THE REPUBLIC OF KENYA
KENYA POWER & LIGHTING CO., LTD.

THE PREPARATORY SURVEY
ON
KISUMU-LESSOS-OLKARIA TRANSMISSION LINE
UPGRADING PROJECT

FINAL REPORT

MARCH 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
TOKYO ELECTRIC POWER SERVICES CO., LTD.
IC NET LIMITED

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PREFACE

Japan International Cooperation Agency (JICA) conducted the preparatory survey on the Kisumu－Lessos－Olkaria Transmission Line Upgrading Project in the Republic of Kenya during the period of May 28, 2009 to March 1, 2010.

The average annual growth of electricity demand in Kenya reaches more than 5% in the past 5 years. To sustain the economic growth of the country, expansion of the limited transmission line system and insufficient generating facilities is urgently needed. The Kisumu－Lessos－Olkaria Transmission Line Upgrading Project is considered as one of the priority projects under the power sector development plan as the important projects which will contribute to reliable supply of power.

The preparatory survey was conducted to collect the necessary information and to review the existing development plans, and to hold discussions with the officials concerned of the Government of Kenya.

I hope that this report will contribute to realization of the project implementation and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Kenya for their close cooperation extended to the teams.

March 2010

Kazunori OSHIYAMA
Director General, Africa Department
Japan International Cooperation Agency

March 2010

Letter of Transmittal

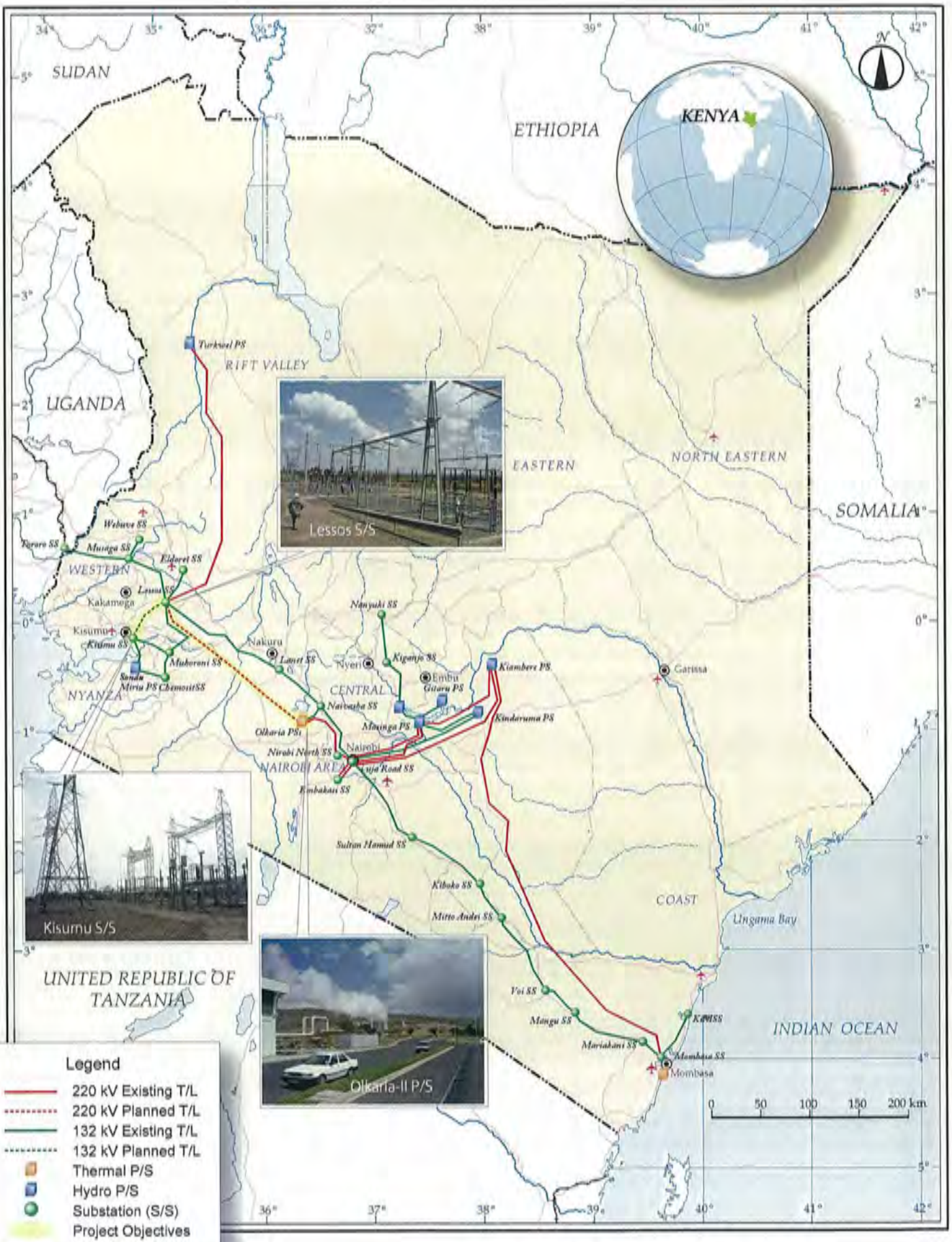
We are pleased to submit to you the preparatory survey report on Kisumu－Lessos－Olkaria Transmission Line Upgrading Project in the Republic of Kenya.

The survey was conducted by the Consortium of Nippon Koei Koei Co., Ltd., Tokyo Electric Power Services Co., Ltd., and IC Net Limited, under a contract of JICA, during the period of May 2009 to March 2010. In conducting the survey, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kenya and formulated the most appropriate outline design for the project under Japan's ODA loan scheme.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Hiroyuki MORITA
Team Leader,
Preparatory Survey Team on
Kisumu-Lessos-Olkaria Transmission
Line Upgrading Project
Nippon Koei Co., Ltd., Tokyo
Electric Power Services Co., Ltd.,
and IC Net Limited



Location Map

The Preparatory Survey

on

Kisumu-Lessos- Olkaria Transmission Line Upgrading Project

The Republic of Kenya

Final Report

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Abbreviations

AEC	African Economic Community
AFD	Agence Francaise de Develpoment
AfDB	African Development Bank
ASEAN	Association of South-East Asian Nations
AU	African Union
CDM	Clean Development Mechanism
COMESA	Common Market for Eastern & Southern Africa
CPI	Consumer Price Index
DOE	Department of Energy
DSM	Demand Side Management
EAC	East African Cooperation
EAPMP	East African Power Master Plan Study
EAPP	East African Power Pool
ECOWAS	Economic Community of East African States
EEPCO	Ethiopian Electric Power Corporation
EIA	Environmental Impact Assessment
ENTRO	East Nile Technical Regional Office
F/Y	Fiscal year
GDP	Gross Domestic Product
IDA	International Development Association
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
ISO	Independent System Operator
JICA	Japan International Cooperation Agency
KANU	Kenya African National Union
KenGen	Kenya Electricity Generating Company Ltd.
KETRACO	Kenya Electricity Transmission Company
KPLC	Kenya Power & Lighting Company Ltd.
MOU	Memorandum of Understanding
NAI	New African Initiative
NARC	National Rainbow Coalition
NBI	Nile Basin Initiative
OAU	Organization of African Unity
OECD	Organization for Economic co-operation and Development
ODA	Official Development Assistance
PRS	Poverty Reduction Strategy
RAP	Resettlement Action Plan

REC	Regional Economic Communities
SAPP	Southern Africa Power Pool
TANESCO	Tanzania Electricity Supply Company Ltd.
UEB	Uganda Electricity Board
WB	World Bank

Units

Currency

Ksh	: Kenyan Shillings
USD	: United State Dollars
¥	: Japanese Yen
ECU or €	: Euro Currency Unit

Electricity

V	: Volts
kV	: Kilo Volts (1,000V)
A	: Amperes
kA	: Kilo amperes (1,000A)
W	: Watts (active power)
kW	: Kilo Watts (10^3W)
MW	: Mega Watts (10^6W)
GW	: Giga Watts (10^9W)
Wh	: Watt-hours (watt x hour)
kWh	: Kilo Watt-hours (10^3Wh)
MWh	: Mega Watt-hours (10^6Wh)
GWh	: Giga Watt-hours (10^9Wh)
VA	: Volt-amperes
kVA	: Kilo Volt-amperes (10^3VA)
MVA	: Mega Volt-amperes (10^6VA)
Var	: Volt-amperes reactive (reactive power)
kVar	: Kilo Volt-amperes reactive (10^3Var)
MVar	: Mega Volt-amperes reactive (10^6Var)
Pf	: Power factor, Pf = W/VA

Chapter 1 Introduction

1.1 Background

The Republic of Kenya has politically maintained a stable administration compared with other countries in Africa, and the annual economic growth it has achieved is 7.0% in 2007 according to the World Bank. In this connection, the annual growth of electricity demand reached more than 6.0% in the last five years. At present, the peak power demand in Kenya is 1,086 MW, whereas the generation capacity in 2008 was 1,135 MW in total, i.e. the margin of the generation capacity is less than 5%. The balance of supply and demand for electric power is always tight because the existing generation facilities are extremely aged, and hydropower stations which are the main sources of electrical supply in the country are easily affected by recent shortage of rainfall.

The government issued the Long Term National Development Policy "VISION 2030" in 2008 to maintain an annual economic growth of 10% and turn the country into a newly industrializing economy by 2030. For this purpose, the government has been promoting to increase the electrification rate in remote areas, and improve the reliability and quality of electricity supply in urban areas.

On the other hand, the construction of the Bujagali Hydropower Plant, which is presently under construction, will commence its operation and will generate 250MW in 2011 in the neighboring country of Uganda. Since the generation will achieve 50% of the whole existing generation capacity of Uganda, Kenya may be able to import the power at a low cost without investing for a new hydropower plant.

Under the above circumstance, the Ministry of Energy (MoE) of Kenya planned to construct new transmission lines connecting through Kisumu, Lessos, and Olkaria. The Government of Kenya applied for Overseas Development Assistance (ODA) loan to the Government of Japan for the construction of these transmission lines. A planned transmission line between Lessos and Olkaria is to function as parts of the international interconnecting transmission line for connecting between Bujagali Hydropower Plant in Uganda and Mombasa where there are several thermal power stations in Kenya. This cross-border interconnection line will transmit very inexpensive power from Uganda, and even from Ethiopia, and will contribute in increasing the power supply reliability and capacity to meet the required energy demand for the social and economical development of Kenya. Likewise, another planned transmission line between Lessos and Kisumu will be for feeding the power generated by the Sondu/Miriu Hydropower Plant to the national grid in Kenya, as well as to be used for coping with recent quick increase of electrical demand in Kisumu area. Sondu/Miriu Hydropower Plant was also constructed under the finance of Japan's ODA Loan.

1.2 Objective of Survey

After the structural reform of the power sector from 1996 to 2000 in Kenya, five organizations in charge of the activities in the sector have been incorporated into the two organizations; (i) Kenya Electricity Generating Company Ltd. (KenGen) for Generation, and (ii) Kenya Power & Lighting Company Ltd. (KPLC) for the transmission, distribution and retail of electricity. This KPLC was the counterpart of this Preparatory Survey.

This Preparatory Survey aimed to evaluate the justification of the project implementation for construction of Kisumu-Lessos-Olkaria Transmission Line Upgrading Project planned by KPLC from the view points of technical, economic and financial aspects. The Survey intended to formulate an implementation plan of this project as a candidate for Japanese ODA Loan(s). Target areas of this Survey covered Nairobi, Kisumu, Lessos, Olkaria, the transmission line route from Olkaria to Kisumu in Kenya side, and in addition, also cover Uganda (Kampala & Bujagali power station site), and Ethiopia (Addis Ababa).

1.3 Schedule & Method of Survey

The Survey was conducted from the end of May 2009 to the end of November 2009 with the following sequence.

(1) First Home Work (28 May 2009 to 6 June 2009)

Preparation of Inception Report, collection of available data etc.

(2) First Field Survey (7 June 2009 to 5 August 2009)

Presentation of Inception Report to Kenya representatives, study and analysis of data collected in the field. Start of field survey by employing local consultants (Topographic survey and Environmental and Social Impact Assessment (ESIA) survey).

(3) Second Home Work (6 August 2009 to 1 September 2009)

Analysis at Home office, and preparation of Interim Report.

(4) Second Field Survey (2 September 2009 to 16 October 2009)

Presentation and discussion of Interim Report to Kenya representatives.

Continuation of the First Field Survey, study and analysis, and preparation of the first Draft Final Report (1st DFR).

(5) Third Home Work (19 October 2009 to 28 November 2009)

Presentation of the 1st DFR to JICA, collection of the comments from JICA and other concerned parties, and preparation of 2nd DFR based on the comments.

(6) Third Field Survey (29 November 2009 to 24 December 2009)

Presentation of the 1st DFR to KPLC and other concerned parties in Kenya.

Preparation of 2nd DFR based on the latest status/results of Environmental Impact Assessment (EIA) and Resettlement Action Plan (RAP) conducted by KPLC. Assistances to KPLC regarding EIA and RAP were also made.

(7) Fourth Home Work (25 December 2009 to 1 March 2010)

Preparation of the 2nd DFR based on the results of Third Field Survey, and collection of comments from JICA and other concerned parties.

Submission of the Final Report.

The works done in the Survey include the review and update of the data collected from KPLC, JICA Kenya Office, donor agencies, and also from power companies, JICA offices in Uganda & Ethiopia etc.. The aforementioned officials, agencies, and companies were interviewed and the collected data were studied and analysed. In addition, the following reports were used to obtain the important information.,

- Kenya Power Transmission Project Feasibility Study, Final Report（year 2003, under USTDA fund, study conducted by POWER Engineers Inc., the owner is KPLC）
- Update of the Least Cost Power Development Plan 2009 - 2029 (September 2008 : December 2008 version also exists : prepared by KPLC）
- Annual Report & Accounts 2008/09 (year 2009, by KPLC）
- Study on the Interconnection of the Electricity Networks of the Nile Equatorial Lakes Countries, Feasibility Report, Volume 1 to 6（year 2007, under African Development Fund's fund, study conducted by Sogreah Consultants etc., the owner NBI）
- Ethiopia - Kenya Power Systems Interconnection Project, Final Report （February 2009, study conducted by FICHTNER GmbH & co. KG, the owner were MOE of Kenya and EEPCo of Ethiopia）
- Grid Development Plan, UETCL, Draft （by UETCL）
- East African Power Master Plan Study, Final Phase II Report（March 2005, study conducted by BKS Acres, the owner is EAC）

The Survey Team visited to the following embassies, JICA offices, donor agencies, government bodies, and companies.

Kenya

- Embassy of Japan in Kenya
- JICA Kenya Office
- JETRO Nairobi (Japan External Trade Organization)
- Ministry of Energy
- KPLC
- KenGen
- AFD (Agence Francaise de Development)
- World Bank

Uganda

- Embassy of Japan in Uganda
- JICA Uganda Office
- Ministry of Energy
- UETCL
- AfDB

Ethiopia

- Embassy of Japan in Ethiopia
- JICA Ethiopia Office
- Ethiopia Electricity Agency
- EEPCo
- EAPP

KPLC designated a meeting room for the Survey Team to facilitate meetings with the forner's management staff and engineers when they are available.

During the site survey, the Survey Team visited the transmission line route including the alternative routes, and related substation and power stations.

Chapter 2 Status of Power Sector in Kenya

1.1 Current Status of Politics and Economy

Source: Central Intelligence Agency. 2008. The World Factbook: 2008

Fig. 2-1.1 Map of Kenya

1.1.1 Geographic Features

The Republic of Kenya is located on the east coast of the African Continent to the inland area on the equator, has an area of 583,000 km^2 (1.5 times to Japan) with population of 39.8 million as of the year 2008. The country geographically faces to Indian Ocean on the east coast, whereas has borders with five countries of Ethiopia, Sudan, Uganda, Tanzania, and Somalia in the inland. As the Great Rift Valley runs from north to south in the country, prominent scenic sites are found such as Mt. Kenya (5,199m above sea level), which is the second highest mountain in Africa, and the Lake Victoria which is the third largest lake in the world and the largest lake in Africa. Almost the whole lands are at the altitude of more than 1,000 m, so that the climate of the country is comfortable compared with other countries in Africa even right on the equator.

Nairobi is the capital of Kenya, with a population of over 2 million. As the largest city in Eastern Africa, Nairobi houses numerous regional headquarters of international organizations and multinational enterprises. Mombasa, the second largest city in the country, is the center for marine transportation and logistics to the west coast of Africa and other overseas countries.

Hence, Kenya leads Africa in the fields of politics and the economy.

The mother language is Swahili while English is well spoken in general. Religiously, there are Protestant in 38% of overall population and Catholic in 28%, and there are other religions such as Islamic, Hindu, indigenous beliefs, etc. African ethnics such as Kikuyu, Ruhiya and Ruo make up the majority, whereas the Indian or British ethnic are minority but having strong political and economical influence under the background of economic forces.

1.1.2 Diplomacy and Politics

Kenya gained her independence in 1963 and shifted to a republic in 1964. Keeping the policy with free economy and pro-Western line as well as all-directional diplomacy, the Republic of Kenya has developed the friendships with a lot of countries as a stabilizing country in Africa. In addition, Kenya accelerate the formation of regional integrations, such as African Unions (AU), East African Community (EAC), and so on. The EAC comprises the five east African countries Burundi, Kenya, Rwanda, Tanzania, and Uganda. EAC introduced the union custom among the member countries and concluded the economic partnership agreement (EPA) with European Union, and target introduction of a single currency and an integrated market in future.

In domestic politics, Jomo Kenyatta of the Kenya Africa National Union (KANU) was inaugurated as the founding president, Kenya was called an honor country in Africa during the 60s to the 70s. Moi succeeded President after Jomo Kenyatta passed away in 1978. Unfortunately, he bred political corruption because of a unequal treatment to a part of ethnic groups and institute vigorous action in political field. Contradicting those actions, the advanced countries suspended the economic assistances to Kenya and this caused economic stagnation after the 80's. Considering the criticism toward one-party dictatorship by KANU for a long period, a multiparty system was introduced. But, the anti-administration parties could not overthrow the regime of KANU, and Moi got reelected at the general elections in 1992 and 1997. Then, the opposition alliance won the election in 2002 after the President Moi retired and a change of political power was realized. President Kibaki prioritized the exposure of corruption and the restoring of fiscal health in the policy. The international authorities resume the economic assistance and the economic growth was placed in orbit once again. However, since a proposed constitutional amendment was voted down by referendum in November 2005, President Kibaki dismissed all cabinet members. From these days, President Kibaki failed to close ranks and the weakness of unity among the ruling alliance was seen.

Although President Kibaki won a close race against Odinga from Orange Democratic Movement (ODM) and got reelected in December 2007, EU election-monitoring team had strong doubts about the election outcome because the process of vote counting was opaque. ODM and the majority of the people opposed to the reelected President, and riots happened in different parts of the country caused more than 1500 deaths and 300,000 displaced persons. To that end, the international community launched a mediation effort, and Party of National Unity

(PNU) of which the leader is President Kibaki and ODM agreed to form the coalition administration in February 2008. However, domestic upheaval for two months caused economic recession and undermined confidence in the international society.

1.1.3 Economy

Per capita GDP in the year 2008 was US$ 829 (IMF estimation), that is classified in the Low-income Countries by DAC of OECD. Kenya, however, is one of the countries having highest potential in agricultural field among Africa. Agriculture, starting from coffee, tea and horticultural plants, accounts for approx 25% of GDP and takes up 60% of working population. On the other hand, it is deficient of natural resources such as fossil fuel and rare metals unlike the neighboring countries resulting in a poor position of mining sector; 1% of GDP. It should, however, be noted that sodium carbonate which is a raw material for glass and fluorite are among the few that are exported.

Looking at the manufacturing sector, which accounts for a little over 10% of GDP and healthily growing, processing foods and cement are found to the primary players. Moreover, commerce and goods distribution business have been growing rapidly taking advantage of the geographical position in the regional commodity flow. In sum, Kenya could be said to have relatively more diversified industry among the sub-Sahara countries. Last but not least, tourist industry, thanks to abundant exotic tropical natural resources, is increasingly popular among foreigners and is playing a very important role to earns precious foreign hard currency

The economy of the country stagnated from the end of 1990s to the beginning of 2000s due to slump in agricultural produce caused by draught and political inability. As a result, average GDP growth rate during the five years from 1997 onward remained at meager +2.3%. Since then the economy turned around thanks to the worldwide economic recovery around 2004 and economic growth rate attained a remarkable +7.0% over the previous year in 2007, the highest in 20 years. However, the growth rate was forced to drop considerably down to +2.0% in 2008 owing to the grobal financial crisis.

Kenya, after suffering chronic financial deficit and current imbalance during 1980s, launched a structural reform program under the auspice of IMF in an attempt to stabilize its macro-economy through reforming public sector and deregulation policy. In spite of the effort, slow progress of political and economic reform came under heavy criticism by the middle of 1990s, that eventually led to cessation of disbursement of IMF loan for the expanded structural adjustment, followed by freezing of new assistance loans from various oversea donors, all of which led to economic slump of Kenya.

IMF, appreciating the government governance created by the transfer of power to the incumbent Kibaki presidency, resumed its loan in 2003. The central government, upon getting its economy back on track, laid down a national development plan called “Vision 2030” in 2007, by which it

aims to maintain an annual economic growth of 10% to become a Newly Industrializing Economy.

Exports are mainly consisted of agricultural produce, horticultural plants, textile products, of which total value in 2008 reached 345 billion Kenyan shilling (approx. 450 billion yen), that is an unprecedented increase of + 25.6% over the previous year. The outstanding are world-famous coffee and tea, while cut flowers have recently come to be increasingly popular in EU and mid-east countries. On the other hand, import of machineries and petro-chemical products have increased due to the domestic economic growth. Consequently, the large unfavorable imbalance of export/import has not been eliminated yet.

Partner countries of foreign trade are, in addition to African countries, previous suzerain United Kingdom and EU countries, while weight of Asian or Asian sub-continent countries such as China and India as well as middle east countries have been growing increasingly important. As for trade with Japan, export to Japan in 2008 was worth 2,340 million Kenya shilling (approx. 3,000 million yen) (+79.2% over the previous year) in which cut flowers such as roses showed remarkable rise, and import 44,800 million Kenya shilling (approx. 58,000 million yen) (+9.0% over the previous year). Import items were primarily industrial machinery and used cars.

Kenya is the member of, in addition to East African Community (EAC), COMESA (Common Market of Eastern Southern Africa) that is constituted of 19 countries residing in the south east segment of the African continent, the fact that will certainly accelerate regional economic cooperation through free trade and improvement of regional macro-economic environs

Table 2-1.1 Major Socio-economic Indexes (Kenya)

Items	2002	2003	2004	2005	2006	2007
Population (millions)	31.5	32.2	32.8	33.4	34.0	34.7
Population growth (annual %)	2.1%	2.1%	2.0%	1.9%	1.8%	1.8%
GDP (current US$) (billions)	13.19	15.04	16.09	18.77	22.52	27.03
GDP growth (annual %)	0.3%	2.8%	4.6%	5.9%	6.4%	7.0%
GDP per capita (current US$)	418.5	467.5	490.5	561.2	661.4	779.9
GDP, PPP based (current international $) (billions)	40.98	43.01	44.91	48.03	52.74	57.96
GDP per capita, PPP based (current international $)	1,300.1	1,337.2	1,369.0	1,436.1	1,549.1	1,672.6
Inflation, average consumer prices (2000=100)	107.8	118.4	132.2	145.8	166.9	183.2
Life expectancy at birth (years)	-	-	-	53	53	54
Fertility rate (birth per woman)	-	-	-	5.0	5.0	5.0
Mortality rate, under-5 (per 1000)	-	-	-	120	121	121
Military expenditure (% of GDP)	-	-	-	1.7%	1.7%	1.8%
Mobile cellular subscriptions (per 100 people)	-	-	-	13	20	30
Internet users (per 100 people)	-	-	-	3.1	7.6	8.0
Foreign direct investment, net inflows (current US$) (millions)	-	-	-	21	51	728
Official development assistance and official aid (current US$) (millions)	-	-	-	767	943	1,275

Sources : IMF - Key Development Data & Statistics 2009, World Bank - World Development Indicators 2009

2.1.4 National Development Plan

The new national development plan was launched under the name of "Vision 2030" and its 1st Edition has got under way in 2007. It envisions to upgrade Kenya into Newly Industrializing Economy by 2030 through maintaining a steady GDP growth of 10%, that in 2007 stands at 4.9%. The Vision 2030 intends to go forward in step-wise manner working out a mid-term development plan every five year. In the first mid-term plan (FY 2008-2012), the government has committed to inject investment in 6 priority sectors, namely tourism, agriculture, manufacturing, marketing, information technology, and financial services, where 20 flagship projects are to be designated.

Goal of the said development plan is to achieve "a society in which people can live in hygienic and safe environment and everyone is equal, fairly treated" and "a democratic political system under which everyone follows rules of law and is guaranteed of basic human rights and freedom.

Power sector is recognized as one of the basic infrastructures to sustain this goal and the central government has been endeavoring in enhancing reliability of power supply, specifically by eliminating power failures in urban areas and expanding rural electrification which currently stands at less than 15% of the total coverage.

The Kenyan government announced their plan to place a bid for the 2028 Summer Olympic Games at the time of Beijing Olympic Games in 2008 as a part of Kenya Vision 2030. This would certainly call for substantial improvement of various social infrastructures, not to mention the electric power sector.

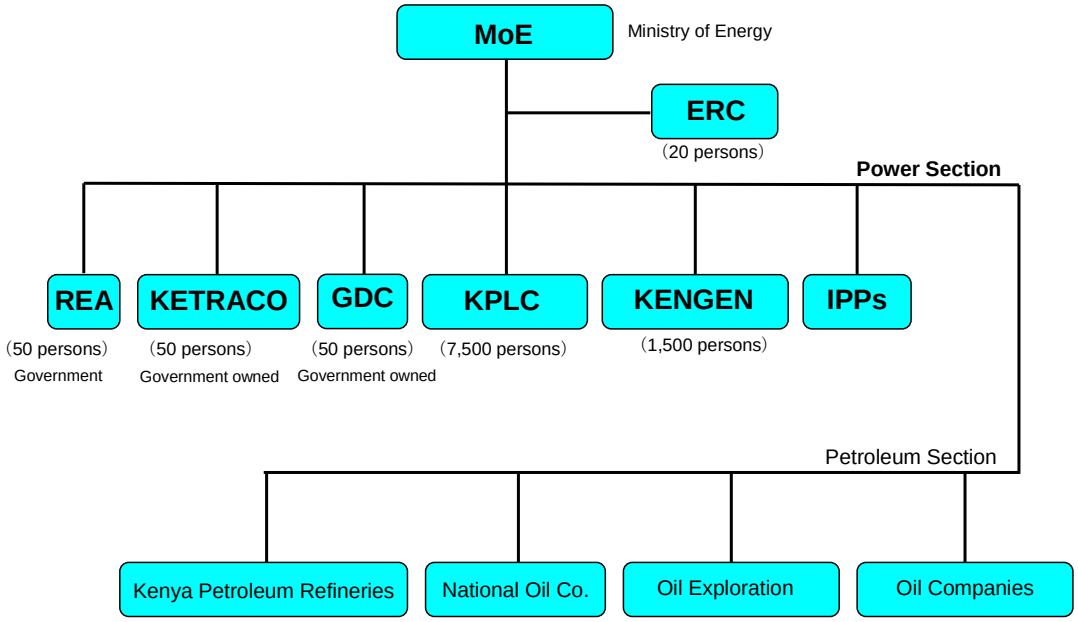
1.2 Outline of Power Sector

1.2.1 Power Companies in Kenya

The electric power sector of Kenya is under the jurisdiction of Ministry of Energy (MoE) that is responsible for national energy policy and rural electrification plan, under which Kenya Power Generating Company (KenGen), Kenya Power & Lighting Company (KPLC), Independent power producers (IPP), Kenya Electricity Transmission Company (KETRACO), Geothermal Development Company (GDC), and Rural Electricity Authority (REA) are placed. As an independent party, Energy Regulation Commission (ERC) is supervising the sector. In addition, companies/organizations relating to petroleum are also under control of MoE.

Emergence of power companies in Kenya dates back to the beginning of 20th century when Mombasa Electric Power & Lighting Company was founded in 1908. Then, Nairobi Electric Power & Lighting Syndicate that had been supplying power in Nairobi and its surroundings since 1907 merged with the foregoing company into East Africa Electric Power & Lighting Company Ltd. (EAPL) in 1922. EAPL later expanded its business over entire East African region such as by capital investment in Tanganyika Electric Supply Company Ltd.

（TANESCO）and acquiring business license for power generation and distribution in Uganda.



Source : KPLC

Fig. 2-2.1 MoE and Organizations/Companies in Power Sector

After the World War II, in 1948 and before independence, Uganda government founded Uganda Power Company while EAPL on its part founded Kenya Power Company (KPC) in 1954 in Kenya. Thereafter, Tanzanian government nationalized TANESCO in 1964 forcing EAPL to confine its business in Kenya market only. EAPL later renamed itself Kenya Electric Power & Lighting Company (KPLC) in 1983.

Later in 1997, re-structuring power sector was carried out, and then the comprehensive power generation-transmission-distribution company KPLC was divided into KPLC and KenGen. As a result, KPLC became responsible primarily for power transmission and distribution undertaking while KenGen and IPP power generation. KPLC is supplying power to consumers under long term power purchase agreements with IPPs.

KenGen is owned by the central government by 70% (End of June 2009) of its stock, whose stock is although open for public. Meanwhile, KPLC is owned by the government by 40.4% (End of August 2009) of its stock, whose stock is also open for public.

1.2.2 Kenya Power & Lighting Company Limited (KPLC)

(1) KPLC and KETRACO

Power transmission business in Kenya has been undertaken solely by KPLC. As a consequence, the field survey and investigation of the Survey Team for the Project were conducted with full cooperation of this company. On the other hand, in an effort to

establish reliable nationwide power distribution network, Kenya Electricity Transmission Company （KETRACO) was founded in 2008 with full capital investment by the government, that is now engaged in preparatory activities, recruiting staff and personnel, setting up offices etc. for a smooth kick-off. As a transitional measure, existing transmission lines are to be maintained by KPLC while new transmission lines by KETRACO. Accordingly, the transmission lines under this Project will come under the responsibility of the latter upon its implementation.

As the power transmission facility would not generate revenue unlike power generation, operation cost of KETRACO will have to be subsidized by the government, but this does not necessarily mean ceding the revenue of KPLC. Since capability of KETRACO has not been proven yet and KPLC is the mother of the former, let us examine the capability of project execution of KPLC at this stage. The detail is given in Chapter 9.

2.2.3 Other Companies／Government Organizations

(1) KenGen

KenGen is, as well as other IPPs, generate electricity and sell it in bulk to KPLC. KenGen is a state corporation, while IPPs are private sector investments. IPPs currently provide about 20% of the whole demand and are expected to continue to play a significant role in power generation. However, KenGen, a state majority company will remain the dominant power generation player in long term.

(2) REA

REA was established in 2007 to accelerate the implementation pace of the Rural Electrification Programme, which is one of the most important challenges of the government. It is fully funded by the government.

(3) GDC

GDC is a state corporation incorporated in 2008. GDC is tasked with developing steam fields to reduce upstream power development risks so as to promote rapid development of geothermal electric power. GDC will underwrite any dry wells sunk by private developers selected through competitive bidding processes.

(4) ERC

The energy; sector legal and institutional frameworks are stipulated in the energy Act No.12 of 2006 while the policy framework is anchored in Sessional Paper No. 4 of 2004, on energy. Pursuant to these documents, MoE is responsible for policy formulation and overall energy planning. ERC takes care of sector regulation both technical and economic covering all sub-sectors including electricity, renewable and down stream petroleum. ERC settles disputes between sector stakeholders, and also supervise tariff system of KPLC.

2.3 Present Power Transmission Network

1.3.1 Power Transmission Network

Current power transmission network of Kenya as of 2008 is illustrated in Fig. 2-3.1. As northern part of the country is mountainous, habitat is concentrated in the southern segment, where the capital city Nairobi having 2 million populations are located. The city also constitutes the center of power consumption. Power generation in the country is comprised of thermal power plants mainly by diesel engines located along the eastern seaboard, geo-thermal power generation in the central region, and hydro-power plants in the northern and western regions. These power generations are linked with 132kV trunk transmission lines in 800km total length along east-west stretch, supplemented by 220kV lines connecting the east power stations and central power demand.

Power transmission network of Kenya shown in single line diagram is attached as **Annex 2-1** in the end of this chapter.

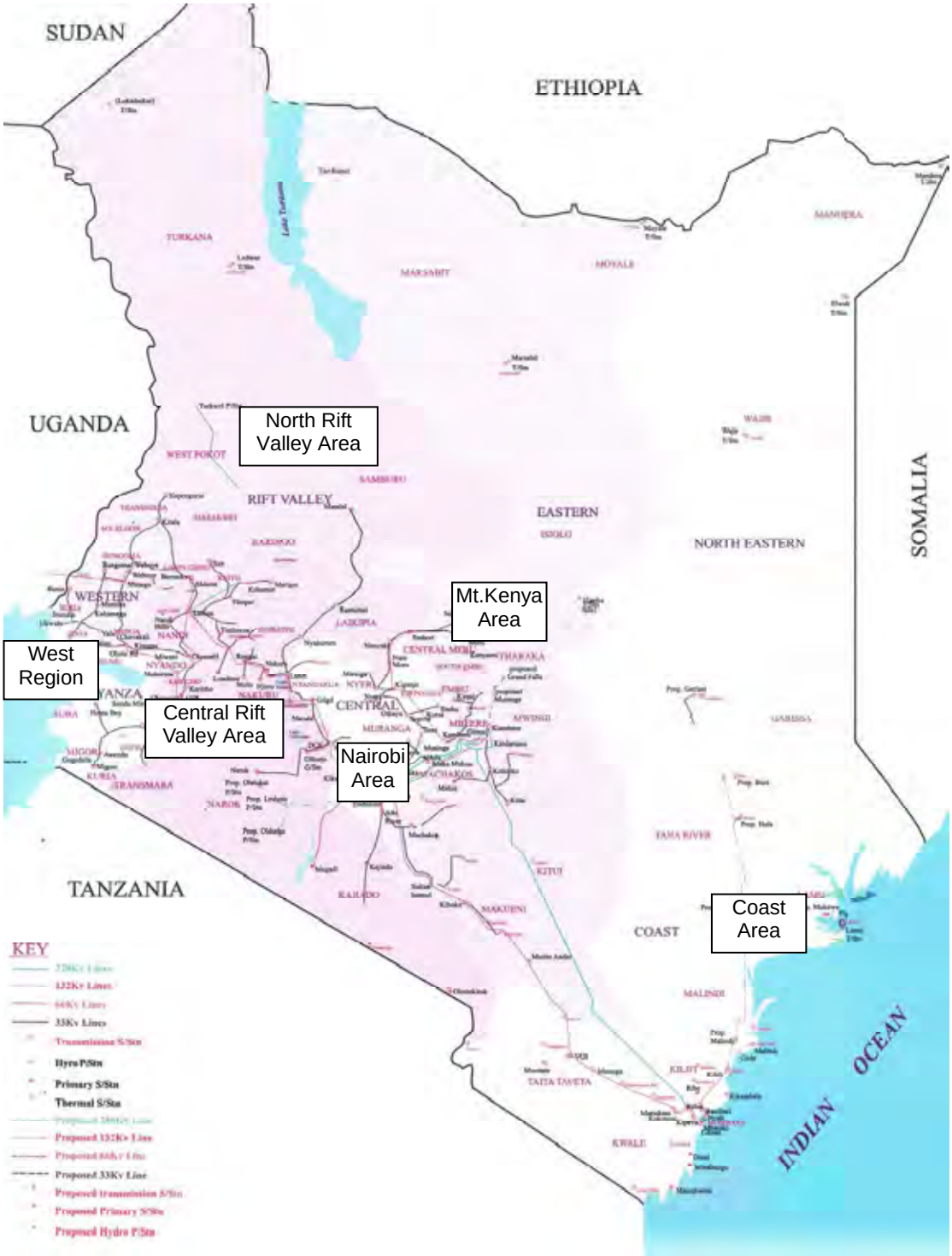
Source : KPLC - Annual Report, 2007/08

Fig. 2-3.1 Power Transmission Network of Kenya (as of 2008)

1.3.2 Geographical Distribution of Load Demand and Power Sources

Zonal classification of Kenya from east to west is follows.

- Coast area centers on Mombasa
- Nairobi area centers on Nairobi
- Mt. Kenya area skirts around the Mt. Kenya and at northern Nairobi
- Central Rift Valley area at center of Great Rift Valley
- North Rift Valley area at northern part of Great Rift Valley
- West Region area centers on Kisumu, the 3rd biggest city of Kenya.



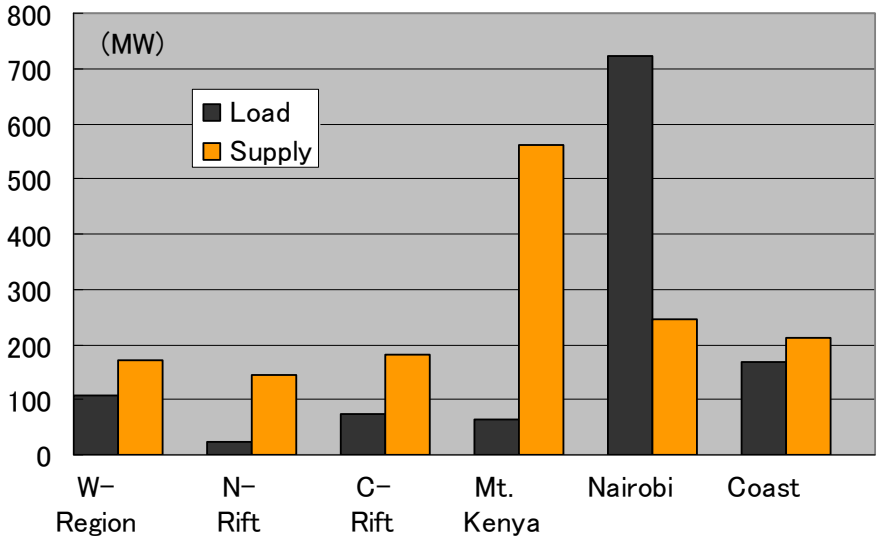
Source : Annual Report of KPLC, 2002/03

Fig. 2-3.2 Six Zones in Kenya

Distribution chart of load demand and power sources of the aforementioned six zones are shown in Figure 2-3.3. Area-wise proportional comparison of demand and power sources are shown in Figure 2-3.4.

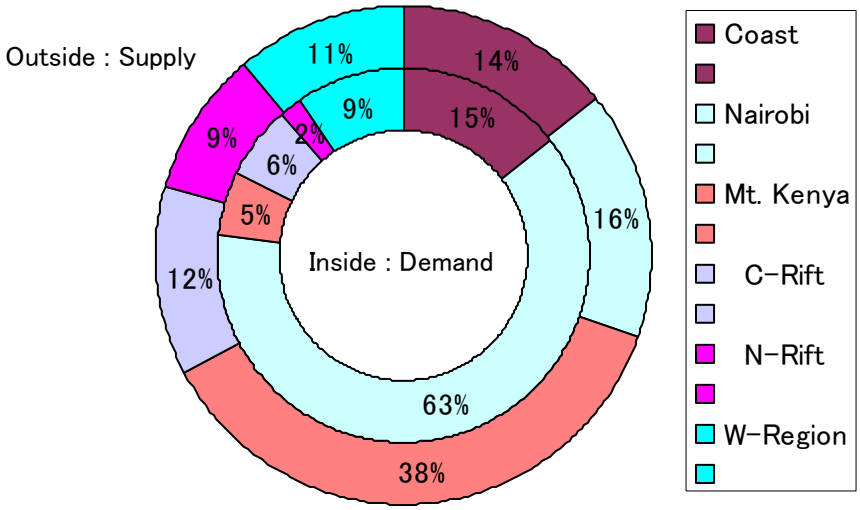
Nairobi area comprises the majority of the total load demand (62%). Meanwhile, Mt. Kenya area comprises the majority of the total power sources (37%). Thermal power plants and geo-thermal power plants are main sources in Coast Area and Nairobi area respectively.

Coast area sourced by thermal power generation and Nairobi area sourced by geo-thermal power generation are under stable power supply through the year. But other areas mainly sourced by hydro-power generation are facing to seasonal variation of power supply due to dry and wet seasons.



Source : KPLC, processed by Survey Team

Fig. 2-3.3 Distribution Chart of Load Demand and Power Sources

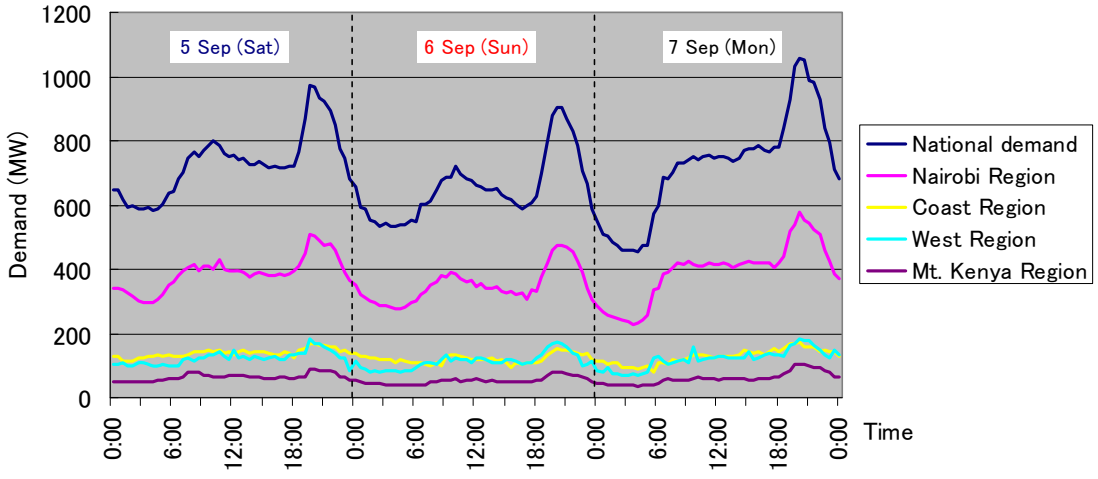


Source : KPLC, processed by Survey Team

Fig. 2-3.4 Area-wise Proportional Comparison of Demand and Power Sources

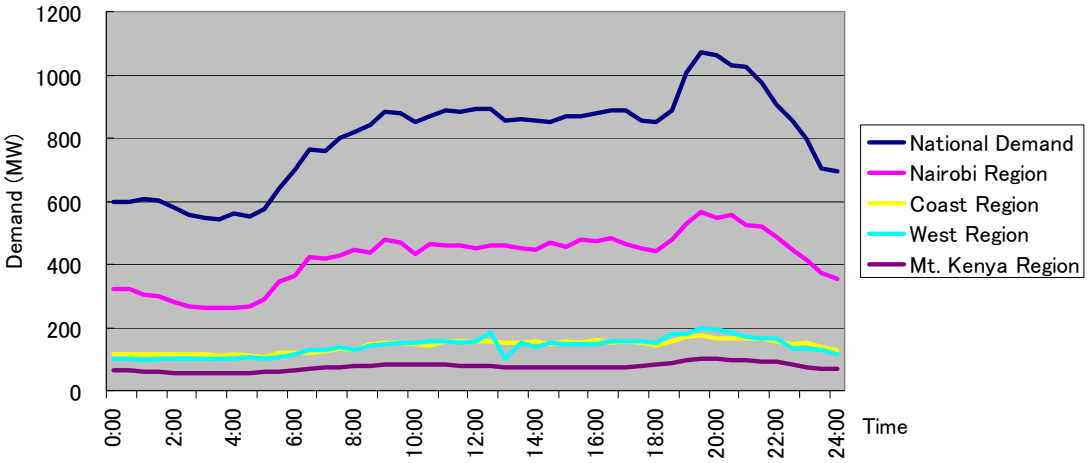
1.3.3 Status of Demand

Daily load curve of Kenya from September 5, 2009 (Saturday) to September 7, 2009 (Monday) is shown in Figure 2-3.5. The daily load curve of November 26, 2009 (Wednesday) when the maximum demand of FY 2008/2009 (Jul. 2008 to Jun. 2009) was recorded is shown in Figure 2-3.6. Even though Kenya is located right on the equator, because of its elevation of 1,700m, average temperature of each month is between 15℃～19℃ and relatively cool. This results in small demand of air conditioners. The peak is made at around 20:00 p.m. because the loads are for lighting purpose.



Source : KPLC

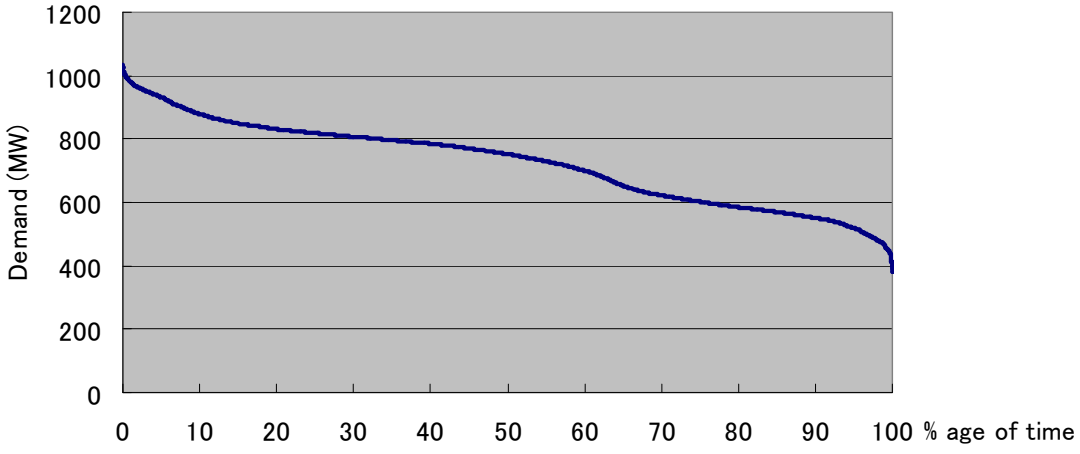
Fig. 2-3.5 Daily Load Curve (Sep. 5, 2009～Sep. 7, 2009)



Source : KPLC

Fig. 2-3.6 Daily Load Curve (Nov. 26, 2009, Wednesday)

In Figure 2-3.7, the load duration curve of one day in the year 2007 is shown. This curve indicates values in order of their magnitude of each 30 minutes demand (MW) from January to December. Due to small demands for air conditioning, there is no steep peak of the curve. Load factor of this year was 69.9%.



Source : KPLC

Fig. 2-3.7 Load Duration Curve (2007)

2.3.4 Power-Generation Infrastructure

List of Power-Generating facilities (as of June 2009) is shown in Table 2-3.1. Classification of the generating facilities are shown in Figure 2-3.8.

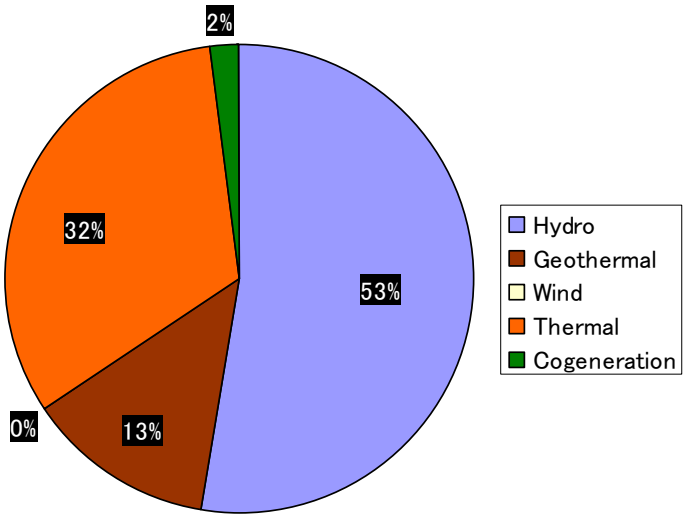
Total generation capacity of main network system is 1,293 MW at installed capacity and 1,253 MW at actual output capacity. As shown in the Table 2-3.1, classification of generation consists of, hydro-power: 52%, geo-thermal power: 13%, thermal power: 33% and cogeneration : 2%. Because majority of power supply is by hydro-power, seasonal variation of power generation occurs according to the amount of rainfall.

Table 2-3.1 Power-Generating Facilities (as of June 2009)

Type		Ref. No.	Name	Installed capacity (MW)	Effective capacity (MW)
Hydro		G-1	Tana	14.4	10.4
		G-2	Wanjii	7.4	7.4
		G-3	Kamburu	94.2	90
		G-4	Gitaru	225	216
		G-5	Kindaruma	40	40
		G-6	Masinga	40	40
		G-7	Kiambere	82	82
		G-8	Small Stations	6.3	5.6
		G-9	Turkwel	106	106
		G-10	Sondu	60	60
		Total Hydro		**675.3** (52%)	**657.4** (52%)
Geothermal		G-11	Olkaria I (KenGen)	45	45
		G-12	Olkaria II (KenGen)	70	70
		G-13	Olkaria III (IPP)	48	48
		Total Geothermal		**163** (13%)	**163** (13%)
Wind		**G-14**	**Ngong**	**0.4** (0%)	**0.4** (0%)
Thermal	Kengen	G-15	Kipevu I Diesel	75	60
		G-16	Kipevu GT1 and GT2	60	60
		G-17	Nairobi Gas Turbine	13.5	10
	IPP	G-18	Iberafrica Diesel	56	56
		G-19	Tsavo Power Diesel	74	74
	Emergency	G-20	Aggreko Power	150	146
	Total Thermal			**428.5** (33%)	**406** (33%)
Cogeneration		G-21	Mumias Cogeneration	**26** (2%)	**26** (2%)
Total Interconnected System				**1,293** (100%)	**1,253** (100%)
Isolated Stations		G-22	KenGen Diesel Stations	5.2	4.6
		G-23	REF Diesels and Wind Off-grid Stations	6.1	5.1
		Total Off-grid Capacity		11.3	9.7
Gross Capacity				**1,305**	**1,263**
Interconnected System Peak Demand					**1,071**

Source: KPLC

Ref. No. shown in Table 2-3.1 refers to the location shown in Figure 2-3.9.



Source : KPLC

Fig. 2-3.8 Classification of Power Plants (Main System)

In addition to the above, there are isolated systems mainly in northern part of the main land and islands having generating capacities of around 11MW. Rural Electrification programme is going on by applying the best measures according to their distances from the main system, namely, integrating the isolated system into the main system, or use of diesel generation, solar system, wind power system, etc. case by case. Rural Electrification will be described in the separate clause.

1.3.5 Power Transmission Facilities

List of power transmission facilities (as of June 2009) is shown in Table 2-3.2.

Total length of transmission lines are, 220 kV: 1,330 km, 132 kV: 2,055 km, and 66 kV: 610 km, and the total reaches 3,995 km. Main trunk line system is made by 220 kV and 132 kV transmission lines. 66 kV transmission lines are for regional supply. In addition, distribution line network is made by 33 kV lines: 11,163 km, and 11 kV lines: 21,918 km, then 33,081 km in total.

Transmission capacity of 132 kV transmission lines constructed in early times have only 73~81 MVA due to small size conductors. This conductor capacity is not enough and soon be overload in very near future.

Table 2-3.2 Transmission Lines (As of June, 2009)

Voltage	Ref. No.	From	To	No. of circuits	Rating (MVA)	Length (km)
220 KV	T-1	GITARU	KAMBURU	1	250	9
	T-2	KAMBURU	DANDORA	2	250	108
	T-3	KIAMBERE	EMBAKASI	1	250	151
	T-4	OLKARIA II	NAIROBI NORTH	2	250	69
	T-5	OLKARIA II	OLKARIA III	1	250	7
	T-6	DANDORA	EMBAKASI	1	250	13
	T-7	DANDORA	NAIROBI NORTH	2	250	51
	T-8	KIAMBERE	RABAI	1	210	440
	T-9	TURKWEL	LESSOS	1	210	218
	T-10	KAMBURU	KIAMBERE	1	210	35
	Total (Circuit length)					**1,330**
132 KV		KAMBURU	MASINGA	1	150	18
		OLKARIA I	OLKARIA II	1	150	4
		OLKARIA I	NAIVASHA	1	150	23
		JUJA	DANDORA	2	150	2
		KIPEVU	RABAI	2	73	17
		KIPEVU	RABAI	2	150	18
		GITARU	KAMBURU	2	126	8
		MASINGA	KIGANJ0	1	81	88
		JUJA	RUARAKA TEE	2	81	5
		RABAI	BAMBURI	1	81	25
		ELDORET	LESSOS	1	81	32
		MUHORNI	KISUMU	1	81	48
		MUHORNI	CHEMOSIT	1	81	31
		MUHORNI	LESSOS	1	81	57
		KISUMU	SONDU	1	150	50
		WEBUYE	MUSAGA	1	81	18
		KIGANJO	NANYUKI	1	81	51
		TORORO	MUSAGA	2	81	71
		MUSAGA	MUMIAS	1	81	40
		LESSOS	LANET	2	81	126
		LANET	NAIVSHA	2	81	67
		NAIVSHA	RUARAKA TEE	2	81	71
		RUARAKA TEE	RUARAKA	2	81	2
		KINDARUMA	KAMBURU	1	73	18
		KINDARUMA	JUJA	1	73	119
		JUJA	SULTAN HAMUD	1	73	125
		RABAI	MARIAKANI	1	73	21
		KILIF1	BAMBURI	1	73	49
		MUSAGA	LESSOS	2	73	66
		SULTAN HAMUD	KIBOKO	1	73	43
		KIBOKO	MTITO ANDEI	1	73	86
		MTITO ANDEI	VOI	1	73	90
		VOI	MAUNGU	1	73	28
		MAUNGU	MARIAKANI	1	73	86
	Total (Circuit length)					**2,055**
66 KV	**Total (Circuit length)**					**610**
Grand total (Circuit length)						**3,995**

Source: KPLC

Ref. No. shown in Table 2-3.2 refers to the location shown in Figure 2-3.9.

1.3.6 Substation Facilities

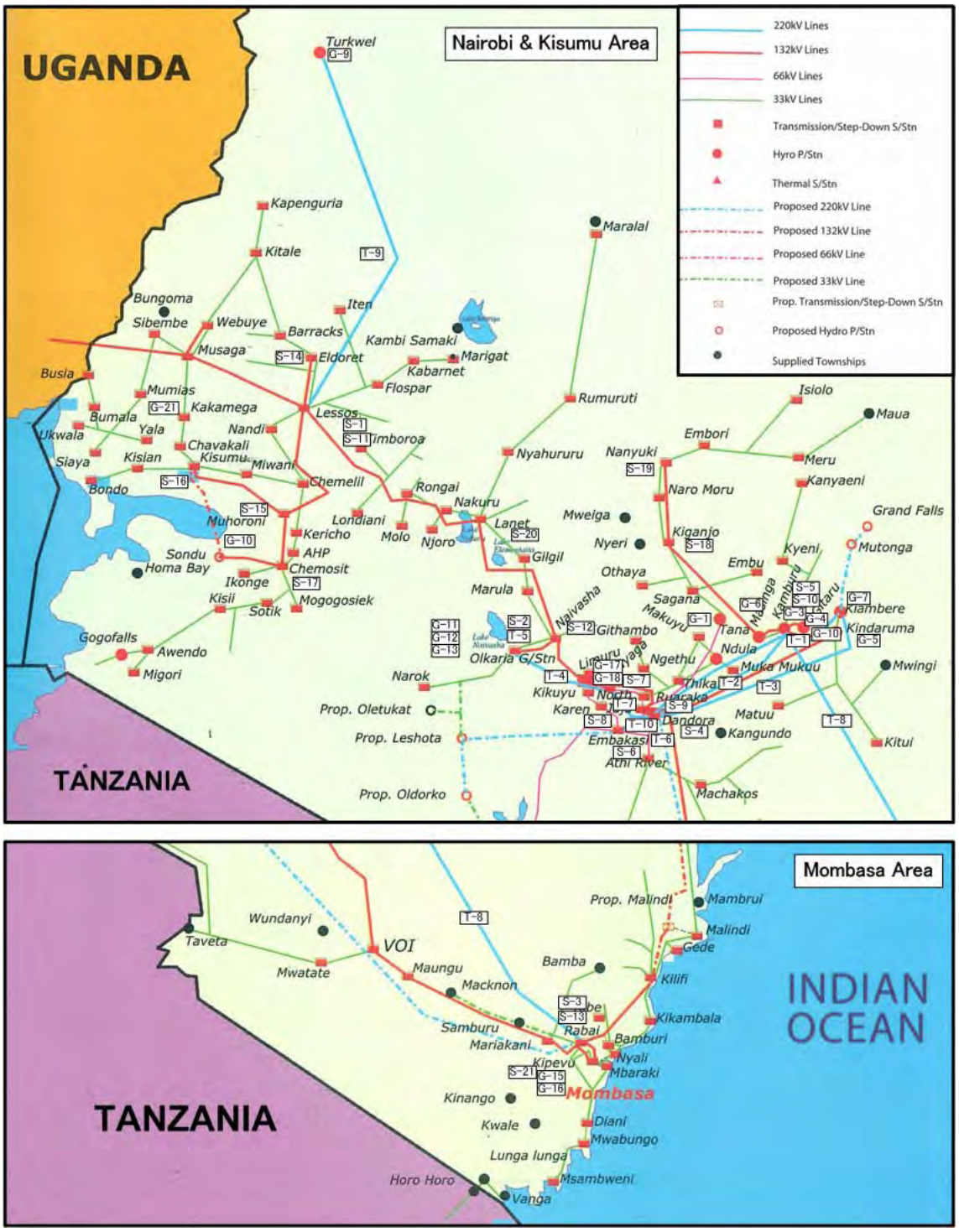
Table 2-3.3 is the list of substation transformers in the existing substations, excluding step-up transformers for generating plants. Installed capacities are 1,720MVA, 862.5MVA, and 1,099MVA in 7 locations of 220kV, 14 locations of 132kV, and 29 locations of 66kV substations respectively. Total capacity of those substations reaches to 3,682MVA.

Table 2-3.3 Substation Transformers (As of June 2009, excluding Step-up Transformers for Generators)

Voltage	Ref. No.	Substation name	No. of units	Transformer		
				Primary voltage (kV)	Secondary voltage (kV)	Capacity (MVA)
220 KV	S-1	LESSOS	2	220	132	75
	S-2	OLKARIA II	1	220	132	90
	S-3	RABAI	2	220	132	90
	S-4	DANDORA	2	220	132	200
	S-5	KAMBURU	2	220	132	270
	S-6	EMBAKASI	2	220	66	90
	S-7	NAIROBI NORTH	2	220	66	90
	Total					**1,720**
132 KV	S-8	JUJA	3	132	66	15
			1	132	66	30
			3	132	66	60
	S-9	RUARAKA	2	132	66	60
	S-10	KAMBURU	1	132	33	7.5
	S-11	LESSOS	1	132	33	15
	S-12	NAIVASHA	2	132	33	15
	S-13	RABAI	2	132	33	23
	S-14	ELDORET	2	132	33	23
	S-15	MUHORNI	1	132	33	23
	S-16	KISUMU	2	132	33	23
	S-17	CHEMOSIT	2	132	33	23
	S-18	KIGANJO	2	132	33	23
	S-19	NANYUKI	1	132	33	23
	S-20	LANET	3	132	33	23
	S-21	KIPEVU	3	132	33	30
	Total					**862.5**
66KV		ATHI	1	66	33	10
		THIKA	1	66	33	23
		RUIRU	1	66	33	23
		BAHATI	2	66	11	23
		LIMURU	2	66	11	5
			1	66	11	23
		AIRPORT	2	66	11	5
		ATHI	2	66	11	5
			1	66	11	5
		KIKUYU	2	66	11	10
		KAREN	2	66	11	23
		KILELES	1	66	11	21
		NAIROBI SOUTH	2	66	11	30
		NAIRONI SOUTH1	1	66	11	23
		NAIROBI SOUTH2	1	66	11	23
		NAIROBI WEST	2	66	11	45
		RUARAKA	2	66	11	23
		KITISUR	2	66	11	23
		CATHEDRAL	2	66	11	23
		INDUSTRIAL	2	66	11	23
		THIKA	2	66	11	23
		JEEVANJEE	2	66	11	23
		RUIRU	2	66	11	23
		EPZ	1	66	11	23
		CIANDA	1	66	11	23
		STEEL BILLETS	2	66	11	23
		MATASIA	1	66	11	23
		BABADOGO	2	66	11	23
		PARKLANDS	2	66	11	45
		RUARAKA	2	66	11	7.5
		EMBAKASI	1	11	66	23
			1	11	66	45
	Total					**1,099**
Grand total						**3,681.5**

Source: KPLC

Ref. No. shown in Table 2-3.3 refers to the location shown in Figure 2-3.9.



Source: KPLC

Fig. 2-3.9 Location of Generating Equipment, Transmission Lines, & Substations

Table 2-3.4 shows ratings of circuit breakers existing in substations of 132kV or more. 220kV circuit breakers have been installed recently, therefore they have rated breaking current of over 31.5kA, however, those for 132kV lines have a variety of rated current ranging 1250～3150A, and rated breaking current ranging 12.5~40kA as seen in the following table.

Table 2-3.4 Rating of Circuit Breaker (132kV or more)

Voltage	Sub-Station	Rated voltage	Rated current	Rated breaking current
220kV	Rabai	245kV	2500A	40kA
	OlkAria II	245kV	3150A	50kA
	Kamburu	245kV	2500A	40 kA
		245kV	2000A	31.5 kA
	Kiambere	245kV	3150A	40 kA
	Kiambere S	245kV	3150A	40 kA
	Dandora	245kV	1600A	40 kA
		245kV	3150A	50kA
		245kV	2500A	40 kA
	Embakasi	245kV	1600A	40 kA
	Nairobi-North	245kV	1600A	31.5kA
	Lessos	245kV	2000A	31.5 kA
132kV	Kipevu	170kV	3150A	40kA
	Kipevu2	170kV	3150A	40kA
	Rabai	145kV	2000A	31.5kA
		145kV	3150A	40 kA
	New Bamburi	145kV	3150A	40kA
	Kilifi	170kV	3150A	40kA
	Kokotoni	145kV	2000A	40kA
	MariakAni	145kV	2000A	40kA
	Voi	170kV	3150A	40kA
	Dandora	145kV	2000A	31.5 kA
	Juja	132kV	1250A	25 kA
	Naivasha/Suswa	132kV	2000A	12.5kA
		145kV	3150A	40kA
	OlkAria 1	132kV	2000A	12.5kA
	Kamburu	132kV	1250A	25 kA
		145kV	3150A	40 kA
		145kV	2000A	31.5 kA
	Kindaruma	145kV	3150A	40 kA
		132kV	1250A	25 kA
	Masinga	145kV	3150A	40 kA
		145kV	2000A	31.5 kA
	Lessos	145kV	2000A	31.5 kA

Source: KPLC

2.3.7 Power System

(1) System Configuration and Transmission Capacity

Figure 2-3.10 shows power system configuration and transmission capacities.

Kenya's transmission system is constituted of a 132kV transmission line that runs from east to west direction in a length of 800km, and another 132kV line internationally connecting Musaga substation in the western Kenya with Tororo substation in Uganda in a length of 70km, which is serving for cross-border power transaction between the two countries.

Power supply to capital city Nairobi which accounts for majority of power demand is carried out by collecting power from Olkaria geo-thermal power plant in the central south and Gitaru hydro-power station in the north, to 220kV Nairobi North substation, Dandora substation, Embakasi substation, and 132kV Ruaraka substation where stepping down of voltage is executed, for power distribution in Nairobi.

Eastern region of Kenya including the second largest city Mombasa on the eastern seaboard facing Indian Ocean is catered by local diesel engine generators and gas turbine generators. The system here is connected with the central system with two lines, namely 220kV single circuit transmission line (assumed to have a capacity 199MW under power factor 95%) and 132kV single circuit transmission line (assumed to have a capacity 69MW under power factor 95%).

In western region of Kenya, hydro-power is the main source of power and main consumer is the third largest city Kisumu and surroundings. The power system here is connected to the central system with two circuits of 132kV transmission line. This line was however constructed more than 50 years ago and aged, then the size of power conductor is very small with sectional area of 158mm^2 (ACSR 158, code name Wolf) having transmission capacity of only 77MW per circuit (under power factor 95%). Further, the line supplying power to Kisumu is only 132kV Kisumu-Muhoroni-Lessos line (transmission capacity 77MW under power factor 95%). As this line is single circuit, power supply to Kisumu area is quite unreliable. Power interruption can not be avoided at fault or overload condition on the transmission line.

(2) Power Flow

Figure 2-3.11 indicates result of power flow analysis during wet season in 2009. Power is generated at almost full rated capacities at all power stations. As a consequence, balance of demand and supply is maintained within the central system centering around Nairobi owing to Olkaria geo-thermal power station plus Gitaru and other hydro-power stations. East and west systems are also balanced owing to local thermal power plant in the former and local hydro power station in the latter. As a consequence, power flow on 220kV transmission line connecting east and central systems and 132kV line turns out to be negligibly small, 16MW between Kianblin－Rabai (220kV) and 6MW between Voi－

Mutio Andei (132kV) respectively. Likewise, power flow on 132kV line connecting central and west systems is also small as 17MW between Naivasha－Lanet. Thus any overload on the lines is unlikely.

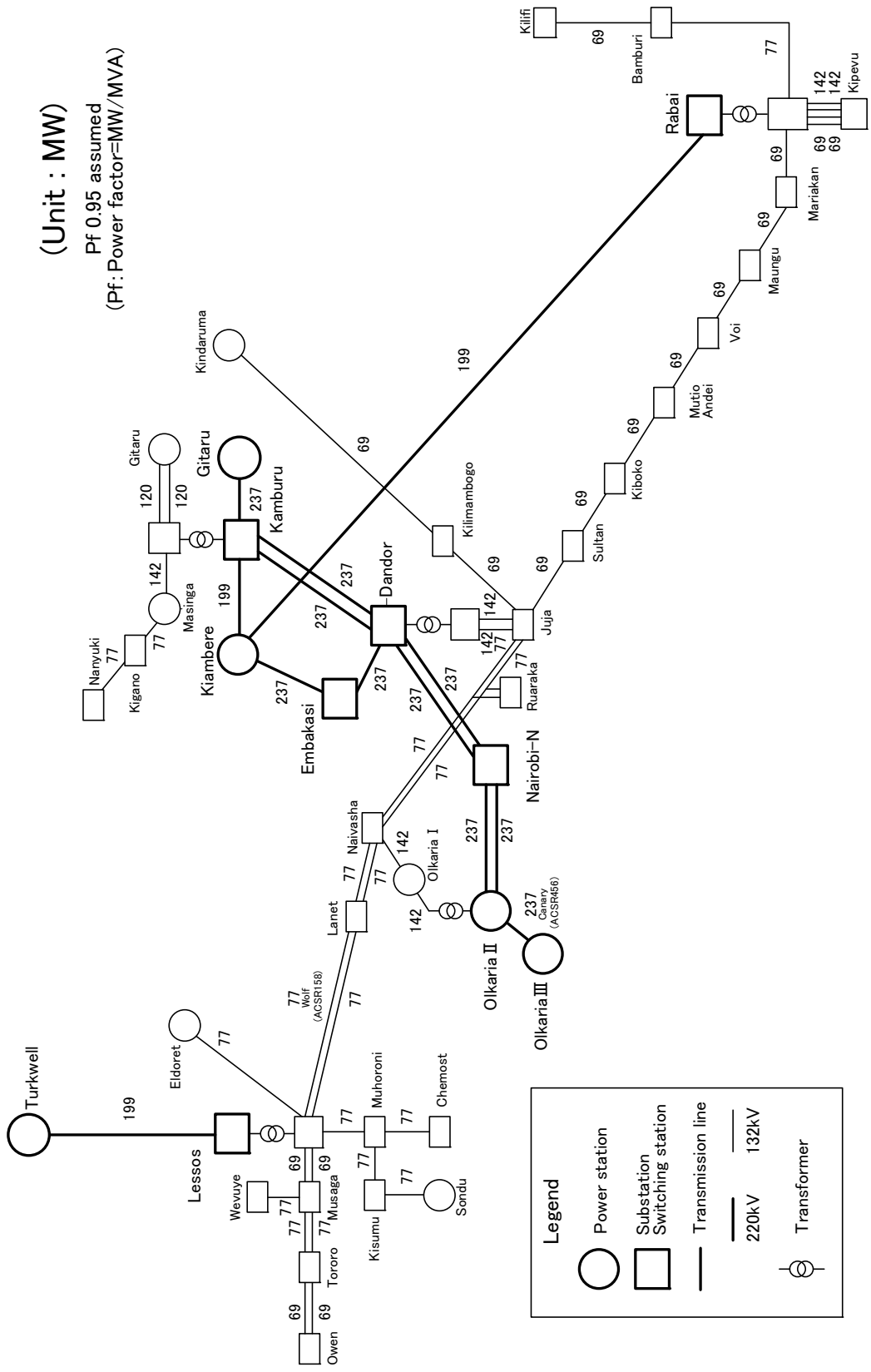
(3) Fault Current

Figure 2-3.12 and table 2-3.5 show the result of fault current analyses. Largest fault currents on 220kV and 132kV systems turned out to be 7.24kA and 10.93kA respectively, both at Kamburu substation. These are far small compared with the rated breaking current of the breakers (40kA) and thus the system would not be endangered.

Table 2-3.5 Result of Fault Current Analysis (2009 year system)

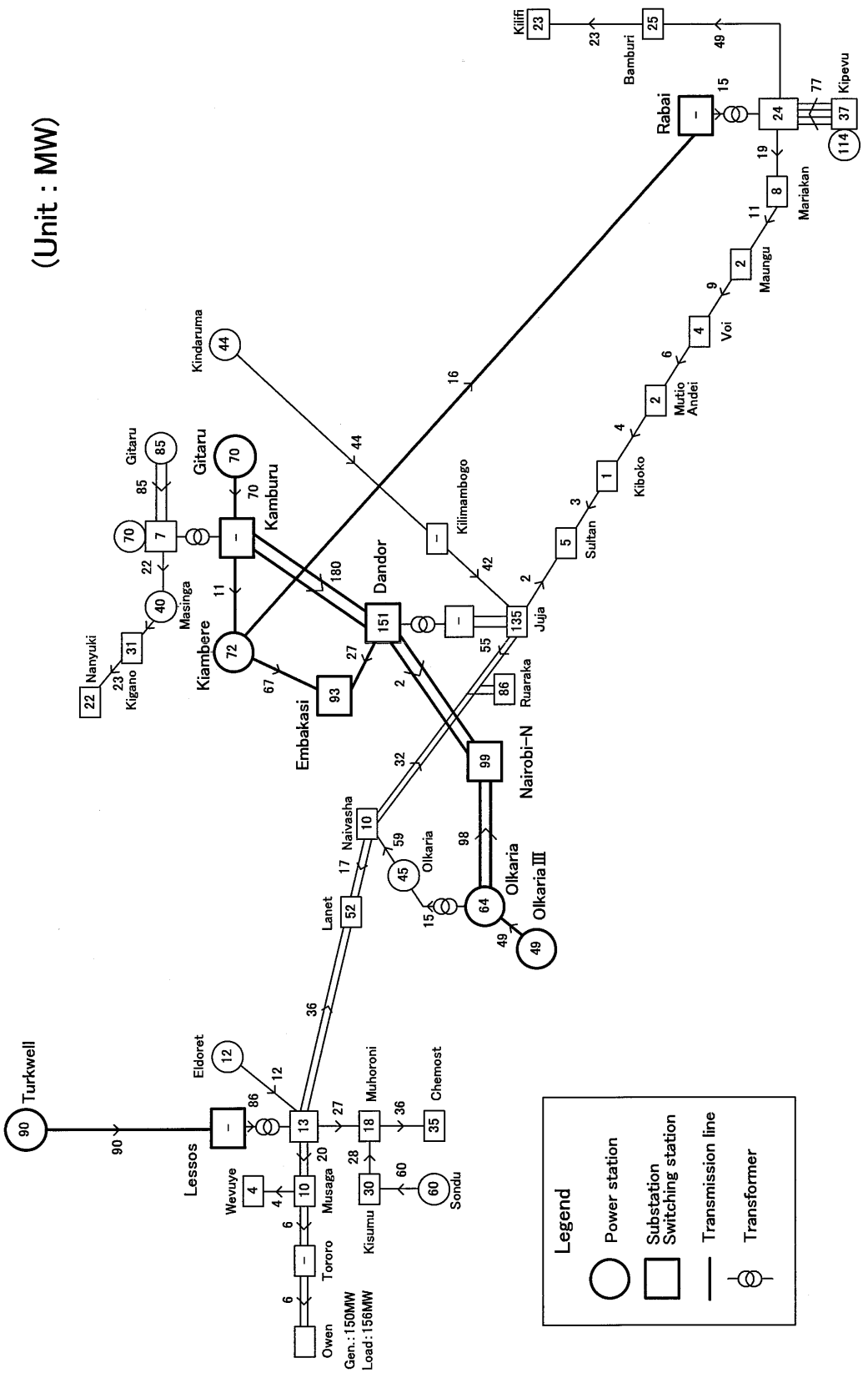
220kV station			132kV station		
Name	**Fault current (kA)**	**Rated breaking current (kA)**	**Name**	**Fault current (kA)**	**Rated breaking current (kA)**
Kamburu	**7.24**	**40**	**Kamburu**	**10.93**	**40**
Dandor	**6.71**	**40**	**Dandor**	**9.22**	**31.5**
Nairobi-N	**5.19**	**31.5**	**Juja**	**9.17**	**40**
Olkaria	**4.60**	**50**	**Olkaria**	**5.41**	**12.5**
Lessos	**1.89**	**31.5**	**Lessos**	**4.23**	**31.5**
Rabai	**2.18**	**40**	**Kipevu**	**5.26**	**31.5**

Source: The Survey Team



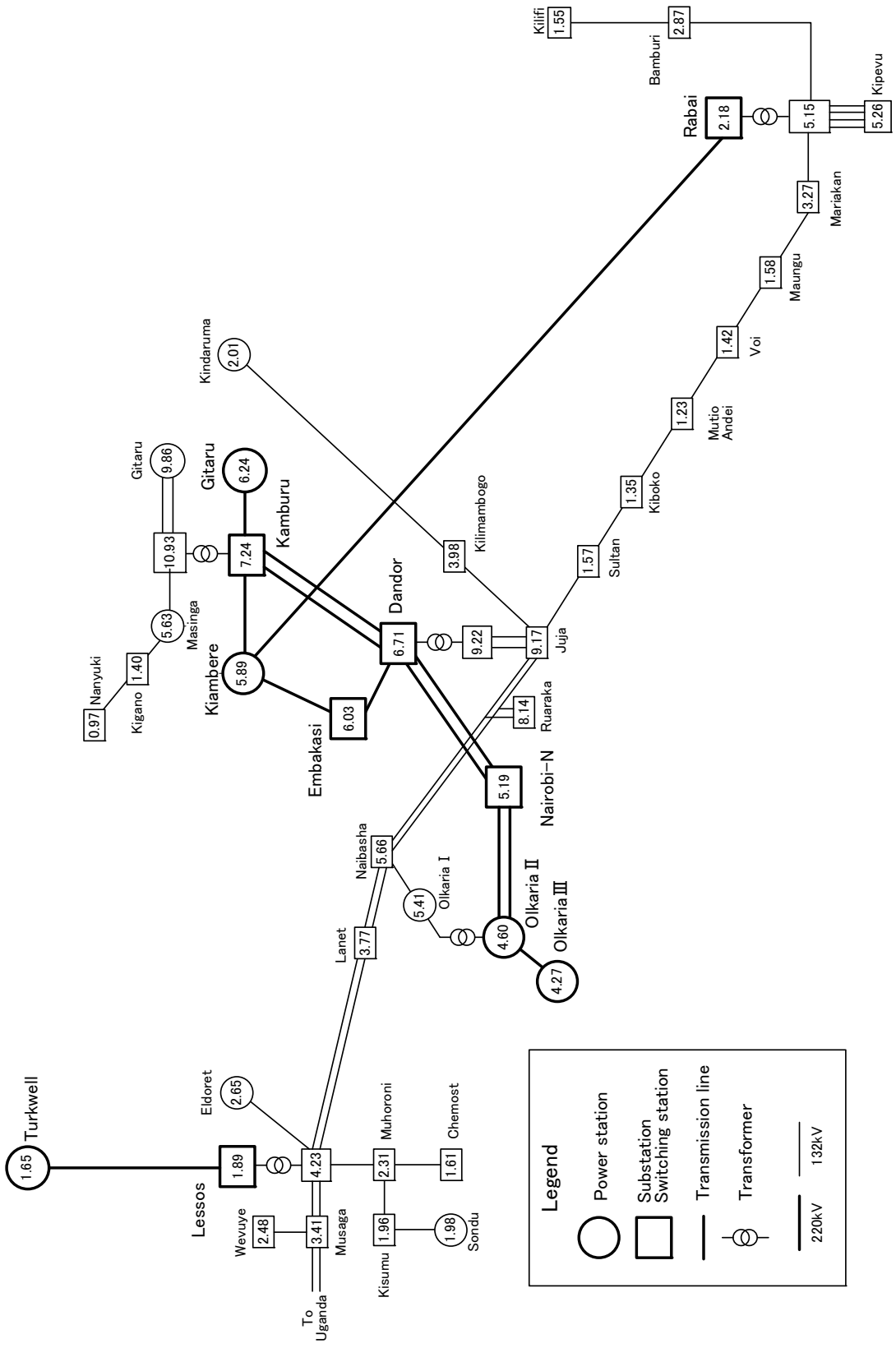
Source: The Survey Team

Fig. 2-3.10 Power System Configuration and Transmission Capacity



Source: The Survey Team

Fig. 2-3.11 Result of Power Flow Analysis (2009 year system in wet season)



Source: The Survey Team

Fig. 2-3.12 Result of Fault Current Analysis (2009 year system)

(4) Stability

Breaking times which are determined based on the operating time of breaker upon fault must comply with Kenya Grid Code, Schedule 3.1, Article S3.1.9 as listed below:

400kV:100ms、220kV:120ms、132kV:120ms

As there is no 400kV system existing in Kenya in 2009, stability analysis was conducted as described below.

Three phase short circuit fault on one circuit of transmission line, then breaker to operate and isolate faulty circuit after 120ms of the fault

Further, faulty line was selected under the following criteria:

Object transmission line of the Project is Olkaria－Lessos line, function of which is to link central system with west system of Kenya. The line performing the same function is existing 132kV Juja－Naivasha－Lanet line. Under the circumstances, this existing 132kV line is selected as the faulty line in the analysis. Further in view of the fact that a fault on transmission line carrying large power flow tends to affect stability of the system more severely, existing 220kV Olkaria II－Nairobi North line was also placed under analysis.

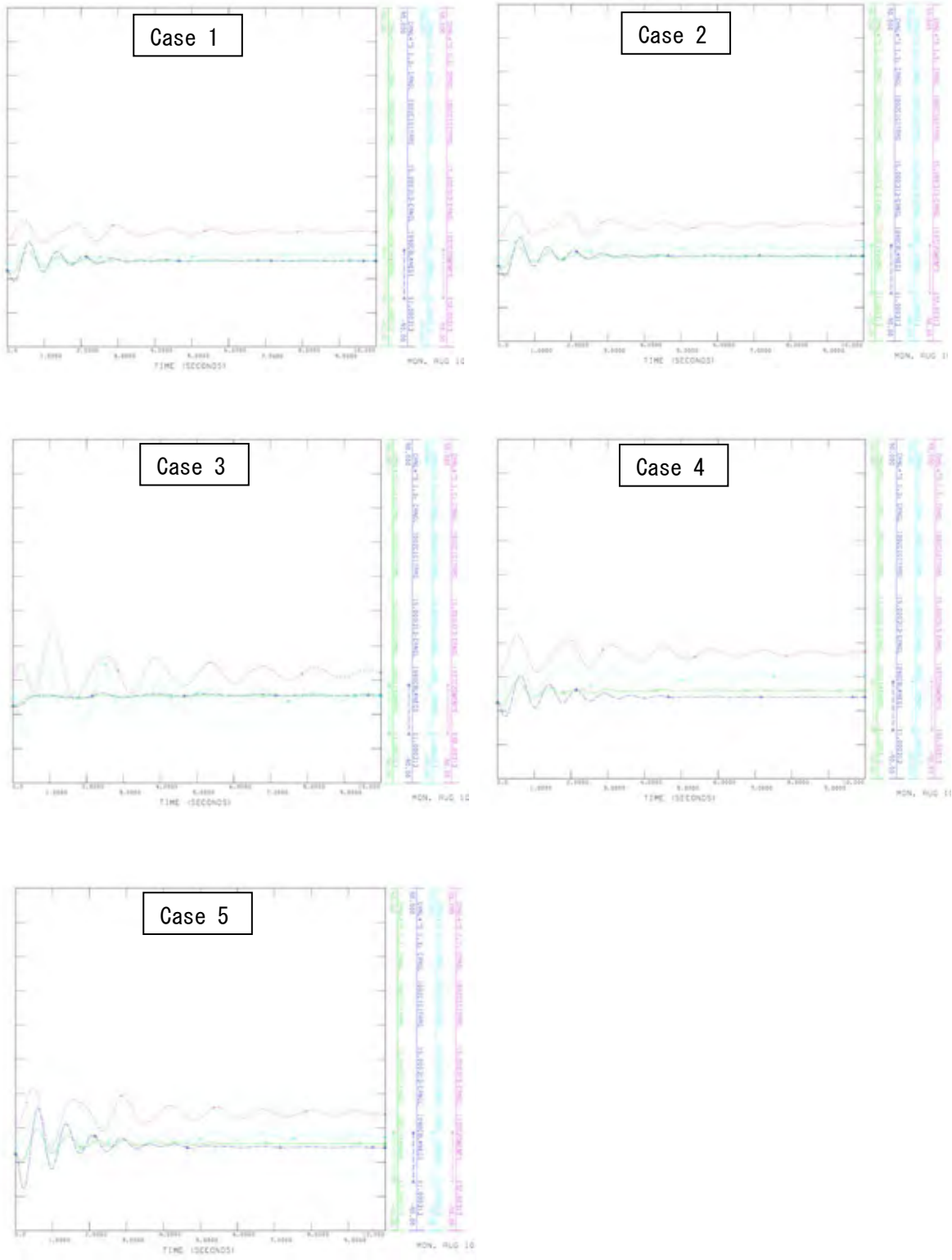
Table 2-3.6 and Figure 2-3.13 show the result of stability analysis and phase-voltage fluctuation curve in generator.

After operation of breaker and isolation of faulty line, previous power flow on the said line is surcharged on the sound line. It turned out that in every case shown in the table, the system appears to remain stable because the power flow before fault is relatively small and phase-voltage fluctuation curves appear to attenuate and converge with time.

Table 2-3.6 Result of Stability Analysis（2009 year system）

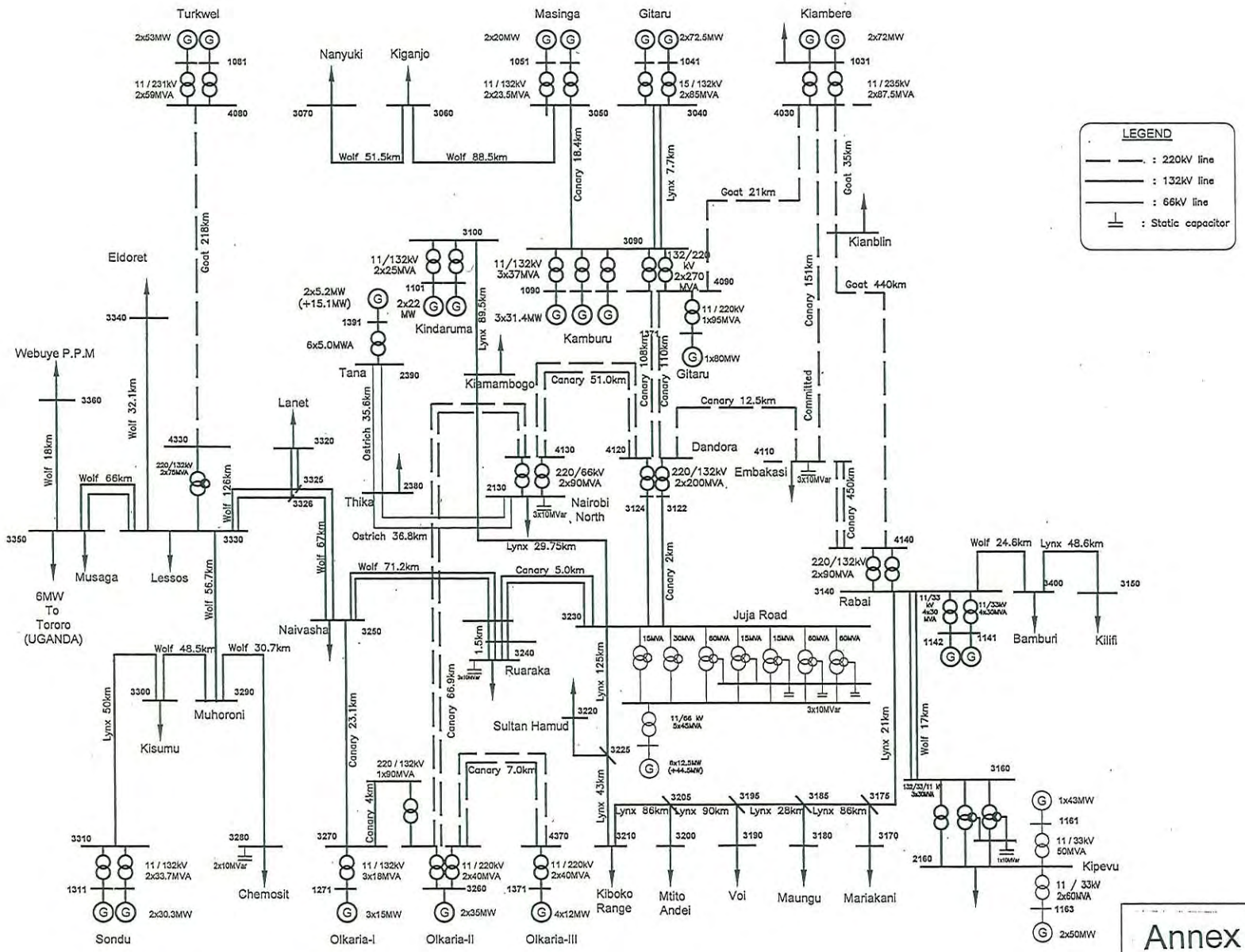
Fault line	Fault point	Power flow before fault	Stability	Case No.
132kV Naivasha-Ruaraka	**Naivasha**	**32MW**	**Stable**	**1**
132kV Naivasha-Lanet	**Naivasha**	**17MW**	**Stable**	**2**
132kV Lanet-Lessos	**Lessos**	**36MW**	**Stable**	**3**
132kV Olkaria Ⅰ-Naivasha	**Olkaria Ⅰ**	**59MW**	**Stable**	**4**
220kV Olkaria Ⅱ-Nairobi North	**Olkaria Ⅱ**	**98MW**	**Stable**	**5**

Source: JICA Survey Team



Source: Survey Team

Fig. 2-3.13 Phase-Voltage Fluctuation Curve in Generator



Annex 2-1

Present KPLC System

Chapter 3 Long Term Power Development Plan in Kenya

3.1 Load Forecast

3.1.1 Introduction

It is very important to have a correct forecast of the peak demand because serves as the basis for calculating the installed capacity and revenue in managing the project for the coming decades. The survey team will carefully examine the load forecast based on the current economic situation and the Least Cost Power Development Plan (LCPDP) of the Ministry of Energy and KPLC.

3.1.2 Forecast by Kenyan Authorities

The load forecast in the LCPDP is based on the assumption that the GDP of Kenya will keep growing by 10% each year, which the Vision 2030 aims to achieve. Kenyan authorities including KPLC officially state that the peak demand of electricity will grow in accordance with that GDP growth forecast.

The Update of the LCPDP 2009-2029, announced in September 2008, also followed this GDP forecast and calculateed the electricity demand for base, low and high cases for the next 20 years. The update predicts that the peak demand will keep growing by 10 ~ 11% annually in the 2010s and beyond. However, the December 2008 modified version of the LCPDP predicts that, reflecting the immediate economic downturn and slow recovery, the peak demand growth will remain at 8.0% until fiscal year (FY) 2012, which is lower than the previous forecast. At the same time, the peak demand is still expected to grow by around 10% annually in the mid- and long term. It is estimated that the peak demand will be 1,715MW in FY 2013[1], when this project is planned to start operation, an increase of 58% since FY2008. It is expected to reach 3,474MW in FY2020, and 8,183MW in FY2029, displaying an increase of 320% and 750%, respectively, since FY2008.

3.1.3 Updating of LCPDP

The authorized development plan for Kenya, LCPDP has been prepared for the first time in around 1966. According to planning section of KPLC, the full version of LCPDP had been made in 1980's with assistance of the World Bank. From description in LCPDP (September 2008), the complete development plan of Kenya system was first prepared by Acres International Limited (Canada) in 1986. Then, the version has been updated according to the

[1] Commissioning year of 2013 for Olkaria~ Lessos Line is forecasted by LCPDP. However, in this study, it is forecasted to start commissioning in 2016.

changes of economical situation and power demand. The version Sept. 2008 targeted 2008 - 2029 had employed 10% of GDP for the coming 10 years as per Vision 2030. Later, this GDP was slightly revised downward by KPLC and the version Dec. 2008 has been internally prepared. This version (Dec. 2008) is employed in this study. However, this version is still under preparation and will soon be finalized as the Version 2010-2030.

Table 3-1.1 Updating of LCPDP

No	Edition and Target period	Issued in	Prepared by	Remarks/Under assistance of
1.	1966-1986	No record left	No record left	
2.	1978-2000	No record left	No record left	
3.	1986-2006	Jun. 1986	Acres	UNDP/ World Bank
4.	1991-2010	1992	Acres	
5.	1994-2013	1994	MOE/KPLC	
6.	1997-2017	1998	Acres	
7.	2000-2020	Apr. 2000	Acres/ MOE/KPLC/KENGEN	
8.	2001-2019	Apr. 2001	MOE/KPLC/KENGEN	
9.	2003-2022	Sep. 2002	MOE/KPLC/KENGEN	
10.	2004-2024	Mar. 2004	MOE/KPLC/KENGEN	
11.	2006-2026	May 2005	MOE/KPLC/KENGEN	
12.	2006-2026	Dec. 2005	MOE/KPLC/KENGEN	No report exists; only plan schedule presented in a PowerPoint was prepared under World Bank training support for newly introduced planning models.
13.	2008-2028	Feb. 2007	MOE/KPLC/KENGEN	
14.	2009-2029	Mar. 2008	MOE/KPLC/KENGEN	
15.	2009-2029	Sep. 2008	MOE/KPLC/KENGEN	
16.	2009-2030	Dec. 2008 (Preparation on-going)	MOE/KPLC/KENGEN/ ERC	World Bank No report exists; only electric data.

Legend :

MOE -Ministry of Energy, Kenya
KENGEN -Kenya Electricity Generating Company
ERC -Energy Regulatory Commission, Kenya

Source : KPLC

The First Report (September 2008) of LCPDP provided by KPLC consists of Executive Summary, Introduction, Demand forecast, Forecast of fuel price, List of possible development plans for generating equipment & transmission lines, Planning method of generating equipment (by using software called Generation simulation or GENSIM). As the output, the recommendable priority of development, the sequential patterns of "Geothermal + Coal + Import (Hydro) + Gus turbine" etc. are listed.

Table 3-1.2 shows the load forecast in Kenya. There is an official report of LCPDP (September 2008) and it forecasts the three cases, Base Case, Low Case, High Case. However, LCPDP (December 2008) describe only Base Case. Under this study, LCPDP is referred to as the December 2008 version, unless otherwise specified.

Table 3-1.2 Load Forecast in Kenya by LCPDP

	Total Load Forecast by LCPDP (Sep. 2008 Update)						Modified Forecast (Dec. 2008)	
	Low Case		**Basic Case**		High Case		**Basic Case**	
Fiscal Year*	Net System Peak (MW)	Annual Growth	**Net System Peak (MW)**	**Annual Growth**	Net System Peak (MW)	Annual Growth	**Net System Peak (MW)**	**Annual Growth**
2007/08	1,036	5.8%	**1,036**	**5.8%**	1,036	5.8%	**1,086**	**10.9%**
2008/09	1,183	14.2%	**1,188**	**14.7%**	1,190	14.9%	**1,173**	**8.0%**
2009/10	1,318	11.4%	**1,334**	**12.3%**	1,342	12.8%	**1,267**	**8.0%**
2010/11	1,452	10.2%	**1,481**	**11.0%**	1,494	11.3%	**1,368**	**8.0%**
2011/12	1,628	12.1%	**1,672**	**12.9%**	1,693	13.3%	**1,477**	**8.0%**
2012/13	1,777	9.2%	**1,838**	**9.9%**	1,868	10.3%	**1,715**	**16.1%**
2013/14	1,947	9.6%	**2,029**	**10.4%**	2,070	10.8%	**1,905**	**11.1%**
2014/15	2,134	9.6%	**2,242**	**10.5%**	2,296	10.9%	**2,112**	**10.9%**
2015/16	2,350	10.1%	**2,487**	**10.9%**	2,557	11.4%	**2,339**	**10.7%**
2016/17	2,595	10.4%	**2,767**	**11.3%**	2,855	11.7%	**2,586**	**10.6%**
2017/18	2,853	9.9%	**3,066**	**10.8%**	3,175	11.2%	**2,856**	**10.4%**
2018/19	3,142	10.1%	**3,401**	**10.9%**	3,536	11.4%	**3,151**	**10.3%**
2019/20	3,460	10.1%	**3,774**	**11.0%**	3,938	11.4%	**3,474**	**10.3%**
2020/21	3,811	10.1%	**4,188**	**11.0%**	4,387	11.4%	**3,828**	**10.2%**
2021/22	4,197	10.1%	**4,647**	**11.0%**	4,887	11.4%	**4,215**	**10.1%**
2022/23	4,617	10.0%	**5,151**	**10.8%**	5,437	11.3%	**4,638**	**10.0%**
2023/24	5,075	9.9%	**5,706**	**10.8%**	6,046	11.2%	**5,102**	**10.0%**
2024/25	5,576	9.9%	**6,318**	**10.7%**	6,722	11.2%	**5,611**	**10.0%**
2025/26	6,125	9.8%	**6,995**	**10.7%**	7,471	11.1%	**6,168**	**9.9%**
2026/27	6,726	9.8%	**7,742**	**10.7%**	8,302	11.1%	**6,779**	**9.9%**
2027/28	7,383	9.8%	**8,568**	**10.7%**	9,224	11.1%	**7,449**	**9.9%**
2028/29	8,104	9.8%	**9,480**	**10.6%**	10,248	11.1%	**8,183**	**9.9%**
2029/30	8,894	9.7%	**10,489**	**10.6%**	11,385	11.1%	**N/A**	**-**

Source: LCPDP (September 2008/December 2008)

* Fiscal year in Kenya is from July to June of the following year. In each fiscal year, two calendar years at both ends are usually shown like 2007/08, which means FY2008.

3.1.4 Demand Forecast and Economic Condition

While the Government of Kenya aims to achieve more than 10% of GDP growth in the mid- and long term, some international organizations see more modest prospects for the Kenyan economy.

According to the latest World Economic Outlook (WEO) released by the International Monetary Fund (IMF) in April 2009, Kenya's GDP growth rate at constant prices, affected by the global economic downturn, was 2.0% in the calendar year (CY) 2008, which is significantly lower than 7.0% in the previous year. The IMF estimates that the growth rate will recover to 6.3% in CY2012 and reach 6.5% in CY2013, the same level as before the global economic crisis in 2008, but will not increase further.

Through interviews with analysts of various agencies in Kenya, such as World Bank or Japan External Trade Organization (JETRO), they have the same opinion as IMF regarding 6.5% of GDP growth.

The LCPDP assumes that electricity demand grows on par with GDP growth. Hence, the survey team applied the same forecast method as that of LCPDP to the load forecast on the IMF's GDP outlook. Since the IMF data are in calendar years, they need to be converted to fiscal years to compare then with KPLC's data..

Table 3-1.3 GDP Growth Forecast by LCPDP and IMF

Fiscal Year	Low Forecast	**Basic Forecast**	High Forecast	**IMF Forecast***
2007/2008	4.5%	**4.5%**	4.5%	**4.5%**
2008/2009	6.9%	**7.9%**	8.4%	**2.5%**
2009/2010	7.7%	**8.7%**	9.1%	**3.5%**
2010/2011	8.4%	**9.4%**	9.9%	**4.5%**
2011/2012	9.0%	**10.0%**	10.5%	**5.7%**
2013/2013	10.0%	**11.0%**	11.5%	**6.4%**
After 2014	10.0%	**11.0%**	11.5%	**6.5%**

*Modified CY data for FY

Sources: LCPDP (September 2008), IMF: The World Economic Outlook, updated in April 2009

The IMF forecast shown in Table 3-1.3 considers the effect of the global economic crisis in 2008. Therefore it is more realistic than the LCPDP whose forecast was released before the crisis. As the LCPDP assumes that the GDP growth in the low forecast is 1% lower, and 0.5% higher in the high forecast, than that in the basic forecast, the demand forecast in Table 3-1.5 which is based on the IMF GDP growth data may vary between +0.5% and -1.0% from the basic case. Here, the growth of System peak demand (recorded in MW) and GDP growth rate will be compared. Table 3-1.4 shows System peak demand (actual MW) and System effective capacity of the generating equipment (MW) in Kenya.

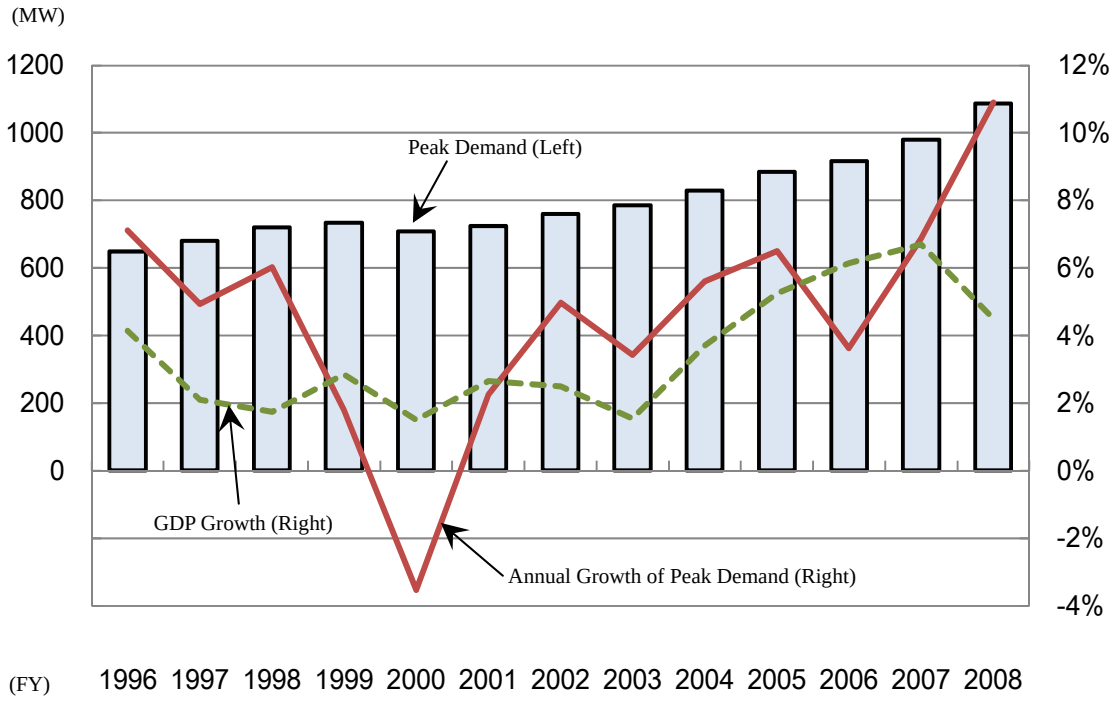
Table 3-1.4 System Peak Demand and Effective Capacity

Fiscal Year	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01
System Peak Demand (MW)	605	648	680	721	734	708	724
System Effective Capacity (MW)	Not av.	723	754	791	831	909	988
Fiscal Year	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
System Peak Demand (MW)	760	786	830	884	916	979	1,036
System Effective Capacity (MW)	1,096	1,047	1,142	1,067	1,135	1,153	1,267

Note: System Peak Demand excludes export demand. "Not av." means "Data not available".

Source : KPLC Annual Report (1999-2008)

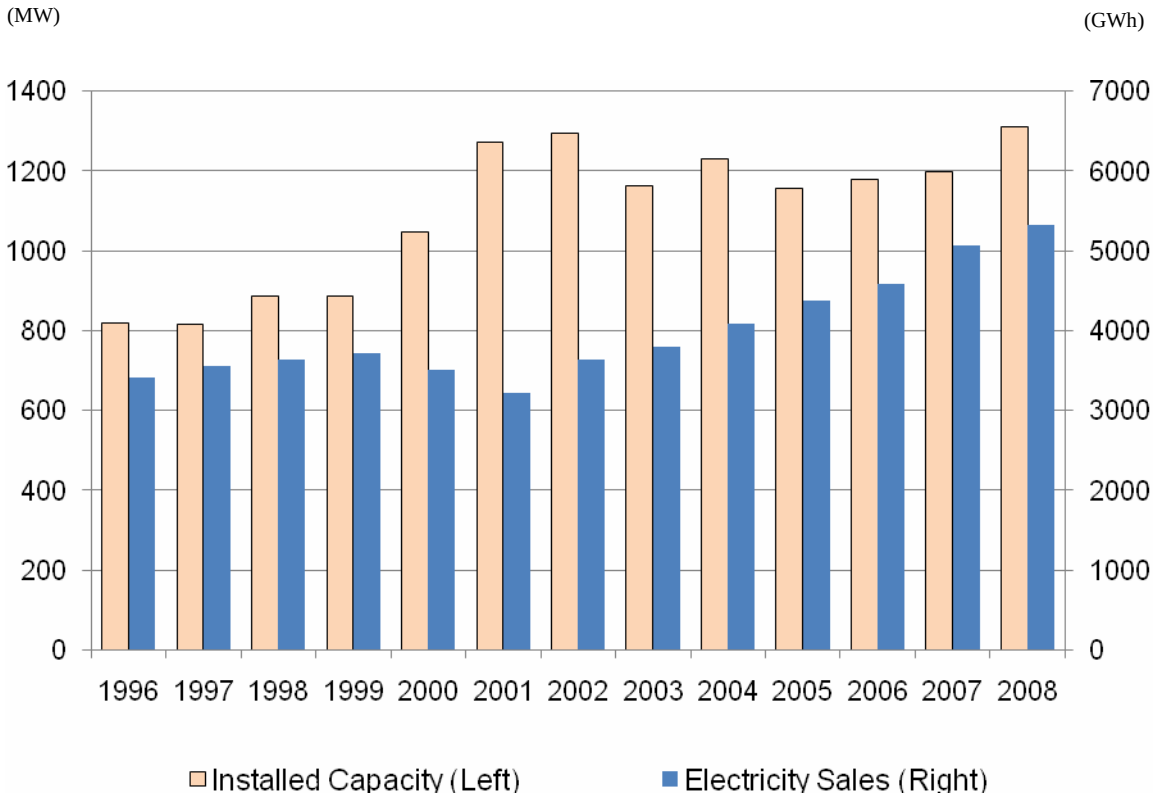
In Figure 3-1.1, Peak demand of the above table is shown in bar chart (left longitudinal axis in MW), and Annual peak demand growth in the past and GDP growth is shown in sequential line graphs (right longitudinal axis in %). As Figure 3-1.1 shows, the peak demand growth usually shifts 1 to 2% above the GDP growth. Hence, the Study Team assumed that Peak demand growth of each year is 1% above the GDP. That is, the Peak demand growth in 2014 where GDP becomes stable at 6.5% is assumed as 7.5% as base case, 6.5% as low case, and 8.0% as high case. The forecast in Table 3-1.5 assumes that Annual growth of Net system peak will shift likewise.



Source: KPLC Annual Report 1999-2008

Fig. 3-1.1 Growth of Peak Demand and GDP in the past years

Electricity sales (GWh) and System effective capacity (MW) are compared in Figure 3-1.2 for reference.



Source: KPLC Annual Report 1996-2008

Fig. 3-1.2 Installed Capacity and Electricity Sales

Table 3-1.5 Load Forecast based on GDP Forecast by IMF

	Total Load Forecast based on the GDP Growth Forecast by IMF (as of Apr. 2009)						LCPDP's Forecast (Dec. 2008)	
	Low Case		**Basic Case**		High Case		**Basic Case**	
Fiscal Year	Net System Peak (MW)	Annual Growth (%)	**Net System Peak (MW)**	**Annual Growth (%)**	Net System Peak (MW)	Annual Growth (%)	**Net System Peak (MW)**	**Annual Growth (%)**
2007/08	1,086	10.9%	**1,086**	**10.9%**	1,086	10.9%	**1,086**	**10.9%**
2008/09	1,113	2.5%	**1,124**	**3.5%**	1,129	4.0%	**1,173**	**8.0%**
2009/10	1,152	3.5%	**1,175**	**4.5%**	1,186	5.0%	**1,267**	**8.0%**
2010/11	1,204	4.5%	**1,239**	**5.5%**	1,257	6.0%	**1,368**	**8.0%**
2011/12	1,273	5.7%	**1,322**	**6.7%**	1,348	7.2%	**1,477**	**8.0%**
2012/13	1,354	6.4%	**1,420**	**7.4%**	1,454	7.9%	**1,715**	**16.1%**
2013/14	1,442	6.5%	**1,527**	**7.5%**	1,570	8.0%	**1,905**	**11.1%**
2014/15	1,536	6.5%	**1,641**	**7.5%**	1,696	8.0%	**2,112**	**10.9%**
2015/16	1,636	6.5%	**1,764**	**7.5%**	1,832	8.0%	**2,339**	**10.7%**
2016/17	1,742	6.5%	**1,896**	**7.5%**	1,978	8.0%	**2,586**	**10.6%**
2017/18	1,855	6.5%	**2,039**	**7.5%**	2,136	8.0%	**2,856**	**10.4%**
2018/19	1,976	6.5%	**2,192**	**7.5%**	2,307	8.0%	**3,151**	**10.3%**
2019/20	2,104	6.5%	**2,356**	**7.5%**	2,492	8.0%	**3,474**	**10.3%**
2020/21	2,241	6.5%	**2,533**	**7.5%**	2,691	8.0%	**3,828**	**10.2%**
2021/22	2,387	6.5%	**2,723**	**7.5%**	2,907	8.0%	**4,215**	**10.1%**
2022/23	2,542	6.5%	**2,927**	**7.5%**	3,139	8.0%	**4,638**	**10.0%**
2023/24	2,707	6.5%	**3,146**	**7.5%**	3,390	8.0%	**5,102**	**10.0%**
2024/25	2,883	6.5%	**3,382**	**7.5%**	3,662	8.0%	**5,611**	**10.0%**
2025/26	3,070	6.5%	**3,636**	**7.5%**	3,954	8.0%	**6,168**	**9.9%**
2026/27	3,270	6.5%	**3,909**	**7.5%**	4,271	8.0%	**6,779**	**9.9%**
2027/28	3,482	6.5%	**4,202**	**7.5%**	4,612	8.0%	**7,449**	**9.9%**
2028/29	3,709	6.5%	**4,517**	**7.5%**	4,981	8.0%	**8,183**	**9.9%**
2029/30	3,950	6.5%	**4,856**	**7.5%**	5,380	8.0%	**N/A**	**-**

Sources: Survey Team, LCPDP (December 2008)

Table 3-1.5 shows that a slight difference in the GDP growth can be a substantial one in the peak demand of each case in the future, even if the same calculation method is used. For example, the LCPDP, assuming an annual GDP growth of 10%, estimates the peak demand in 2014/15 to be 2,112MW, which is about 129% of the basic case in the IMF forecast. In 2028/29, however, the LCPDP forecast is 8,183MW and the IMF forecast is 4,517MW. The ratio between the two will expand to about 180%.

In this study, the demand forecast in LCPDP is to be mainly referred because it is the officially authorized forecast. While, IMF based forecast will also be taken into consideration to avoid the overinvestment.

In designing transmission system for long-term future, differences in the employed demand will cause the different development plan of the system. However, this difference is the difference of the timing of construction for each plants or lines, and anyway the targeted system will be unchanged basically. Therefore, in power system study we will indicate fiscal year based on the LCPDP forecast.

In Table 3-1.6, comparison of each fiscal year for LCPDP base and IMF base forecast is made. 1,700MW system will be achieved in 2012/13 under LCPDP base, while the same system will be achieved about 2 years later under IMF base. 8,000MW system will be only achieved 8 years later by IMF base, than LCPDP base.

Table 3-1.6 Comparison Table of Each Fiscal Year for LCPDP base and IMF base, with the Similar Scale of the System

LCPDP base	Fiscal Year	2012 /13	2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018 /19	2019 /20	2020 /21
	Peak demand (MW)	1,715	1,905	2,112	2,339	2,586	2,856	3,151	3,474	3,828
IMF base	Fiscal Year	2014 /15	2016 /17	2018 /19	2019 /20	2020 /21	2022 /23	2023 /24	2024 /25	2026 /27
	Peak demand (MW)	1,641	1,896	2,192	2,356	2,533	2,927	3,146	3,382	3,909
LCPDP base	Fiscal Year	2021 /22	2022 /23	2023 /24	2024 /25	2025 /26	2026 /27	2027 /28	2028 /29	2029 /30
	Peak demand (MW)	4,215	4,638	5,102	5,611	6,168	6,779	7,449	8,183	
IMF base	Fiscal Year	2027 /28	2028 /29	2030 /31	2031 /32	2032 /33	2034 /35	2035 /36	2036 /37	
	Peak demand (MW)	4,202	4,518	5,221	5,612	6,033	6,972	7,495	8,057	

Source : JICA Survey Team

3.2 Power Development Plan

3.2.1 Vision 2030 and Power Development Plan

In Vision 2030, objectives of maintaining average 10% GDP growth for coming 25 years, and achieving 40% of electrification rate in 2020 were presented, and based on those objectives, the Least cost power development plan (LCPDP) and the Rural electrification master plan (REM 2009) are prepared. On the other hand, the master plan for the East African Power Pool (EAPMP) was prepared by EAC employing BKS Acres of Canada, and it envisaged future power interconnection network among member countries of NBI. Relationship between those vision and development plans are described below.

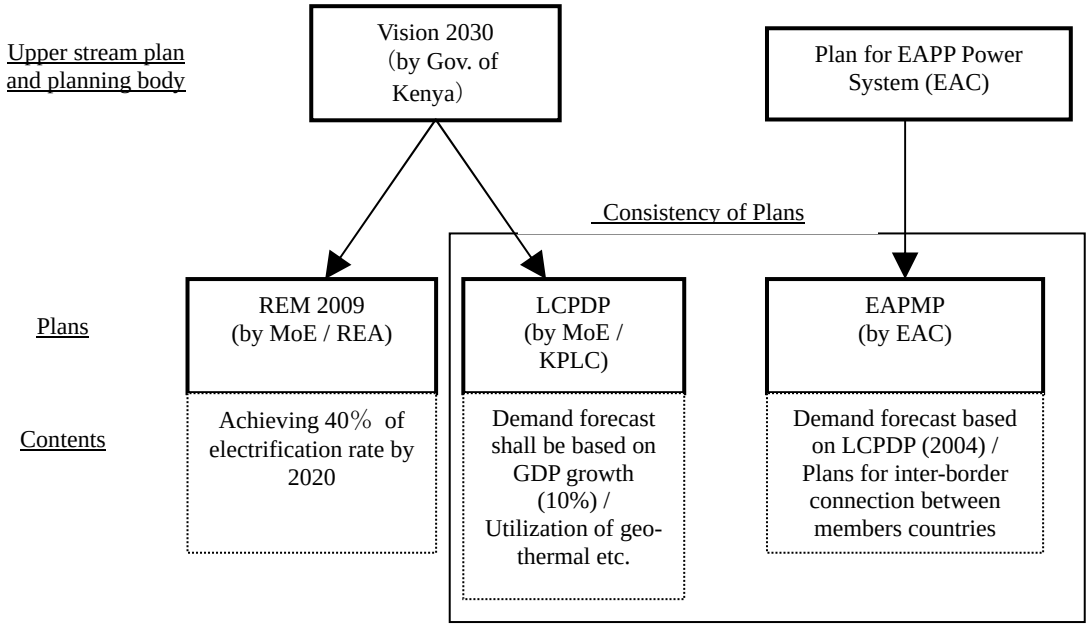


Fig. 3-2.1 Vision 2030, REM, LCPDP, and EAPMP

LCPDP of Kenya and REM 2009 are prepared based on Vision 2030. EAPMP for the East African Power Pool is for inter-border connections for countries and its target area is much wider than the target area of LCPDP. However, EAPMP is anyway referring to LCPDP even though it is 2004 version, and demand forecast or system planning was made according to the 2004 version. REM's target of 40% of electrification rate, which causes huge demand growth, is reflected in the demand forecast in LCPDP.

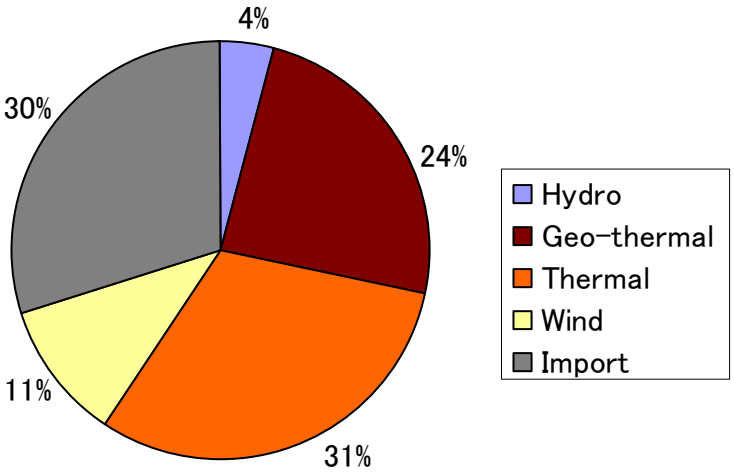
3.2.2 Power Development Plan in Kenya

Power development plan up to 2020 is shown in Table 3-2.1. This is taken from LCPDP (December 2008). Summary of the plans are 1) development of power resources during the period of 12 years from 2008/09 to 2019/20, namely 70.6 MW of hydro power, 795.1 MW of geo-thermal power, 1,028 MW of thermal power and 355.1 MW of wind power, with a total of 2,248.8MW (including decommissioning of old plants by 2019/20), and 2) import of 1,000 MW from Ethiopia.

Proportion of power resources to be developed from 2008/09 to 2019/20 including imported power is shown in Figure 3-2.2. Major sources of energy supply to be developed are geo-thermal and thermal (principally coal-thermal), imported power is also high percentage.

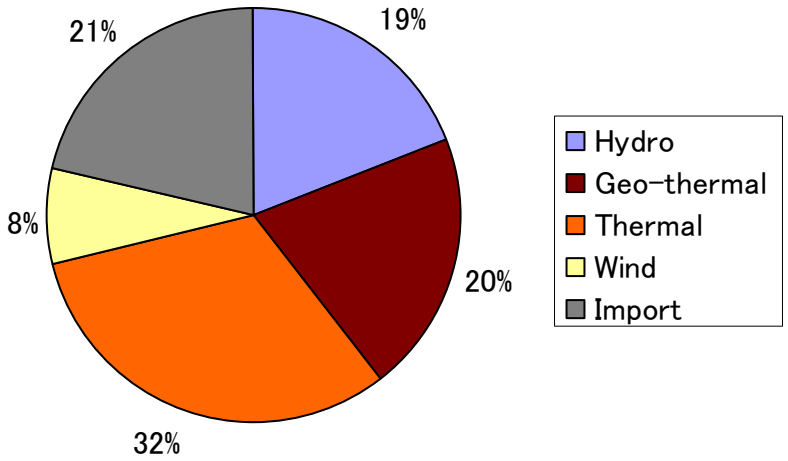
Figure 3-2.3 shows Proportion of Power Resources in 2020. Comparing with the existing system described in 2.3.4 of Chapter 2, ratio of hydro power will be drastically reduced from 52% to 18%, ratio of thermal power will be maintained as 32%, geo-thermal power from 13% to 20%, wind power from 0% to 8%, and import will take up 22%.

Because hydro power is in majority of power source at present, variation of power output between dry and wet seasons causes huge impact on unbalance of supply and demand. Shortage of power occurs in dry season. However, the ratio of hydro power decrease in future, so that variation of power output between dry and wet seasons will less affect the power supply in future.



Sources: Prepared by Survey Team based on data from KPLC

Fig. 3-2.2 Proportion of Power Resources to be developed (Planned in the period of 2009 - 2020)



Sources: Prepared by Survey Team based on data from KPLC

Fig. 3-2.3 Proportion of Power Resources in 2020 (Targeted Proportion in 2019/20)

Table 3-2.1 Development Plan of Power Resources

Fiscal year	Name	Type / Installed capacity (MW)					Total effective capacity (MW)	Peak load (MW)	Reserve margin* (%)
		Hydro	Geo-thermal	Thermal Cogen.	Wind	Import			
2007 /08	Existing	737.3 (Actual)	128 (Actual)	431 (Actual)	0.4 (Actual)	-	1,254 (Actual)	1,086 (Actual)	15
2008 /09	OlkariaⅢ		35.1						
	Mumias Cogen.			25.95					
	Kiambere removal	-144							
	Kiambere upgrade	82							
	Ngong wind				5.1		1,253	1,173	7
2009 /10	Iber Africa MSD			82.5					
	Tana	10							
	Rabai MSD			88.6			1,434	1,267	13
2010 /11	Olkaria		35						
	Emerg. D phase out			-146					
	Aelous wind				50				
	KenGen MSD			100					
	Kiambere upgrade	82							
	FIAT GT phase out			-10					
	Athi river mining			18.5					
	Turkana wind				150		1,514	1,368	11
2011 /12	Sangro	20.6							
	Mombasa IPP coal			300					
	Turkana wind				150				
	Kindaruma	20					1,854	1,477	26
2012	Import Ethiopia					200			
/13	OlkariaⅣ		140				2,194	1,715	28
2013 /14	Olkaria		55				2,249	1,905	18
2014	OlkariaⅣ		70						
/15	Import Ethiopia					200	2,519	2,112	19
2015	KenGen MSD			100					
/16	Olkaria phase out		-30						
	GeothermaⅣ		70				2,659	2,339	14
2016	GeothermaⅣ		70						
/17	Import Ethiopia					200	2,929	2,586	13
2017	Mombasa IPP coal			300					
/18	GeothermaⅣ		70				3,299	2,856	16
2018	Kipevu D phase out			-75					
/19	Menengai geotherm.		140						
	Import Ethiopia					200	3,564	3,151	13
2019	Menengai geotherm.		140						
/20	IBA 1 D phase out			-56.6					
	Mombasa IPP coal			300					
	Import Ethiopia					200	4,147	3,474	19
Total developed capacity (2009-2020)		70.6	795.1	1,028	355.1	1,000			
Total installed cap.		807.9	910.1	1,459	355.5	1,000			

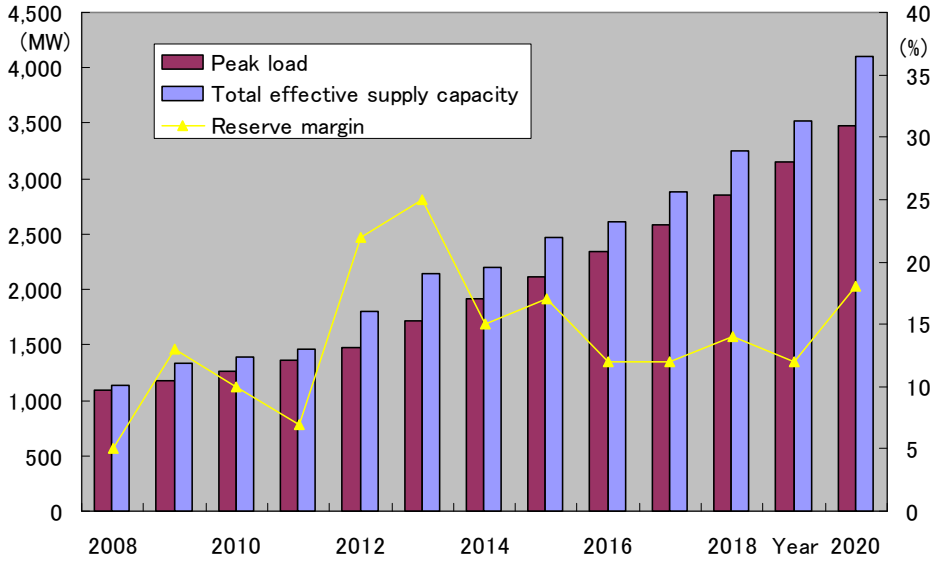
Source : JICA Survey Team ＊：Reserve margin=(Total effective cap.)/(Peak load)-1

3.2.3 Balance of Supply and Demand

Yearly balances between supply and demand, and reserve of power are shown in Figure 3-2.4.

KPLC excludes wind power from supply capacity, because supply capacity is based on the effective output power of all plants while wind power is not counted as effective power at peak load due to variable output of wind power generation.

Severe condition on balance of supply & demand is going to continue for a while. Reserve margin is expected to drop to 11 % at 2010/11. By inauguration of coal-power plant of 300 MW at 2011/12 and start of power import from Ethiopia amounting 200 MW at 2012/13, reserve margin of around 15 % will be secured in the plan.



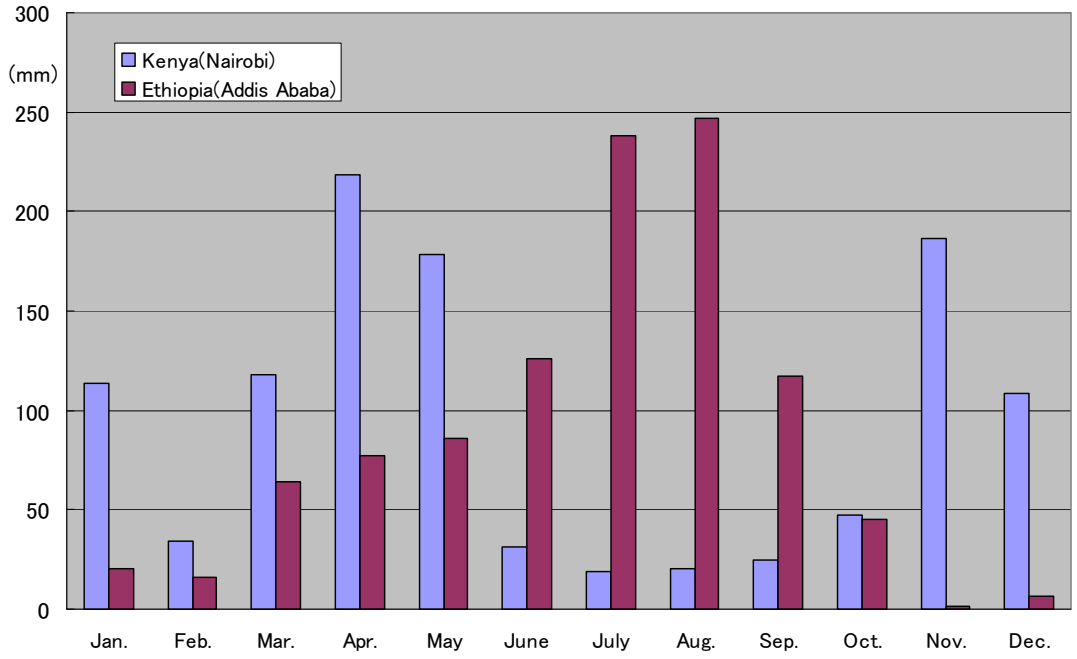
Sources: Prepared by Survey Team based on data from KPLC

Fig. 3-2.4 Balance of Supply & Demand, and Reserve Margin

3.2.4 Power Import from Ethiopia

As mentioned in Table 3-2.1, import power from Ethiopia increases step by step to 200 MW at 2012/13, 400 MW at 2014/15, 600 MW at 2016/17, 800 MW at 2018/19 and 1,000 MW at 2019/20. Details of Ethiopian power sources for import are hereinafter described in Chapter 4. Those power sources are hydro power plants, such as Gibe III Power Station (P/S) (1,800 MW: 900 MW at 2011 and 900 MW at 2012), Mendaya P/S (2,000 MW: to inaugurate in 2018). Power generation cost of Gibe III P/S is of US$0.0457 (from: Ethiopia-Kenya Power System Interconnection Project Draft Final Report May 2008 by Fichtner). Even if the transmission line cost of long distance of 1200 km is added to the generation cost, total cost is still expected to be lower than the cost of thermal power generation. Therefore, importing power from Ethiopia is desirable for Kenya.

In addition, it is advantageous to utilize power from Ethiopia to compensate decreased output of Kenyan hydropower in dry season. Monthly precipitation of Kenya and Ethiopia is shown in Figure 3-2.5. Because Kenya and Ethiopia are positioned on opposite sides of the equator, Ethiopia has rainy season while Kenya has dry season. Especially, in the hottest and dry season called "Kiangazi" from June to September in Kenya, Hydro generations in Ethiopia enjoy rainy season with maximum rainfall of a year. Power trading by cross-border interconnection between Kenya and Ethiopia has the huge advantage for both countries.



Source: Kenyan data by Kenyan Meteorological Office: Nairobi average of 1959-2006, Ethiopian data by Ethiopian Meteorological Office: Addis Ababa average of 1998-2008

Fig. 3-2.5 Monthly Precipitation of Kenya and Ethiopia

3.3 Network Augmentation Plan

Network augmentation plan from LCPDP (December 2008) is shown in Table 3-3.1 and Figure 3-3.1. In 2011/12, the first 400 kV transmission line in Kenya will be inaugurated between Mombasa (Mariakani P/S) and Nairobi (Isinya S/S) to utilize power from Mariakani P/S, large scale coal thermal power plant at coastal area. In 2012/13, direct-current interconnection line with Ethiopia will be inaugurated and power import of 200 MW will be started. To transmit the imported power to inland of Kenya a 400 kV transmission line (Logonot-Isinya line) will be inaugurated. And another 400 kV transmission line (Arusha-Isinya line) will also be completed to transmit power from/to Tanzania. Additionally, upgrading of existing 132 kV interconnection line with Uganda into 220kV system by inauguration of 220 kV Lessos-Tororo line will make drastic increase of power trading capacity.

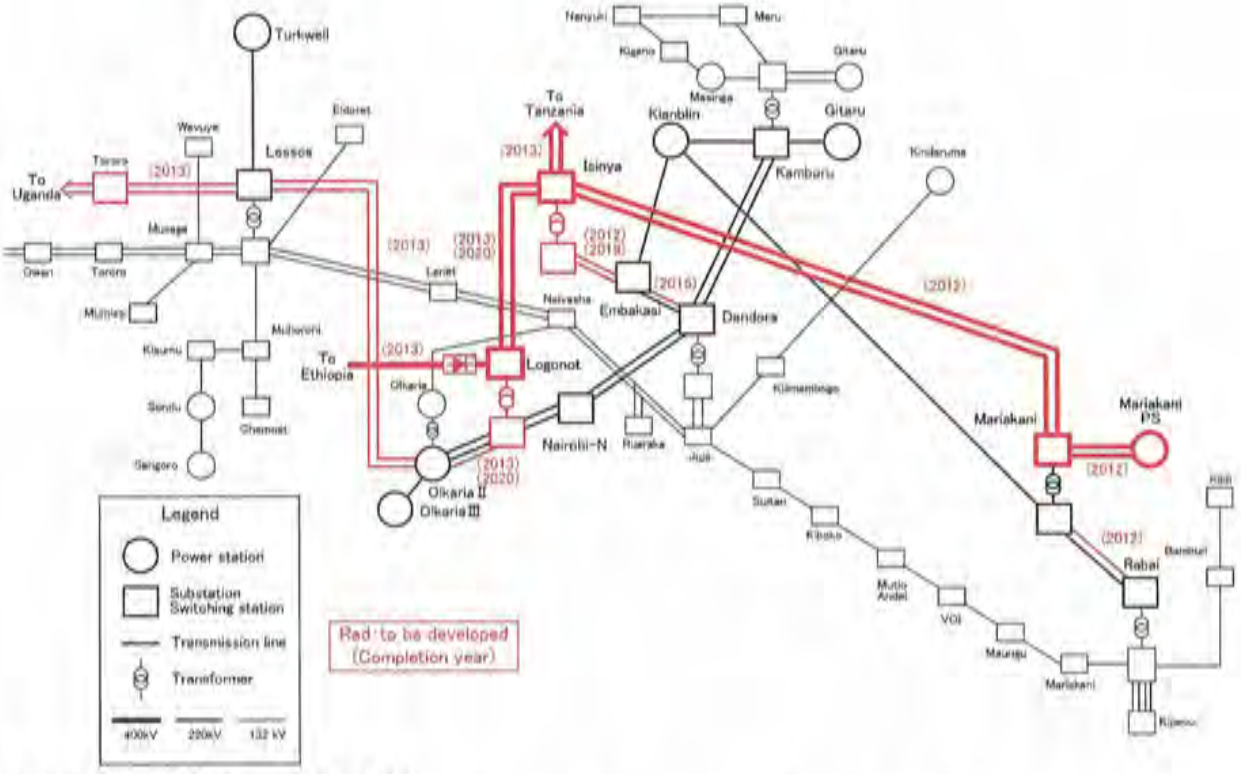
Because existing 132 kV transmission line (Juja-Naivasha-Lanet-Lessos) is aged over 50 years and its carrying capacity per circuit of 77 MW (at power factor of 95%), as a measure against overload and reliability improvement, new 220 kV line (Olkaria-Lessos) is planned to inaugurate in 2012/13.

By construction of above mentioned trunk transmission lines, power highway network runs right across the east-west direction of Kenya will be built and a huge cross-border interconnection line with neighboring countries, such as Ethiopia, Uganda and Tanzania, will also be completed.

Table 3-3.1 Power Transmission System Augmentation Plan (2008/09-2019/20)

Year	Line section	Voltage (kV)	Length (km)	No. of circuits	Remarks
2011/12	Mombasa(Mariakani)－Nairobi(Isinya)	400	429	2	
	Rabai－Mariakani	220	20	2	
	Isinya－Embakasi	220	35	2	
2012/13	Olkaria－Lessos	220	203	2	
	Lessos－Tororo	220	120	2	Interconnection to Uganda
	Arusha－Isinya	400	150	2	Interconnection to Tanzania
	Ethiopia(Sodo) －Kenya(Logonot)	DC500	1200	2	Interconnection to Ethiopia
	Logonot－Isinya	400	80	2	
	Olkaria－Logonot	220	30	2	
2014/15	Isinya－Dandora	220	40	2	
2018/19	Isinya－Dandora	220	40	2	
2019/20	Olkaria－Logonot	220	30	2	
	Logonot－Isinya	400	80	2	

Sources: KPLC



Sources: Survey Team based on KPLC data

Fig. 3-3.1 Transmission System Augmentation Plan (2009-2020)

There is a description that "The interconnector will require implementation of the proposed Olkaria-Lessos 220kV, Lessos-Tororo 220kV and Lessos-Kisumu 132kV transmission projects." and "An additional interconnector will enhance power exchange between the two countries..." in 4.5.4 of Chapter 4 of LCPDP (September 2008). However, there is no description regarding priority of those transmission line projects in LCPDP. In KPLC's power system analysis by using PSS/E, both Olkaria-Lessos 220kV and Lessos-Kisumu 132kV lines are considered.

3.4 Rural Electrification

The ratio of electrification in Kenya in June 2007 is said to be around 17% of households, if only rural areas are considered, then the rate raanges from 7 to 8%. The Ministry of Energy established Rural Electrification Authority (REA), and set the target of 20% electrification by 2010, and 40% by 2020. This target, 40% by 2020, is also presented in KPLC's "5 Year Corporate Strategic Plan 2007/08 to 2011/12" as one of the important targets to contribute to Vision 2030.

Rural electrification basic plan was made in 1997, and also in 2007. At present, the rural electrification project is being implemented following the latest plan made March 2009 by revising the plan of 2007 mentioned above. This latest plan is "The Completion of the Rural Electrification Master Plan", and indicates its target period of 10 years from 2008 to 2018.

The plan targeted electrification of additional 650,000 households in 2008 - 2013, and additional 850,000 households in 2014 - 2018, then additional 340,000 households by 2020, totaling 2,920,000 households. This value is 40% of total targeted households of REM, 7,240,000. In REM, through field survey and assistance of Local Community, the numbers of possible households which can have access to electricity by limited budget are estimated yearly base, and the study came to the conclusion that the value is to be 40% in 2020.

3.4.1 Rural Electrification Plan

The Government of Kenya, who considers the rural electrification (RE) as one of its important policy, established REA to proceed with the work quickly and efficiently. The position of REA in the government organization is shown in Chapter 2. The rural electrification plan consists of the following two projects according to the density of demands and access (distance) from the existing power grid.

- Grid Extension RE Project :
  Extension of the existing grid and extension of high voltage distribution lines (11~33kV)
- Off-grid RE Project :
  Construction of small scale isolated grid, in rural area apart from the existing grid

(1) Grid Extension RE Project

At first stage, a public utility which is located nearby the existing grid (but not yet electrified) will be electrified as a model case of electrification center. Then, the project will spread the distribution system from the center. The numbers of the centers are approximately 4,400 as shown in Table 3-4.1.

Numbers of necessary facilities are ; 4,900 sets of pole mounted transformers (Total capacity is 305MVA), 23,800km of high voltage distribution lines, and 5,700km of low voltage distribution lines.

(2) Off-grid RE Project

Small scale isolated grid will be constructed where the consumers do not have easy access to the existing grid nearby. 350 points of electrification centers in 24 districts are selected. Finally 66,000 households in 200 districts are to be electrified. 74 sets of diesel generators (20 - 500kW), 16 sets of wind power generator (20 - 200kW), and 20 modules of solar batteries (10 - 100kW) are to be installed as the power sources within 5 years from 2009 to 2013. 141 sets of high/low voltage transformers (Total capacity is 28.5MVA), 4,300km high voltage distribution lines, and 630km low voltage distribution lines are also to be installed.

Fig. 3-4.1 Numbers of Electrification Centers for Grid Extension RE Project

Province	District headquarters	Trading centers	Secondary schools	Health facilities
Rift Valley	3	588	176	207
North Eastern	5	0	0	0
Eastern	3	653	351	149
Coast	0	188	30	75
Nyanza	0	548	366	128
Western	0	304	193	48
Central	0	209	128	44
Total	11	2490	1244	651

Source : Completion of the Rural Electrification Master Plan (REM) Draft Final Report (March 2009)

Fig. 3-4.2 Numbers of Electrification Centers for Off-Grid RE Project

Province	District headquarters	Trading centers	Secondary schools	Health facilities
Rift Valley	1	46	17	30
North Eastern	5	62	21	47
Eastern	3	37	13	30
Coast	0	8	6	9
Total	9	153	57	116

Source : Completion of the Rural Electrification Master Plan (REM) Draft Final Report (March 2009)

(3) Progress of Rural Electrification

REM 1997 proposed about 270 subprojects. At present, constructions of almost all of the subprojects have been started. However, exact monitoring of the actual progress is very difficult due to the following reasons. Expecting consumers cannot wait for the service connection from the RE project and acquire power by branching from other consumers who have already received electricity. In other case, they purchase diesel generator by themselves and share the power. Those consumers are called "Non REP electrified rural households" who actually got power but still are registered in the waiting list. For REA who monitors actual progress, the above facts give difficulty in counting the progress. The RE project has come to the latter half stage, and the remaining consumers are more isolated than the ones already connected. There is no consultant to assist REM.

3.4.2 Investment and Project Outcome

Table 3-4.2 shows required amount of investment and project outcome. Figure 3-4.1 and Figure 3-4.2 show target areas of the rural electrification. Total amount of investment is US$ 1,203 mil. and numbers of households to be electrified will be 650,000. 626 GWh energy, and 305 MW of capacity will be increased through the project.

Table 3-4.3 Necessary Amount of Investment and Project Outcome (2008－2013)

Item		Unit	Off-grid RE Project	Grid Extension RE Project	Overall REM Project
Investment	Grid connected RE	Million US$	61	842	903
	Off-grid connected RE		150	0	150
	Stand-alone generation		50	0	50
	Transmission network development		0	100	100
	Total		261	942	1,203
Funds	Connection fee	Million US$	0	0	324
	External financing		0	0	879
Number of connections	Grid connected RE	Number	24,613	551,000	575,613
	Off-grid connected RE		68,461	0	68,461
	Stand-alone generation		4,255	0	4,255
	Total		97,329	551,000	648,329

Source : Completion of the Rural Electrification Master Plan (REM) Draft Final Report (March 2009)

REM 2009 recommends the consumer price of Ksh. 20/kWh for rural consumers of low income category as "RE Social tariff. Meanwhile, the report says the economically feasible price is ; Ksh. 24/kWh for Grid Extension RE Project and Ksh. 48/kWh for Off-grid RE Project. Considering that the consumer price of ordinary small scale consumers connected to KPLC system in city area is nd Ksh. 9 /kWh, it can be easily understood the difficulty of the connection of rural consumers in Kenya to KPLC grid, or to connect isolated grid.

3.4.3 Measures for Increasing Electrification Rate

For increasing electrification rate, finding appropriate donors for realizing subprojects recommended in REM 2009 is off course important. However, as the measures of providing low income households with electricity, the government of Kenya established special tariff system and loan system.

As the case in Japan, if the consumers are located far away from the existing KPLC's distribution lines or isolated system, an electric company charges the consumers at least the partial prices of

additional new distribution lines, necessary meters & service wires for the new connection. In case of KPLC, this "Connection fee" is normally around Ksh. 35,000 for single phase and around Ksh. 44,000 for three phase. However, in case the tariff for the consumer is categorized as "Rural Deferred Payment" the tariffs are discounted to Ksh. 15,000, and Ksh. 25,000 respectively. In addition, for this discounted tariffs, the special loan systems are applied.

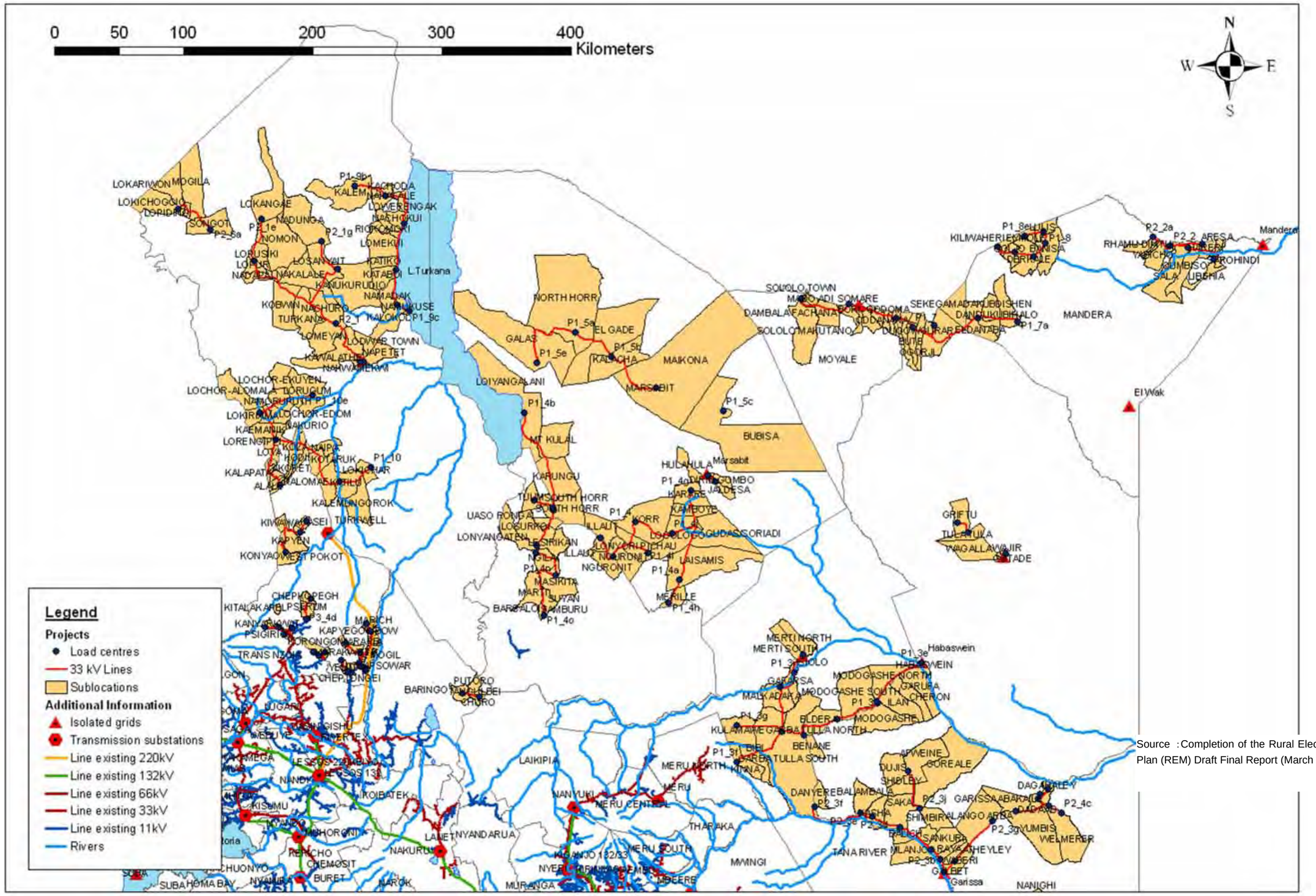
There are ; "Stima Loan (KPLC)" operated by KPLC and "Stima Loan (Equity Bank)" operated by banks, and those two systems are compared in the following table. Equity Bank is to be, in case in rural area, basically the largest bank in the area where the consumer lives.

Table 3-4.4 Stima Loan (KPLC) and Stima Loan (Equity Bank)

	Parameter	Stima Loan (KPLC)	Stima Loan (Equity Bank)
1	Loan Interest	Nil Interest	15% Interest
2	Down Payment	30% down payment of loan amount	20% down payment of loan amount
3	Risk Mitigation	Disconnection to act as security	Chattels act as Collateral
4	Loan Processing Time	One week	Tow days
5	Maximum Loan Amount	Ksh. 100,000.	Ksh. 100,000.
6	Target Group	Low income and SMEs	No strictly defined target group (but focus on transformer maximization & group schemes
7	Repayment Period	18 months maximum	36 months maximum

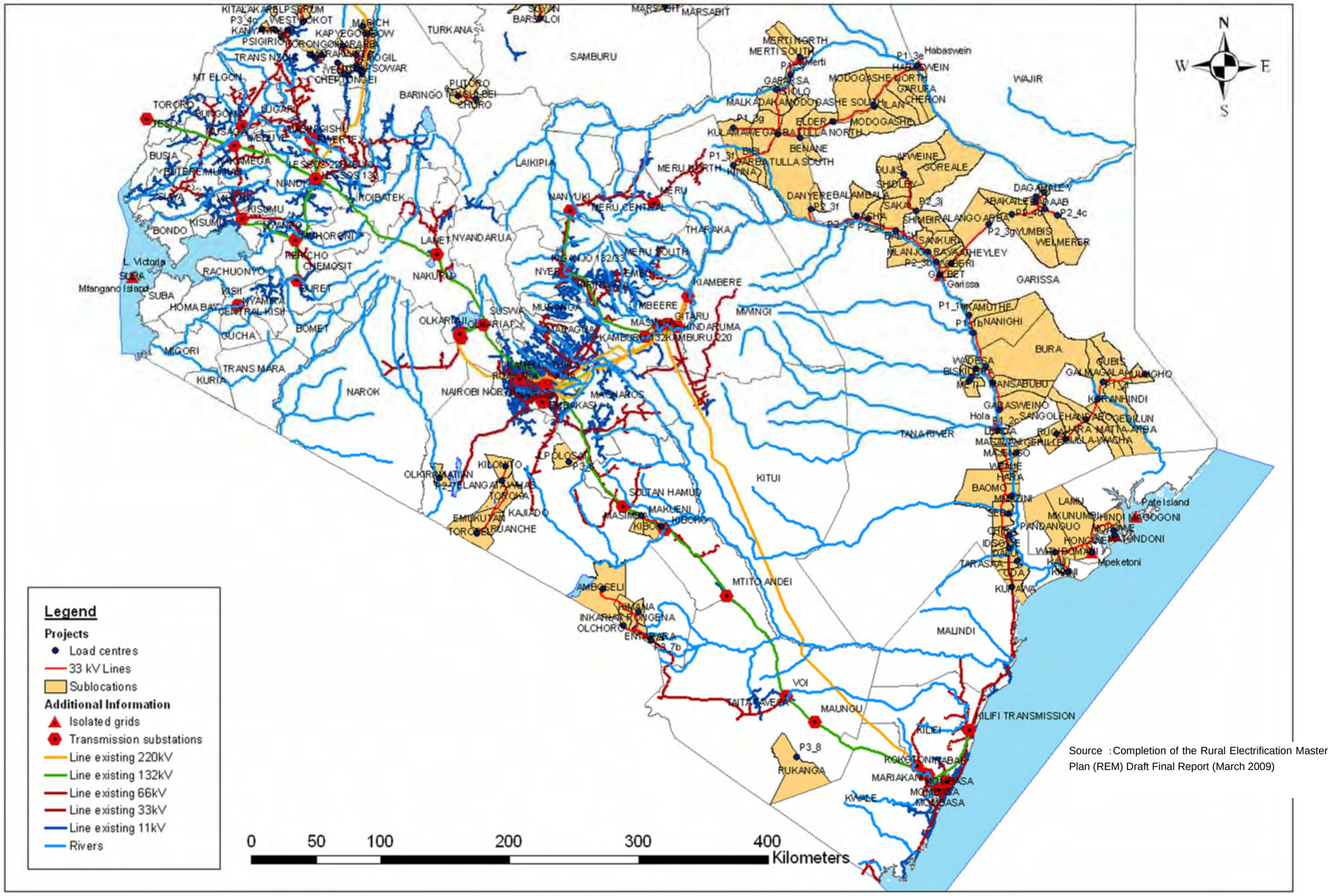
Source : KPLC

From the above table, Stima Loan (Equity Bank) looks easier in its process, however, Stima Loan (KPLC) has merit of Nil Interest.



Source : Completion of the Rural Electrification Master Plan (REM) Draft Final Report (March 2009)

Fig. 3-4.1 Target Area of RE (1) (Northern Kenya)



Source : Completion of the Rural Electrification Master Plan (REM) Draft Final Report (March 2009)

Fig. 3-4.2 Target Area of RE (2) (Southern Kenya)

3.5 Energy Sector Donor Coordination Group Meeting

In order to examine current status of assistances to power sector of Kenya, Energy Sector Coordination Group Meeting is being held every 4 months in Kenya among representatives of every donor country where views are exchanged to maintain assistance on right track. As scope of assistance includes multi-national integration schemes of electric power systems, review is also made on relevant electric power development plans of not only Kenya but also the neighboring countries. The meeting is organized by Ministry of Energy, Kenya and chaired by the representative of Agence Francaise de Developpement (AFD). Given below are outline of assistance to power sectors by these donors that are being subjected to review at the meeting.

3.5.1 Agence Francaise de Developpement（AFD）

AFD who chairs Energy Sector Donor Coordination Group Meeting has been engaged in the following activities.

Table 3-5.1 AFD Funded Projects for Generating Equipment in Kenya

Type	Power station	Installed Capacity (MW)	Estimated cost	Loan/ Grant	Partner	Remark
Geo-thermal	Olkaria-II geothermal No.3 extension	35	EUR 20 mil. (Co-finance with EIB)	Loan	KenGen	Co-finance with EIB
	Support to geothermal development company	-	EUR 35 mil.	Loan	MoE/ GDC	Under preparation
Co-generation	Mumias Suger co-generation	25	US$ 35 mil.	Loan	Mumias (IPP)	Under implemen-tation
Thermal	Rabai heavy fuel generation plant	90	23 mil. (Co-financing)	Loan	Rabai (IPP)	Under implemen-tation

Source : JICA Kenya Office and JICA Study Team

Table 3-5.2 AFD Funded Projects for Transmission, Distribution, and Substation in Kenya

Connection From - To Or Substation location	Voltage (kV)	Estimated cost	Loan/ Grant	Partner	Remark
Nairobi - Mombasa	400	EUR 60 mil.	Loan	MoE/ KETRACO/ KPLC	L/A signed in 2009 Under implement-tation

Energy Sector Recovery Project - D (Rehabilitation of substations in Nairobi and Coast provinces)	66, 33, 11	EUR 25 mil.	Loan	KPLC	Under implementation
Rural Electrification in Six Provinces	33 and 0.4	EUR 30 mil.	Loan	MoE/ REA/ KPLC	Under implementation
Kenya - Ethiopia Interconnection	400	EUR 60 mil. (Co-financing)	Loan	MoE/ KETRACO/ KPLC	Under preparation

Source : JICA Kenya Office and JICA Study Team

AFD aims to reduce poverty and inequality, attain sustainable financial and economic growth and protect "Global Public Goods" to benefit all humanity, and fight against climate change and pandemics. AFD is supporting the Kenyan Government in all segments of the energy sector. From the Sectoral Commitments in the East African Region by the AFD Group in the past 10 years, their contribution to energy sector reaches to 40% and largest.

3.5.2 African Development Bank（AfDB）

Activities of AfDB in Kenya as a donor agency include the following activities.

Table 3-5.3 AfDB Funded Projects for Transmission Lines in Kenya

Connection From - To Or Substation location	Voltage (kV)	Estimated cost	Loan/ Grant	Partner	Remark
Nairobi - Mombasa	400	EUR 24 mil.	Loan	MoE/ KPLC	Preparation of Appraisal Report to begin
Part of interconnection line between Kenya - Uganda	220	-	Loan & Grant	NBI	Appraisal Report finished

Source : JICA Kenya Office and JICA Study Team

AfDB provides financing to its 53 regional member countries for projects that will effectively contribute to their economic and social development and have the strongest poverty reduction impact in these countries. From the list of on-going projects in the member countries, it looks the fields of agriculture, irrigation, and water supply have high proportion among others.

3.5.3 German Development Bank (KfW)

Activities of KfW in Kenya as a donor agency include the following activities.

Table 3-5.4 KfW Funded Projects for Generating Equipment in Kenya

Type	Power station	Installed Capacity (MW)	Estimated cost	Loan/ Grant	Partner	Remark
Geo-thermal	Olkaria-III geothermal station	48	EUR 20 mil.	Loan	IPP	Under preparation
	Oklaria-IV appraisal drilling	-	EUR 7.6 mil.	Loan	KenGen	Under preparation

Source : JICA Kenya Office and JICA Study Team

Table 3-5.5 KfW Funded Projects for Transmission Line in Kenya

Connection From - To or Substation location	Voltage (kV)	Estimated cost	Loan/ Grant	Partner	Remark
Feasibility Study for Kenya - Ethiopia	-	EUR 0.2 mil.	Loan	Grant	Under preparation

Source : JICA Kenya Office and JICA Study Team

As a promotional bank under the ownership of the Federal Republic and the federal states, (of Germany) it offers support to encourage sustainable improvement in economic, social, ecological living and business conditions, among others in the areas of small and medium-sized enterprise, entrepreneurialship, environmental protection, housing, infrastructure, education finance, project and export finance, and development cooperation. Under the law of KfW, KfW is established in 1948 and it had the original purpose of establishment to reconstruct European countries. Hence, comparing with other donors, KfW does not put high priority on development cooperation as its business.

KfW, at present, provides finance to development schemes of Olkaria geo-thermal generation in the power sector of Kenya.

3.5.4 International Development Association / World Bank（IDA/WB）

Activities of IDA/WB in Kenya as a donor agency include the following activities.

Table 3-5.6 IDA/WB Funded Projects for Generating Equipment in Kenya

Type	Power station	Installed Capacity (MW)	Estimated cost	Loan/ Grant	Partner	Remark
Thermal	Mombasa coal thermal plant	600	US$ 1,000 mil.	Loan	KenGen	Under preparation (Verbal information from WB)

Source : JICA Kenya Office and JICA Study Team

Table 3-5.7 IDA/WB Funded Projects for Transmission, Distribution, & Substation in Kenya

Connection From - To Or Substation location	Voltage (kV)	Estimated cost	Loan/ Grant	Partner	Remark
Energy Sector Recovery Project (Transmission lines and substations in Peri-urban areas)	66, 33, 11	US$ 80 mil.	Loan	MoE/ KenGen/ KPLC	Under implementation and includes Co-financing for Olkaria-II No. 3
Energy Sector Recovery Project (Additional Financing)	66, 33, 11	US$ 80 mil.	Loan	MoE/ KenGen/ KPLC	Under preparation
Energy Access Expansion (Generation, transmission lines, distribution for rural areas)	33 etc	US$ 250 mil.	Loan	MoE/ KenGen/ REA/ KPLC	Under preparation includes renewable energy

Source : JICA Kenya Office and JICA Study Team

World Bank prepared a Country Assistance Strategy (CAS) in May 2004. According to the strategy, the priority themes for the Bank's engagement in Kenya include :

- Strengthening public sector management and accountability
- Reducing the cost of doing business, and improving the investment climate,
- Reducing vulnerability and strengthening communities including support to agriculture and the environment, local governments, and reducing poverty the poorest urban and rural areas,
- Investing in people through support to social services, such as health, education, etc.

The CAS also reflects greater attention to governance and supports the Government's Governance Strategy for Building a Prosperous Kenya (GSPK) and Governance Action Plan (GAP). The Bank focuses on transparency initiatives (including transparency in the judiciary, and capacity building in the prosecutorial and judicial services), etc.

3.5.5 European Investment Bank (EIB)

Activities of EIB in Kenya as a donor agency include the following activities.

Table 3-5.8 EIB Funded Projects for Generating Equipment in Kenya

Type	Power station	Installed Capacity (MW)	Estimated cost	Loan/ Grant	Partner	Remark
Geo-thermal	Olkaria-II geothermal No.3 extension	35	US$ 40.8 mil.	Loan	KenGen	Co-finance with AFD

Source : JICA Kenya Office and JICA Study Team

Table 3-5.9 EIB Funded Projects for Transmission, Distribution, & Substation in Kenya

Connection From - To Or Substation location	Voltage (kV)	Estimated cost	Loan/ Grant	Partner	Remark
Nairobi - Mombasa	400	-	Loan	MoE/ KPLC	L/A signed in 2009 Under implementation
Grid Development (Upgrading distribution lines and substations)	33 etc	EUR 43 mil.	Loan	KPLC	Under implementation

Source : JICA Kenya Office and JICA Study Team

EIB has its purpose of business to contribute equal development of EU countries, and to contribute closer relationship among EU countries in economical/social aspects. Similar to KfW, development corporation is not the highest priority in its business. EIB has 6 priority objectives for its lending activity as follows.

- Cohesion and Convergence (within EU)
- Support for small and medium-sized enterprises (SMEs)
- Environmental sustainability
- Implementation of the Innovation 2010 Initiative (i2i : Education, R&D, IT, ICT)
- Development of Trans-European Networks of transport and energy (TENs)
- Sustainable, competitive and secure energy

For the power sector of Kenya, EIB is providing financing to various projects such as the first 400kV transmission line project (Nairobi-Mombasa), distribution project, and geo-thermal development.

3.5.6 European Commission

Activities of European Commission in Kenya as a donor agency include loans to mini-hydro power generation, and bio-gas plant etc. that are related to rural electrification projects. However, the projects are still in their preparatory stages.

3.5.7 Other Donors

It is reported that there are a number of future assistance plans for rural electrification by the governments of Finland, Spain, and Belgium.