livelihood		• Employment opportunities during construction	EEP
Vulnerable Groups	Vulnerable groups	- Loss of crops used for subsistence		• Cash compensation in addition to the above	EEP

Type of Loss	Eligible Groups	Impact	Entitlement	Responsible Bodies
	(Households headed by women, physically impaired persons and seriously ill persons)	- Loss of livelihood	compensation for crop loss	

Source: JICA Study Team

6) Grievance redress mechanism

The "Proclamation No. 455/2005 to Provide for the Expropriation of Land Holdings for Public Purposes and Payment of Compensation" stipulates the grievance mechanism.

The Sub-article 1 of Article 23 states that the individual who has been given expropriation order can submit his complaint with details of reasons and documentation within 15 working days to the organization, which issued the expropriation order. Sub-article 2 indicates that "the organization referred to in Sub-Article (1) shall examine the complaint and give its decision within 15 working days and let the complainer know of its decision in writing. If the complaint hasn't been accepted by the organization, the reason has to be clearly explained in the decision. Article 24 states that if the complainer (referred to in Article 23) is dissatisfied with the decision referred to in sub-article 23(2) above, he/she can present his appeals to the Addis Ababa City Expropriation and Compensation Issues Grievance Council within 30 days. The Directive doesn't provide further information on grievance mechanism.

In this project, the following procedure will be taken for grievance redress mechanism.

- If an individual is not satisfied with the amounts of compensation or any other decision, he/she can fill the Grievance Application Form and present it to the Grievance Committee established under the Land Devt and Urban Renewal Office.

- Upon receipt of the complaint, the Grievance Committee would communicate the case to the head of the office and request the official to arrange for examination of the data collection and valuation process of the compensation issue. Then, the official would communicate the Compensation Committee to check the data on the individual's assets and the valuation procedures again. As necessary, the official or Compensation Committee may assign a separate expert or team of experts who would collect the data on assets and make the valuation process again based on the directive and current

compensation rates provided by the AAC Land Development & Urban Renewal Agency. Finally, the Committee would provide its final decision in writing to the head of the office who would pass this to the Grievance Committee.

- Then, the Complainer would receive the decision through the Grievance Committee. If the Complainer is still dissatisfied with the decision, he can take the case to the concerned regular court.

7) Institutional Framework

Institutional framework for the implementation of ARAP is as follows

(a) EEP

EEP has an Environment, Health, Safety & Quality Department, which has 21 staff members as of 2018. The department consists of three sections: 1) Environmental monitoring & control, 2) Quality assurance and 3) Health & safety. This department is in charge of preparation, review and monitoring of ESIA and RAP (including the development of ToR) for transmission line projects as well as power generation projects. This department is the focal point of grievances related to transmission lines and substations.

(b) Ministry of Water, Irrigation and Electricity

MEFCC delegated the roles of reviewing and approving ESIA in water and energy sectors to the MOWIE. Hence, MOWIE has an Environmental and Climate Directorate, which in charge of (a) Review and approval of ESIA reports and RAP, (b) Monitoring of environmental management plan and RAP (reporting to MEFCC as necessary), (c) Measures for climate change and green economy. Since this project falls into power transmission and distribution lines, EEP and EEU shall submit an ESIA report and RAP to MOWIE, and then MOWIE shall issue an environmental permit.

(c) ARAP Implementation Committee

ARAP implementation committee is set up at the sub-city level, and is responsible for monitoring proper payment of compensation. The committee reports to sub-city offices and EEP, and is in charge of coordination of the relevant agencies in ARAP implementation.

Table 6.2-13 ARAP implementation committee members

No	ARAP implementation committee members	Roles
1	Sub-city Land Devt and Urban Renewal Office (Head/Expert)	Chairperson
2	Sub-city Finance and Economic Office	Secretary
3	Sub-city Trade Office	-
4	Representative of the respective Woredas along the transmission lines, Representatives of PAPs	-
5	Woreda Community Mobilization Office	-
6	EEP	-

Source: JICA Study Team

8) Implementation schedule

The schedule of ARAP implementation is shown in Table 6.2-14.

Table 6.2-14 Schedule of ARAP implementation

No.	Activities	Required time	Responsible body
1	Disclosure of ARAP (PAPs, Woredas, Sub-cities)	6 days (after the approval of ARAP)	EEP
2	Verification of assets by experts (including preparation of final compensation payment)	6 days	Sub-city Land Development and Urban Renewal Office, ARAP implementation committee
3	Grievance redress (if any grievance is raised by PAPs)	4 days	Sub-city Grievance Committee
4	Consultation with PAPs regarding the compensation payment	3 days	EEP
5	Payment of compensation	2- 3 months (before the commencement of construction)	EEP, Compensation implementation committee
6	Monitoring, evaluation and audit	4 days	EEP, Independent consultant
7	Preparation of completion reports	10 days	EEP

Source: JICA Study Team

9) Cost and Finance

Total cost and breakdown of compensation is summarized in Table 6.2-15.

Table 6.2-15 Total cost and breakdown of compensation

No.	Description	Input (A)	Unit rate (Birr/Person/Day) (B) (ETB)	Total cost (A x B) (ETB)
1	Disclosure of ARAP (PAPs, Woredas, Sub-cities)	4 days x 3 persons	2,000	24,000
2	Verification of assets by experts (including preparation of final compensation payment)	6 days x 4 persons	1,500	36,000
3	Grievance redress (if any grievance is raised by PAPs)	4 days x 4 persons	1000	16,000
4	Consultation with PAPs regarding the compensation payment	3 days x 2 persons	2,000.	12,000
5	Payment of compensation	-	-	463,872.70
6	Additional support for vulnerable groups (4 households)	-	10, 000	40,000

No.	Description	Input (A)	Unit rate (Birr/Person/Day) (B) (ETB)	Total cost (A x B) (ETB)
7	Monitoring, evaluation and audit	8 days x 2 persons	10, 000	160,000
8	Preparation of completion reports	10 days x 2 persons	2,000	40,000
Total cost		-	-	791,872.7
Contingency (10% of total cost)		-	-	79,187.27
Grand total				**871,059.97**

Source: JICA Study Team

(6) Monitoring System

The monitoring of compensation payment will be carried out by EEP in the following two steps (Refer to the monitoring form attached in "6.2.8 (1) Draft monitoring form".

(a) Before the disbursement of payment, to check all the steps and processes for compensation has been carried out properly

(b) After the disbursement of all payments, to ensure that the appropriate amount has been disbursed to eligible PAHs and to address grievances, if any.

(7) Stakeholder meetings

The Ethiopian Constitution gives the right to people to consult and participate in the planning and implementation of programs and projects that would affect them. The Ethiopian EIA Guideline Document also emphasizes the need to engage the interested and affected parties including project affected communities in the EIA process, which includes the design of appropriate mitigation or compensation measures for PAPs. In this project several stakeholder meetings were conducted for stakeholders from Sub-cities and Woredas including PAPs.

For PAPs, public meetings, focus group discussions and one-to one discussions were organized. For local government officers, interviews and one-to-one discussions were organized. EEP informed them of the project activities, then arranged the date of stakeholder meetings with PAPs and local government officers.

During the stakeholder meetings, the project outline and impacts were explained, and necessary mitigation measures were discussed. The participants agreed with the project outline and the mitigation measures. It should be noted that ARAP was prepared in an officially used language, English. ARAP will be disclosed in the website of EEP, and will be available at the offices of Addis Ababa City.

The outline of stakeholder meetings is described in Table 6.2-16.

Table 6.2-16 Outline of stakeholder meetings

Methods	Date	Participants	Outlines
Public meetings	April 10, 2018	12 representatives of PAPs for overhead transmission lines (Woreda 4/ Akaki Kaliti Sub-city)	• Explanation about the project outline and the previous similar projects • Discussion about the project impacts, mitigation measures and concerns of PAPs
	April 10, 2018	10 representatives of PAPs for underground transmission lines (Woreda 5 & 6/ Kirkos Sub-city)	
	April 11, 2018	18 representatives of PAPs for overhead transmission lines (Woreda 7/ Akaki Kaliti Sub-city)	
	April 12, 2018	14 representatives of PAPs for overhead transmission lines (Woreda 11/ Nifas Silk Lafto Sub-city)	
Focus Group Discussion	April 10, 2018	5 representatives of PAPs for overhead transmission lines (Woreda 4/ Akaki Kaliti Sub-city)	
Individual consultation	April 10, 2018	7 governmental officers from the areas along the overhead transmission lines (Woreda 4 & 7/ Akaki Kaliti Sub-city)	• Explanation about the project outline • Exchange opinions about previous similar projects • Discussion about the project impacts, mitigation measures and concerns
	April 10, 2018	12 governmental officers from the areas along the underground transmission lines (Woreda 5 & 6/ Kirkos Sub-city)	
	April 11-12, 2018	8 governmental officers from the areas along the overhead transmission lines (Woreda 11& 12/ Nifas Silk Lafto Sub-city)	
	April 12, 2018	6 governmental officers from the areas along the underground transmission lines (Woreda 6/ Nifas Silk Lafto Sub-city)	

Source: JICA Study Team

Main comments raised during the stakeholder meetings and responses from EEP were described in Table 6.2-17.

Table 6.2-17 Main comments and responses during the stakeholder meetings

Participants	Opinions and concerns raised by participants	Responses from EEP
Stakeholders from the communities along with overhead transmission lines	Existing cobblestone roads could be damaged during the project construction period. Potential damage to public utilities (like electric distribution lines, water supply systems, telephone lines) is a concern.	The project will repair any damages caused to community access roads. Impacts on public utilities will be minimized and any damages caused will be repaired properly by consulting with the service providers.
	There are a number of vulnerable groups along the transmission lines and these include female headed households, old people and economically poor people. Additional support should be provided for these vulnerable groups.	Additional support for vulnerable groups is examined and described in ARAP.
Governmental officials from the Sub-cities and Woredas along with overhead transmission lines	There will be potential damages to access roads mainly cobblestone roads due to operation of heavy equipment and vehicles during construction of the transmission lines, and this situation may affect the economic and social activities of the road users. Excavation works for construction may cause damages to water supply lines etc.	Damaged roads will be repaired upon completion of construction works and the costs of road maintenance will be covered by the project or EEP. Care will be taken during design, as well as, during construction to avoid or minimize damage of public utilities.
Governmental officials from the Sub-cities and Woredas along with underground transmission lines	Project activities that would involve operation of heavy equipment and vehicles to execute construction works such as excavation and drilling in ground, and transport of materials are likely to cause air and noise pollution problems. It is necessary to take all appropriate measures to reduce air and noise pollution problems during the construction period to acceptable levels.	Mitigation measures will be examined and provided in ESIA report.
	The project is expected to generate excavation or spoil materials that may cause environmental pollution, access and safety problems etc., unless they are properly collected and disposed of at the approved disposal sites.	All the waste generated by the project will be collected and disposed in a proper manner. The mitigation measures will be examined and provided in ESIA report.

Source: JICA Study Team

(8) Others

1) Draft Monitoring Form

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

I. Preconstruction Phase

1. Monitoring on ARAP and land acquisition to monitored by EEP

Activities	Expected Date Completion	Responsible Organization
Approval of ARAP	Approved on October 30, 2018	MOWIE
Processing Compensation Fund	Upon approval of project implementation	EEP & Sub-cities

2. Progress of Compensation Payment

Components	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									
Kaliti 1 - Gofa (Overhead TL)		No. of PAPs							EEP
NADC - Gofa (Underground TL)		No. of PAPs							EEP

3. Record of grievance management

Monitoring Item	Monitoring Results
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)

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Results of vehicle inspection		Construction site	Once/month
Interview results with surrounding communities		Surrounding communities	Once/two months

2.2 Noise

Item	Unit	Country's Standards (*1)	Referred International Standards (*2)	Measurement Point	Frequency	Measured Value (Mean)	Measured Value (Max.)
Noise Level Leq	dB(A)	N/A	55	Construction site and access roads	Daily		
				Nearest sensitive receptors	Once/week		

(*1) Guideline ambient environment standards for Ethiopia (EPA, August 2003) was drafted but not approved yet.
(*2) IFC EHS Guidelines, General EHS Guidelines Table 1.7.1 Daytime (07:00-22:00)

2.3 Waste

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Waste type		Construction site	Once/2 weeks or Once/ month depending on waste amount
Waste amount			
Waste volume			
Disposal conditions			

2.4 Soil

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

2.5 Ecosystem

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Type and number of cut down trees		Transmission line routes	Daily where the issues are relevant
Status of planting and growing conditions			

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

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
No. of workers provided with training & awareness education		Construction site	Daily during active construction period
No. of workers provided with protective clothing & equipment:			

3.3 Accidents

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
No. of work zone secured safe through fencing, posting signs, barricades, reflectors etc.		Construction site and the surrounding areas	Once/week
Traffic management situation around construction sites - speed limits, provision of alternative routes to divert traffic from construction sites			
No. of traffic accidents occurred			

3.4 Gender

Monitoring Item	Monitoring Results	Monitoring Point	Frequency
Employment condition of women		Construction site	Quarterly
No. of project sites provided with separate toilets for women workers at project sites			

3.5 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
Number of grievance	
Contents of grievance	
Actions to be taken	

2) Environmental Check List

Table 6.2-18 below is the Environmental Check List of the Project based on the JICA Guidelines for Environmental and Social Consideration.

Table 6.2-18 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 MOWIE and approved on October 30, 2018. (c) The conditions were general issues such as regular reporting to MOWIE, so will be satisfied by EEP/EEU. (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 guideline 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. Application of underground and 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) There are no rivers or water areas around the project sites.
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) The Project site is within Addis Ababa City and there is no protected area nearby. The Project will not affect the protected area.
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves,	(a) N (b) N	(a) There is no forested area near the project site. (b) There is no protected habitat of endangered species.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		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	(c) Trees within ROW of electrical lines are removed during the construction. An apple tree will be cut down and compensated. In addition, Some negative impacts on road-side trees (487 trees and shrubs) in the median of underground transmission lines are predicted. Among these trees, two tree species categorized as VU of IUCN Red List are included (*Araucaria heterophylla* (92 trees) and *Jacaranda mimosifolia* (3 trees)). However, these are artificially planted road-side trees. Hence, the impact will be mitigated by setting the routes avoiding the median and if unavoidable, by replanting trees in another location. In addition, birds were observed around the project site. However, since the electrical routes of this project follow the existing overhead transmission lines, no impacts on birds are expected. The existing overhead transmission lines will be replaced by underground transmission lines (from Black Lion Substation to Addis Center Substation and Gofa Substation), which will mitigate the impact on bird such as bird strike. (d) No significant impacts are expected on habitat fragmentation and migration routes. (e) There is no such possibility as there is no important ecosystem near the project site. (f) The project site is within Addis Ababa city, which is already developed.
3 Natural Environment	(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?	(a) N (b) N (c) N	(a) There are no locations along the electrical lines which have risks of slope failure and land sliding. The protection measures such as installation of rain gutters will be conducted. (b)-(c) The site of the New Addis Center Substation is flat and will not cause landslides. Since the soil is relatively hard, there are no risks of slope failure and

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(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?		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? (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?	(a) N/A (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A (i) N/A (j) N/A	(a)-(j) No involuntary resettlement is expected.
	(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? (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?	(a) Y (b) N (c) N (d) Y	(a) Economic displacement such as the loss of crops and trees is expected. ARAP was developed and the loss will be compensated at full replacement cost. (b) The project site is located within Addis Ababa City, and 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 the local laws and ARAP.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		(d) Are the compensations for transmission wires given in accordance with the domestic law?		
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) Five churches were found along the planned transmission lines. However, the project will not cause any impacts on these churches, because the distance between the churches and the electrical lines is sufficiently secured. 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 (b) 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 not to violate safety of other individuals involved, or local residents?	(a) N (b) Y (c) Y (d) Y	(a)- (d) EEP/EEU 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)? (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,	(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. Mitigation measures to be taken will include water sprinkler, installation of cover to prevent dust and control of construction working hours.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
		are adequate measures considered to reduce impacts?		(b) The project site is within Addis Ababa City hence construction activities are not going to affect the natural environment or ecosystem. 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. EEP/EEU require 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, EEP/EEU 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	(a) There is 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 7

PRELIMINARY DESIGN

CHAPTER 7 PRELIMINARY DESIGN

7.1 OVERHEAD TRANSMISSION LINE

Preliminary Design for Over Head Transmission Line Facilities will be described in Chapter 7.

7.1.1 Route of Over Head Transmission Lines

Overhead transmission lines will be divided into the following two (2) sections as shown in Table 7.1-1 .

Table 7.1-1 Section of Over Head Transmission Line Portion

	Demarcation Point (Start)	Demarcation Point (End)	Length
Section 1	Cable Terminated Dead End Tower at EEP/EEU store at Gofa	Kaliti-I Substation	9.1 km
	Ditto	Gofa (Addis South) Substation	0.2 km*
Section 2	At Tower T67 at St. Mary's church (Insert one new Dead End Tower)		0.0 km*

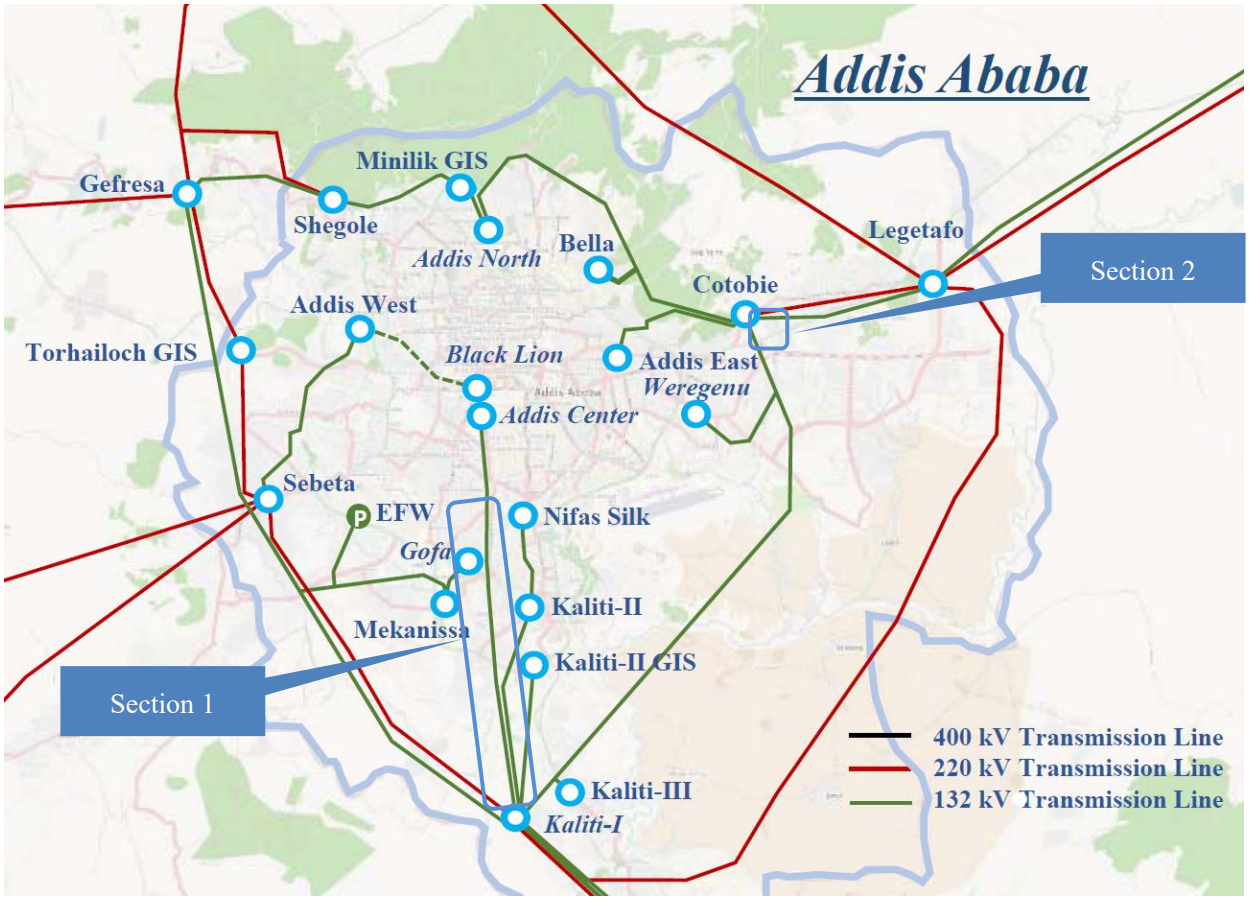


Fig. 7.1-1 T/L Network of Addis Ababa City

7.1.2 Minimum Current Capacity for Over Head Transmission Line

The Minimum Current Capacity required for the Over Head Transmission Line is considered as following, based on the contents shown in Chapter 3.

The final transformer's total capacity in the new ADC substation will be 225 MVA as 5units of 50 MVA (100% of 132/15 kV utilization rate, 75% utilization rate of 132/33 kV). This capacity is considered as the least minimum capacity of one circuit of the transmission line, and even when only one (1) circuit is energized, transmission of 200 MVA shall be secured taking into account 110% of the long-term overload rate. In addition, it should be considered to have 375 MVA the power transmission capacity on two lines, so that power can be accommodated at 150 MW (132/15 kV 3 units utilization rate 100%) to Black Lion substation. In this case, one line stop is not considered.

From the above, the least minimum current capacity (I) required for 200 MVA / single circuit or 375 MVA / double circuits electric wire is obtained as follows.

$$I = 200 \text{ MVA} / 132 \text{ kV} / 1.7321 = 875 \text{ [A]}$$

In addition to the above, the capacity of the existing transmission line in EEP network is applied an increased capacity by adding a tolerance of 25% to 85% to the least minimum current capacity obtained from the total transformer capacity installed in the substation, as shown in Appendix-6: Addis Ababa Transmission Networks. Therefore, Minimum Current Capacity for Over Head Transmission Line is calculated by adding 25% as a margin to the above calculated least minimum value. This margin can contribute to ensure the capacity of overhead transmission line during forced operation caused by in-sufficient maintenance or increased power demand.

Minimum Overhead transmission line current capacity I_{TL}

$$I_{TL} = 200 \text{ MVA} / 132 \text{ kV} / 1.7321 \times 1.25 = 1093 \text{ [A]}$$

7.1.3 Preliminary Design for Over Head Transmission Line Facilities

It is recommended that the preliminary design of the overhead power transmission facilities be in line with the preliminary design applied in the existing facilities of EEP such as tower, conductor and insulation, as much as possible. As many tubular steel towers are already used for 132kV overhead transmission lines in Addis Ababa, the similar design can be applied for this study. Common designing allows exchange of materials between any projects of EEP.

Preliminary design will be as follows.

- The route for overhead transmission line shall be in the existing ROW (Right of Way as Corridor). The angle tower shall be kept in the same original location, and the suspension tower will be adjusted to an optimum position within the ROW.
- The tower design shall be designed to have a common compatible design with the existing 132 kV steel tower in the EEP, and the diameter of the phase conductor which will be directly related to the wind pressure loading, and it shall not exceed the diameter which is used in design of the existing 132kV towers in EEP, and phase conductor shall have necessary thermal current capacity.
- The first dead-end tower between T20 and T21 shall be designed to terminate underground cables on the platform of the tower with ceiling ends and surge arresters. The tower will be designed as a lattice tower to have sufficient strength for holding large size under-ground cables, which will be over 2,000-2,500mm^2.
- The underground cables from Weregenu substation will be terminated near T67 by constructing a new tower between T67 and T68 of Kaliti-I to Cotobie substation. Tubular tower will be implemented to minimize the foundation size and for clearing the other circuits of Kaliti-I to Cotobie substation which is at a distance of 30meter parallel to it. The tubular tower will be designed as a dead-end tension type with platform to keep ceiling ends and surge arrester. The foundation will be a concrete chimney to hold a tubular tower which has balanced tension. The existing tower shall be kept as original, without any modification.

(1) Selection of Phase Conductor

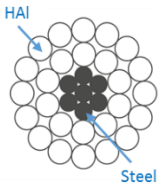
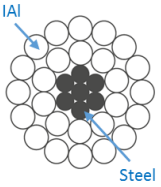
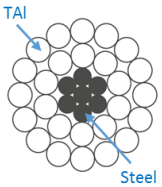
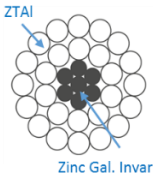
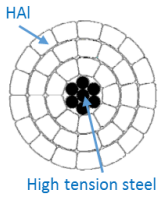
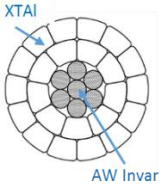
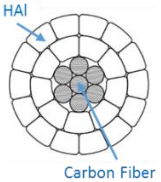
The size of conductor will be designed as following to correspond with the existing design of tubular towers, which apply single conductor ACSR 240/30 (21.49 mm)., and the minimum thermal capacity is calculated by the size of transformer. The point to be noted is that the 220kV designed towers are constructed on T54 and T55, which are designed to have ACSR 494 (28.96mm). However, it seems that currently, the tower has less strength due to missing tower materials.

Minimum thermal capacity （I_{TL}）	1,093 [A]
Maximum diameter of conductor	21.49 [mm]

Remarks

Thermal capacity of EEP overhead transmission line is indicated in Table 4.1-3 and the required conditions are indicated in Table 7.1-2.

Table 7.1-2 Conductor Types

Type	Cross Section	Max.	Current Capacity	Construction and Features	Material
ACSR		90℃	620 A (21.5mm)	Aluminum Conductor Steel Reinforced, which is a combination of HAl centered on steel wire and is used as overhead power transmission line and overhead power distribution line.	Hard Aluminum Wire (HAl: hard-drawn aluminum wire): It is manufactured from high-quality aluminum ingot, and it is used for strands of hard aluminum wire and steel core wire (ACSR).
IACSR		90℃	600 A (21.5mm)	It is a combination of IAl centered on the steel wire, it has high mechanical strength and it is used for transmission lines etc. for long span crossing.	I-Aluminum Alloy Wire (IAl) Alloy with Si, Mg and Fe added to Al, the tensile strength is about twice that of the blunt aluminum wire, used as the IACSR for the long-distance transmission line, the overhead ground wire, the power supply wire, etc.
TACSR		150℃	934 A (21.5mm)	It is a combination of TAl centered on steel wire and is used for large capacity transmission line.	Heat-resistant aluminum alloy wire (TAl) Alloy to which trace zircon (Zr) is added, can raise recrystallization temperature and can be used continuously up to 150 ℃. It is used for large capacity transmission and distribution lines as high-capacity buses for power generation substations and steel wire heat-resistant aluminum alloy strands (TACSR)
ZTACIR		210℃	1100 A (22.4mm)	Which was more combined ZTAl around the galvanized invar wire, it has been used as practical use as a multiple capacity wire.	Ultra-heat-resistant aluminum alloy wire (ZTAl) Continuous use allowable temperature raised to 210 ℃, heat resistance was raised, and as a countermeasure to increase the capacity of the existing transmission line, practical use for twice capacity electric wire which can double the current capacity with the same design steel tower Has been made.
Low Loss ACSR		90℃	806 A (21.5mm)	High tensile strength steel wire or aluminum coated steel wire was adopted for the core of the steel and the inner layer aluminum wire was compressed to reduce resistance	
XTACIR		230℃	1100 A (21.2mm)	It is made by further combining XTAl with aluminum coated incarnine as the center, and it has been put to practical use as a double capacity electric wire.	Ultra-Heat Resistant Aluminum Alloy Wire (XTAl) The continuous use allowable temperature was raised to 230 ℃ in heat resistance, and as a countermeasure to increase the capacity of the existing transmission line, it was applied to a double capacity electric wire which can double the current capacity with the same designed steel tower Has been made.
ACFR		175℃	1270 A (22.3mm)	ACFR (Carbon Fiber Heart Aluminum Conductor Carbon Fiber Reinforced) is lightweight and features low linear expansion coefficient, it can increase capacity and sag control	ACSR wire of steel wire instead, CFCC (Carbon composite material cable) Adapted 

Following three (3) types of conductors can be considered as their diameter is less than 21.5mm and the thermal capacity is over 1,000A

1. ZTACIR Aluminum Conductor with Zinc Galvanized Invar alloy Reinforced
2. XTACIR Aluminum Conductor with Aluminum coated Galvanized Invar alloy Reinforced
3. ACFR Aluminum Conductor with Carbon Fiber reinforced

The current capacity of ZTACIR and XTACIR is about more than twice of ACSR, which has the same wire diameter and is made of super heat resisting aluminum alloy or special heat resistant aluminum alloy instead of the normal aluminum. The sagging depth for both conductors will be approximately same as ACSR with a 90°C sag, which is the allowable temperature of ACSR.

Recently, ACFR has begun to be used for experimental or trial use in the world, but some reports of disconnection and drop conductor accidents are coming up after operation, due to mal-installation during construction. So twin conductors per phase shall be considered to avoid the dropping of conductor. Then, the design of tower strength shall be upgraded to have twin conductors on each cross arm, in which case, the tension on cross arms will be doubled, due to the twin conductors.

The main difference between ZTACIR and XTACIR is the coating material for steel strand under aluminum strands. ZTACIR applies zinc galvanized steel core against XTACIR applied aluminum-coated steel wire. As melting point of aluminum is much higher than zinc, the permanent allowable conductor temperature will be 210°C for ZTACIR and 230°C for XTACIR. The instantaneous allowable temperature will be 280°C for ZTACIR and 360°C for XTACIR. If the conductor having same cross sectional area, the transmission capacity can be increased by about 5%, as a result, smaller diameter conductor can be applied under same transmission capacity requirement. Furthermore, XTACIR has trapezoidal strand aluminum structure, so the total cross section size will be much bigger but with the same diameter, as the gap between the aluminum is reduced by trapezoidal strand wire. The aluminum area ratio in the cross section of the conductor will be about 90%, and as a result, the resistance is less and the thermal capacity will be increased by about 20% without changing the outside diameter.

Should a normal ACSR 500 or AAAC 570, which has continuous permissible current of 1,000 A or more, be used in this overhead transmission line, the diameter of the conductor would be 30 mm

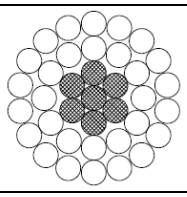
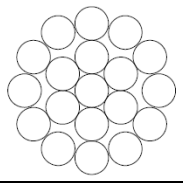
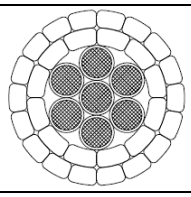
or more, and the wind pressure on those conductors will be more than the design limit of the existing design of 132 kV tower. As it cannot be accepted in the preliminary design, the type of conductor will be either ZTACIR or XTACIR. In these two types, XTACIR uses a trapezoidal (compression molded type) strand wires, and it is possible to get the same continuous permissible current value with somewhat less diameter than that of ZTACIR.

Trapezoidal strand aluminum structure Invar XTACIR 210 (diameter of 17.6mm) can be used at 230 ℃ with a continuous permissible current of 1,000 A for short time of 400hours at 290 °C, so it's mechanical size will be similar to the Tiger ACSR 166 (diameter 16.5mm) which are used in the existing 132kV transmission lines. Since Invar XTACIR 210 has sufficient current capacity for the transmission line of Section-1, the Conductor shall be designed to be equal to or more than the Invar XTACIR 210 (diameter 17.6mm).

Since the conductor, Tiger ACSR 166 is used in the entire Section-2 of the existing transmission line, it is not required to change the current conductor type with current capacity of 490 A. The same type of conductor shall be used between the existing towers and the newly built tower for cable termination.

The following table shows the comparison of conductor characteristic used in the Addis Ababa 132 kV transmission line system.

Table 7.1-3 Comparison of Conductor Characteristic

Description		Unit	Tiger ACSR 166	ASH/AAAC 180	Invar XTACIR 210
Construction	Aluminum	No./mm	30 / 2.36 mm	19 / 3.48 mm	16 / 2.5 + 12 / 2.6 mm
	Steel Core		7 / 2.36 mm		7 / 3.5 mm
Diameter		mm	16.52 mm	17.40 mm	17.60 mm
Cross Section Area	Aluminum	mm^2	131.20 mm^2	180.7 mm^2	142.4 mm^2
	Core		30.62 mm^2		63.3 mm^2
	Total		161.82 mm^2	180.7 mm^2	209.7 mm^2
Normal Weight		kg/km	362 kg/km	497 kg/km	872 kg/km
Ultimate Tensile Strength		kN	58.0 kN	50.6 kN	81.1 kN
DC Resistance at 20°C		Ω/km	0.2202 ohm/km	0.1830 ohm/km	0.191 ohm/km
Elastic Modulus		GPa	82.0 GPa	68.0 GPa	90.8 GPa
Thermal Expansion coefficiency		1/°C	0.000019	0.000023	0.0000126
Continuous Allowable Temperature		°C	90 °C	90 °C	230 °C
Short Time Allowable Temperature			120 °C (400 hrs)	120 °C (400 hrs)	290 °C (400 hrs)
Continuous Current Capacity at continuous allowable temperature		A	490 A	510 A	1,000 A
Cross Section					

(2) Tower design

1) Tower design for Section I

Two (2) kinds of tower, namely, “Tubular Tower” and “Lattice Tower” will be applied in the following section to utilize the feature of each tower type.

Table 7.1-4 Application of Tower Type

Tower Type	Applied Section
Tubular Tower	T25/26 toT30/31, where it has a new road construction plan T31 where the tower land is limited by existing houses T31 toT32/33 where a part of ROW (Corridor) is occupied by houses, so ROW (Corridor) shall be narrowed.
Lattice Tower	T22 dead-end tower having large sized underground cable T23 and T 24 having long span heavy weight span T24 located on the steep slope side T25 anchor section tower on the T24 side T33 having bigger weight span and section tower for the crossing with ring road. T34 beside ring road and located in industrial area T34 to T53 tower located in industrial area where large embankment works are expected in future.

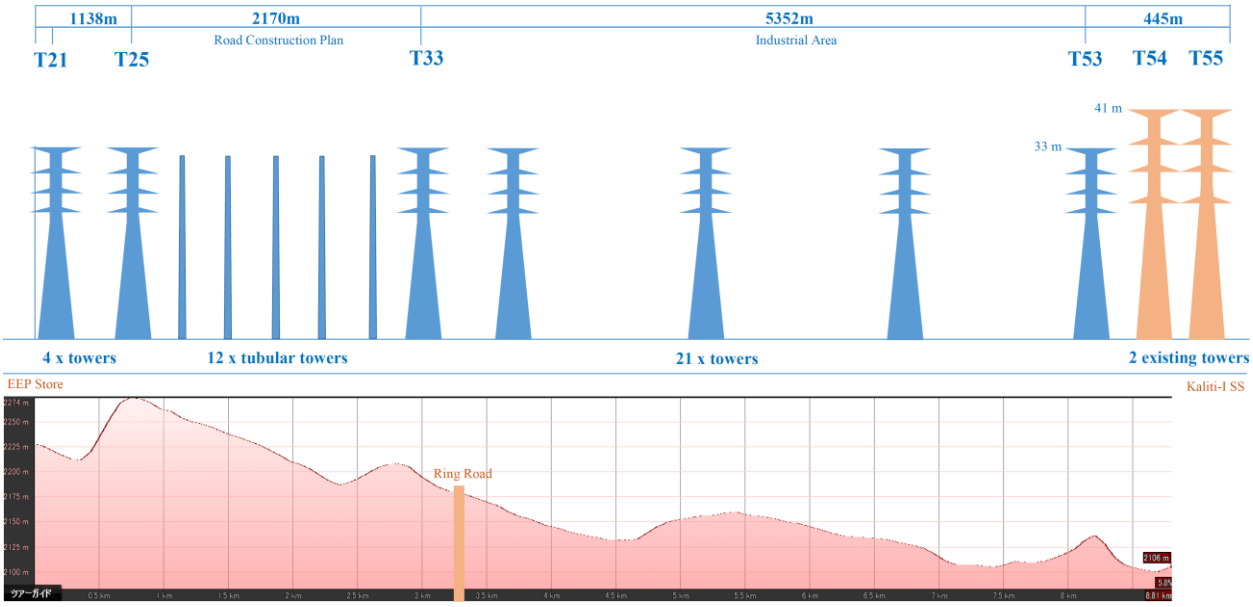


Fig. 7.1-2 Tower Arrangement

New road construction is planned within the same ROW (Corridor) for the section T25 / 26 to T30/31, so it is recommended to apply tubular tower for this section in order to reduce the span between tower by 160-180 meter and for having smaller foundation, which shall be constructed in the center of road. Moreover, the spacing of two circuits can be reduced by applying insulated cross arms. Final configuration will be described in the final reports. Reference drawings are attached in Appendix - 5: Conductor Tower & Foundation Design.

2) Tower design for Section 2

A tubular dead-end tower will be designed for this cable termination tower, which will be located and constructed between the existing tower T 67 and 68, beside the national road and LRT. This tower shall be constructed in the limited land space in the garden of the church, and it has only a short electrical distance from the 132kV transmission line Cotobie - Kaliti. Therefore, new cable termination tower shall be designed as compact as possible. Also, tower shall have enough height to make enough electrical clearance from the LRT which was constructed a few years ago.

The tower will be located in the public open area of the church, so, tower shall have a simple design as tubular monopole type and it shall not disturb anything in the point of view of physical matters such as foundation size.

The existing tower T67 (suspension) and T68 (tension) shall be retained in their current state without any reinforcement.

Fig. 7.1-3 Tower plotting for cable termination

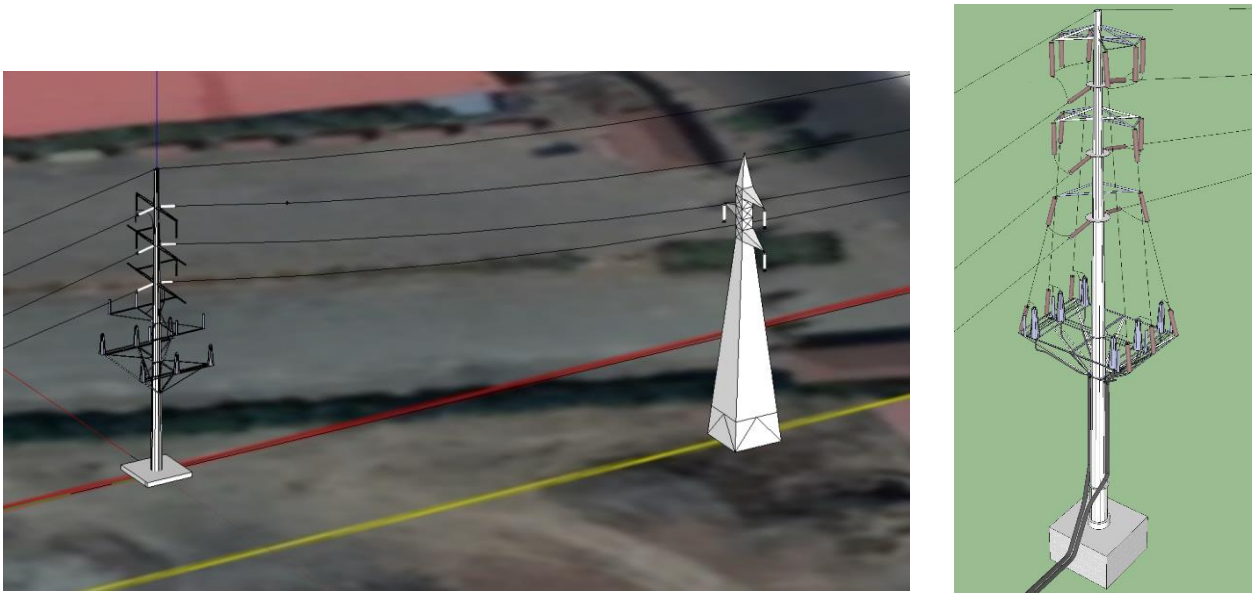


Fig. 7.1-4 Bird view of Cable Termination Tower

In the Preliminary design, the lattice steel tower type shall be designed to use conductors which have diameter similar to conductors such as Tiger, Ostrich, ASH/AAAC 180, which are used in the existing EEP 132 kV transmission lines. The load conditions such as wind pressure, wind span length and weight span length, in the design of new tower for conductors shall be same as the design used in existing 132kV transmission line. As a result, the newly designed lattice tower will be compatible with the other lattice towers in the EEP transmission lines, and this design policy will contribute in controlling the standard design in EPP. For the design of foundation, the original tower lands of one (1) circuit tower shall be used in the new design of two (2) circuit tower. The dimension of back to back stub angle of standard tower shall be same as the original one (1) circuit tower.

In the preliminary design of tubular monopole tower, it is necessary to minimize the width of Right of Way (ROW), as the tubular monopole tower will be installed on the median of the road which will pass through residential area. Also the design is intended to keep the impact on the landscape to a minimum, by applying simple insulated cross arms, which makes the tower look simple, without causing any heavy impact to the look of the surroundings. Design examples of steel towers are shown in Appendix - 5 Conductor Tower & Foundation Design.

Table 7.1-5 Preliminarily Design for Every Tower Type

Tower Type	LD	MD	ND	ND
	AD	BD	CD	DD
Phase Conductor	Invar XTACIR 210 x Single Conductor (2 circuit)			
Ground Wire	OPGW, 48 fibers, (max 7/3.20mm-91.71mm2, 12.90 dia)			
Deviation Angle	0º-2º	0º-30º	0º-60º	Dead End
Insulator Strings	Suspension	Tension	Tension	Tension
Basic Span	350 m	350 m	350 m	350 m
Wind Span	450 m	450 m	450 m	450 m
Weight Span	700 m	700 m	1500 m	700 m
Uplift	- 175m	- 400 m	- 400 m	- 350 m

Tower Type	Tubular Monopole 2cct	Tubular Monopole 1cct
	TAD	TDS
Phase Conductor	Tiger ACSR 166 x Single Conductor (1cct)	
Ground Wire	Existing OPGW	
Deviation Angle	0º-2º	0º-5º
Insulator Strings	Suspension	Tension
Basic Span	160 m	250 m
Wind Span	180 m	250 m
Weight Span	250 m	350 m
Uplift	N/A	N/A

Source: EEP

The code in tower type are as follows

A, B, C, D : Type of suspension, tension and dead-end tower

T : Tubular Monopole

D, S : Type of double Circuit, Single Circuit tower

The tower height shall be designed to keep minimum clearances to the phase conductors as stipulated in Directives on Overhead Electric Line Clearance issued by Ethiopian Electricity Agency in 2005. Specially, in order to avoid faults arising from electrical contact with trees, under the transmission line and phase conductors, the minimum height of the lowest phase conductor shall be kept more than 13 m from ground level in the entire transmission line route.

To avoid the relocation of any residence who lives under the ROW of existing 132kV transmission line, extended height towers shall be applied. A clearance distance of 8 m shall be kept, considering the construction of a two-story house in the future. As a result, the resettlement of residents can be avoided. Also during the construction stage, the contractor shall adjust and confirm the location of towers and the height of every tower again, so that the required electrical clearance distance can be maintained in the longitudinal profile drawing, which shall be created in the field survey. The extension of tower shall be designed with +3, +6, and +9 m at every 3 m.

Table 7.1-6 Electrical Clearance

Clearance	Objects
8.0 meters	Vehicle accessible road and any other objective points
10.5 meters	Railway and tramway
13.0 meters	Vegetation where may be planted by tree, crop and vegetation
4.6 meters	Any other overhead line including communication line

Profile drawings and tower schedule are shown in the Appendix-4. A small deviation tower (BD) shall be designed on T25 to make a line deviation angle of 3° toward T26. 12 tubular monopole suspension towers shall be constructed between T-25 and T-33. So a small deviation tower (BD) shall be designed on T-33 also. The height of tubular monopole tower shall be adjusted to keep sufficient clearance from the ground by using body extension. A ring road of Addis Ababa will pass between T-33 and T-34, and the area from T34 up to Kaliti substation will be designated as industrial zone.

A small deviation tower (BD) shall be designed on T52, which is located at the top of the hill, to make line deviation towards the Kaliti side. A Dead-end tower shall be designed on T-53, which is located inside the Kaliti substation, to make T-53 as section tower, as full tension will be applied toward T-52 side and slack span will be applied toward T-54. Existing tower T-54 and T-55 shall be used with necessary rehabilitation using slack tension span as the design standards were not same as the design standards of the new tower. Finally, dead-end tower shall be designed on T56, in front of gantry, in Kaliti substation. The gantry tower had been constructed over 35 years ago, so the applied conductor tension shall be kept to a minimum strength.

Table 7.1-7 Bill of Quantity for Tower

Description	Unit	Quantity
Tower AD	tower	19
Tower BD	tower	5
Tower CD	tower	1
Tower DD	tower	2
Tower DD-C (Cable Termination)	tower	1
Tower DD-G (Kalit Dead-end)	tower	1
Tower TA (Tubular Monopole)	tower	12
Tower TCD (Cable Termination)	tower	1

Lose of nuts and bolts due to thefts has become a serious maintenance problem in EEP. As the transmission line passes through in-accessible and unmonitored area on steep hill side, with many trees and bushes, nuts and bolts in the lower part of the tower are removed and taken away, also important braced angle steels were stolen. Nuts of anti-climbing devices have been completely removed from many towers. Also there are many towers located in locations, which are accessed by vehicles, such towers have received serious mechanical damages on the bottom tower steel by trucks or cars, which hit their body. Several towers have collapsed and are hanging by the tension of phase conductors from both the sides of the tower. For this reason, maintenance works to keep tower in good condition is so important for EEP. It is recommended to provide anti-theft measures and counter protection from vehicles, by using anti-theft nuts and providing a stronger tower body which can withstand external mechanical forces. Conventionally, spot welding on nuts and angles are applied, however those measures may not be effective considering the current situation of theft or external forces. Recently, anti-theft nuts have been found to be very capable in protecting the tower from theft, as they cannot be removed by ordinary tools such as spanners. The details of the nut are shown in Appendix-5.

(3) Design for Insulator Assemblies

1) Insulator

NGK's porcelain insulator has been used for the existing 132kV transmission line, and they have been in service for over 30 years since the 1980's, without electrical problems. Hence composite polymer type insulators made by Tonly China are applied for new 132 kV and 220 kV transmission lines in EEP after 2010. Also the EEP's technical specification stipulates to use the composite polymer type insulator, and not the porcelain insulator or the glass insulator. Electric power companies in Southeast Asia suspended and stopped using those composite polymer type insulators, in the recent years, as those composite insulators have to be replaced with new ones every ten years. So their life cycle cost is much higher than that of the original type glass and porcelain insulators.

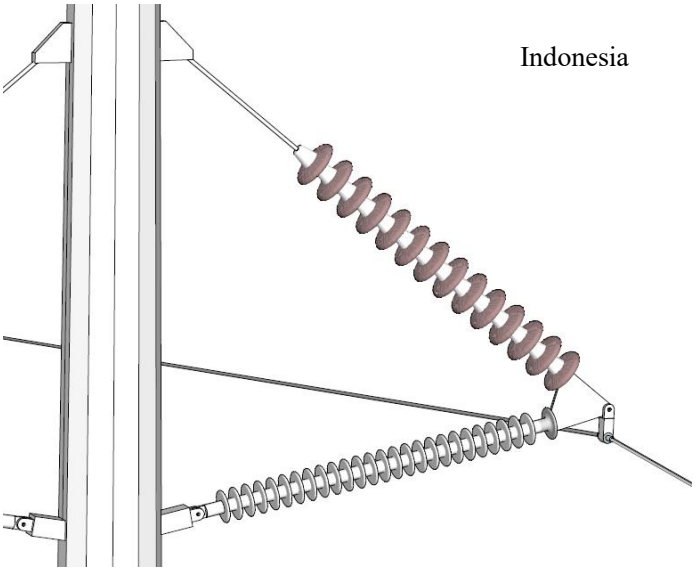
From the above, it is recommended to apply a porcelain type insulator which is used for existing transmission lines and its durability is confirmed though its long operation period without failure. Addis Ababa is located at the high altitude of 2400 m above sea level, the air pressure (air density) is decreased and the flush overvoltage of switching impulse is also decreased, which is an important feature of the insulation design of the transmission line. So insulation strength (number of insulator disc) shall be adjusted to compensate the decrease of

air density. As the flashover voltage will be decreased by 25% at 2,500 m, and 13 or 14 discs/insulator strings of ball-clevis type suspension guards of 70kN and 120kN have already been used for existing transmission lines, and its insulation strength has been confirmed. Therefore we recommend to apply 14 numbers of porcelain discs per insulator strings for this project.

Ball and clevis of type 70 kN, 120 kN are currently being used on the existing transmission lines, so it is recommended to use U120B x 14. To guarantee the quality of porcelain insulators, manufacture is requested to submit a type test report issued by a reputable international laboratory from any country other than the manufacturing country.

2) Insulated Cross Arms

For the section between T-25 and T-33, tubular monopole tower will be constructed on the median strip of the road with two lanes. In order to design a tower as much compact as possible and to minimize ROW, a braced post insulator shall be designed for this section. Braced post insulators have been applied in the Philippines and Indonesia.



Indonesia

Japan and Philippine

EEP in Addis Ababa

Fig. 7.1-5 Reference samples in other countries

(4) Foundation

The outline design of the foundation will be carried out after obtaining the result of soil investigation, and will be studied during the implementation of the second field study. The progress up to this period is as below.

The existing basic design of EEP has five basic types as shown in Table 4.1-12. However, the preliminary designs have been carried out by considering only the load reaction force of the tower, without considering other force such as external pressure from road and embankment. Specifically,

the excavation depth is shallow, at about 2 m in the existing design, the tower base body has moved due to the pressure load from the surrounding area of the towers, and the problem of deformation of the steel tower material has been observed in many locations. (Fig. 7.1-6).

The foundation footing shall be designed in such a way that the deformation by unexpected soil pressure after construction shall be minimized.

In addition, the tower foundation setting level for towers T34 to T48 will surely increase in the future, as the areas are in a factory complex and the land for factory will need higher ground leveling as shown in photos.

Fig. 7.1-6 Deformation by Soil Pressure of road and houses

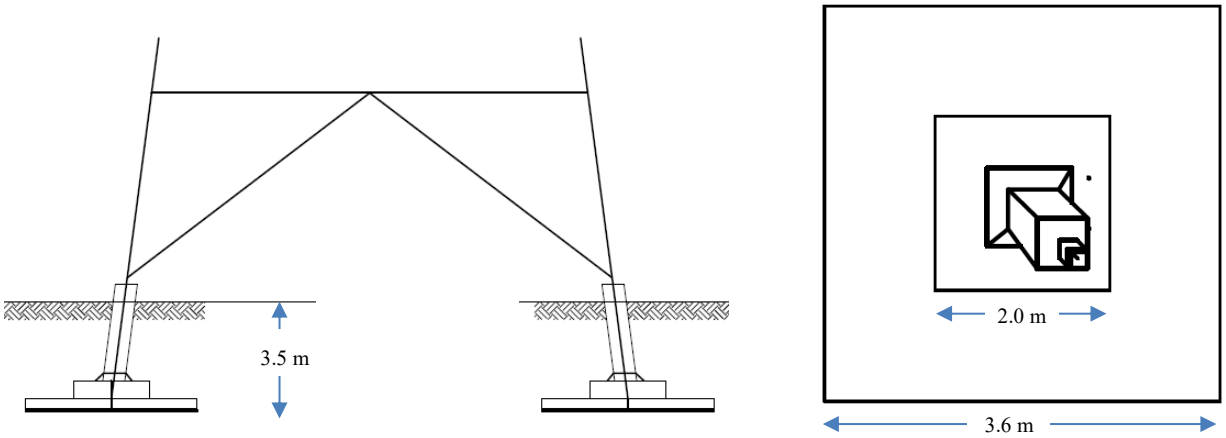
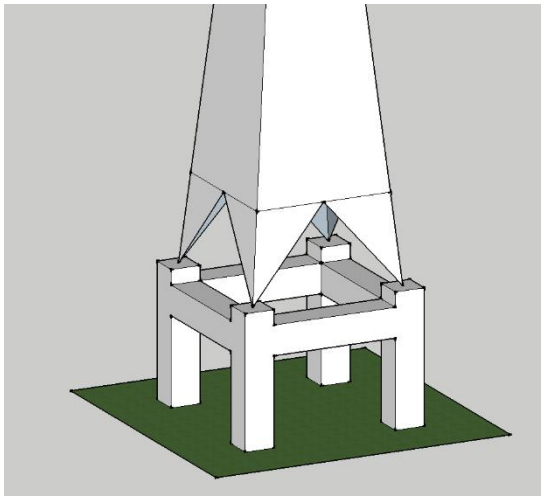


Fig. 7.1-7 Basic Foundation Design



T34
T35
T36
T40
T41
T42
T46
T47
T48

Rigid foundation is required

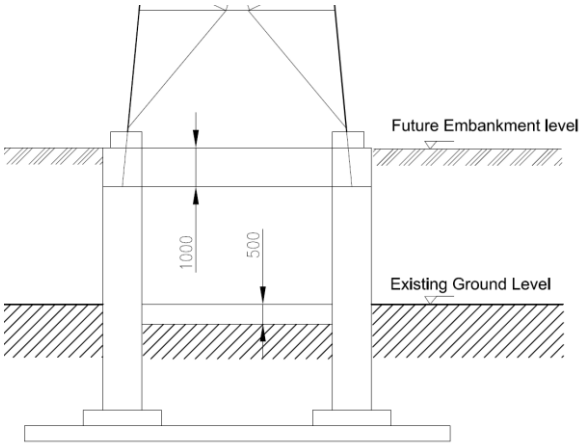


Fig. 7.1-8 Rigid Foundation

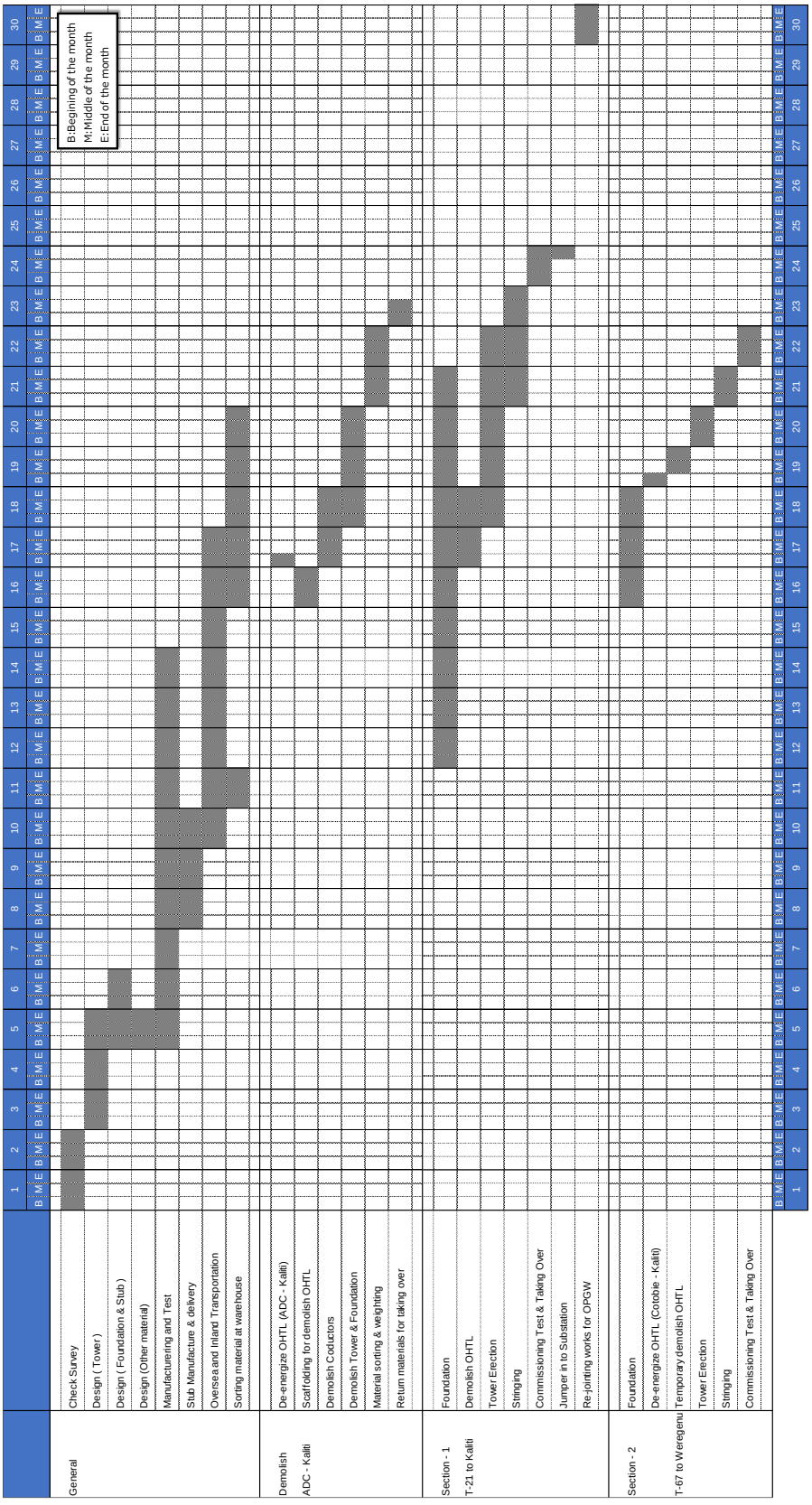
7.1.4 Budgetary Cost for Overhead Transmission Line

Nonpublic Information

7.1.5 Constriction Schedule for Over Head Transmission Line

Construction schedule is shown in Table 7.1-8.

Table 7.1-8 Construction Schedule for Overhead Transmission Line



7.2 UNDERGROUND CABLE

This section describes the preliminary design of the 132 kV underground cable system.

7.2.1 Outline of Route

The scope is divided into three sections. Table 7.2-1 summaries the outline of the route for each section.

Table 7.2-1 Outline of route

	Terminal 1	Terminal 2	Route length
Section 1	Black Lion substation	New Addis Center substation	*1,950 m
Section 2	New Addis Center substation	Connecting point with the overhead line which is close to Gofa substation	4,285 m
Section 3	Weregenu substation	Connecting point with the overhead line which is close to St. Mary's church	3,540 m

* 200 m of the temporary branch to connect with the temporary substation in Addis Center is not included.

7.2.2 Required Transmission Capacity

Table 7.2-2 shows the required transmission capacity for the cable based on the study in section 3.1.1.

Table 7.2-2 Design condition for the cable

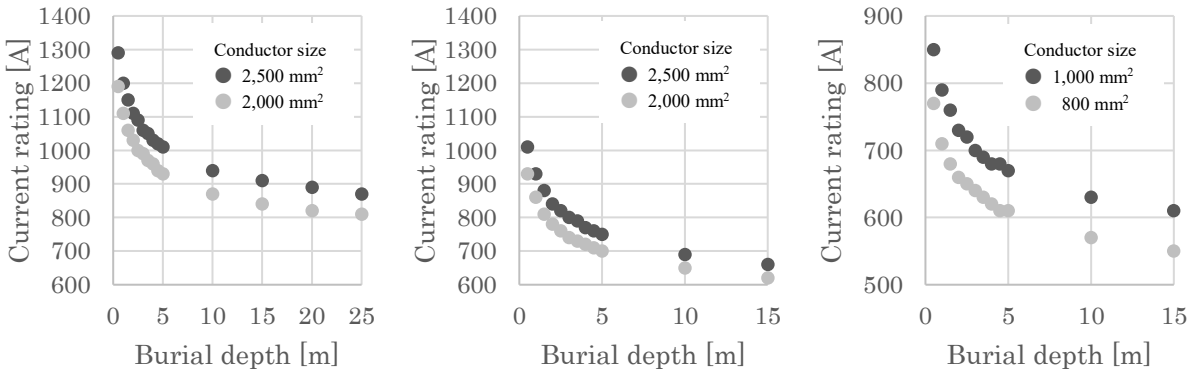
	Study in section 3.1.1		Required transmission capacity
	Normal condition	Short time overload	
Section 1	N/A	225 MVA	*205 MVA (corresponds to 225 MVA of short time overload)
Section 2	225 MVA	375 MVA	342 MVA (corresponds to 375 MVA of short time overload)
Section 3	150 MVA	N/A	150 MVA (corresponds to 165 MVA of short time overload)

* 205 MVA is a sufficient capacity for the temporary substation in Addis Center substation.

7.2.3 Preliminary Design of the Underground Cable System

Firstly, necessary conductor size is determined by the required current capacity mentioned in Table 7.2-2 and the calculation of current rating is also done. There are factors which influence the calculation. The ambient soil temperature and the thermal resistivity of soil are some of the influential factors. In general, the maximum ambient soil temperature at the depth of about 1 m from the ground surface is lower than the ambient air temperature because, it is not affected by solar radiation. According to the WORLD Weather online, the annual maximum temperature of Addis Ababa from 2009 to 2017 has changed from 25 °C to 28 °C, which is about 27 °C on an average. According to IEC 60287, 2.0 K.m/W is set as the thermal resistivity of soil under conditions that soil condition is dry and weather condition is such that it seldom rains. From the above, the ambient soil temperature is set at 27 °C and the thermal resistivity of soil is set at 2.0 K.m/W, and the mentioned values are applied for the calculation of current rating.

Fig. 7.2-1 shows the relationship between the current rating and the burial depth of the cable. It suggests that the current rating decreases with burial depth. “Single core” and “Triplex” are the cable types shown in Table 7.2-4.



(a) Single circuit and Single core (b) Double circuit and Single core (c) Single circuit and Triplex

Fig. 7.2-1 Relationship between the current rating and the burial depth of the cable

Table 7.2-3 shows the results of calculation of current rating. Since the cable must avoid other buried objects, the allowable burial depth recommended is 5 m or more. For Section 1, assuming the case of traversing the underpass by a drilling method, the depth shall be set to 15 m more over.

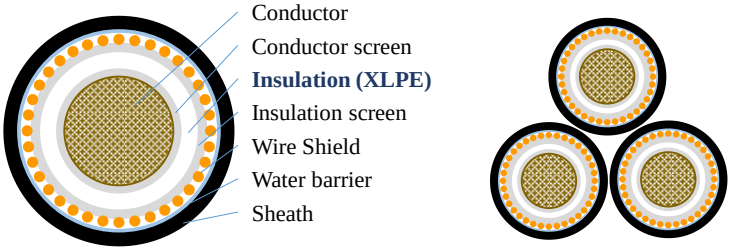
Table 7.2-3 Relationship between conductor size and permitted burial depth

	Required transmission capacity		Conductor size	Calculation result	
	Capacity	Rating current		Permitted burial depth	Evaluation
Section 1	205 MVA	900 A /cct under single circuit condition	2,000 mm^2	6 m	Poor
			2,500 mm^2	**15 m**	**Good**
Section 2	342 MVA	750 A /cct under double circuit condition	2,000 mm^2	2.5 m	Poor
			2,500 mm^2	**5m**	**Even**
Section 3	150 MVA	660 A/cct under single circuit condition	800 mm^2 (Triplex)	2 m	Poor
			1,000 mm^2 (Triplex)	**6 m**	**Even**

Table 7.2-4 shows the specification of the cable. The protection from water ingression should be considered because moisture intruding inside the cable can cause breakdown in future. Compared to the metallic over sheath like an aluminum corrugated sheath, an aluminum laminated tape is an excellent material for water barrier from the viewpoints of thickness and flexibility.

Triplex, adopted in section3 has a structure, which bundles three cables into a single, and it is mainly adopted when the conductor size is 1,000mm^2 or less. Compared to the single core, it is advantages as it has less number of work for cable pulling, and in case the conduit system is adopted, the number of pipes required will be small.

Table 7.2-4 Specification of the cable

	Single core	Triplex
Schematic diagram of cross section		
Conductor size	2,500 mm^2	1,000 mm^2
Approx. core diameter	120 mm	95 mm (assembled: 210 mm)
Weight	35 kg/m	60 kg/m

Compared to the direct-buried-method, the conduit system requires additional cost initially but the system has many advantages as follows. The system protects the cables from unexpected damages caused by other construction works. Once the system is installed, the cables can be replaced without excavation work. And the system enables a flexible work schedule because it is not necessary to keep a trench until the cables are laid.

Table 7.2-5 compares the features of the different conduit pipes. This table indicates that Polycon Fiber reinforced Plastic (PFP) is optimal for power cables from various perspectives.

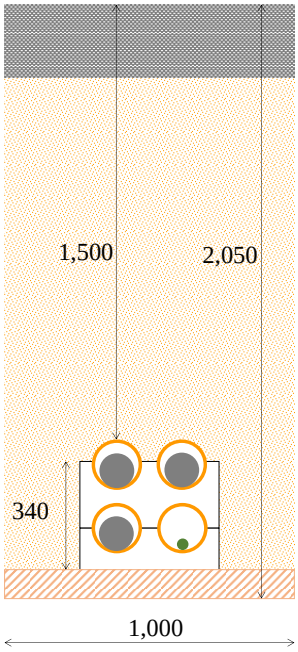
Table 7.2-5 Comparison of conduit pipes for power cables

	PFP pipe	*U-PVC pipe	**HDPE pipe
Strength	Strong	Not so strong	Not so strong
Water tightness	Very good	Good	Very good, but need adhesion at joint
Durability	Have stable performance in the long term	Need to consider creep of pipe	Need to consider creep of pipe
Continuity	Low friction resistance makes it easy to install cables	Flattened pipes make it difficult to install cables	Flattened pipes make it difficult to install cables
Workability	Easy to connect pipes without special skills and easy to make curve section because of the variety of pipes including bent pipes	Easy to connect pipes without special skills but difficult to make curve section because of the unavailability of bent pipes	Difficult to connect pipes without special skills of adhesion and difficult to make curve section because of the unavailability of bent pipes

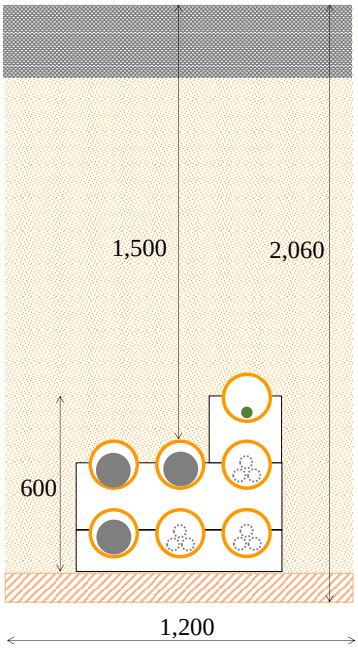
* Unplasticized Polyvinyl Chloride, ** High Density Polyethylene

Fig. 7.2-2 shows the schematic diagram for the layout of conduit pipes when the burial depth is 1.5 m.

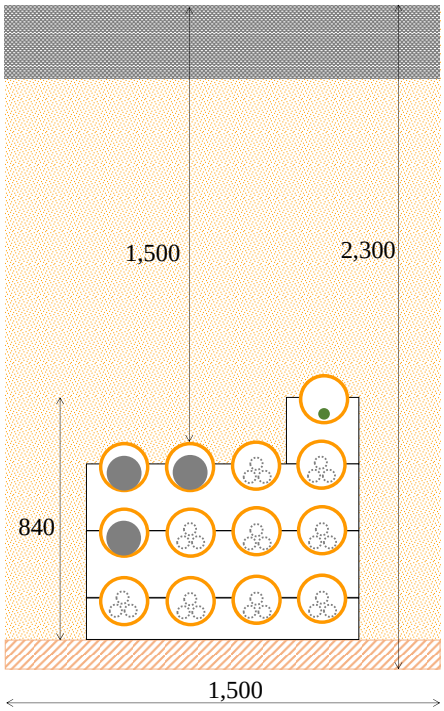
Three distribution cables go to New Addis Center substation from the front of Addis Center substation along with the 132 kV cables. On the way, six distribution cables merge with them at the intersection located on the north side of Africa Union.



From Black Lion substation to the front side of Addis Center substation

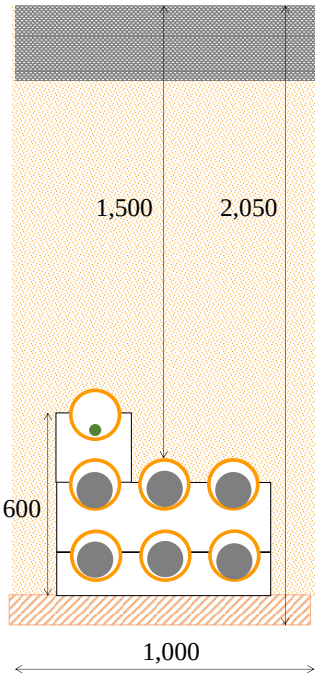


From the front side of Addis Center substation to the street north of Africa Union

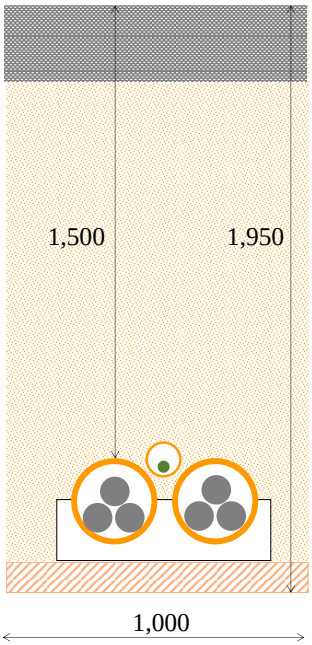


From the intersection north of Africa Union to New Addis Center substation

Section 1



Section 2



Section 3

Fig. 7.2-2 Schematic diagram for layout of conduit pipes

Pipe jacking is one of the methods to install a conduit system, which is applied to a section where an open excavation method cannot be applied. Fig. 7.2-3 shows the schematic diagram for the section of the conduit system. At first, hume concrete pipes are installed from the departing shaft to the arrival shaft with an excavator at the top. Then the conduit pipes for the cables are laid inside the hume concrete pipe. At last, the gap between the hume pipe and the conduit pipes is adjusted. Fig. 7.2-4 shows examples of equipment layout at departure shaft and plane views of shafts. In this project, there is a possibility that the pipe jacking method is adopted to traverse Mexico square in Section 1 as shown in Fig. 7.2-5.

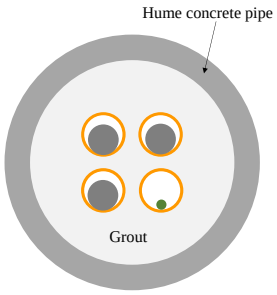
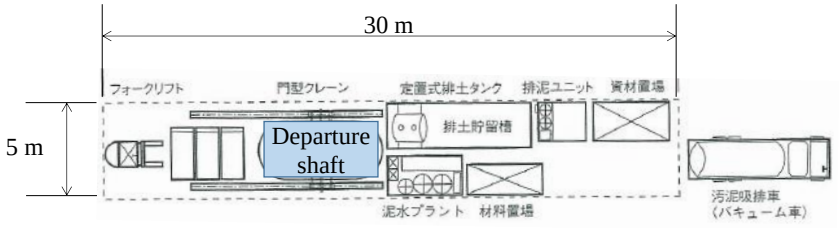
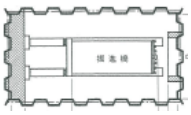


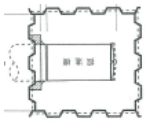
Fig. 7.2-3 Section of a conduit system installed by a pipe jacking method



Equipment layout at a departure shaft



Departure shaft



Arrival shaft

Fig. 7.2-4 Examples of equipment layout at departure shaft and plane views of the shafts.

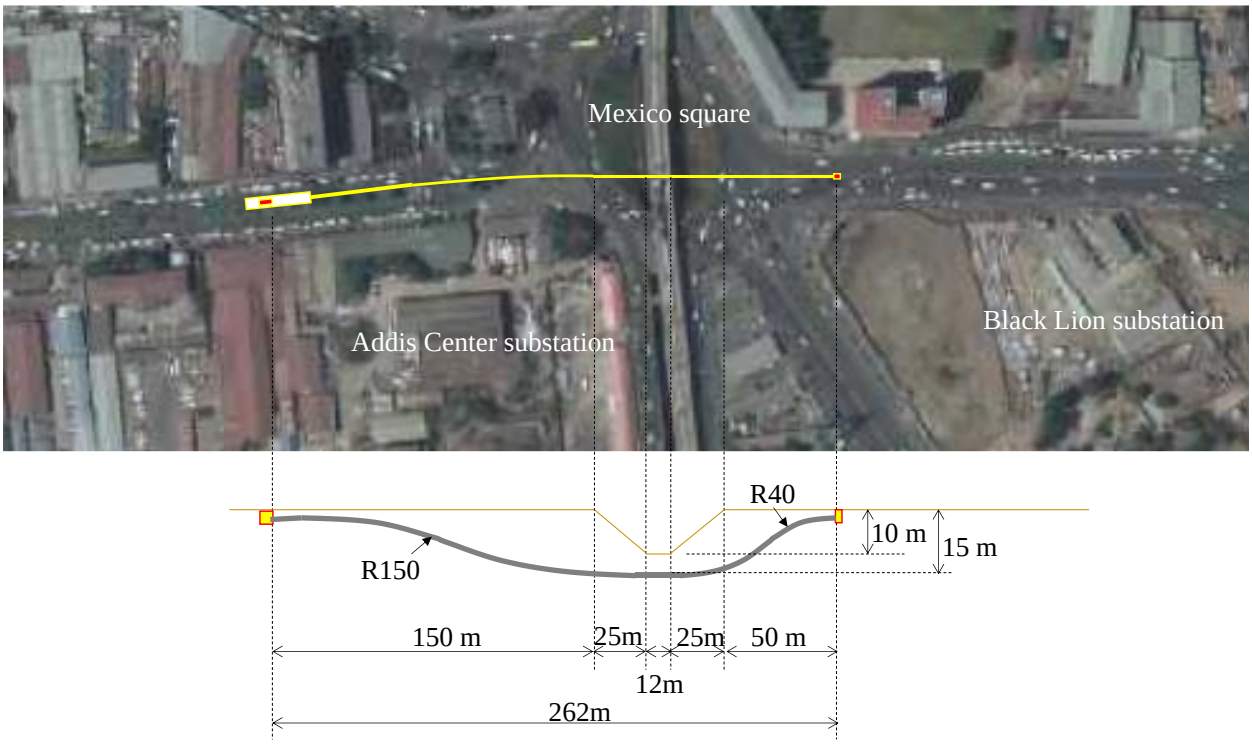


Fig. 7.2-5 Schematic diagram for the application of pipe jacking method

A manhole is one of the essential equipment of the conduit system. The cables need to be connected in appropriate span with a joint box. The joint boxes are protected in the manhole. Fig. 7.2-6 shows an example of the cable and the joint box cable arrangement in the manhole. In general, the size including the space necessary for the installation work varies from 2 m to 4 m by width and from 8 m to 14 m by length.

It is necessary to have a frame supporting for the sealing end to install outdoor termination, because the connecting point with the overhead line, which is close to Gofa substation, adopts outdoor termination. Fig. 7.2-7 shows an example of frame supporting for a sealing end.

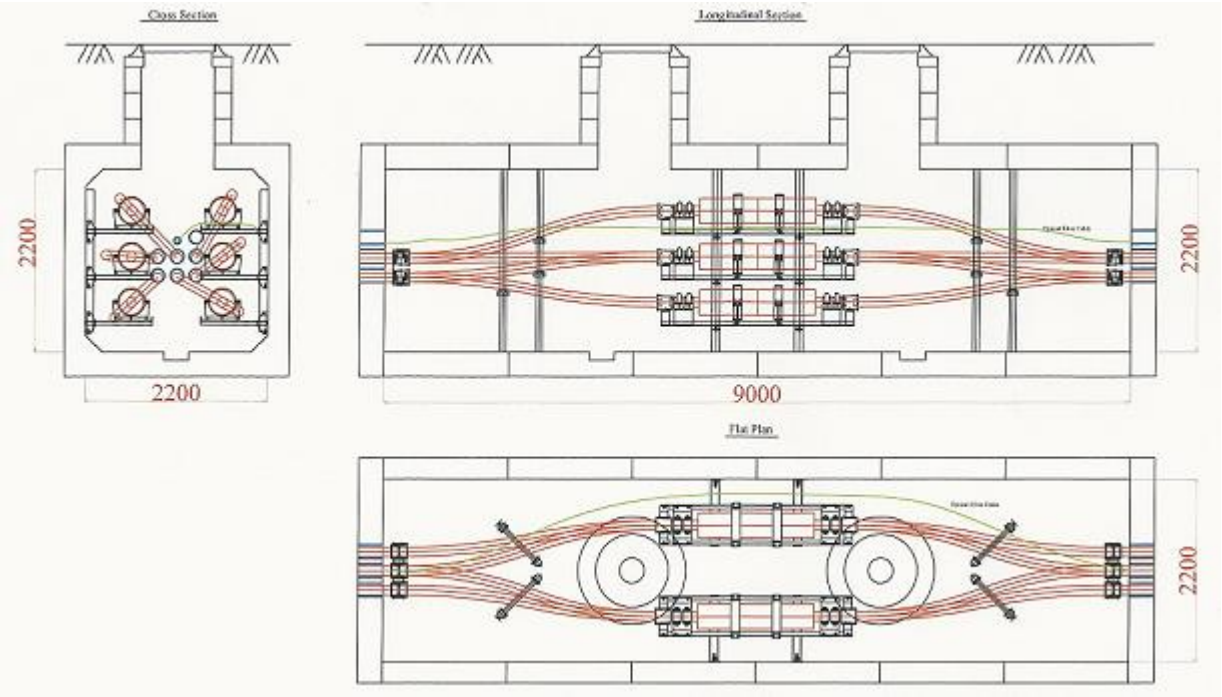


Fig. 7.2-6 Example of cable and joint box arrangement in manhole

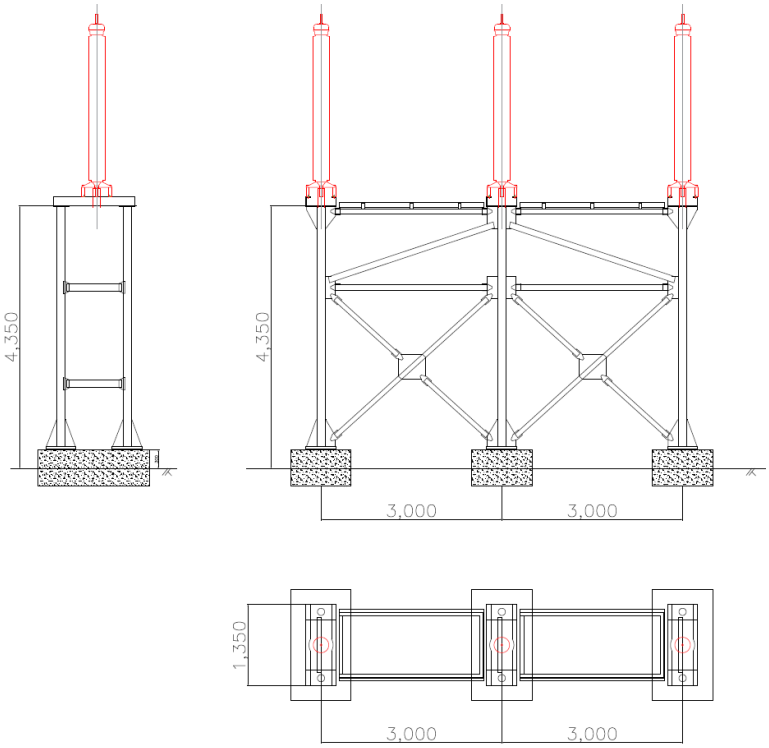


Fig. 7.2-7 Example of frame supporting for a sealing end

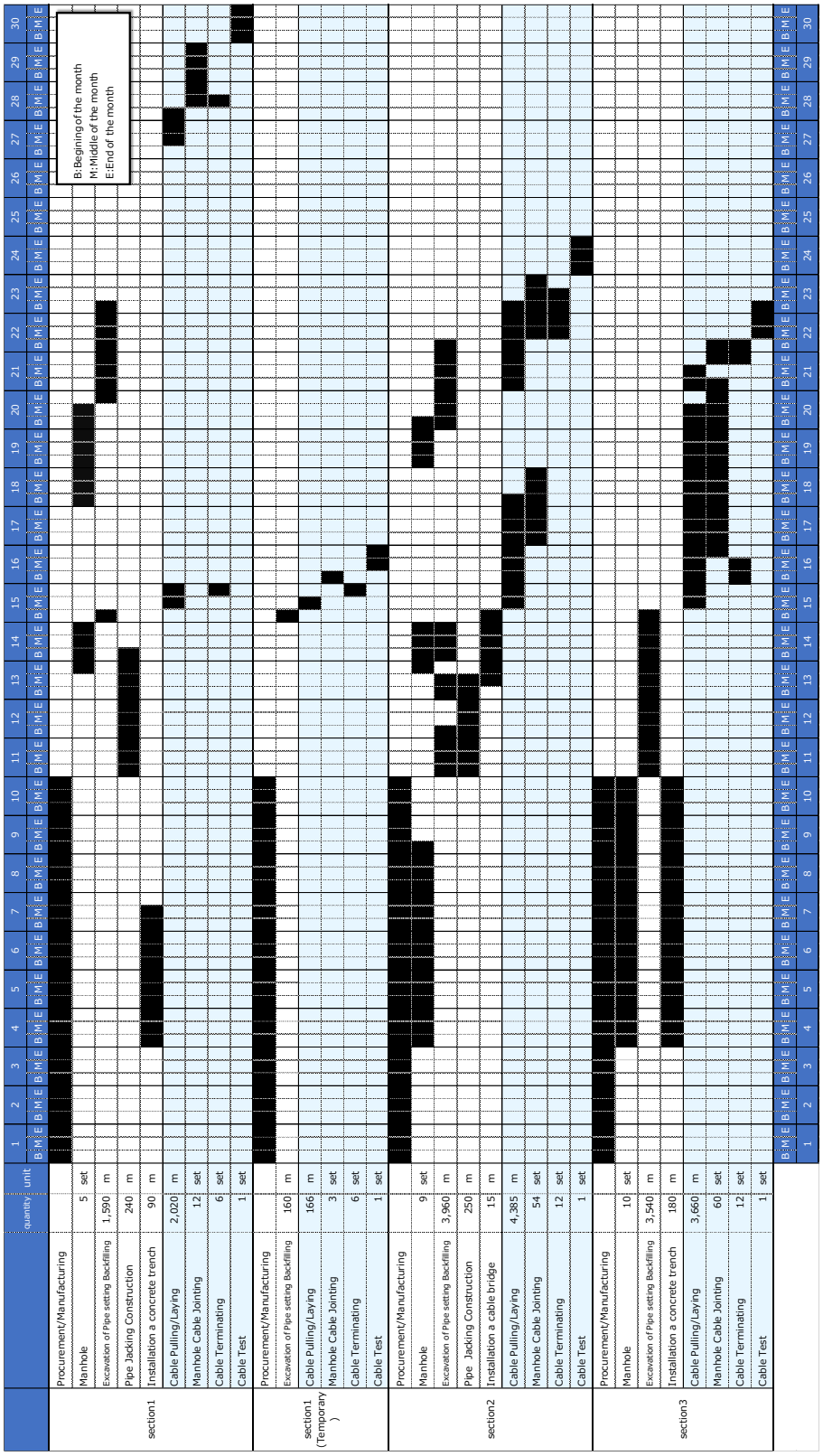
7.2.4 Budgetary Cost for Underground Cable

Nonpublic Information

7.2.5 Construction Schedule for Underground Cable

Construction schedule is shown in Table 7.2-6.

Table 7.2-6 Construction Schedule for Underground Cable



7.3 SUBSTATION FACILITY

7.3.1 Preliminary Design Concept

The scope of this study includes one new substation and 11 substations which will be reinforced and demolished. Preliminary design concept of the substation facility related to this study is shown below.

(1) Type of substation

1) Existing substation：Air Insulated Switchgear (hereinafter called “AIS”) substation

There is no big concern about site constraint in the existing substation. Therefore, existing substation will be reinforced as AIS to meet the criteria of the existing facilities.

2) New substation：Gas insulated Switchgear (hereinafter called “GIS”) substation

From the view point of site constraint, new ADC substation will be constructed as GIS substation to reduce size of substation site. New ADC substation will be located at a central area of the city where new buildings are expected to be constructed one after another. Therefore, the new ADC substation shall be installed not as a conventional indoor type GIS which have mainly been installed in Western countries but as an outdoor type GIS to minimize the size of substation site.

Characteristics of AIS, indoor type GIS and outdoor type GIS are shown below.

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

(2) Countermeasure against Altitude

Addis Ababa is a city at a high altitude of 2500m above sea level. According to IEC, at the altitude of over 1000m, the dielectric strength is decreased by one (1) percent for every 100m upwards. Therefore, at 2500m above sea level, the dielectric strength will be decreased by 15% compared to zero (0) m above sea level. As a conclusion of field survey, JICA study team found that Lighting Impulse Withstand Voltage (hereinafter called “LIWV”) of the existing equipment is not 650kV

which is the highest LIWV in the rated voltage of 145kV based on IEC60071, but 750kV, which is one rank higher LIWV. In fact, phase to phase and phase to earth clearance of existing equipment are secured at more than 1500mm corresponding to LIWV750kV. This clearance satisfies the relevant requirement, therefore, the designs of new and existing substations at high altitude will follow the design of the existing substation.

(3) Substation capacity and adopted voltage

The decision regarding the substation capacity and adopted voltage of each substation are based on the request from EEP and network system analysis.

(4) Bus bar configuration (scheme)

- Existing substation：Meets the existing bulbar configuration
- New substation：Double bulbar scheme

The new ADC substation will have a double bulbar configuration for high reliability, because, the new ADC substation will supply power to important customers such as African Union and the palace. One breaker and half bulbar configuration is not applied to the new ADC substation because of load supply substation in the city area.

(5) Power transformer

Power transformer will be of 132kV/15kV or 132/33kV configuration with an on-load tap changer. The tap changer unit will have a vacuum on-load tap changer as it involves no maintenance. Transformer winding will be two winding type and the vector group will be YNd11 (primary side: wye connection and solidly grounded, secondary side: delta connection and non-grounded, 30 degree lag).

Moreover, low-noise type power transformer will be installed because the new ADC substation will be located in the center of the city.

(6) Reactive power equipment

New ADC substation will be installed with 15kV capacitor bank.

(7) Grounding scheme (Network and Substation)

Existing substation：Meets the existing scheme. Earth mesh of substations which will be expanded are connected with the existing earth mesh properly.

New substation：Meets the existing scheme. This means, 132kV network will be solidly grounded. 33kV and 15kV network will be non-grounded using earthing transformer.

(8) Protection relay scheme

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

- 132kV T/L protection： Current differential relay, Distance relay
- 132kV Bus bar protection： Differential relay
- 132kV Transformer protection： Current differential relay
- 15 (33) kV D/L protection: Overcurrent relay

New substation: Meets the existing protection scheme for future maintenance and operation. Basic concepts of the main protection relay are shown below.

- 132kV T/L protection： Current differential relay, Distance relay
- 132kV Bus bar protection： Differential relay
- 132kV Transformer protection： Current differential relay
- 15 (33) kV D/L protection: Overcurrent relay

(9) Substation control system

Existing substation: Meets the requirements of existing substation control system

New substation: Installed with a Substation Automation System (hereinafter called “SAS”) based on IEC61850 to match the specification of the new substations such as BLL substation.

(10) Communication system

The most important aspect of the communication system is to integrate the specifications of communication system. Therefore, the communication equipment to be installed in this project will be the one using multiplexer which are currently installed in the city area’s substation. Specifically, FOX615 manufactured by ABB will be installed for this project.

(11) Countermeasures against disaster

The occurrence of a big earthquake or a flood in Addis Ababa city region is minimal. Necessary countermeasures against disaster with respect to the substation will be examined.

(12) Countermeasures against environmental safety

The new ADC substation will be located in the center of the city, and new buildings are expected to be constructed around the substation site. The main cause of substation's noise is the sound from the operation of the power transformer. Therefore, installation of low-noise type transformers will be examined. Of course, the new ADC substation will be installed with an oil storage pit to prevent the flow of power transformer oil outside the substation site.

7.3.2 New ADC Substation

Proposed single line diagram and layout of new ADC substation are shown in Fig. 7.3-1, Fig. 7.3-2.

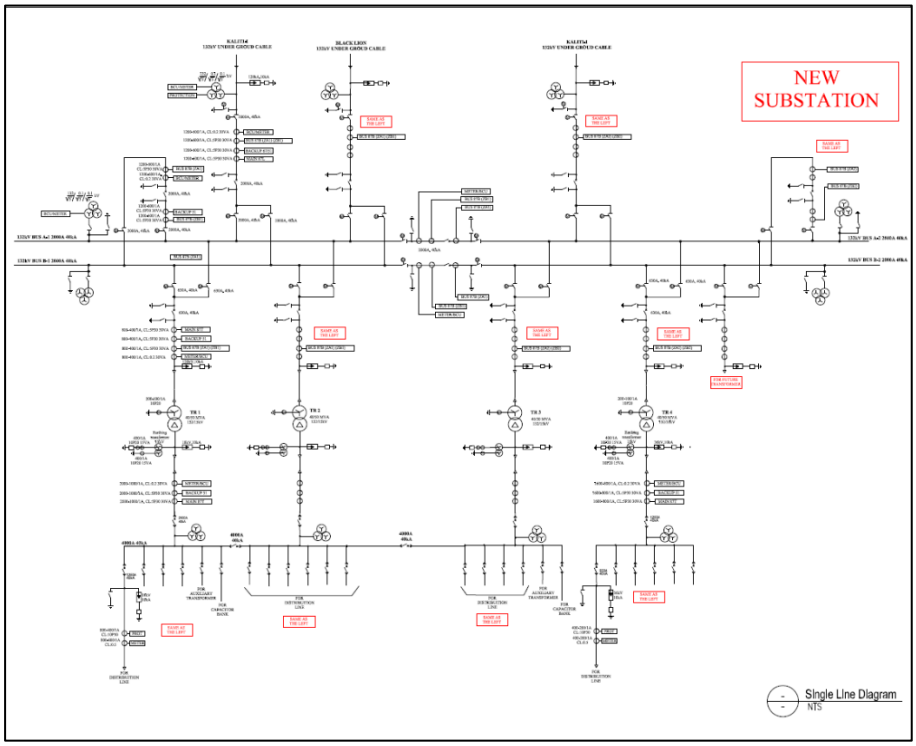


Fig. 7.3-1 Single Line Diagram of New Addis Center Substation

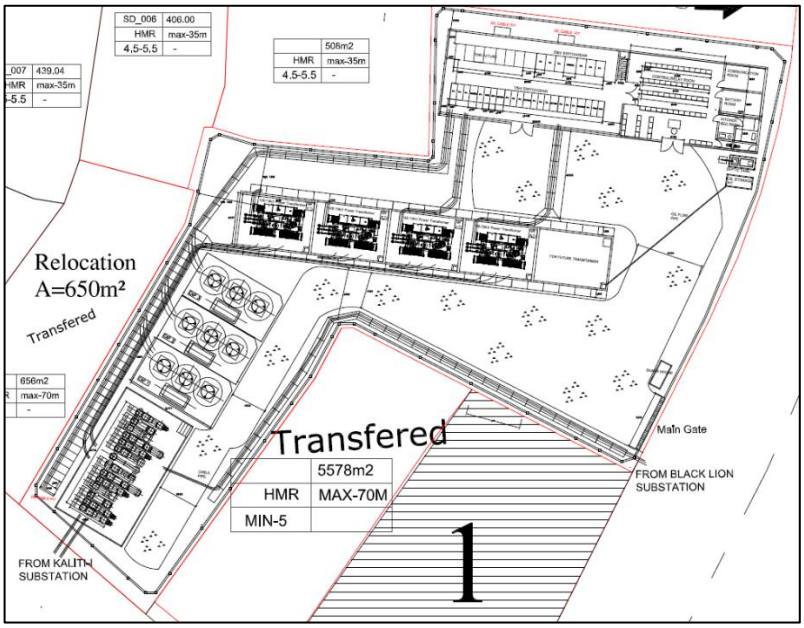


Fig. 7.3-2 Layout of New Addis Center Substation

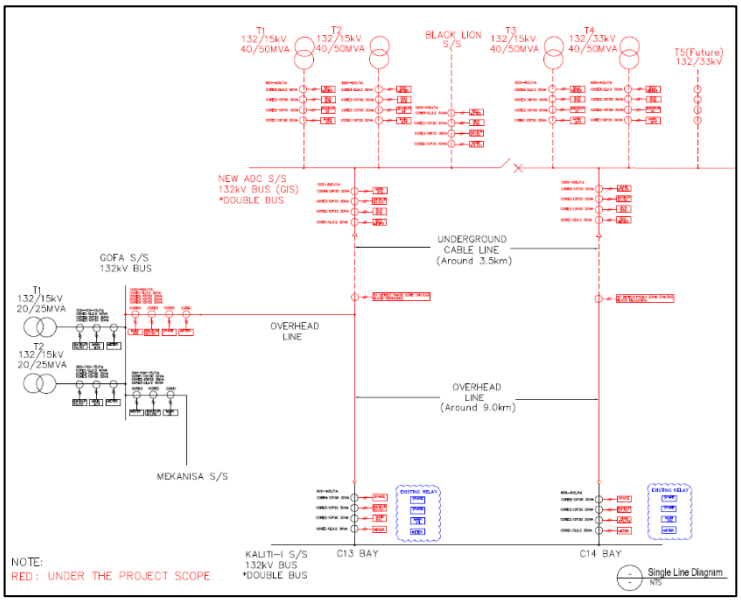


Fig. 7.3-3 Protection Overview Diagram related to New ADC substation

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

(1) Main switchgear

From the view point of reliability and site constraint, the new ADC substation will be installed with 132kV outdoor GIS. For future expansion, the outdoor type GIS will be installed with five (5) transformer bay units. Moreover, the GIS cable terminal will be plug-in type, and it will be installed in such a way that a GIS modification will not be necessary when a new power cable is connected.

- 132kV GIS units 1 lot

Description	Basic specification
GIS or AIS	GIS
Rated Voltage	145kV
Rated current	Bus: 2000A Transmission line feeder: 2000A Transformer feeder: 630A
Rated short time current	40kA
Bay configuration	3 transmission line bay 5 transformer bay 2 voltage transformer bay 2 bus coupler bay 2 bus section bay

(2) Power transformer

- 132/15kV power transformer 3 units
- 132/33kV power transformer 1 unit
- 15kV earthing transformer 4 units (for detection of ground fault)

Description	Basic specification
Rated Voltage	HV: 132kV, LV: 15kV, 33kV
Rated Capacity	40 MVA (ONAN) / 50MVA (ONAF)
Winding Type	YNd11

(3) Reactive power equipment

- 15kV Capacitor Bank 3 units

Description	Basic specification
Rated Voltage	15 kV
Rated Capacity	15 MVA

(4) Protection relay

Protection relays for the new ADC substation will be of Bay Control Unit (hereinafter called "BCU") type based on IEC61850.

- 132kV T/L protection panel 3 units
- 132kV Transformer protection panel 4 units
- 132kV Bus bar protection panel 2 units (including bus coupler / section protection)

(5) Control system

Control system for the new ADC substation will be of Bay Control Unit (hereinafter called "BCU") type based on IEC61850.

- 132kV Transmission line bay control panel 3 units
- 132kV Bus bar coupler/section control panel 2 units
- 132kV Transformer line bay control panel 4 units

(6) SCADA system

The SCADA system of the new ADC substation will consist of double ring units using Ethernet.

- Substation Automation System (SAS) 1 unit

(7) Communication system

Communication system of the new ADC substation will contain FOX615 by ABB, incorporated with SDH/MUX to integrate the existing substations.

The joint box of OPWG is considered in the scope of transmission line work, therefore it is not described in this section.

- Optical distribution flame 1 lot
- ABB FOX615（MUX/SDH） 1 lot
- PBX system 1 lot

(8) Middle voltage metal cubicle

- 15kV metal cubicle 3 units
- 33kV metal cubicle 1 unit

Description		Basic specification
Rated Voltage		15 (24) kV, 33 (36) kV
Rated current	15kV	Transformer bay: 2500A Bus: 4000A Feeder: 1250A
	33kv	Transformer bay: 1250A Bus: 2000A Feeder: 630A
Rated short time current		40kA

(9) Low voltage AC/DC system

For securing reliability, the new ADC 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. Emergency generator will not be installed to save the construction cost, and also because the new ADC will be supplied by two (2) substations, BLL substation and KALI substation.

- 15kV/380-220V auxiliary transformer 2 units
- 110V Charger (Rectifier) 2 units
- 48V Charger (Rectifier) 2 units
- DC110V battery unit 1 unit
- DC48V battery unit 1 unit
- Emergency generator N/A

(10) Civil and building work

- Substation land grading 1 lot
- Equipment foundation and oil pit 1 lot
- Cable pit 1 lot
- Water supply and drainage 1 lot
- Site boundary wall 1 lot
- Control building and guard house 1 lot

7.3.3 Existing ADC Substation

The demolition of the existing ADC substation will be carried out by EEP prior to this project. Therefore, it is out of the scope of this project, the same applies to the removal of transformer.

7.3.4 Temporary ADC Substation

Temporary ADC substation will be connected with BLL substation using temporary underground cable to minimize the project period. Terminal end of temporary underground cable will be air insulated type. Therefore, it is only needed to connect terminal end with substation equipment using bare conductor.

The temporary ADC substation will be demolished after the construction of the new ADC substation. The removal of equipment and foundation in the temporary ADC substation will be carried out by the EEP.

7.3.5 BLL Substation

Single line diagram and layout of BLL substation are shown in Fig. 7.3-4, Fig. 7.3-5.

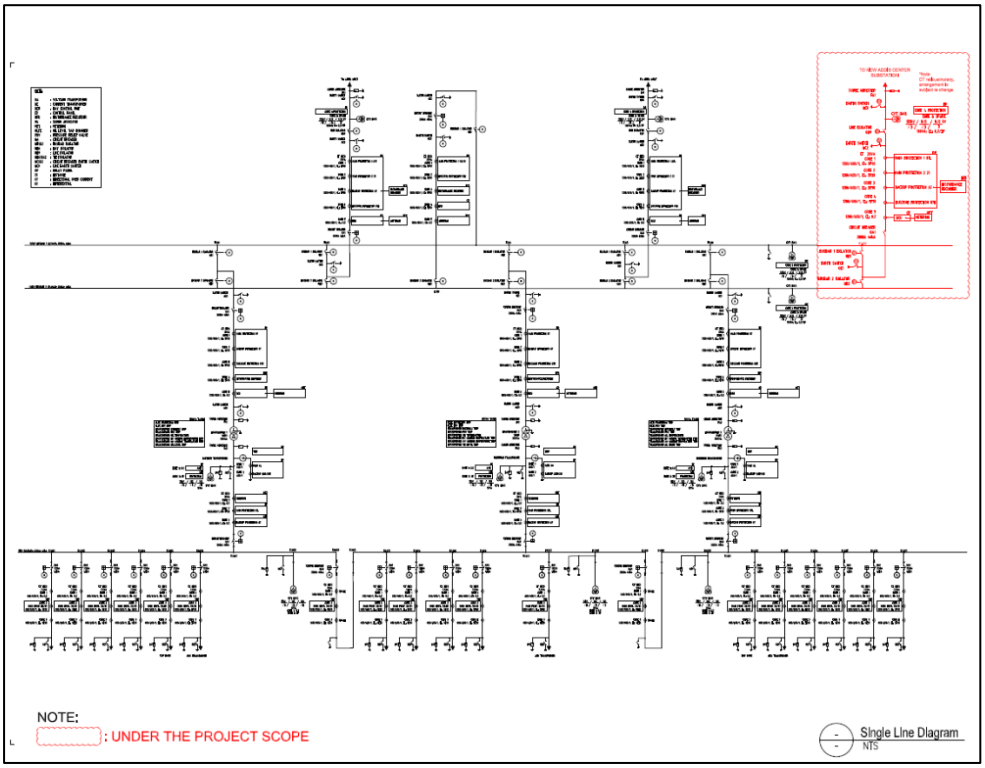


Fig. 7.3-4 Single Line Diagram of Black Lion Substation

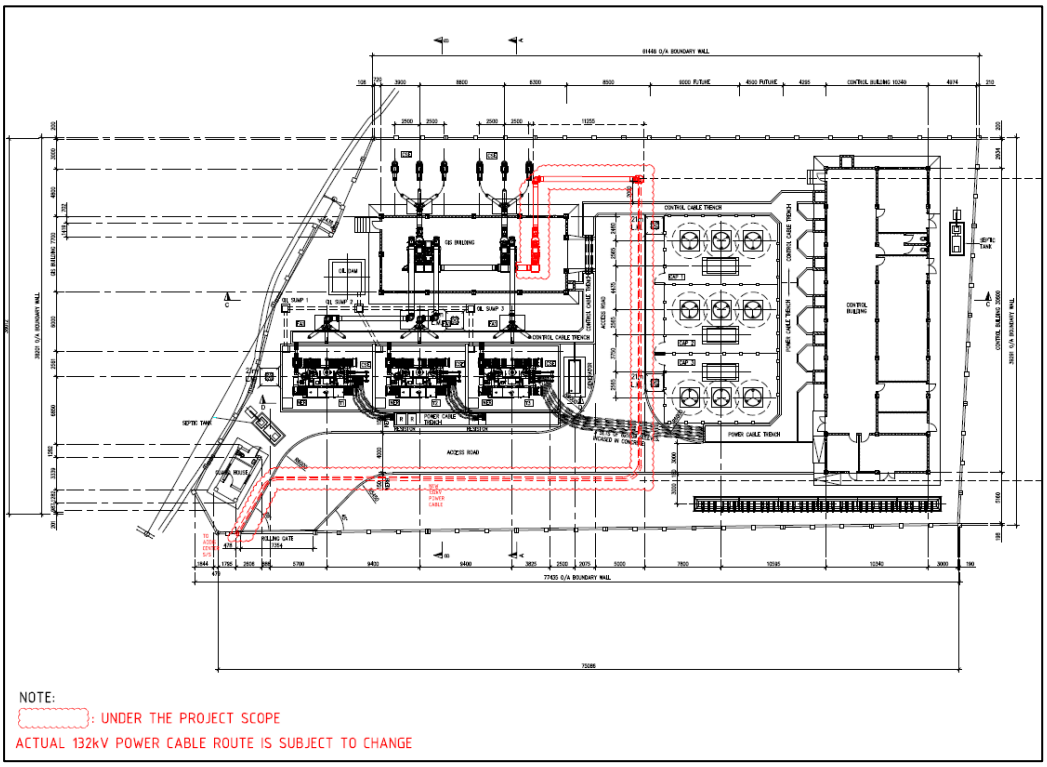


Fig. 7.3-5 Layout of Black Lion Substation

The number and the basic specification of each equipment to be installed in the BLL substation are described below.

(1) Main switchgear

Existing 132kV GIS is expanded to connect the new transmission line for the new ADC substation. Terminal of the new GIS units will be of direct-cable-connection type because underground cables are installed in all the new transmission lines from BLL to the new ADC substation.

- 132kV GIS units 1 lot

Description	Basic specification
GIS or AIS	GIS
Rated Voltage	145kV
Rated current	Bus: 2000A, Feeder: 2000A
Rated short time current	40kA

(2) Protection relay

The protection relay of the new ADC substation will be of Bay Control Unit (hereinafter called "BCU") type based on IEC61850.

- 132kV T/L protection relay 1 unit
- 132kV bulbar protection panel modification 1 lot

(3) Control system

The control system for the new ADC substation will be of Bay Control Unit (hereinafter called "BCU") type based on IEC61850.

- 132kV T/L bay control panel 1 unit

(4) SCADA system

Connection to the existing SCADA system is carried out.

- Connection to Mini-SCADA system 1 lot

(5) Civil and building work

- Equipment foundation 1 lot
- Cable pit for power cable 1 lot

7.3.6 GOF (Addis south II) Substation

Single line diagram and layout of GOF substation are shown in Fig. 7.3-6, Fig. 7.3-7.

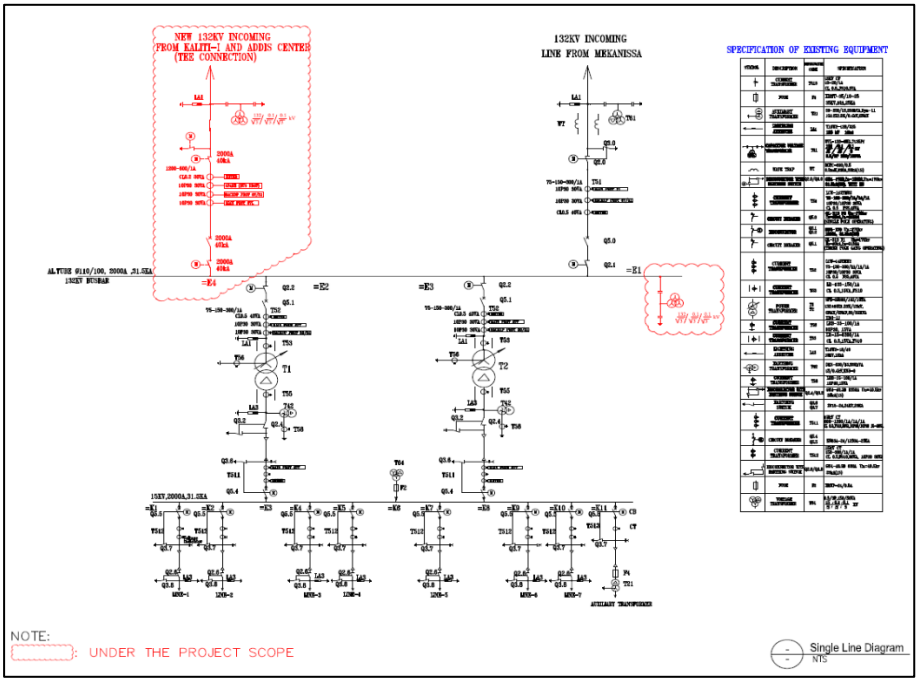


Fig. 7.3-6 Single Line Diagram of Gofa Substation

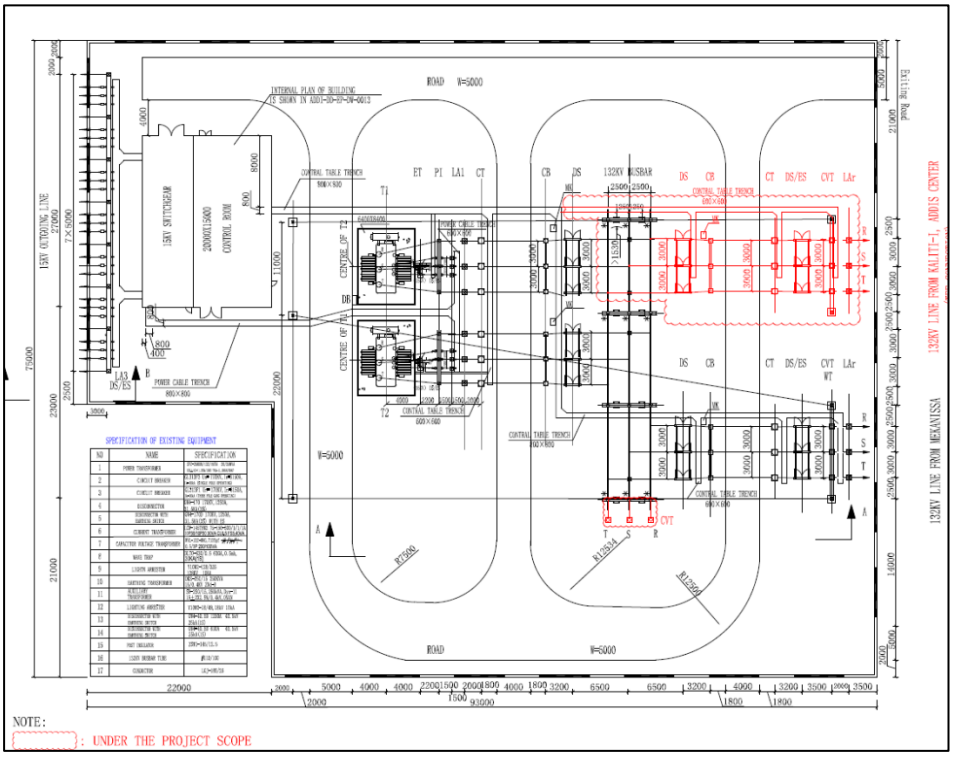


Fig. 7.3-7 Layout of Gofa Substation

The number and the basic specification of each equipment to be installed in GOF substation are described below.

(1) Main switchgear

A New 132kV transmission line bay is installed to satisfy N-1 criteria in GOF substation. The new transmission line is teed off from the transmission line between KALI to the new ADC substation. The new switchgear is of AIS type to match the existing transmission line bay. The specification is based on the existing equipment.

- 145kV Circuit breaker 1 set
- 145kV Disconnector with earth switch 1 set
- 145kV Disconnector 1 set
- 145kV Current transformer 1 set
- 145kV Voltage transformer 1 set
- 120kV Lighting arrester 1 set

Description	Basic specification
GIS or AIS	AIS
Rated Voltage	145kV
Rated current	GCB:2000A, DS: 2000A
Rated short time current	GCB: 40kA, DS: 40kA

(2) Protection relay

Protection relay of GOF substation is of BCU type based on IEC61850. Transmission line protection relay consists of malt-terminal protection for GOF, KALI and the new ADC substation.

To secure proper operation of current differential relay, transmission line protection relay will be of the same manufacture type as GOF, KALI and the new ADC substation.

Each existing 132kV current transformer has only 3 cores, for main protection, back up protection and metering. Therefore, it is needed to modify secondary circuit of current transformer or install auxiliary current transformer in secondary circuit if 132kV bus protection try to install.

However, possibility of bus fault is very small. Moreover, GOF substation is mainly supplied power from another substation, not suppling power to another substation. From the view point of

possibility of fault and installation cost, GOF substation does not install 132 bus protection panel in this project.

- 132kV T/L protection relay panel 1 unit

(3) Control system

The control system for the new ADC substation will be of BCU type based on IEC61850.

- 132kV T/L bay control panel 1 unit

(4) SCADA system

Connection to the existing SCADA system is carried out.

- Connection to Mini-SCADA system 1 lot

(5) Low voltage AC/DC system

As a result of field survey, it can be confirmed that DC48V battery unit has deteriorated. However, this JICA project would be carried out in few years preferably by EEP. Therefore, it is preferable to have the battery replacement carried out by the EEP and it is not included in this JICA project.

(6) Civil and building work

- Equipment Foundation 1 lot
- Cable pit installation 1 lot

(7) Others

To minimize power outage during the installation of new transmission line bay, JICA study team proposes temporary construction using bi-pass power cables. Construction procedure is as follows.

Step 1. Prepare temporary bi-pass power cables and terminals.

Step 2. Connect the bi-pass cables with bulbar side of line CB for Mekanisa substation and primary side of transformer.

Step 3. Install new DS and support insulator for bulbar side of new transmission line bay.

Step 4. Remove the bi-pass cables and commissioning test for new transmission line bay.

The figure of Construction procedure is shown in Fig. 7.3-8.

- Temporary construction work 1 lot

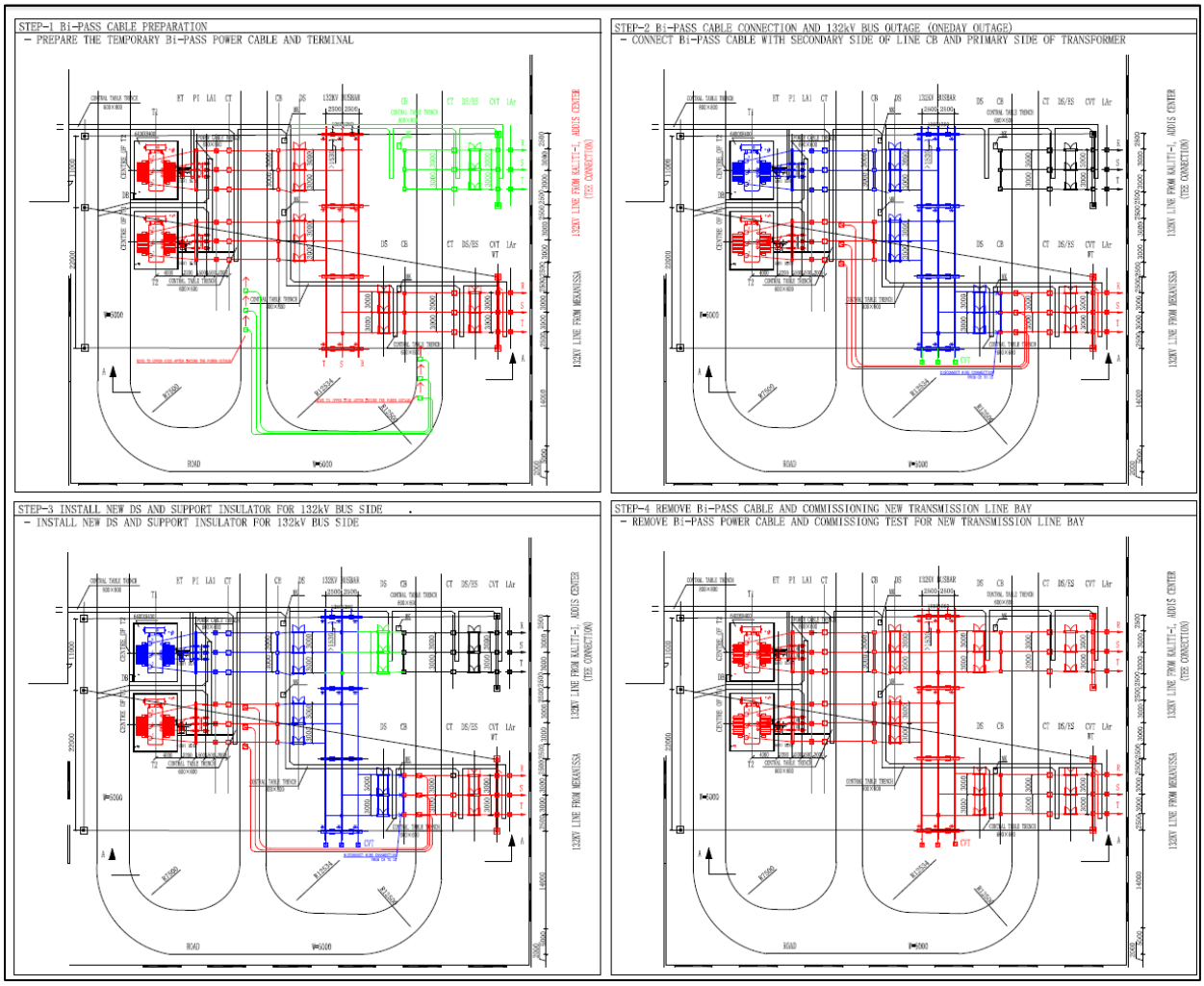


Fig. 7.3-8 Construction Procedure in Gofa Substation

7.3.7 KALI Substation

KALI substation will be installed with a new 132kV transmission line bay for the new ADC substation. Existing 132kV transmission line for the existing ADC substation is located in C14 bay area.

Currently, the 132kV switchgear in KALI substation has a spare bay at C11 bay. Though C11 bay needs to connect the new transmission line for ADC substation, the dead end tower of C12 bay (Gefresa) and C13 (Sebeta) bay would be an obstruction in the connection of new transmission line.

Therefore, JICA study team proposes to shift bay from C12 to C11 and from C13 to C12. As a result, C11 bay will be for Gefresa line, C12 bay will be for Sebeta line, C13 bay will be for the

new ADC line, C14 bay will be for the existing ADC line.

Existing bay connection and proposed bay connection are shown in Fig. 7.3-9, Fig. 7.3-10.

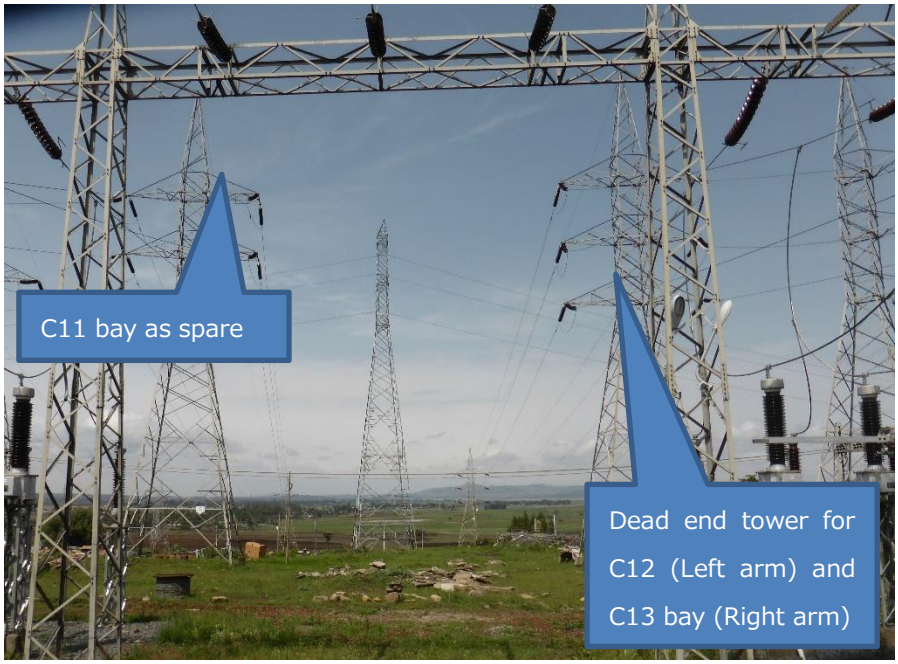


Fig. 7.3-9 Existing bay connection in 132kV KALI S/S

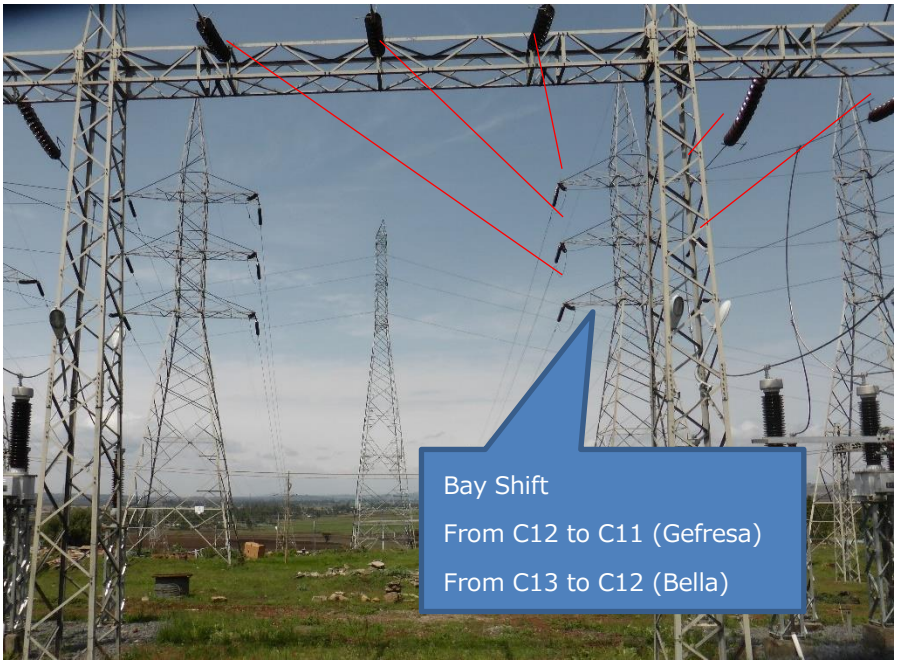


Fig. 7.3-10 Proposed bay connection

Single line diagram and layout of KALI substation are shown in Fig. 7.3-11, Fig. 7.3-12.

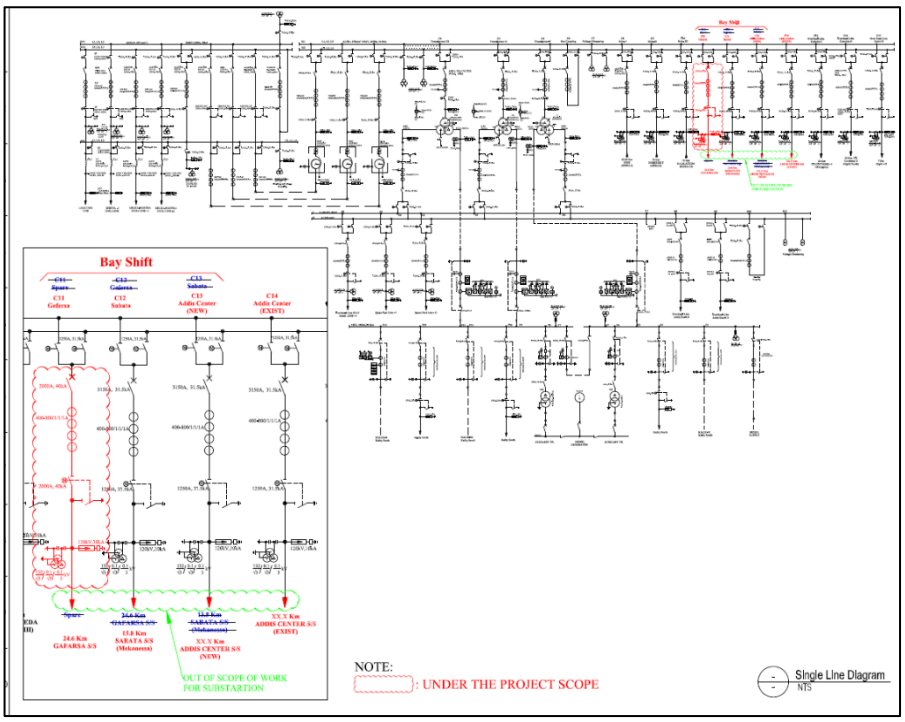


Fig. 7.3-11 Single Line Diagram of KALI Substation

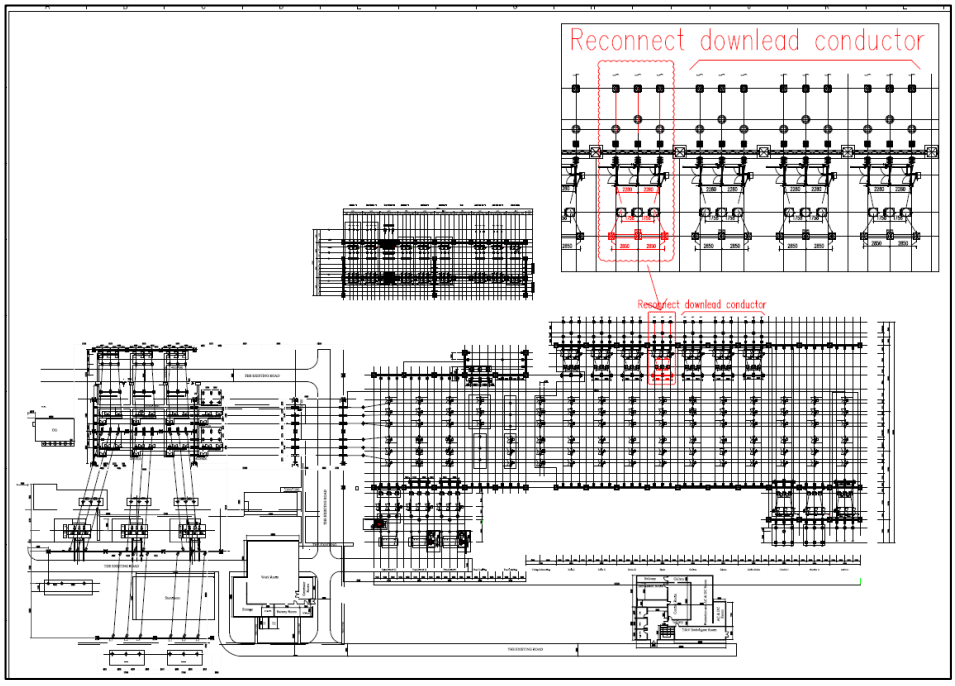


Fig. 7.3-12 Layout of KALI Substation

(1) Main switchgear

- 145kV Circuit breaker 1 set
- 145kV Disconnector with earth switch 1 set
- 145kV Disconnector 1 set
- 145kV Current transformer 1 set
- 145kV Voltage Transformer 1 set
- 120kVLighting arrester 1 set

Description	Basic specification
GIS or AIS	AIS
Rated Voltage	145kV
Rated current	GCB:2000A, DS: 2000A
Rated short time current	GCB: 40kA, DS: 40kA

(2) Protection relay

The protection relay of KALI substation will be of Bay Control Unit (hereinafter called “BCU”) type based on IEC61850.

- 132kVT/L protection relay panel 4 units
- 132kVBusbar protection panel 1 unit

(3) Control system

The control system of the new ADC substation will be of BCU type based on IEC61850.

- 132kV T/L bay control panel 2 units

(4) SCADA system

Connection to existing SCADA system based on RTU and SAS are carried out.

- Connection to Mini-SCADA 1 lot

(5) Low voltage AC/DC system

As a result of field survey, it can be confirmed that DC220V battery unit has deteriorated. However, this JICA project would be carried out in few years, preferably by EEP. Therefore, it is preferable to have battery replacement carried out by the EEP and it is not included in this JICA project.

(6) Civil and building work

- Equipment foundation 1 lot
- Cable pit installation 1 lot

(7) Others

Bay shifting is in the scope of work of transmission line. It is not described in this section.

7.3.8 WER Substation

Proposed single line diagram, layout and protection overview diagram related to WER substation are shown in Fig. 7.3-13 to Fig. 7.3-15.

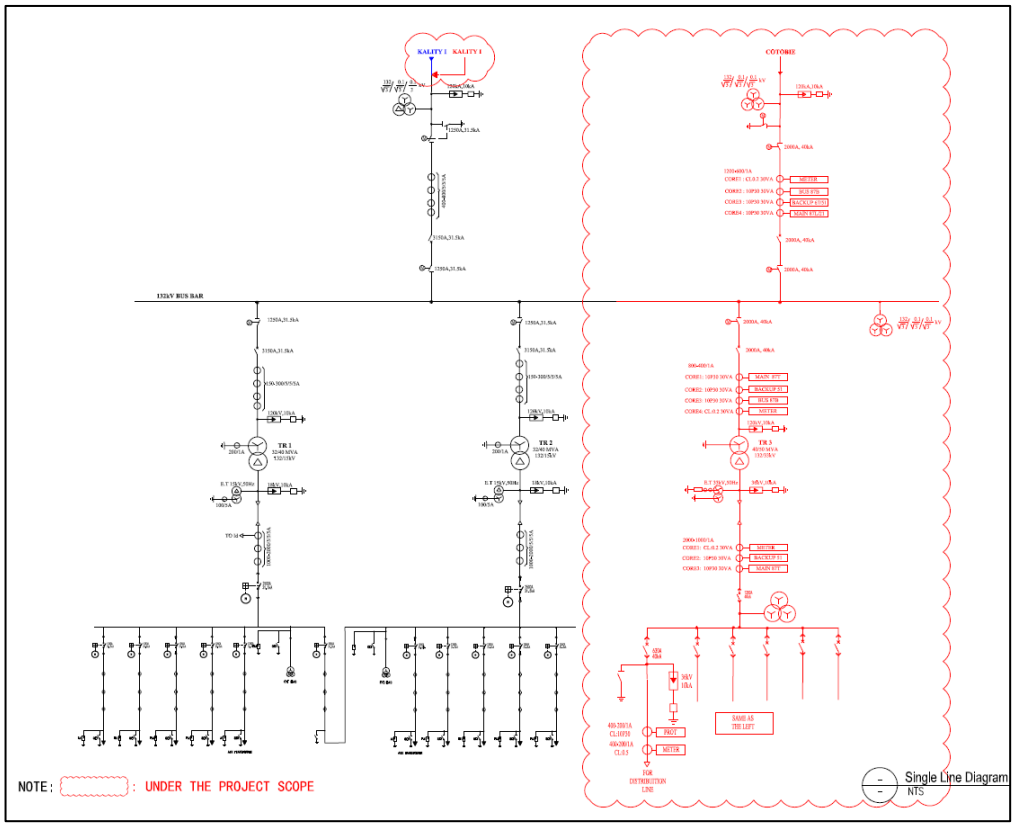


Fig. 7.3-13 Single Line Diagram of Weregenu Substation

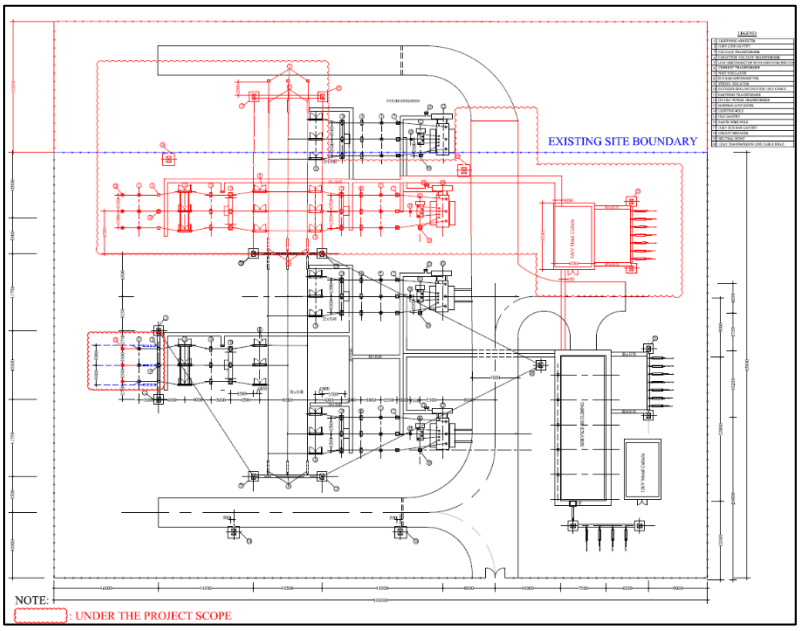


Fig. 7.3-14 Layout of Weregenu Substation

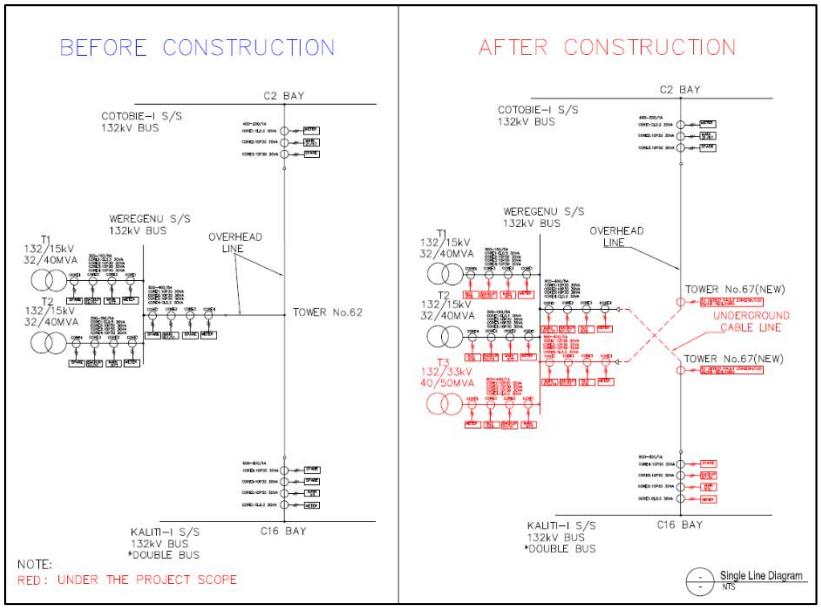


Fig. 7.3-15 Protection Overview Diagram related to WER Substation

The number and basic specification of each equipment to be installed in WER substation are described below.

(1) Main switchgear

WER substation will be installed with a new 132kV transmission line bay because of the change in the transmission line network from teed off to line in-line out connection between WER and KALI substation. However, the existing transmission line bay will remain as it is and will be connected to the new cable terminal using bare conductor. Moreover, WER will be installed with a new transmission line bay for the newly installed transformer.

- 145kV Circuit breaker 2 sets
- 145kV Disconnector with earth switch 1 set
- 145kV Disconnector 2 sets
- 145kV Current transformer 2 sets
- 145kV Voltage Transformer (line) 1 set
- 145kV Voltage Transformer (bus) 1 set
- 120kV Lighting arrester 2 sets
- 132kV bus bar extension 1 lot

Description	Basic specification
GIS or AIS	AIS
Rated Voltage	145kV
Rated current	GCB:2000A, DS: 2000A
Rated short time current	GCB: 40kA, DS: 40kA,

(2) Power transformer

Installation of one (1) new unit of transformer is under consideration as it was requested by EEP.

- 132/33kV Power transformer 1 unit (under consideration)

Description	Basic specification
Rated Voltage	HV: 132kV, LV: 33kV
Rated Capacity	40 MVA (ONAN) / 50MVA (ONAF)
Winding Type	YNd11

(3) Protection relay

The existing protection relays are replaced because they have deteriorated very much. Protection relays for WER substation will be of BCU type based on IEC61850.

- 132kV T/L protection relay 2 units
- 132kV Transformer protection relay 3 units
- 132kVbusbar protection relay 1 lot

(4) Control system

The existing protection control panels are replaced because they have deteriorated very much. Control system of the new WER substation will be of BCU type based on IEC61850.

- 132kV T/L bay control panel 2 units
- 132kV Transformer bay control panel 3 units

(5) SCADA system

Communication system of the WER substation will contain FOX615 by ABB, incorporated with SDH/MUX to integrate the existing substations.

- ABB FOX615（MUX/SDH） 1 lot
- PBX system 1 lot

(6) Middle voltage metal cubicle

- 33kV metal cubicle 1 unit

Description		Basic specification
Rated Voltage		33 (36) kV
Rated current	33kv	Transformer bay: 1250A Bus: 2000A Feeder: 630A
Rated short time current		40kA

(7) Low voltage AC/DC system

As a result of field survey, it can be confirmed that all the low voltage equipment such as battery, charger and distribution panel have deteriorated very much. Therefore, entire replacement is carried out.

- 15kV/380-220V Auxiliary transformer Remains as it is
- 125V Charger 1 unit
- 48VCharger 1 unit
- DC 125V battery 1 unit
- DC 48V battery 1 unit

(8) Civil and building work

A new building is constructed for the new 33kV metal cubicle. The new building will accommodate 33kV metal cubicle and the control panel. To secure the foot print to construct the new building, the existing abandoned building which has no control panel will be demolished.

- Control building 1 lot
- Existing building demolition 1 lot
- Equipment foundation 1 lot
- 132kVgantry for bus bar 1 lot
- Earth mesh expansion 1 lot
- Cable pit installation 1 lot

7.3.9 COT Substation

COT substation has been upgraded to a 230kV substation and has been installed with a new 132kV switchyard. However, the existing 132kV switchyard has deteriorated very much; not only outdoor equipment but the control building and panels are also in a severe condition. COT substation needs relay modification because of the change in the network system of WER substation from teed off to line in – line out. However, as described above, the entire replacement of 132kV switchyard is considered because of the deterioration of existing equipment due to aging. It is more efficient, reasonable and easy to replace control panels when outdoor switchgears are replaced.

Therefore, in this project, replacement of each protection panel will not be carried out, but the protection relay setting will only be changed.

(1) Protection relay

- 132kVT/L relay setting 1 lot

7.3.10 ADN Substation

Proposed single line diagram, layout and protection overview diagram related to ADN substation are shown in Fig. 7.3-16 to Fig. 7.3-18.

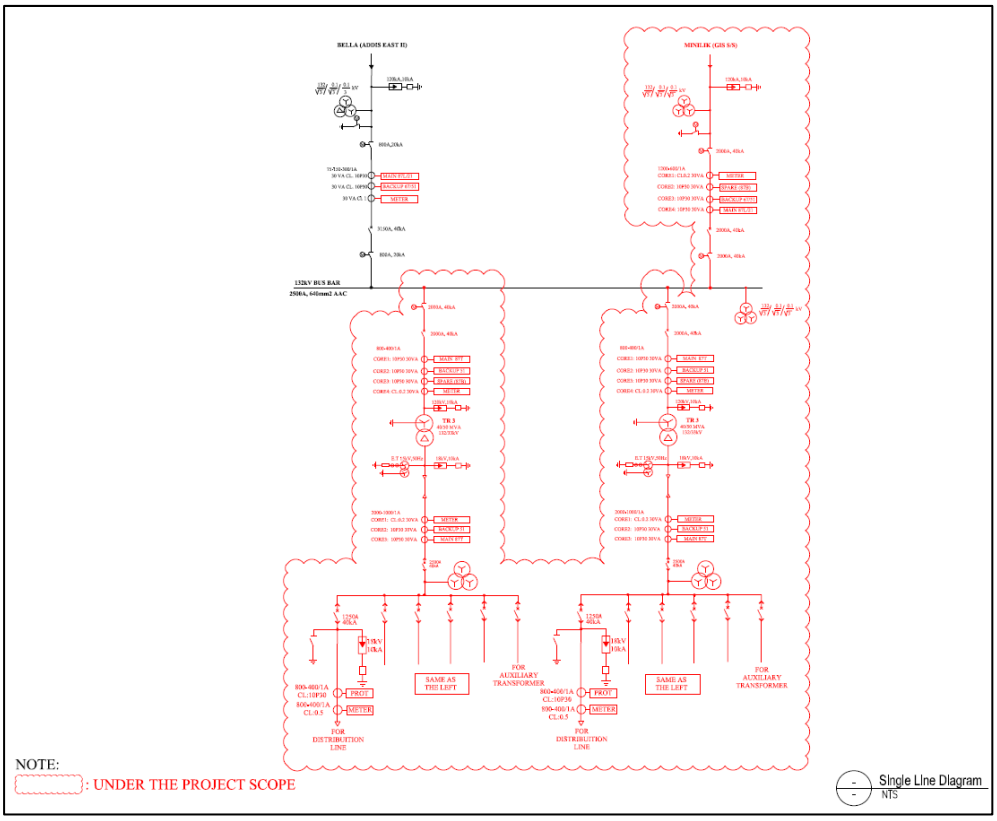


Fig. 7.3-16 Single Line Diagram of Addis North Substation

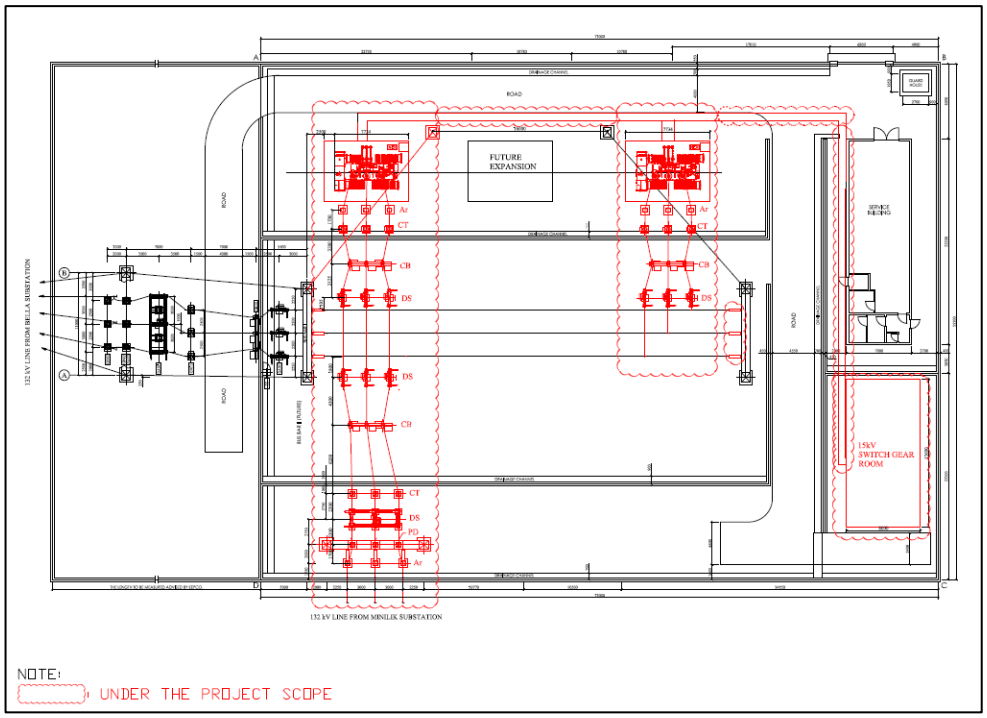


Fig. 7.3-17 Layout of Addis North Substation

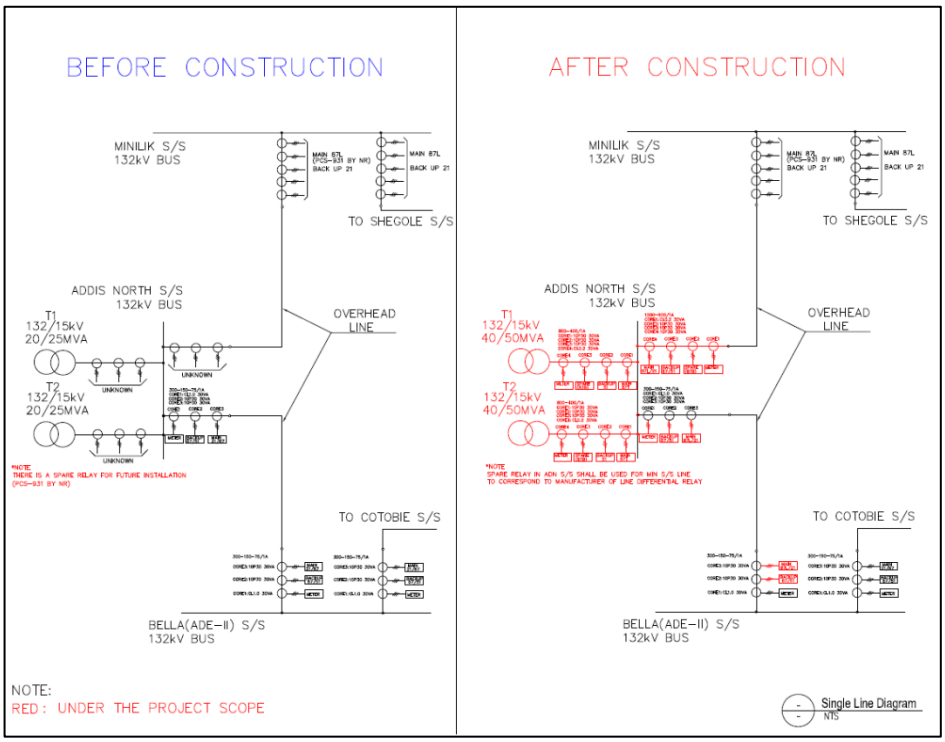


Fig. 7.3-18 Protection Overview Diagram related to ADN Substation

The number and basic specification of each equipment to be installed in ADN substation are described below.

(1) Main switchgear

132kV outdoor switchgear in ADN substation has deteriorated very much. JICA study team proposes entire replacement of 132kV switchgear. However, the transmission line bay to BEL substation was installed around the year 2003. Therefore, only BEL transmission line bay will remain as it is. Moreover, 132kV gantry will remain as it is except for the insulator and hardware.

- 145kV Circuit breaker 3 sets
- 145kV Disconnector with earth switch 1 set
- 145kV Disconnector 3 sets
- 145kV Current transformer 3 sets
- 145kV Voltage transformer (line) 1 set
- 145kV Voltage transformer (bus) 1 set
- 120kV Lighting arrester 3 sets
- 132kVbus insulator and hardware 1 lot

Description	Basic specification
GIS or AIS	AIS
Rated Voltage	145kV
Rated current	GCB:2000A, DS: 2000A,
Rated short time current	GCB: 40kA, DS: 40kA,

(2) Power transformer

Replacement of existing power transformer is carried out based on EEP's request.

- 132/15kV Power transformer 2 units

Description	Basic specification
Rated Voltage	HV: 132kV, LV: 15kV
Rated Capacity	40 MVA (ONAN) / 50MVA (ONAF)
Winding Type	YNd11

(3) Protection relay

The existing protection relays are replaced because they have deteriorated very much. Protection relay for ADN substation will be of BCU type based on IEC61850.

There is spare relay panel manufactured by NR (China) in ADN substation. MIN substation is the substation opposite to ADN substation, and it has been installed with a current differential protection relay of NR. Therefore, transmission line protection relay to MIN substation shall be used as a spare relay panel of ADN substation and to meet the relay specification of each protection relay between MIN and ADN substation.

- 132kV T/L protection relay panel 1 unit (spare relay is used for BEL S/S)
- 132kVTransformer protection relay panel 2 units
- 132kV bus bar protection relay panel 1 unit

(4) Control panel

The existing protection control panels are replaced because they have deteriorated very much. The control system of the new ADN substation will be of BCU type based on IEC61850.

- 132kV T/L bay control panel 2 units
- 132kVTransformer bay control panel 2 units

(5) SCADA system

Connection to existing SCADA system based on RTU are carried out.

- Connection to Mini-SCADA 1 lot

(6) Middle voltage metal cubicle

- 15kV metal cubicle 2 units

Description		Basic specification
Rated Voltage		15 (24) kV
Rated current	15kV	Transformer bay: 2500A Bus: 4000A Feeder: 1250A
Rated short time current		40kA

(7) Low voltage AC/DC system

- 15kV/380-220V auxiliary transformer 2 units

(8) Civil and building work

Based on the replacement of power transformer using the new foot print, the new equipment foundation and oil pit are installed.

- Control building 1 lot
- Earth mesh modification 1 lot
- Cable pit installation 1 lot
- Oil pit installation 1 lot

(9) Others

To minimize power outage during the replacement of power transformers and outdoor switchgears, JICA study team proposes temporary construction using bi-pass method and power cables. Bi-pass cable in ADN substation will use GOF substation's bi-pass cable. Construction procedure is as follows.

Step 1. Install new power transformer and 15kV switchgears and prepare temporary bi-pass power cables and terminals.

Step 2. Connect the bi-pass cables with bus bar side of line CB for Bella substation and primary side of transformer.

Step 3. Replace the other transformer and 15kV switchgears and transmission line bay for MIN substation.

Step 4. Remove the bi-pass cables.

The figure of Construction procedure is shown in Fig. 7.3-19.

- Temporary construction work 1 lot

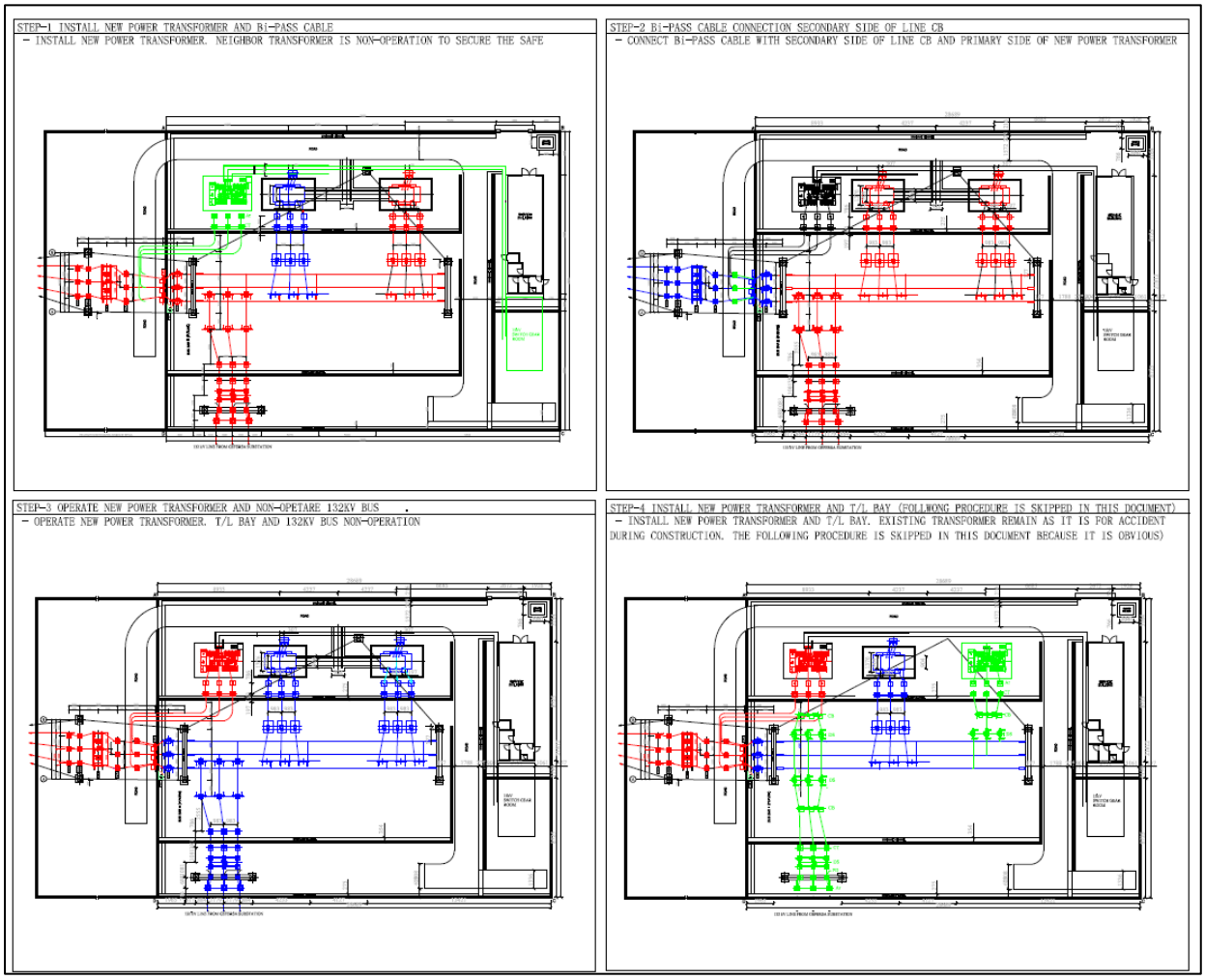


Fig. 7.3-19 Construction Procedure in Addis North Substation

7.3.11 BEL Substation

The number and basic specification of each equipment to be installed in BEL substation are described below.

(1) Protection relay

BEL substation is in the opposite side of ADN substation. Replacement of BEL substation's protection relay is carried out because of replacement in ADN. Currently, there is no 132kV bus protection relay in BEL substation. However, as the same reason of GOF substation, BEL substation will not install bus protection relay in this project. Protection relay for BEL substation will be of BCU type based on IEC61850. It will have the same specification as the current differential relay of BEL and ADN substation.

- 132kV T/L Protection relay 1 unit

(2) SCADA system

Connection to the existing SCADA system based on RTU are carried out.

- Connection to Mini-SCADA 1 lot

7.3.12 MIN Substation

The number and basic specification of each equipment to be installed in MIN substation are described below.

(1) Protection relay

MIN substation is in the opposite side of ADN substation. There is a current differential relay for transmission line manufactured by NR. As described above, transmission line protection relay toward MIN substation in ADN substation is installed with NR's protection relay. Each substation's transmission line protection relay are matched to it. Therefore, only the setting of relay is carried out in MIN substation.

- 132kV T/L line protection relay setting 1 lot

7.3.13 DBZ II Substation

The number and basic specification of each equipment to be installed in DBZ II substation are described below.

(1) Protection relay

DBZ II substation will be installed with TSS system in the 15kV distribution line. TSS system needs specific protection relay in the 15kV metal cubicle to detect fault location (section). Therefore, the DBZ II substation will be replaced with a new 15kV distribution protection relay which will be implemented by another project. However, the 132kV switchgear in DBZ II substation has deteriorated very much. JICA study team recommends entire replacement of not only the switchgear but also the control panels.

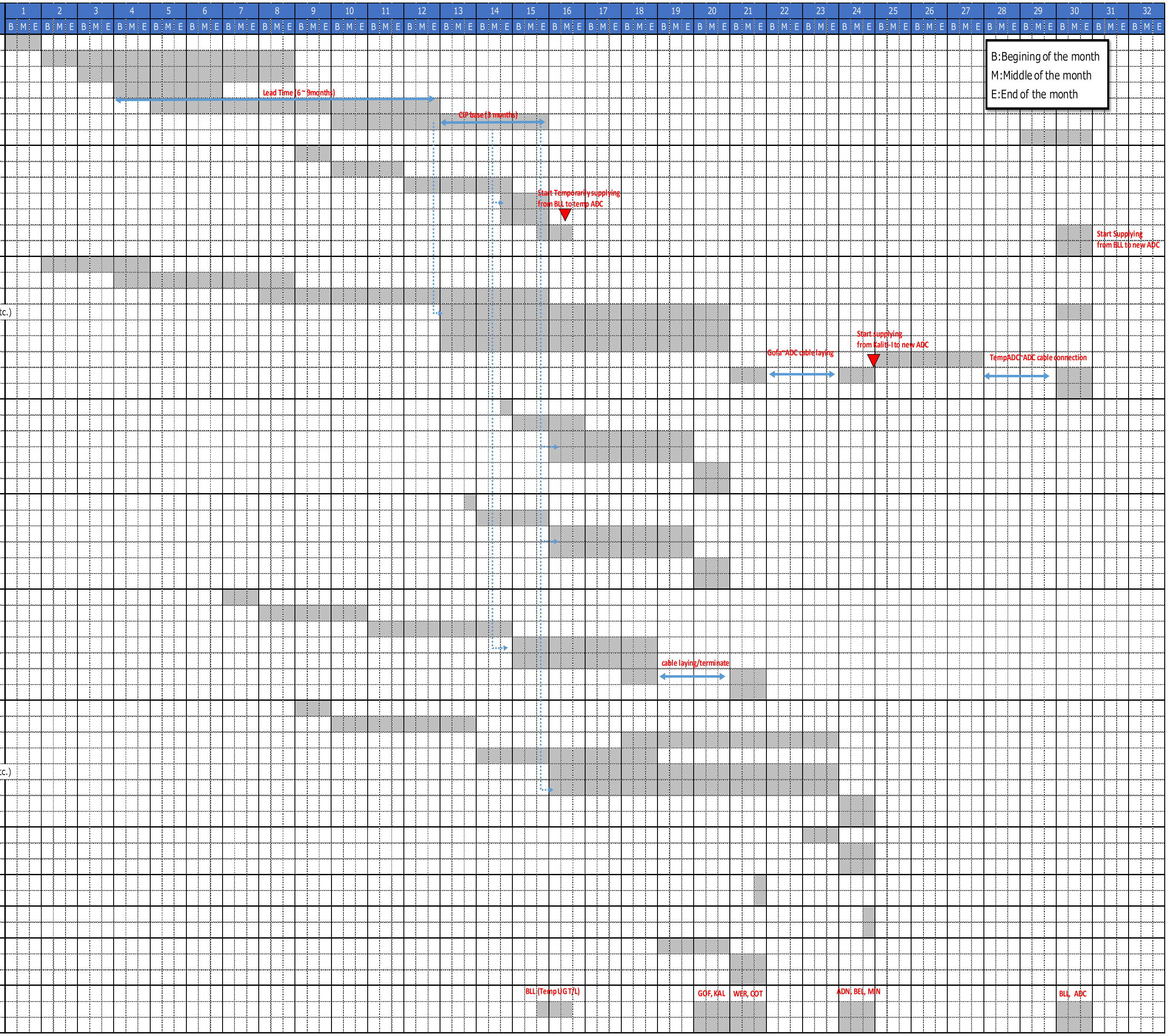
- 15kV replacement of auto reclosing relay 1 lot

7.3.14 Budgetary Cost Estimate for Substation Facility

Nonpublic Information

Table 7.3-1 Construction Schedule for Substation Facility

Substation	Activity
General	Site Survey
	Design and Engineering (General)
	Design and Engineering (Civil)
	Design and Engineering (Equipment)
	Manufacturering and Test
	Oversea and Inland Transportation
	Site clearance
Black Lion	Mobilization
	Land embankment and levering works
Note: Subject to delivery of GIS by 15th month	Construction of equipment foundation and Cable Trench
	Installation of Main equipment (GIS)
	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over
Addis Center	Mobilization, Set up site office
	Land embankment and levering works
	Construction of equipment foundation and control Building
	Installation of Main equipment (Power Transformer, GIS, etc.)
	Installation of CRP, telecommunication, etc.
	Construction of roads, drainage, fencing, etc.
	Load Transfer from temp ADC to new ADC
	Pre-commissioning Test
	Commissioning Test and Taking Over
Kaliti-I	Mobilization
	Construction of equipment foundation
	Installation of Main equipment (AIS)
	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over
Gofa	Mobilization
	Construction of equipment foundation
	Installation of Main equipment (AIS)
	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over
Weregenu	Mobilization
	Land embankment and levering works
	Construction of equipment foundation and Cubicle Building
	Installation of Main equipment (Power Transformer, AIS)
	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over
Addis North	Mobilization, Set up site office
	Land embankment and levering works
	Removal of Existing Equipment
	Construction of equipment foundation and Cubicle Building
	Installation of Main equipment (Power Transformer, AIS, etc.)
	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over
Bella	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over
Cotobie	Relay setting work
	Commissioning Test and Taking Over
Minilik	Relay setting work
	Commissioning Test and Taking Over
Debra Zeit-II	Retrofit Auto reclosing relay
	Pre-commissioning Test
	Commissioning Test and Taking Over
Load Dispatching Center	Installation of CRP, telecommunication, etc.
	Pre-commissioning Test
	Commissioning Test and Taking Over



7.4 DISTRIBUTION FACILITY

7.4.1 Basic Design for the Distribution facilities

The Basic policies for the distribution facilities in this project are: carrying out rehabilitation of medium voltage facilities and measures for overloaded distribution transformers. The target facilities such as the deteriorated facilities and overloaded transformers are determined based on the result of field survey, conducted by the sub-contractor. The work pattern of rehabilitation and upgrade are determined by the deterioration status and load situation of the facilities, and the rehabilitation flowchart, which is prepared in this study.

The rehabilitation policy is described below.

(1) Basic Policy for the Rehabilitation of Medium Voltage Feeders

In AADMP project, upgrading works are proposed according to the analysis result of each feeder in Addis Ababa capital region. Since the upgrading works will be executed by the AfDB project, in principle, the target of JICA project is only the rehabilitation of facilities, which fit the following conditions.

- The pole is deteriorated.
- The conductor is deteriorated.
- The facilities mounted on pole are deteriorated.

The detailed conditions are described below.

1) Deterioration of poles

According to the result of the field survey, pole is reconstructed if one or more of the following are observed, regardless of the type of poles: tilt, crack, bad foundation. Many poles are made of wood in the medium voltage feeders targeted by this project. However, since the pole is supported by the conductor when a pole is broken, the possibility of such a situation leading to a serious accident such as pole collapses is low. Therefore, in this project, the pole, which is deteriorated, is only reconstructed.

2) Deterioration of conductor

The conductor should be replaced in the defective section, if one or more of the following damages to the electric wire are observed: crack of conductor, insufficient separation between the phases, bad connection. In this case, it is assumed that the adjacent section is also

deteriorating in the same way, because it can be considered that the conductor, where the defect is found, and the conductor in the adjacent section were installed at the same time. In addition, if the replacement work is carried out only in a short span length, the conductor replacement work may cause a decrease in the efficiency of construction and reliability due to an increase in connection points, which are not necessary.

Therefore, when there is a defective part within a certain section, the entire section is to be replaced. The term "certain section" refers to the 9 spans between poles (This means the range of 10 poles), considering the length of the 1 drum conductor and the length of the anchoring section.

3) Deterioration of facilities mounted on poles

According to the result of field survey, the facilities installed on a pole (cross arm, accessories such as insulator, disconnector, sectionalizing switch etc.) should be replaced if the equipment is confirmed to be rusted, cracked, or faulty mounted.

(2) Basic Policy for the Rehabilitation of Distribution Transformer

In this project, distribution transformer that fits the following conditions should be replaced.

- The pole on which the transformer is installed is deteriorated.
- The transformer is deteriorated.
- The transformer is overloaded.

1) Judging deterioration of poles

The poles should be reconstructed, if one or more of the following is observed: tilting, cracking, bad foundation. However, if the pole is wooden, it is reconstructed regardless of the deterioration situation. This is because JICA study team have judged that there is a high risk of severe accidents in case of wooden poles, because of the following reasons.

- According to the field survey, more than 60% of the wooden poles are deteriorated.
- It is likely that the pole, on which the transformer is installed, is the end point of distribution feeders.
- Because of the heavy weight of the transformer, unbalanced weight is applied on the poles.

Fig. 7.4-1 shows an example of transformer installed on a wooden pole.

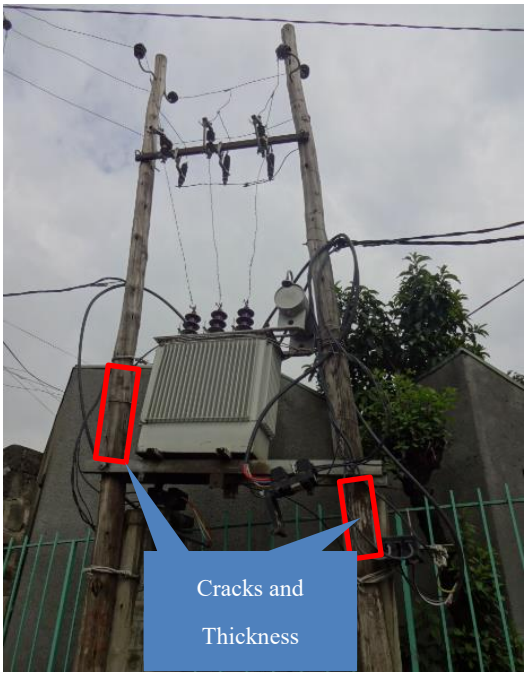


Fig. 7.4-1 A transformer installed on a wooden pole

2) Judging deterioration of transformers

The relevant transformer is reconstructed, if one or more of the following is observed: oil leaking, corrosion of body, crack of bussing. This is because, it is thought that such a situation will develop into an event, which will seriously impact the supply reliability.

3) Judging overloading of transformers

The transformer is judged as overloaded, if the estimated peak value of transformer exceeds the rated capacity. This means that the utilization of transformer exceeds 100%. And, in this case, the estimated peak value of each transformer is determined from the detailed load measurement result, which is carried out with 20 transformers selected from the target transformers. The method to estimate the peak load is described in Section7.4-2.

7.4.2 The Flowchart for the Rehabilitation Work

Based on the basic policy for rehabilitation, the JICA study team have made a flowchart to determine, how to rehabilitate the distribution facilities, based on the result of field survey. Fig. 7.4-2 and Fig. 7.4-3 shows the flowchart for rehabilitation of medium voltage feeder and distribution transformer.

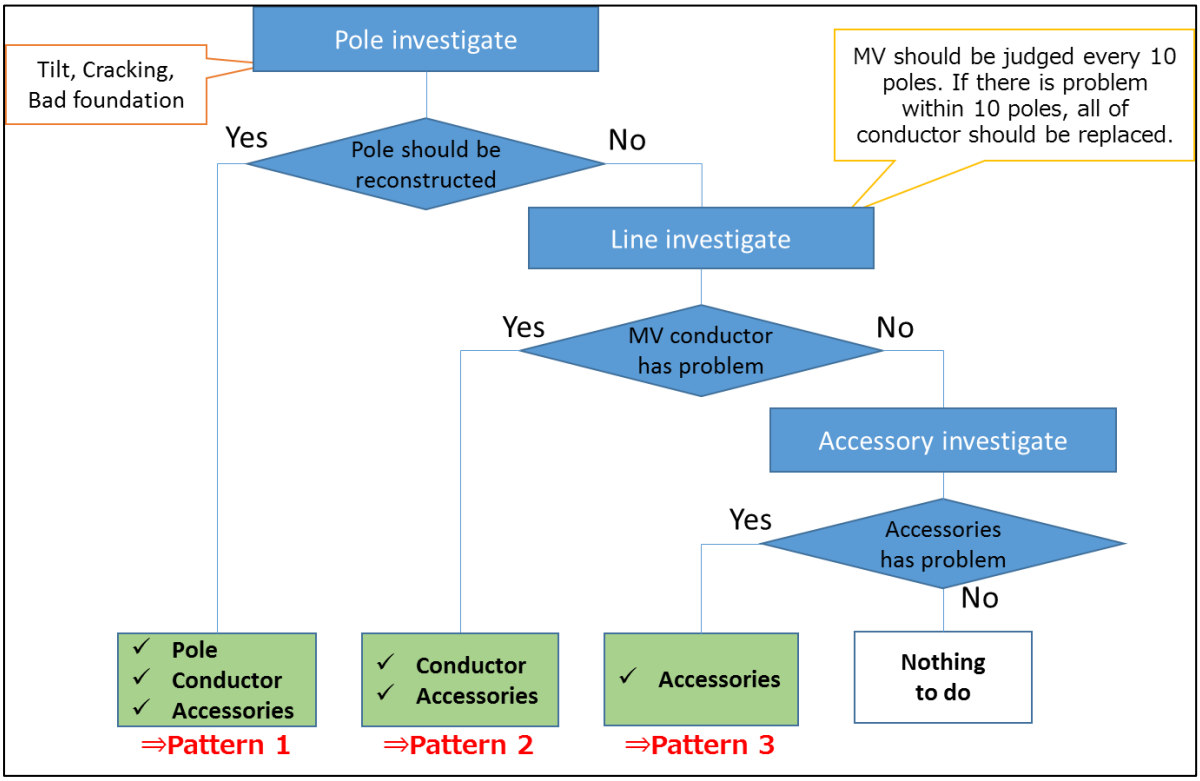


Fig. 7.4-2 The flowchart for rehabilitation of medium voltage feeder

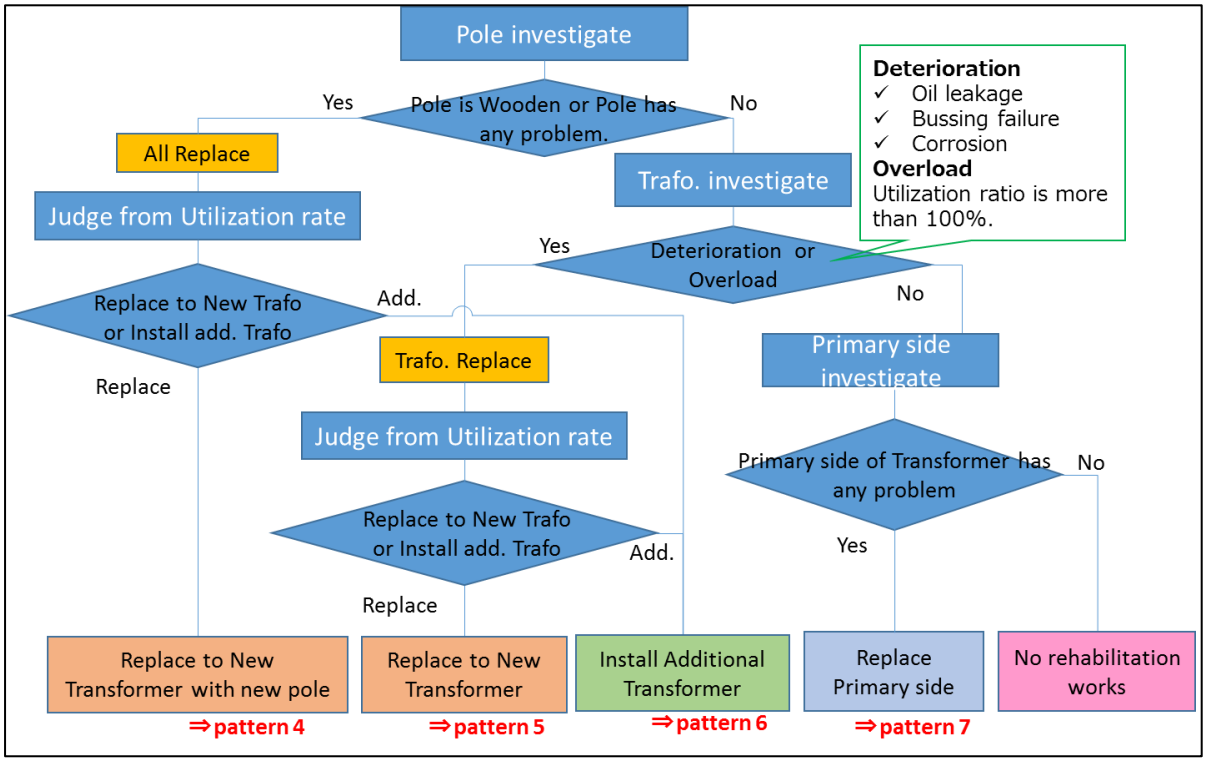


Fig. 7.4-3 The flowchart for rehabilitation of distribution transformer

7.4.3 The Method for estimating Transformer's Peak Value

In this project, although it is determined that JICA study team would implement the countermeasures for overloading of transformers, it is difficult to confirm the peak value by conducting detail load measurement in every transformer. Therefore, the JICA survey team devised a method to estimate the peak value from the result of simple load measurement and "Standard Load Curve". The formula to calculate the estimated peak value, and the work process to determine this formula is shown below.

(1) The Formula to estimate the Peak Value

(Estimated peak value [%])
= (the result of simple measurement[kVA])× (conversion rate)+(correction factor)

The transformer is judged to be overloaded if the estimated peak value calculated by the above formula is greater than 100%. This correction factor is determined as the safety factor to keep all measurement results within the assumed range, because the number of transformers for which, the detailed measurement is carried out, is 1% of the project target and it cannot be said that the number of samples is statistically sufficient.

(2) Work Process for estimating Peak Value

1) As a sample measurement, measure the load every 15 minutes for 1 week for the chosen 20 transformers, which have average low voltage equipment configuration.
2) Make the graph of load curve for 24 hours, by averaging the above measurement values of each transformers and normalize those values with the maximum peak value.
3) Calculate the average value of each transformer's load curve for every 15 minutes.
4) Normalize the values of process 3 and make "Standard load curve" by making a graph of these values.

Fig. 7.4-4 shows the "Standard load curve" made by the above process

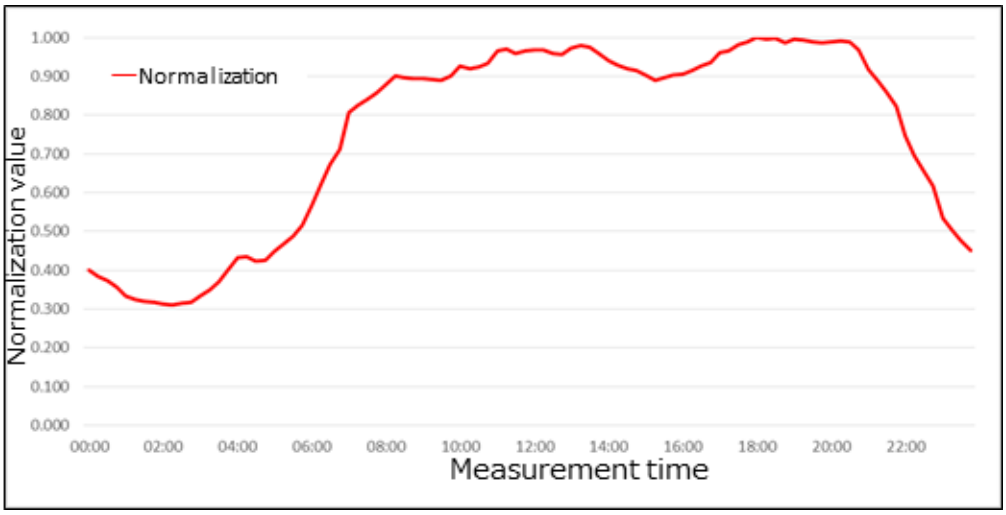


Fig. 7.4-4 Standard load curve

5) Calculate the "Conversion rate" at measurement time to estimate the peak value, from the value of "Standard load curve" and the result of simple measurement value.

Because the Conversion rate is calculated again in a later process, the conversion rate in this process is termed as "Tentative conversion rate" for convenience.

To calculate the conversion rate, the divergence value, which is obtained by averaging the value of 20 transformer's simple measurement values in measurement time, and the divergence value at 18:00, which is the peak time, are used. This process take into consideration the variations in measured values for each time period, and is a measure to avoid estimation of a significantly lower value, by comparing the assumed peak value with the actual peak value (Fig. 7.4-5).

The formula to calculate the tentative conversion value is shown below.

(Conversion rate)
= (1+$\sigma_{\text{peak time}}$) /
{(the value of standard load curve at measurement time)-1$\sigma_{\text{measurement time}}$)}

$\sigma_{\text{peak time}}$: The divergence value at peak time(=18:00)
$\sigma_{\text{measurement time}}$: The divergence value at measurement time

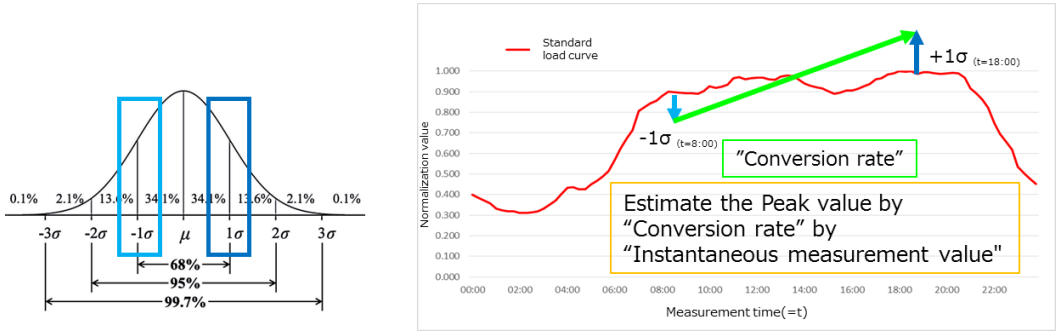


Fig. 7.4-5 An image of the procedure to determine the conversion rate

6) Multiply the conversion rate and the detailed measurement value of 20 transformers.

This process is conducted to confirm the effectiveness of conversion rate. The value calculated in this process is termed as "Tentative estimated value" for convenience.

7) Calculate "Divergence value" between tentative estimated peak value and actual peak value.

To confirm the effectiveness of convergent rate, calculate the peak divergence value by subtracting actual peak value from tentative estimated peak value, and calculate the "Peak divergence value" by calculating the average of 20 transformer's divergence value. The graph of the average of peak divergence value is shown in Fig. 7.4-6. The measurement time period is from 7:00 to 8:00. The contractor usually measures the load value in this time period because the current used by customers is stable during this time period.

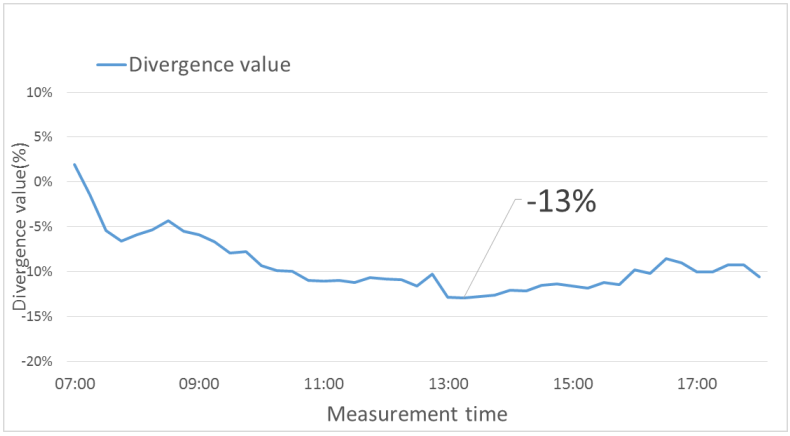


Fig. 7.4-6 Peak Divergence value

8) Define the largest value in the Peak Divergence Value as “correction factor” (=13%). And calculate the estimated peak value by adding the correction factor to the tentative estimated value.

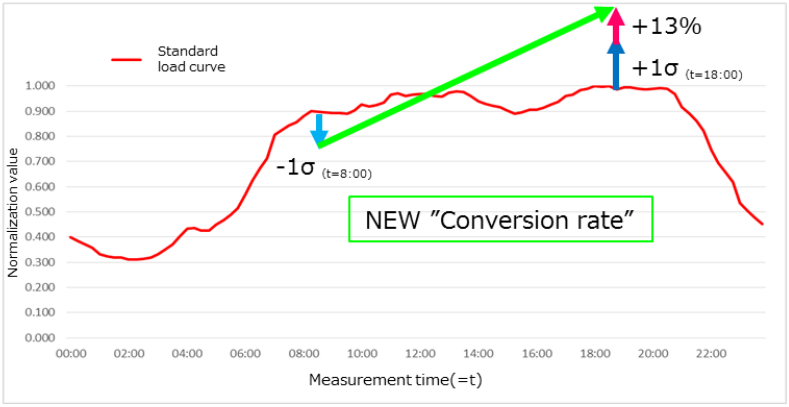


Fig. 7.4-7 An image of peak estimation

Fig. 7.4-7shows an image of the procedure to determine the estimated peak value.

7.4.4 Preliminary Design

(1) Conductor

Different kinds of conductors such as AAC, AAAC, and ACSR and so on have been used in combination in medium voltage feeders, which are targeted in Item B and C. The size of the conductor is mainly 95sq or less. In JICA project, the AAAC conductor, which is also applied in the ongoing AfDB project, is adopted. Moreover, to ensure public safety and to improve the reliability of power supply, covered conductors are adopted. The size of the conductor is 200 sq. for all feeders, in order to enable flexible system operation such as power supply from interconnected feeders. In addition, as for the size of the conductor, it is recommended to review the same in the detailed design stage based on the condition of power system.

(2) Sectionalizing Switch

In the MV feeders of Item B, Sectionalizing switch is installed every 3km which is the same criteria in AfDB project. On the other hand, in the MV feeders of Item C, it is planned to adopt TSS system and the number of installed them in each feeder is seven. And it is necessary to consider individually at the time of detail design that where the switches should be installed.

(3) Lightning Arrester

Arrester should be installed at the pole where the transformer and/or the sectionalizing switch are installed, at the connection point between the overhead line and the underground line, and the dead-end point of the distribution feeders. In addition to the above, since covered conductors are adopted in this project, arresters should be installed at every 500 m along the feeders, in order to suppress the insulation breakdown of the covering material by flashover.

(4) Selection of the Type of Transformer

In this project, amorphous transformer is adopted when the capacity of newly installed transformer is smaller than 400kVA, and the conventional type transformer (CRGOT) is adopted when the capacity of the newly installed transformer is greater than 630kVA. Installation of the amorphous transformer contributes to the mitigation of distribution loss. The details of amorphous transformer are described in the subsequent Chapter 8.

(5) Selection of the Capacity of Transformer

The capacity of the newly installed transformer which will replace a deteriorated or overloaded transformer is selected based on the estimated peak value of the replaced transformer. And the capacity should be lesser than 100% until 2034, which is the duration of AADMP project considering the demand increase assumed in AADMP. On the other hand, the capacity of industrial transformer should be determined without considering the increase of customer's demand, because it is basically installed as a dedicated transformer.

In addition, depending on the situation, installation of additional transformer and splitting of the low voltage power feeder are required. In this case, the details of the work, such as the position of the newly installed transformer or determining the necessity of whether medium voltage line expansion is required or not and so on must be considered individually, because it depends on the composition of low voltage power system and the medium voltage power system around the transformer. In the budget estimation of this survey, the project budget includes such works. Table 7.4-1 shows the combination pattern of the newly installed transformers.

Table 7.4-1 Combination pattern of the newly installed transformers

Estimated Load of Existing Trafo(kVA)		How to replace	New Transformer		
Residence/ Business	Industry		# 1	# 2	# 3
~13	~22	Replace to New Trafo (include upgrade)	25		
~26	~44	Replace to New Trafo (include upgrade)	50		
~52	~87	Replace to New Trafo (include upgrade)	100		
~104	~174	Replace to New Trafo (include upgrade)	200		
~164	~274	Replace to New Trafo (include upgrade)	315		
~208	~348	Replace to New Trafo (include upgrade)	400		
~328	~548	Replace and add 1 Bank	315	315	
~416	~696	Replace and add 1 Bank	400	400	
~491	~822	Replace and add 2 Bank	315	315	315
~624	~1,044	Replace and add 2 Bank	400	400	400

In this table, in the case of transformer for Residence/Business, for example, when "Estimated Load capacity of Trafo" is more than 26kVA and lesser than 52kVA, the "New transformer" will be a 100kVA(replace or upgrading). On the other hand, when "Estimated Load capacity of Trafo" is more than 208kVA and lesser than 328kVA, the "New transformer" will be two 315kVA. The capacity and the quantity of new transformers to be installed is determined based on the premise that by 2034, which is the target period of AADMP's assumption, no replacement due to overload occurs.

For example, in the case of a transformer for Residence / Business, since in the demand assumption of AADMP the demand is expected to increase by 2.3 times from 2018 to 2034, it is necessary to have an initial capacity of lesser than 52% (120% ÷ 2.3 = 52%), so as not to exceed 120% (exhibition: Distribution Design Manual) in 2034, which will lead to its replacement.

(6) Quantity of Rehabilitation Work

Based on the flow chart, JICA study team estimated the quantity of rehabilitation work with regard to medium voltage feeder and distribution transformer. According to the survey results, it is revealed that about 57 % of target medium voltage feeders require total replacement, including the replacement of utility poles, about 40% of them need replacement of electric conductor, and about 90% of the target transformers have to be replaced. A summary of the survey results for Item A, B, C is shown in the Table 7.4-2.

Table 7.4-2 Quantity of rehabilitation work

	number of facilities			Rehabilitation pattern						
				For MV feeder (number of poles)			For Transformer (units)			
	MV (km)	Pole (pcs)	Trafo. (units)	Pattern 1☒ (Whole replace)	Pattern 2☒ (Conductor+ Accessory)	Pattern 3☒ (Only Accessory)	Pattern 4 (whole replace)	Pattern 5 (Trafo replace)	Pattern 6 (Add Trafo)	Pattern 7 (Primary replace)
Item A	N/A	N/A	903	N/A	N/A	N/A	727	54	297	46
Item B	414.3	6,827	1,213	3,188	2,792	101	961	143	127	49
Item C	145.0	2,721	347	2,029	683	3	249	72	23	17
Total (%)	**559**	**9,548**	**2,463**	**5,217 (54.6%)**	**3,475 (36.4%)**	**104 (1.1%)**	**1,937 (78.6%)**	**269 (10.9%)**	**447 (18.1%)**	**112 (4.5%)**

And the points representing target feeders of Item B, C are shown in Fig. 7.4-8 and Fig. 7.4-9.

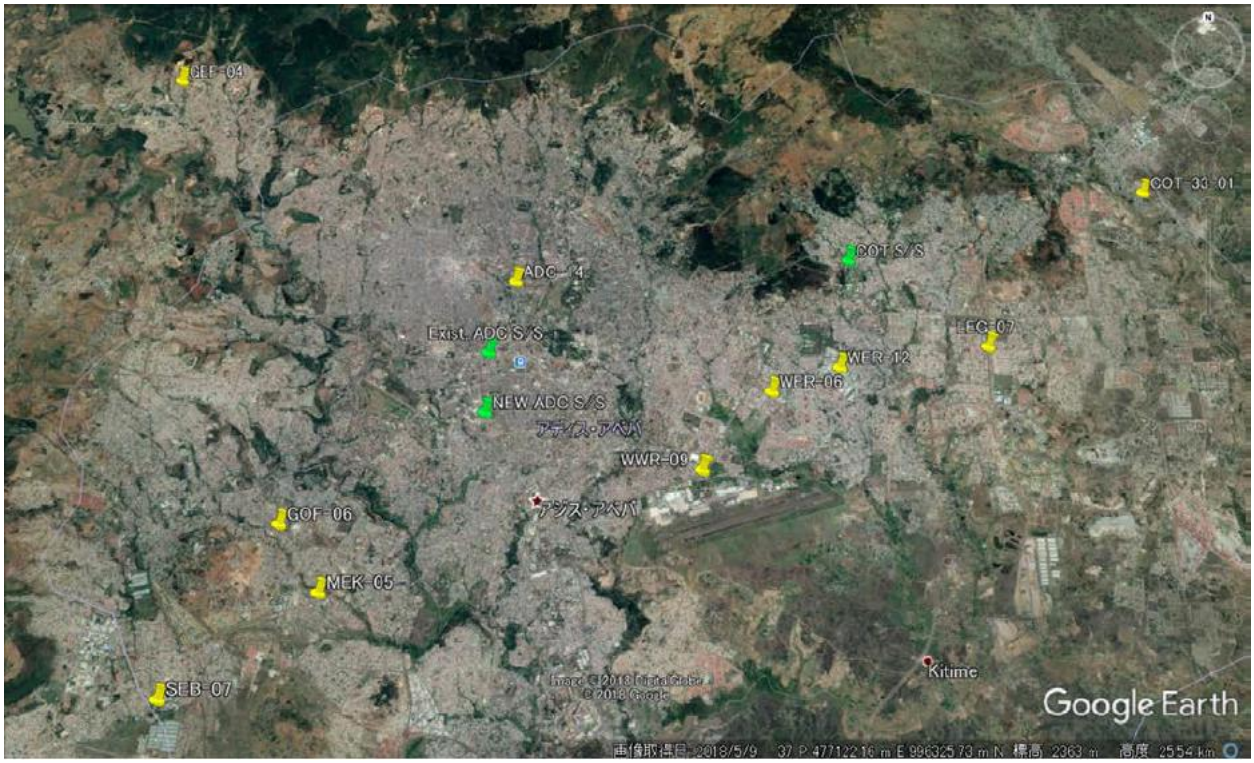


Fig. 7.4-8 Points representing target feeder of Item B

Fig. 7.4-9 Points representing target feeder of Item C

7.4.5 Budgetary Cost Estimate for Distribution Facilities

Nonpublic Information

CHAPTER 8

PROJECT PLAN

CHAPTER 8 PROJECT PLAN

8.1 CONSTRUCTION SCHEDULE

Nonpublic Information

8.2 PROJECT COST ESTIMATION

Nonpublic Information

8.3 STUDY OF PROCUREMENT

Nonpublic Information

8.4 TERMS OF REFERENCE (TOR)

Nonpublic Information

CHAPTER 9

PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE ORGANIZATION

CHAPTER 9 PROJECT IMPLEMENTATION AND OPERATION AND MAINTENANCE ORGANIZATION

9.1 EEP/EEU'S FINANCIAL STATUS

Nonpublic Information

9.2 PROJECT ORGANIZATION AND O&M ORGANIZATION

9.2.1 Current Project Organization and O&M Organization

(1) Implementation Organization

The PIT (Project Implementation Team) manages the projects funded by international organizations.

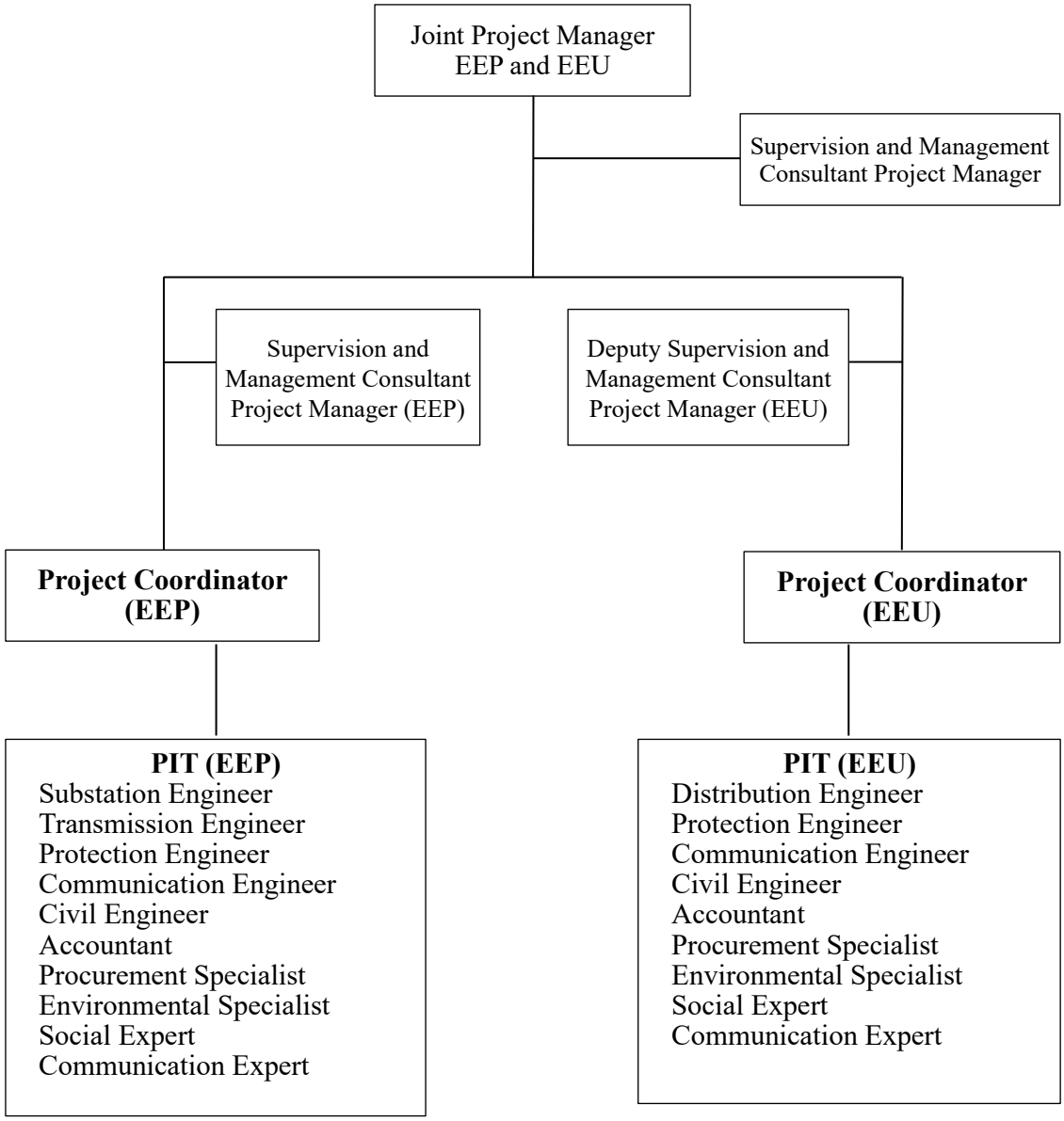


Fig. 9.2-1 Implementation Organization (AfDB Project)

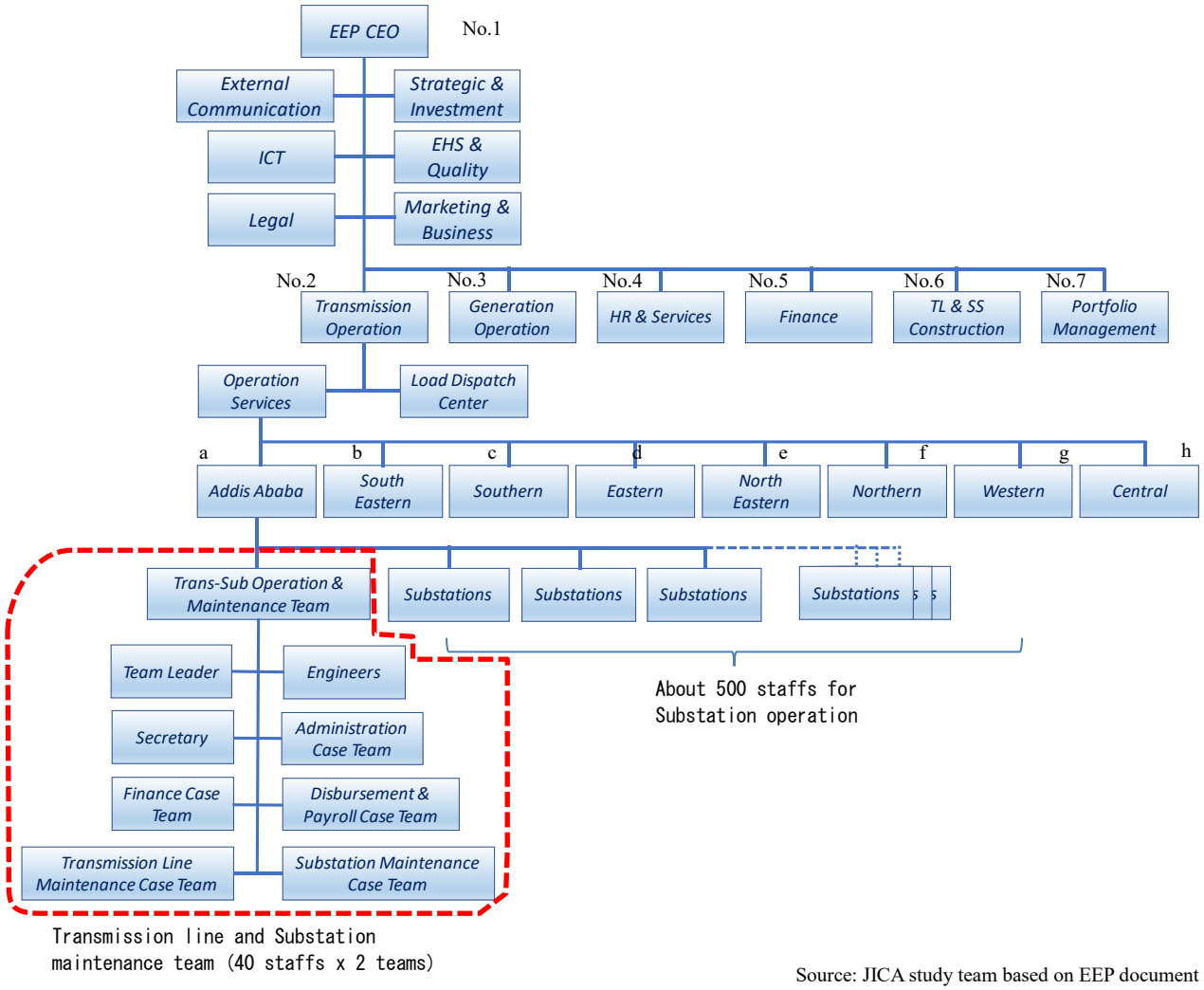
Source: ADDIS ABABA TRANSMISSION AND DISTRIBUTION SYSTEM REHABILITATION AND UPGRADING PROJECT (AATDRUP), AfDB November 2017

(2) O&M Organization

EEP organization chart is shown in Fig. 9.2-2. It is composed of seven (7) units under board members including CEO. The activities and personnel structure each unit are shown in Table 9.2-1. The number of staff in the Transmission Operation Units (No. 5) comprising 1,121 persons, which is responsible for operation and maintenance of all substations and transmission lines above 66kV, divided into Ethiopia into eight (8) areas (a to h) to conduct operation and maintenance for transmission lines and substations. The Addis Ababa regional office (a), among one of the eight regions, has the largest power demand which is more than half of Ethiopia's power demand as of year 2017, so this Addis Ababa regional office covers most the substation and transmission facilities related with this project. As of year 2018, the Addis Ababa regional office is responsible to maintain about 30 substations and related transmission lines located in Addis Ababa. About 500 employees, including maintenance personnel and operators, are stationed in those substations, and addition to substation employees, they are a team for operation and maintenance to charge of electrical testing for substations and transmission lines, adjustment setting of equipment, and replacement/installation work of malfunctioned equipment as shown in Table 9.2-2.

Table 9.2-1 Activities of each unit in EEP

No.	Work Units	Activities
1	Board Management by Chief Executive Officer (115)	The management board is the supreme body responsible for the performance of EEP at the highest level. CEO is leading and managing the company and its day-to-day operations and activities.
2	Portfolio Management (618)	This unit is responsible for assuring strategic alignment of investment through identifying and selecting portfolio programs for investment, defining activities, developing project schedules, and evaluating the overall progress of performance of project management.
3	Transmission & Substation Construction (402)	This unit is responsible for the execution of transmission and substations construction works.
4	Generation Operation (1,074)	Unit is responsible for operation and maintenance of all substations and transmission lines above 66kV, defining the transmission strategy, defining transmission policies and procedures, and defining the transmission plan.
5	Transmission Operation (1,121)	This is responsible for operation and maintenance of all substations and transmission lines above 66kV, defining the transmission strategy, defining transmission policies and procedures, and defining the transmission plan.
6	Finance (97)	This unit is responsible for administrative, finance and control activities (financial processes, budgeting, forecasting, financial investment management and capital planning), procurement, logistics and warehousing.
7	Human Resource & Services (94)	This unit is responsible for managing company organization and employees, through activities like hiring new resources; developing and training employees; managing organizational issues; managing labor relations; and management of company assets.
	Total 3,521	



Source: JICA study team based on EEP document

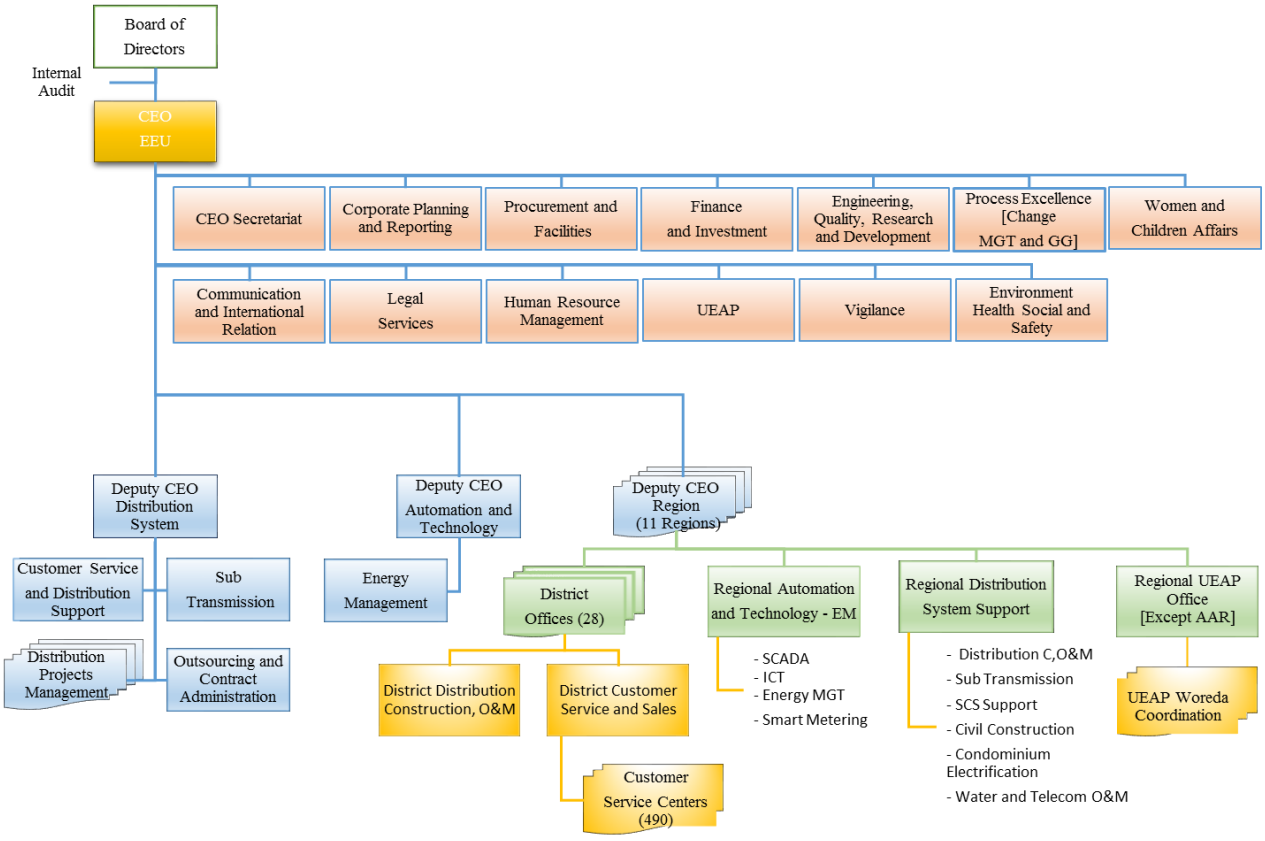
Fig. 9.2-2 EEP Organization Chart

Table 9.2-2 Operation & Maintenance Team

No.	Activities	Numbers
1	Trans-Sub-Operation and Maintenance Team Leader	1
2	Secretary	2
3	Engineers	4
4	Substation Maintenance Team	12
5	Transmission Line Maintenance Team	12
6	Finance Team	3
7	Administration Team	3
8	Disbursement & Payroll Team	3
	Total	40

EEP organization chart is shown in Fig. 9.2-3. EEU has conducted reorganization in May 2018. Under this reorganization, newly thirteen Deputy CEO were assigned. Eleven Deputy CEO among them are responsible for respective region, nine regional states and two city administrations. Other two Deputy CEO are responsible for distribution system and automation. This change is introduced so that various problems occurring in the power distribution system in each region can be solved quickly under the responsibility of each Deputy CEO.

Under the Deputy CEO, who is responsible for Distribution System, PMO (Project Management Office) is established, and under the management of this PMO, multiple distribution projects are being implemented in the Addis Ababa metropolitan area. Addition, the O & M team was established at all District Office laid under Deputy CEO, who is responsible respective region. These O & M teams are responsible for maintenance and management of distribution facilities in each district.



Source: JICA study team based on EEU document

Fig. 9.2-3 EEU Organization Chart

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1) Overhead transmission line

The maintenance office of transmission line and substation is located in the north side of Addis Ababa City, near Jupiter Hotel. Office is away from the EEP headquarters, and the office space is jointly used by EEU and EEP. The EEP maintenance team have divided their facilities into seven blocks, throughout Ethiopia. Addis Ababa transmission and transformation Team is in charge of the Addis Ababa city. Each team has a Team Leader with about 40 workers working under him/her. A small two-story residential house is used as an office, so maintenance organization/team is still very small.

The team's activities under the control of Team Leader and Engineer.

- Bush & Tree clearing operations to prevent grounding faults caused by contact between trees under transmission line and conductors.
- Arrange security personal with suitable weapons such as guns to maintain security under the transmission line right of way.
- Recovering works from disconnection accident or grounding fault accident of transmission lines
- Administration control for the land usage of 30meter width for Right of Way under transmission line, such as rental as car paring purpose.
- Coordination with city planning for land usage in future.

2) Underground Cable

EEP has seven regional offices which are in charge of operation and maintenance of transmission facilities. On interviewing the Office of Addis Ababa Transmission Substation Operation & Maintenance, it was confirmed that EEP has the ability and experience to operate and maintain the underground system of up to 22kV class by themselves. On the other hand, they don't have technical experience in the operation and maintenance of the underground system of 132kV class.

3) Substation facility

According to EEP, Addis Ababa regional office located in Kazanchis has operated and maintained substations which are in the scope of this JICA study except Debre Zeit II substation which is located outside Addis Ababa. Central regional office in Cotobie substation manage Debre Zeit II substation.

Addis Ababa regional office has 30 substations. Total number of employees in Addis Ababa regional office is around 500 people, including maintenance officers, operators for each

substation, etc. (Fig. 9.2-2). They mainly carry out minor maintenance and do not carry out installation work, major maintenance work, etc. They do not carry out daily maintenance, but carry out only visual inspection.

In each substation, operators are on duty for 24 hours a day by dividing into three (3) shifts, and about five maintenance workers also work in three (3) shifts. Debre Zeit II substation also has the same formation and structure. Substation patrol is undertaken by Substation Maintenance Team (Substation Maintenance Team: Table 9.2 2) of Addis Ababa Regional Office, and it carries out patrol twice per year and inspections twice in total, only four (4) times in total are conducted, because of the lack of personnel. Periodic patrol is hardly practiced so far.

4) Distribution Network

Distribution facilities in the Addis Ababa metropolitan area are maintained and managed by the four regional centers of EEU. The engineer and technician of these four regional centers carry out initial responses in case of distribution power outage and customer requests, and when large-scale construction becomes necessary, they request the emergency center to respond to it. Since such responses are basically after-actions, routine maintenance and inspection works are not carried out. Therefore, planned repair work of the distribution equipment is also not implemented. Because of this, the distribution facilities in the metropolitan area are in a bad situation.

In each regional center, even if some constructions are implemented, the process to update the facility data, which has to be managed, is not in place, so the facility data has not been updated for a long time. Furthermore, they have not sufficiently grasped information on the multiple projects, which are underway, in the Addis Ababa metropolitan area, due to the lack of information sharing with the project team.

9.2.2 Proposal for the Project and O&M Organization

(1) Implementation Organization

The structure shown in Fig. 9.2-4, will be the Project implementation structure. The Project Manager for EEP and the Project Manager for EEU will be appointed by each organization together with members of Project Implementation Team (PIT). Basically, the Project will be managed by the Project Managers and PITs from EEP and EEU with mutual coordination, and Joint Quarterly Monitoring Meeting will be held in quarterly basis to monitor overall progress of the Project and approve the Progress Report which will be submitted to JICA. The members of Joint Quarterly Monitoring Meeting will be assigned by EEP and EEU, with director level staff, such as Director

of Transmission and Substation Office of EEP, and Director of Distribution Project Office of EEU.

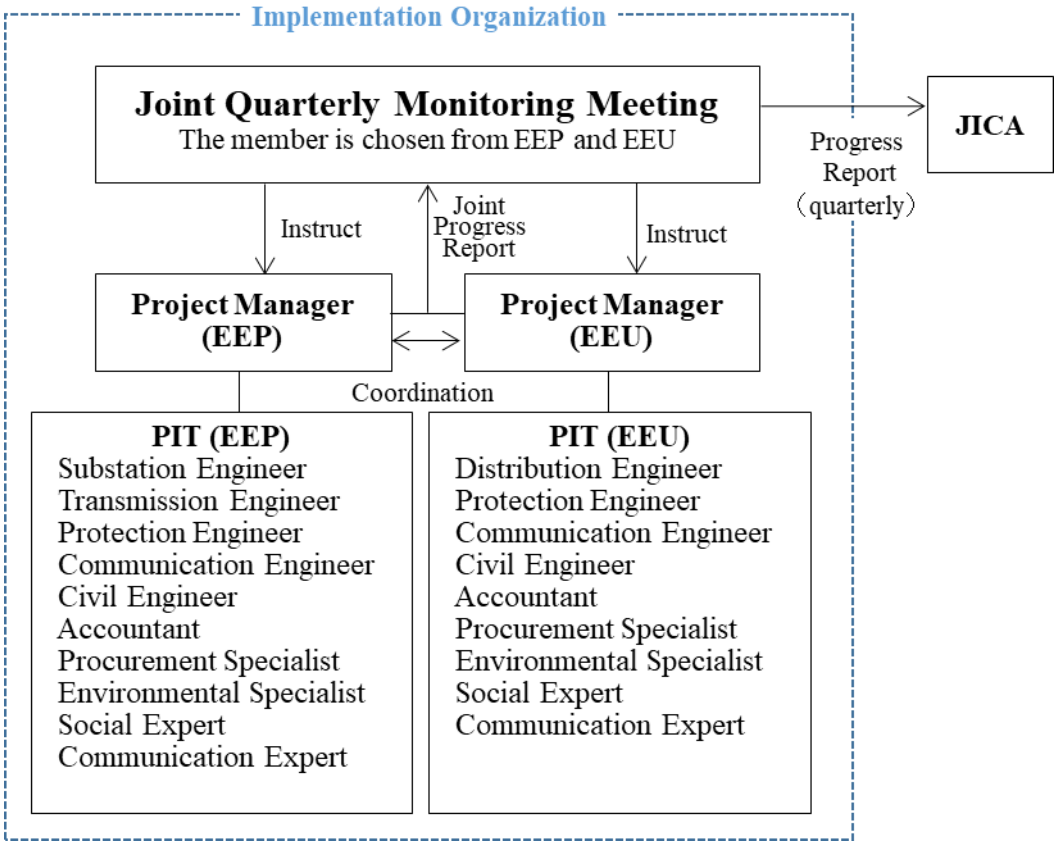

Fig. 9.2-4 Implementation Organization

(2) O&M Organization

1) Overhead transmission line

Because there is no organization other than the EEP to conduct maintenance works for the transmission line, the EEP maintenance team have to do all maintenance and repair works. Therefore, EEP has experience to do all kinds of maintenance and repair work, except for live-line work on high-voltage power transmission lines, which requires special equipment, like the other countries in Southeast Asia and South-East Asia. The EEP has complete access rights for ROW, including the tower site and route width of 30 m, with 15 m on both sides from the center of the route, so that the access to any tower site is secured. There are many cases in which general residents use a part of EEP's ROW temporarily as their access ways, car parking space and other temporary structures, but basically it is acknowledged by the residents that EEP has the vested right to the ROW.

It seems that sufficient has not been provided to obtain the correct technical know-how regarding facility maintenance. They have a different technical know-how when compared to

the trainings of other countries, as their knowledge is were purely based on their past experience.

For example, the reason why breakage of discs occur often in glass and porcelain insulators, is believed to be stones thrown by children; these stone hit the discs and break them. The maintenance team did not understand that the shattering of glass insulators is the cause of brakeage. So the maintenance team considered to apply composite insulators as countermeasure, as they won't break when hit by stones. However the maintenance team does not know that the life cycle cost increases when using composite insulators, which has been experienced by other countries. In Southeast Asia, countries such as Vietnam and Indonesia, composite insulators were used for over 10 years, but they found that composite insulators have to be replaced with new ones every 10 to 20 years. It results in a huge life cycle cost, and they have stopped using composite insulators. Such information is not shared with the maintenance team.

Damages on steel towers caused by the theft of bolts and angles has become a serious maintenance problem. The nuts and bolt at the bottom of the tower have been removed, and the main angle steels have been stolen. The maintenance team reports that there are cases where the angle steel have been cut by saw and stolen, but since the angle material at the lower part of the steel tower is large in size and there is no scaffold for standing and cutting such large size steel, the nuts and bolts should have been removed by ordinal spanner, which is available at any place. On some tower, more than 50 bolts and nuts are removed. Maintenance team still does not have any knowledge of anti-theft nuts/bolts that are already being used in other countries. Anti-theft nuts are commonly used in Japanese-made motorcycles and cars. So it is recommended to use anti-theft nuts/bolts to keep the tower strength for a long period.

Development around the transmission line tower are in progress, and due to the construction of new roads and the other construction works, the ground elevation level has increased due to the embankment works. Electrical distance between the conductor and the ground has decreased, and is lesser than the safety distance. As a result, it is necessary to cut trees on such locations to prevent electrical fault accident. Currently, the cutting of trees is done periodically for the existing transmission line, however the new steel tower shall be designed to have a sufficient height.

2) Underground Cable

A cable system composed with a solid insulation does not require regular maintenance basically because there are not rotating parts, oil or gas. And it can be said that the buried system is safer when compared to the overhead system because the general public cannot access the system easily.

However, there are possibilities of accidents, caused by other burial work or manufacture / installation process, to occur. A patrol is an effective countermeasure to prevent accidents such as injuries caused by other burial works. When a burial work is noticed near the route, it is very important acquire information of construction through hearing and give heads up. This shall prevent the occurrence of accidents substantially.

The route length of the 132 kV cable introduced by this project is about 10 km. Maintenance proposal contents are shown as below.

(a) Patrol

Visual confirmation for routes and visible facilities (sealing end in the substation, connecting point of the overhead line etc.).

1 time / 3 months – 1 year 2 persons / times half a day / times

(b) Inspection

Detail investigation of facilities inside manhole and pit.

1 time / within 1 to 2 years after completion, after that 1 time / 5 – 10 years

5 people / times half a day / place (manhole or pit)

About 40 people are employed in transmission / substation operation / maintenance office, which has jurisdiction over Addis Ababa area, so we consider that it is sufficient to organize a patrol system.

On the other hand, if an accident caused by manufacturing or construction process occurs, it is recommended to request the manufacturer to repair the same. Because identification of accident points and replacement of cables require not only special equipment, but also extensive experience and training to carry out the work.

3) Substation facility

As described in Chapter 9.2.1, project implementation system in EEP has been well organized and does not have a big problem. This is because, so far, many projects have been financed by World Bank and AfDB, etc., in EEP.

On the other hand, EEP does not carry out enough daily maintenance work. They carry out breakdown maintenance, which means, they carry out necessary action after some problem occurs.

Japanese power utilities carry out time based maintenance called TBM, and conditioned based maintenance called CBM, to identify the signs of a fault before its occurrence. However, some countries, especially developing countries have adopted breakdown maintenance

EEP needs to strongly shift to TBM and CBM to achieve high reliability of network. From the view point of the limited manpower in EEP, JICA Study Team suggests that the daily visual inspection and minor maintenance be carried out by the operation staff of each substation, in order to effectively utilize manpower of the staff in substation, because all substations in Ethiopia are manned substations. The conventional visual inspection and maintenance team will be changed to specialist team for major maintenance and emergency actions including dismantling/reassembling, due to the manpower saved by the utilization of substation's staff.

As described above, EEP could change to a more independent and self-managed organization.

EEP is being educated about the way of substation maintenance by "Train to trainers" program by USAid. Therefore they will get the knowledge of required technical level and personnel system. (Education of maintenance system for switchgears and transformers is scheduled to be completed within 2018)

4) Distribution Network

As mentioned above, because EEU does not have both organization and process for maintenance and management of facilities, which are necessary to keep distribution facilities in proper condition and to maintain supply reliability and power quality; some improvements are required. Firstly, for facility management, proper management and updating of facility data is important. In other words, it is necessary to update facility data, which is possessed by EEU, every time, during construction or maintenance.

In addition to this, in order to grasp the condition of the facility and maintain proper supply reliability and power quality, organization and process for inspection and maintenance is required. EEU does not conduct periodic inspections and maintenance at present, so they

cannot accurately grasp the deterioration situation of the facility. As a result of this, facilities have deteriorated further without rehabilitation, and the number of outages and equipment damage have increased. This is thought to be due to the lack of both systematic and conscious efforts by EEU to conduct planned inspections and maintenance, because in the current situation, their efforts are mainly focusing only on steps after a trouble occurs. Meanwhile, it is expected that the manpower needed in the handling of troubles will be decrease, once the facilities are updated by the various distribution projects, including this project.

For this reason, JICA Study Team suggests forming an inspection and maintenance team and to carry out periodical equipment inspection, data management and update. The inspection and maintenance teams should set certain criteria, to check the status of all the facilities periodically, and if they find any trouble, they should determine the deadline for rehabilitation depending on the degree of deterioration. The result of repair work should be reflected in the managed facility data.

For example, in a Japanese power utility, they conduct inspection and maintenance of all distribution facilities at a frequency of about once every four years. As a result of that, they can grasp deteriorated and defective facilities, and make a repair plan for efficient operation and maintenance. The team is made up of few engineers, who are familiar with distribution facilities, and they have skills to immediately repair minor troubles. Also in Addis Ababa metropolitan area, it is recommended to establish a systematic facility maintenance process, through such periodic inspections and maintenance, in order to maintain the wide range of enormous distribution facilities at an appropriate level.

In addition, management of facility data, management of customer data is also important. If the customer's load management is insufficient, as in the present situation, as the demand increases, a load connection deviating from the proper utilization rate of the transformer will also occur. As a result, in the long run, there is a possibility that many transformers will be overloaded.

This not only causes a power outage at low voltage system, but also causes public disasters such as a burned fuse touching a passerby, due to the installation method of transformer and its related equipment, in Ethiopia. So, it is urgent issue. Therefore, it is necessary to share customer data within the EEU at the time of load connection and to manage the load capacity of the customer.

CHAPTER 10

EVALUATION OF PROJECT

CHAPTER 10 EVALUATION OF PROJECT

10.1 QUANTITATIVE EVALUATION

10.1.1 Project Benefit

(1) Transmission Line and Substation

The objectives of the project are: solving the transformer capacity shortage of 132kV substations in Addis Ababa power system, increasing the system stability, and reducing the transmission loss. The evaluation targets are the increased electricity supply by the expansion of substations' transformer capacity, and the increased system stability by the increased number of circuits in the incoming transmission line of the substations.

In order to solve the shortage in transformer capacity of the substations, the transformer capacity is expanded in ADC, ADN and Weregenu substation. Therefore, the evaluation can be done by comparing the increased electricity supply, after the expansion of transformer capacity by the project, with the electricity supply of the existing transformer capacity. The evaluation methodology is, to calculate the increased energy (GWh) of each year, by subtracting electricity supply of each substation's existing transformer capacity from the electricity supply forecasted based on the peak demand of the year 2017. After the year in which the peak demand exceeds the expanded capacity, the electricity supply is fixed as the constant base of the expanded capacity. The load factor is 65%.

Table 10.1-1 shows the specification of substations. The power factor is 0.95. Taking into consideration the case where one transformer is in a faulty condition, the availability of each transformer is 75% when two are operated in parallel, and it is 100% when three are operated in parallel. When only one transformer is operated, it is permitted to have an availability of 100%.

Table 10.1-1 Transformer Capacity (Existing & Expanded) and Peak demand (2017) of Each Substation

Substation	Existing		After Expansion		Peak Demand as of 2017(MW)
	Rated Capacity(MVA)	Capacity(MW)	Rated Capacity(MVA)	Capacity(MW)	
A D C	75(31.5×2unit +12×1unit)	59.3	200(50×3unit +50×1unit)	190.0	64
A D N	50(25×2unit)	35.6	100(50×2unit)	71.3	47
Weregenu	80(40×2unit)	57.0	130(40×2unit +50×1unit)	104.5	54

Source: JICA Study Team

Based on the above mentioned conditions, the calculated electricity supply from the operation starting year, 2024 up to 2033 are shown in Table 10.1-2.

Table 10.1-2 Result of Electricity supply Evaluation

Year		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Electricity Supply (GWh)	A D C	296	344	396	452	512	577	647	722	761	761
	A D N	203	203	203	203	203	203	203	203	203	203
	Weregune	196	236	270	270	270	270	270	270	270	270
	Total	694	783	869	925	985	1050	1120	1196	1235	1235

Source: JICA Study Team

In order to increase the system stability, there is a plan to upgrade ADC, Weregenu and Gofa substation by increasing the number of incoming transmission circuits. Therefore, the outage frequency (time per year) caused by a transmission line fault has to be evaluated. The incoming transmission line circuit is duplicated, therefore the substation outage problem, which is caused after the system switching operation in the case of transmission line fault, can be solved.

(2) Distribution

In the distribution facilities, the 2 aspects for evaluation are: increase in electricity supply by strengthening the distribution transformer, and reduction in power loss by the installation of the amorphous transformer.

At first, the steps taken to increase the electricity supply is described below. In this project, since the capacity of transformer is selected at the time of transformer replacement, to correspond to the demand increase amount of 2034, the transformer capacity is either increased or an additional transformer is installed. As a result of this, the total capacity of distribution transformers in the project area will increase, so the electricity supply will also increase.

Next, as for the reduction of power loss, since the transformer which is newly installed at the time of rehabilitation adopts AMT, efficiency is improved when compared to the conventional type CRGOT, and power loss reduction is achieved.

The increase in electricity supply is evaluated by comparing the total electricity supply after the enhancement of the transformer capacity by this project with the total electricity supply of the existing transformer's capacity, which will be replaced in Item A, B, C. The evaluation process is explained in detail below.

Table 10.1-3 shows the number of transformers installed before and after rehabilitation work. As this table shows, the increase in transformer capacity due to the enhancement of the transformer is calculated as 186,560kVA, by subtracting the total capacity of the transformer before construction

from the total capacity of the transformer after construction. With this transformer construction, all the transformers in the project scope will be able to cope with the increase in demand of 2034, without being overloaded. Therefore, the increase in electricity supply from 2018 to 2034, which is calculated to be 10,262 GWh, is considered as a benefit of this project, and the electricity fee income will increase by 923 million USD, if the electricity is sold at the unit price of 0.09 USD / kWh.

Table 10.1-3 Number of transformers installed before and after construction work

Transformer (15kVA&33kVA /433V)	at present		after the project		
	Total Units [kVA]	(a) Total Capacity [kVA]	Total Units [kVA]	(b)Total Capacity [kVA]	(b) - (a)
25kVA	87	2,175	77	1,925	-250
50kVA	163	8,150	136	6,800	-1,350
60kVA	1	60	0	-	-60
100kVA	259	25,900	196	19,600	-6,300
200kVA	533	106,600	540	108,000	1,400
250kVA	1	250	1	250	-
300kVA	11	3,300	10	3,000	-300
315kVA	914	287,910	1096	345,240	57,330
400kVA	43	17,200	398	159,200	142,000
500kVA	12	6,000	9	4,500	-1,500
630kVA	121	76,230	114	71,820	-4,410
800kVA	31	24,800	31	24,800	-
1,000kVA	3	3,000	3	3,000	-
1,250kVA	33	41,250	33	41,250	-
1,600kVA	1	1,600	1	1,600	-
Total	2,213	604,425	2,645	790,985	186,560

Source: JICA Study Team

On the other hand, the power loss reduction due to the installation of the AMT, is calculated by multiplying the number of newly installed AMT with the difference in power transmission loss of AMT and CRGOT (see Table 8.5-2), which is different for each transformer capacity. This can be expressed as follows.

(Power loss reduction amount)

= (The number of newly installed AMT) × (difference in power transmission loss)

The above calculation results are shown in Table 10.1-4. By summing up the power loss reduction amount of each transformer capacity, the total power loss reduction achieved in one year is calculated to be 5,890 MWh, and as a result of this, an income of 530 thousand USD / year can be obtained, if the electricty is sold at the unit price of 0.09 USD / kWh.

Table 10.1-4 Power loss reduction amount

Transformer	(a)Units		(b)Power loss Reduction[kWh/year] /Unit		(a)×(b) Total Reduction[kWh/year]		
	15kVA /433V	33kVA /433V	15kVA /433V	33kVA /433V	15kVA /433V	33kVA /433V	Total
25kVA	63	11	648	673	40,826	7,400	48,226
50kVA	116	10	962	858	111,650	8,577	120,227
100kVA	149	17	1,283	1,320	191,202	22,448	213,650
200kVA	468	29	1,854	2,049	867,481	59,417	926,898
315kVA	980	65	3,178	2,990	3,114,208	194,338	3,308,546
400kVA	376	15	3,256	3,215	1,224,274	48,218	1,272,492
Total	2,152	147	—	—	5,549,641	340,398	5,890,039

Source: JICA Study Team

10.1.2 Evaluation by Economic & Financial Analysis

Nonpublic Information

10.1.3 Estimation of CO2 Emission

One of the benefits brought about by implementing this project is a reduction in transmission loss. The following difference can be expected in the year 2024.

without Project	Energy Loss p.a,＝	20,703 MWh
with Project	Ditto	14,813 MWh

The difference in the amount of electricity saved by implementing the project is 5,890 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.

The emission factor of CO2 in the EEP / EEU electric power system has not been clarified. The result of survey conducted by the Japan Foundation for Public Interest Foundation Institute for Global Environmental Strategies (IGES) for Africa and Ethiopia has been published as an example of past examination.

The amount of CO2 emission is estimated by the Combined Margin Emission Factor, which is one of the emission factors and is often used as a standard indicator in many of the power projects. Emission factor is shown below.

Emission Factor: 0.000034615 t-CO_2/MWh（Source: IGES estimated）

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 0.204 t-CO2 per year as shown in Table 10.1-5.

Table 10.1-5 Reduction of CO2 Emission by the Project (as of 2024)

Calculation Result Sheet : New or Existing			
Addis Ababa Transmission and Distribution System Rehabilitation and Upgrading Project			
Reduction of GHG emission by the Project (t-CO_2/y)			$ER_y = BE_y - PE_y$ (t-CO_2/y)
1. Baseline Emission $BE_y = BL_y \times EF_{BL,y}$			
BE_y	Baseline Emission : Emission of GHG without improvement of efficiency by the Project	0.717	t-CO_2/y
BL_y	Energy Loss before the Project	20,703	MWh/y
$EF_{BL,y}$	CO2 Emission factor of power system in Ethiopia	0.000034615	t-CO_2/MWh
2.Project Emission $PE_y = PL_y \times EF_{BL,y}$			
PE_y	Project Emission : Emission of GHG with improvement of efficiency by the Project	0.513	t-CO_2/y
PL_y	Energy Loss after the Project	14,813	MWh/y
$EF_{BL,y}$	CO2 Emission factor of power system in Ethiopia	0.000034615	t-CO_2/MWh
3. Reduction of emission due to the Project $ER_y = BE_y - PE_y$ (t-CO_2/y)			
ER_y	Reduction of emission due to the Project	0.204	t-CO_2/y
BE_y	Baseline Emission : Emission of GHG without improvement of efficiency by the Project	0.717	t-CO_2/y
PE_y	Project Emission : Emission of GHG with improvement of efficiency by the Project	0.513	t-CO_2/y

Source: JICA Study Team

10.2 PROPOSAL OF OPERATION AND EFFECT INDICATOR

10.2.1 Transmission Line and Substation Facility

The two operation and effect indicators proposed for performing a post-evaluation are shown in Table 10.2-1.

Table 10.2-1 Proposed Operation and Effect Indicators

Indicator	Function	Purpose	
		As Operation Indicator	As Effect Indicator
a) Electricity supply ［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

Source: JICA Study Team

As for the electricity supply, it can be checked if the expanded facilities are used effectively or not by the index such as the increased electricity supply of 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 the index such as the number of outages in the substation's expanded incoming transmission line.

10.2.2 Distribution Facilities

The three operation and effect indicators proposed for performing a post-evaluation, are shown in Table 10.2-2.

Table 10.2-2 Proposed Operation and Effect Indicators

Indicator	Function	Purpose	
		As Operation Indicator	As Effect Indicator
a) Outage frequency in distribution feeder ［times/year］	Annual outage frequency in the Project area caused by a fault in distribution feeder.	To evaluate reliability	To evaluate whether reliability has been improved by a proper value after the Project
b) Outage duration in distribution feeder[hour/year]	Annual power outage duration in the Project area caused by fault in distribution feeder.	To evaluate reliability	To evaluate whether reliability has been improved to a proper value after the Project
c) Fault section detection rate [%]	Percentage of fault sections identified at a substation	To check that the distributing substation is utilized efficiently.	To evaluate the rate achieved by this project.

Source: JICA Study Team

With regard to the number of power outage in the distribution feeder and its duration, it can be confirmed whether the supply reliability is maintained properly by using indexes such as the decrease in the frequency of power outages and power outage duration, which are brought by the removal of the faulty equipment parts in the rehabilitation of the MV feeder in Item B, C The indicators per customer such as SAIFI (System Average Interruption Frequency Index) and SAIDI (System Average Interruption Duration Index) are generally used in the evaluation of supply reliability. But in the target area of this project, it is difficult to evaluate with these indicators due to the lack and inaccuracy of EEU's customer data. So it is recommended to use the frequency and duration of power outages per distribution feeder as evaluation indicators.

And, as for the fault section detection rate, the rate at which a substation operator can determine the fault section by TSS and the control system at the substation when a power outage occurs at the feeders for Item C is evaluated. In this way, it is evaluated whether the TSS, which contributes to the reduction in number of power outage and shortening of power outage duration by the early identification of fault section, is working properly or not.

Reduction in power loss is expected by installing amorphous transformer, which is planned to be adopted in JICA project. But is recommended not to include the distribution loss in the operation and effect indicator, because, it is difficult to acquire data, such as the electricity supply and utilization rate of each transfer, which are necessary for calculating the amount of distribution loss reduced.

10.3 TARGET VALUES OF OPERATION AND EFFECT INDICATORS

10.3.1 Transmission Line and Substation 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 10.3-1.

Table 10.3-1 Target Values of Operation and Effect Indicators

Indicator	Facility	Baseline (2017)	Target Value (2026)	Remark
a) Electricity supply ［GWh］	Addis Center Substation 132/15kV three transformers 132/33kV one transformer	321GWh	665GWh	two-year years after project completion (2026)
	Addis North Substation 132/15kV two transformers	203GWh	406 GWh	
	Weregenu Substation 132/33kV one transformer	325GWh	561 GWh	
b) Substation Outage Frequency ［Time per year］	Addis Center Substation	-	0	two-year years after project completion (2026)
	Weregenu Substation	-	0	
	Gofa Substation	-	0	

Source: JICA Study Team

As for the electricity supply, it can be checked if the expanded facilities are used effectively or not by the index such as the increased electricity supply of 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 the index such as the number of outages in the substation's expanded incoming transmission line.

10.3.2 Distribution Facilities

The values aimed for the year 2026, two years after the completion of project, are set as target values. Table 10.3-2 shows the frequency of power outages and the duration of power outage in 2017, based on the power outage data obtained from EEP and EEU. The record of the outage here includes only outage caused by defects occurred in the distribution facilities, such as ground faults and short circuits, and excluding faults in substation and/or transmission and/or generation equipment and power outages for work. This is in order to accurately grasp the effect of the project, the rehabilitation work of the distribution equipment implemented in this project because it is

impossible to reduce the blackout caused by other equipment or work.

In this table, the term “PERMANENT” indicates a power outage caused by an equipment breakdown such as disconnection of conductor and the power failure will not be resolved unless the equipment is restored. Also, the term “TRANSIENT” indicates a power outage caused by temporary reason such as contact with trees, birds, or animals and the power outage is resolved after a certain period of time, just by closing the CB of the substation. Although EARTH FAULTS and SHORT CIRCUITS are recorded by the operation relays of the substation that detected the fault, the detailed cause of fault is not managed and is unknown.

In addition, each numerical value represents the total value of all feeders for each Item. However, there is no power outage data for each distribution feeder of item C. There is only power outage data of 15kV substation total. So, the frequency of outages and the outage duration for Item C is assumption based on calculation by the ratio of the number of feeders.

In Table 10.3-2, it is shown that power outage occurred 2,123 times for a duration of 2,073 hours in total for Item B target distribution lines. And in Item C target distribution lines, the power outage occurred 438 times for a duration of 627 hours in total.

Table 10.3-2 Outage frequency and Outage duration of Item B and C in 2017

Item	Type	OUTAGE RECORD(2017)					
		Frequency(no.)			Duration(hour)		
		EARTH FAULT	SHORT CIRCUIT	Total	EARTH FAULT	SHORT CIRCUIT	Total
ItemB	PERMANENT	289	401	690	831	1,124	1,954
	TRANSIENT	1,067	366	1,433	89	31	119
	Total	1,356	767	2,123	919	1,154	2,074
ItemC	PERMANENT	44	114	158	120	486	606
	TRANSIENT	136	144	280	10	11	21
	Total	180	258	438	130	497	627

Source: JICA Study Team

Based on this data, the reduction in frequency of outages and power outage duration brought by this project is described below. In this project, covered conductor and pin post insulators, which are expected to have high reliability, are adopted in the replacement of deteriorated distribution facilities.

As a result of the project, in addition to the renovation of aged facilities, a reduction in the frequency of power outages and power outage duration due to adoption of such highly reliable equipment can be expected, but EEU does not have detailed data on the cause of fault in distribution feeders. Therefore, it is difficult to concretely calculate them as an effect of this project.

In a Japanese power utility, which introduced covered conductor in the 1960's., SAIFI was reduced

by about 69% in the 10 years. In this project, about 90% of the subject MV feeders will be replaced with covered conductor, so JICA study team assumed that the causes of outage occurring in Items B and C will be eliminated by 60%, and set the target values.

In addition to the effects mentioned above, it is expected that the duration of power outages can be further shortened by the application of TSS for the target distribution feeders of Item C. Seven TSS switches are installed in the target distribution feeders, and each distribution feeder is divided into 8 sections. As mentioned above, EEU does not have detailed data on the distribution feeder outage, so the probability of a distribution feeder accident occurring is assumed to be same for all these 8 sections. (Probability of distribution feeder accident in each section = 1/8 = 12.5%)

If the fault section can be determined properly by TSS, it is possible to transmit power by closing the substation CB unless the accident occurs in the first section (7/8 = 87.5%).

To be exact, the effect of shortened power outage duration should be considered only after reviewing the possibility of power transmission by section basis. However it is difficult to conduct detailed examination on the target setting and monitor after the implementation of project, considering the actual situation of EEU for management of the load information and customer information. Therefore, in this report, the effect is considered only based on the information on the status of substation's CB.

Even at a Japanese power utility that has an operation experience of the TSS system over the long term, the fault section detection rate is about 85%. However, it is considered difficult to achieve the detection ratio same as Japan, since evaluation of this project is carried out two years after the project completion. So, JICA study team set the target of fault section detection rate as 40% half of Japan.

From the above, the target values of the power outage duration of Item C is calculated by the following formula.

Power outage duration = Power outage duration when determining the fault section succeeded
+ Power outage duration when determining the fault section fails

$= T1 \times \alpha \times 1/8 + T1 \times (1 - \alpha)$

$= T1 \times (\alpha \times 1/8 + 1 - \alpha)$

$= T1 \times (1 - \alpha \times 7/8)$

$= T1 \times 0.65$

$= T0 \times 0.26$

T0 : Power outage duration before project implementation
T1 : Power outage duration after project implementation (0.4 × T0)
α : Fault section detection rate

From this formula, it is assumed that the power outage duration in item C can be reduced by 74%.

The target value is shown in Table 10.3-3.

Table 10.3-3 Targeted Values of Operation and Effect Indicators

Indicator	Target Feeder	Baseline (2017)	Target Value (2026)	Remarks
a) Outage frequency in distribution facilities ［times/year］	Item B feeder	2,123 times	60% reduction	two years after project completion (2026)
	Item C feeder	438 times	60% reduction	
b) Outage duration in distribution facilities [hour/year]	Item B feeder	2,074 hours	60% reduction	two years after project completion (2026)
	Item C feeder	627 hours	74%reduction	
c) Fault section detection rate [%]	Item C feeder	-	40%	two years after project completion (2026)

Source: JICA Study Team