TRACTEBEL Engineering
GDF SUEZ

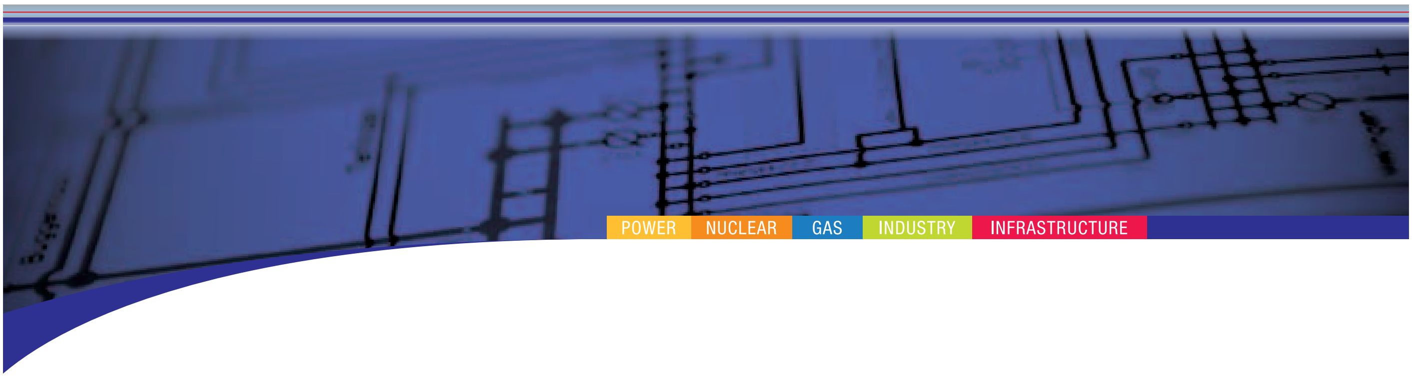
UPDATE OF THE ECOWAS REVISED MASTER PLAN FOR THE GENERATION AND TRANSMISSION OF ELECTRICAL ENERGY

Final Report Volume 1 : Study Data

Economic Community
Of West African States

Communauté Economique
Des Etats de l'Afrique de l'Ouest

General Secretariat / Secrétariat Général



WEST AFRICAN POWER POOL (WAPP)

October 2011

TABLE OF CONTENTS

1. INTRODUCTION

The present report constitutes the Volume 1 of the Final Report of the 'Update of the ECOWAS Revised Master Plan for the generation and transmission of electrical energy'.

The Final Report includes the following volumes:

Volume 1: Study Data

Volume 2: Optimal development plan and analysis of transmission network performance and stability

Volume 3: Investment programme development and priority project implementation strategy

Volume 4: Executive summary

1.1. Context and objectives of the study

The Economic Community Of West African States (ECOWAS) includes 15 countries, of which fourteen are located on the continent, and of which the total population was estimated at 260 million in 2005. This population is very unequally distributed inside this economic space. The growth rate of the urban population (3.81%/an) is definitely higher than that of the global population of the area.

The main energy resources available to West Africa (hydro-electricity, oil, natural gas, coal and renewable sources) are also unequally distributed on the territory of the region.

The West African Power Pool (WAPP) which is a specialized institution of ECOWAS constitutes the institutional framework of the regional electric system. The strategic objective of the WAPP is based on a dynamic vision of the integration of the operation of the national electricity networks in a unified regional market. This unified regional market must make it possible to ensure in the medium and long term an optimal electricity supply, reliable and at an affordable cost to the population of the various Member States.

The objective is to trend to collective economic welfare, thanks to a long-term co-operation in the energy sector and to the development of cross-border electricity exchanges.

The WAPP grid covers two geographical zones A and B:

- The countries of zone A (Nigeria, Niger, Benin, Togo, Burkina Faso, Ghana, and Ivory Coast) are already connected by interconnections.
- Among the countries of zone B (Mali, Liberia, Guinea, Sierra Leone, Guinea Bissau, Senegal and Gambia) only Senegal and Mali are already interconnected. Currently, the electric sector of the WAPP countries supplies only 30% of the population. The peak load of the region has exceeded 6500MW for a total consumption of almost 40000GWh.

The last WAPP Master Plan, that was carried out in 2004, envisaged for the target year 2020 a maximum demand of almost 22500MW. However, since 2007, the total production of the interconnected systems has strongly decreased, deviating thus from the important growth foreseen in the last plan. This production decrease was mainly related to the insufficiency of the generation and transmission infrastructure, to the energy crisis of 2007 and to the inadequacy of the electricity tariffs.

Thus, currently, the electricity demand is far from being satisfied with a level of failure particularly high in almost all the countries of the region.

This situation leads the WAPP Member States to develop emergency programs to build new generation capacity, often ambitious, but often different from those envisaged in the 2004 Master Plan. One can mention in particular the WAPP Emergency Power Supply Security Plan (EPSS) that was established in 2007. This plan aims at applying solutions of regional scale to mitigate the situation of severe insufficiency in generation and transmission.

The important gaps identified between the objectives of the last Master Plan and the effective development of power systems, have highlighted the urgent need to update the WAPP Master Plan.

The purpose of the present study is thus to update the regional plan of generation and transport on behalf of the WAPP General Secretary and the electricity sectors of all Member States.

The aim of the study is, given the present background, to make it possible to the various actors of the electricity sectors to have a clear, global and consistent vision of the future development of power generation and transmission infrastructure within the region, and to serve as a basis for decision making with regards to its implementation.

The purpose is to integrate current developments into a medium to long term strategy for the expansion of the regional power generation and transmission infrastructure in compliance with the WAPP's vision.

The various actions to be undertaken in the course of updating of the master plan include:

- Updating the characteristics of the regional power system: Inventory by country and by regional organization (OMVS, OMVG) of major sources of power generation, transmission network, cross-border electricity exchanges; the institutional (public/private, governance, power generation /transmission /distribution companies, etc.)and financial status of the electricity sector;
- Analysis of the demand/supply balance in each country and at the sub regional (control areas) and regional levels; identification of severe constraints (load shedding, unmet demand, availability of service 24h);
- Identification/determination of an optimal development plan for the regional power generation and transmission system, which takes into account inter alia financial and political constraints that affect the functioning of utilities;
- Update of the investment costs required for implementation and estimation of necessary tariff increases;
- Update of static and dynamic stability studies in order to assess the impact of new power generation and transmission infrastructures;
- Preliminary assessment of the major impacts on the environment;

- Recommendation of implementation strategies for WAPP priority investment programme taking into account the newly approved projects, while indicating the preconditions for their implementation and their respective advantages and disadvantages.

1.2. Structure of the Volume 1 of the Final Report

This first intermediate report is structured as follows:

In chapter 2, the principles of the methodology to be applied in the study are first reminded.

In chapter 3, the data relating to the economic study are described.

Chapter 4 the data relating to the network studies are described.

Chapter 5 relates to the institutional and financial aspects

The annexes give more details about the generation of electricity (wind potentials of the countries, 'thermoflow' simulations gas and coal) and about the technical characteristics of the branches in the electrical networks.

2. METHODOLOGICAL ASPECTS

Before describing the methodology more in details, it is worth defining criteria and standards to be used in systems planning.

2.1. Planning criteria and standards

Setting up a master plan requires to define a certain number of criteria and standards to be respected. These criteria correspond, on the one hand, on security criteria related to the network operation and, on the other hand, on criteria related to the reliability of the power system. The final goal is to harmonize these criteria for all WAPP member states.

The WAPP has completed the definition of common criteria for planning and operation in the WAPP operation handbook which will be used as reference for the study.

The guidelines mentioned in this document will moreover be supplemented by rules followed in Europe (ENTSO-E ex UCTE) and in African countries. The standards used in Europe cannot, at least in the first years, be applied in the WAPP countries, taking into account the characteristics of the networks and the important current capacity deficits in the regional reference system. It is thus necessary to consider a phasing to gradually mitigate these deficits.

2.1.1. WAPP operation handbook (July 2007)

In this operation handbook, the main directives to be considered for network operation relate to the following topics:

- The power-frequency control (policy 1);
- The interchange scheduling and accounting between control areas (policy 2);
- The operational security (policy 3);
- The operational planning (policy 4);
- Emergency procedures (policy 5).

For the primary control, the reference incident is the simultaneous loss of the largest unit in Nigeria (220 MW) and the largest unit of the group Ghana-Ivory Coast-Togo-Benin-Burkina Faso (170 MW).

One can notice that, regarding the secondary control, the correction process must be able to be carried out in 20 minutes and corresponds to the largest unit of the control area considered.

Regarding the operational security, the N-1 criterion is applied (loss of a generator or an element of the transmission network) in all control areas.

Each control area operator will have to operate his reactive resources so as to maintain the system voltages within the acceptable limits according to the N-1 criterion.

In normal operation, the voltages of the 330 kV, 225 kV, 161 kV and 132 kV transmission networks at the borders will remain normally within the limits of more or less 5% of the nominal value. The maximal and minimal voltages are of +10% and -10% (but only during maximum15 minutes when beyond more or less 5% of the nominal value).

Nominal Voltage	V normal operation +- 5%	Vmin -10%	Vmax +10%
330 kV	315-345	300	360
225 kV	214-236	200	245
161 kV	153-169	145	175
132 kV	126-138	120	145

Table 1 – Voltages of operation, minimal and maximum

The transits of reactive energy on the interconnections are maintained at a minimum level and if possible not beyond the natural power, with the aim of limiting the voltage drops and of allocating transfer capacity to active energy.

2.1.2. Application to each country case and standardization

2.1.2.1. TRANSMISSION CRITERIA

Each control area operator must comply with the N-1 rule while taking account of the specificities of his local network to avoid overloads, unacceptable voltage drops, loss of stability, cascade outages, etc. He will also have to take corrective actions including load reductions and load shedding if necessary.

With the aim of standardizing the security criteria for all countries while taking account of their specificities, the following assumptions are proposed in the present study for the whole region. It should be stressed that these criteria are an objective that will be reached in many countries only after a transition period necessary to invest and to put the power system at the right security level.

Acceptable voltage range in operation

State N (normal situation or sane state): ± 5%

State N-1 (after incident): ± 10%

Acceptable frequency range in operation

State N (normal situation or sane state): 49.8 to 50.2 Hz

State N-1 (after incident): 49.5 to 50.5 Hz

The secondary reserve must act within 20 minutes and is equal to the capacity of the largest generating unit on line in the considered control area.

Level of compensation in distribution

Taking into account the presence of air conditioning in the loads (induction motors), it is necessary to guarantee the highest possible power factor in the distribution substations in order to reduce the risk of voltage collapse and to minimize the necessary investments in transmission equipment. It is proposed to implement in the long run a minimum power-factor of 0.9 at this level.

Acceptable short-circuit powers

The target values suggested are:

330 kV: 50 kA

225 kV: 50 kA

161 kV: 40 kA

Acceptable equipment loading in planning studies:

The maximum acceptable values proposed (expressed in % of the nominal capacity) are the following ones:

Lines: 100% in N state and 110% in N-1 state

Transformers: 100% in N state and 120% in N-1 state

Reliability of transmission equipment

The reliability of lines and transformers is supposed to be 0.995. This value corresponds to a total unavailability (planned + unplanned) of 44 hours per annum.

2.1.2.2. GENERATION CRITERIA

The reliability of a generation system is expressed in term of ability of this system to meet the power demand at any time.

This capacity to meet the power demand depends on the one hand on the uncertainty which affects this demand, and on the other hand on many parameters which limit the total power that the generation system can develop at every moment.

The factors which limit the power that the system can develop are for example:

- Unplanned forced outages of generating units;
- Generating units un-availabilities due to maintenance;
- Reductions of power output of the thermal generators due to a rise in temperature;
- Lack of water in the reservoirs of hydroelectric plants.

It is necessary for the generation system to permanently keep a reserve in capacity to be able to tackle the various types of outages that may occur.

So, generation system planning requires to take into account security criteria which guarantee a sufficient reserve margin of available capacity in the long term.

The criteria in use are generally:

- A minimum reserve margin of installed capacity or available capacity;
- The expected duration of failure, (or loss of load probability LOLP);
- The annual expected energy not served (ENS).

The minimal necessary capacity reserve which guarantees a maximum level of LOLP or ENS depends notably on:

- The relative size of each production unit compared to the total peak demand;
- The water inflows (wet year, average year or dry year);
- Proportion of hydroelectric installed capacity compared to the thermal installed capacity;
- Degree of interconnection of the considered system with other neighbouring systems.

Bringing together several generation systems by means of a sufficient interconnection network makes it possible to reduce the relative size of each unit compared to the total peak load and to reduce consequently the total installed capacity in the whole set of interconnected countries that is necessary to respect a given maximum level of failure.

Let us note that the size of the units can have an impact not only on the expected energy not served (ENS) in the system but also on the stability of this system. From this point of view it is generally admitted that the size of the largest generating unit may not exceed 8 to 10% of the total peak load.

The generation systems are generally planned by imposing a given minimum reserve margin or a given maximum duration of failure (LOLP). The cost of the un-served energy (CUE) in the system is a consequence of this choice.

Conversely, the choice of a given cost of un-served energy leads in the long term to a corresponding volume of necessary generation investments and hence a corresponding continuity of service:

- If the cost of un-served energy CUE is high, this creates a strong incentive to invest in generation while reducing the expected energy not served ENS (what is generally the case in the industrialized areas, the urban centres…).
- If the cost of un-served energy is low, the system may accept a lower reliability level that is a higher loss of load probability LOLP (what is typically the case of little industrialized areas, of rural regions …).

One can mention the following approaches to estimate the cost of energy not served:

Implicit cost of energy not served:

This cost is based on the cost of installing and keeping in service an additional generating unit in the system to mitigate the expected energy not served. The operating hours of such a generating unit correspond to the value of the LOLP.

Explicit cost of energy not served:

This cost is based on the cost of goods production that is lost due to loss of load.

At the national level, one can assess in a simple way the ratio GDP/electricity produced that gives an indication on the "richness" produced by the country for each consumed kWh. It should be noted that this approach tends to over-estimate the cost of the energy not served (CUE) because, to be accurate, it would be necessary to determine the share of the Gross Domestic Product (GDP) directly depending on the electricity produced.

Cost of substitution:

This consists in calculating the cost of substitution that certain customers are ready to pay (willingness-to-pay WTP) to get a reliable and continuous supply. This cost is the cost of buying, keeping in service and operating a small emergency diesel unit that a customer is ready to pay to guarantee the quality of his own electricity supply.

The implicit cost of energy not served mentioned here-above consists in reducing the number of hours of loss of load in the generation system thanks to the installation of a peak unit, for example a gas turbine. It is calculated by adding to the fixed charges divided by the duration of failure, the proportional fuels and maintenance charges.

One can note that, in practice, if an additional peak unit is implemented in the system, it will replace an older unit in the merit order to cover the demand due to its characteristics, and will relegate this older unit higher in the merit order.

When assuming for a new peak unit a cost of 750 USD per installed kW, a discount rate of 10%, and a life duration of 25 years, it comes, like illustrated in Figure 1 hereafter, that the implicit cost of energy not served varies from more than 9000 USD/MWh for a LOLP objective of 10 h/year to less than 600 USD/MWh for a LOLP objective of 250 h/year.

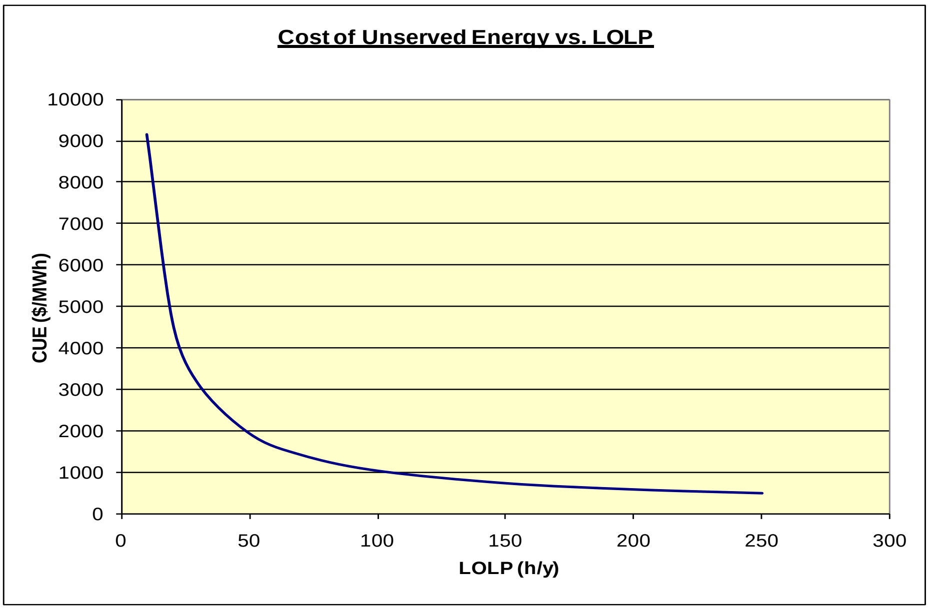


Figure 1– Cost of energy not served in function of the duration in failure (LOLP)

As an example, if one calculates the explicit cost of energy not served mentioned here-above for Ghana considering the national GDP divided by the total electric energy consumed in 2010, one obtains a cost of 2600 USD/MWh, what corresponds on Figure 1 to a LOLP of approximately 45 h/year. By considering the GDP of the industrial sector only, one obtains a cost of 1300 USD/MWh, what corresponds on Figure 1 to a LOLP of approximately 75 h/year.

It is not easy to assess the cost of energy not served because it strongly varies according to the categories of consumers (residential, industrial,), the applications of electricity, the degree and the characteristics of interruptions (day, night, duration of the interruption). Moreover, the characteristics of the Member States of WAPP strongly vary from one country to another.

Table 2 hereafter illustrates the diversity of the values considered for the cost of energy not served in various African and Asian countries.

Country	**Source**	**Value per kWh**	**Money**	**USD/MWh**
South Africa	Eskom	19	Rand	2780
Gabon	study	1200	FCFA	2110
Burkina Faso	study	1000	FCFA	1820
Senegal	Senelec	1000	FCFA	1820
Sri Lanka	study	1.5	USD	1500
Cameroon	contract	700	FCFA	1230
Libye	study	1	USD	1000
Ghana	Master Plan	0.15	USD	150
ECOWAS	Purdue study	0.14	USD	140
Andhra Pradesh	study	0.12	USD	120
Guinée	EDG	0.087	USD	90

Table 2 – Cost of energy not served in various countries (Source: West Africa Regional Transmission Study - vol. 2: Master Plan)

In the European countries and the Gulf Arab countries, a LOLP of about 24 h /year i.e. 0.27% of the time is often taken into account.

It is of good practice, in the developing countries, to consider a maximum LOLP of about 1% of the time. In India for example, one uses a maximum loss of load duration criterion (LOLP) of 1% and a maximum energy not served criterion (ENS) of 0.15%.

However, nowadays the whole set of generation systems of the WAPP countries are strongly under-equipped what entails frequent cuts of electricity. It follows that the expected durations of loss of load are actually much higher.

Let us consider for example the case of Ghana whose under-equipment is currently less than that of the neighbouring countries. The reserve margin in available capacity (that is lower than the theoretical installed capacity) is about 20%. For this reserve margin the calculated LOLP (in isolated operation) remains high and is very sensitive to the hydrological conditions: 7h /year in a wet year and 200 h/year in an average year. Under the current conditions, it would thus be logical to propose for this country a long-term LOLP objective of about 100heures/year what corresponds to a reserve margin in available capacity greater than the current margin of 20%.

Generally speaking, in the context of the WAPP countries that has been described here-above, it seems thus judicious to consider, on average, a LOLP objective of about 100 h/year (1.14%) corresponding to a cost of energy not served of about 1000 to 1500 USD/MWh.

Taking into account the present status of the WAPP countries, it is proposed in the present study:

- To consider a long-term objective of reserve margin in `available capacity' of 25 to 30%.
- To consider a progressive evolution of the available capacity reserve during a transitional period, due to the importance of the current deficit to be filled in.

2.2. Methodology

The methodology proposed for the study comprises the following phases:

Phase 1:

After a data collection carried out in the whole set of the Member States, the consultant will propose a complete and detailed inventory on generation means, transmission networks and electricity demand composing the assessment of the offer/demand balance for the 14 Member States and the 15 years to come. The purpose of this inventory is to have a clear vision of the energy situation of each country and to position in the national development plans the place of the regional WAPP projects.

A workshop on the results of phase 1 with the representatives of the various Member States shall be organized

Phase 2:

Then, based on this inventory, the optimal development plan of generation/transmission will be built. The objectives are the following:

- to find the combined optimum between the development of the total regional generation system and the development of the interconnection transmission network while ensuring the demand at the minimum cost;
- to identify the regional projects in transmission and generation to be developed in priority;

Phase 3:

The third phase of the methodology consists in the simulation and the evaluation of the systemic performance of the interconnected network. It will be checked that the planning and operation criteria of the transmission networks are met. Static and dynamic simulations will be carried out using the EUROSTAG software. The optimal generation and transmission plan will be re-examined to take account of the impact of these technical constraints.

Phase 4:

The fourth phase of the methodology consists in defining a priority investment programme for the years to come. The project hierarchy will be set up on basis of the preceding economic and technical analyzes, of the environmental preliminary evaluation and in dialog with the WAPP.

Phase 5:

Finally, the last phase consists in re-examining the priority investment plan by taking into account the financial and institutional context of the region and by working out the implementation strategy of the projects.

The study will end with the publication of a synthesis report.

The different phases of this methodology are described more in details hereafter.

2.2.1. Phase 1: detailed inventory of the generation means, the transmission networks and the electricity demand

Phase 1 will be more particularly the content of this Volume 1 of the Final Report and will be described in more details in the following chapters.

The chart hereafter presents the big regional interconnection projects as well as the hydroelectric projects that exist, decided, planned and considered.

The information on this plan are provided for information purposes only and does not constitute recognition of international boundaries or regions. Tractebel Engineering assumes no responsibility regarding the accuracy of the maps and use the information they contain.
Les informations reprises sur ce plan sont données à titre d'information seulement et ne constituent pas une reconnaissance de frontières internationales ou de régions. Tractebel Engineering décline toute responsabilité en ce qui concerne l'exactitude des cartes et l'utilisation des informations qu'elles contiennent.

2.2.2. Phases 2 & 3: optimal transmission and generation plan and technical analysis

The pursued objective is to find an optimal combination between:

- On the one hand the development of the big generation projects at the regional scale;
- On the other hand the development of the interconnected network between the various countries.

This optimal combination must make it possible to cover the demands of the countries at the lowest cost, while taking account of the characteristics of the hydro-electric resources, of new thermal and renewable technologies, of the available fuel resources and of an imposed reliability level (see the chapter on the planning criteria and standards).

To calculate this economic optimum a combined model of the generation systems and of the main transmission axes (model PRELE) will be used. This model makes it possible to optimize the operation and the investment decisions of the WAPP power system over the period 2010 - 2025 by taking account of the various constraints in this system. These constraints relate to the demand, the available primary energies (dry years, wet years, availability of natural gas), the operational constraints, etc.

This model will be used in two stages:

First stage: to compare two types of scenarios.

Scenario 1 consists in simulating the national development plans 2010-2025 without developing new interconnections and will be taken as reference.

Scenario 2 consists in building the optimal regional development of WAPP generation system 2020-2025 without any limitation of transit on the possible interconnections between the Member States.

This second scenario is an 'ideal' scenario. It will highlight the most interesting generation projects at the regional WAPP level. It will make it possible to establish the list of the big priority generation projects at the same time as the corresponding energy transits between the countries concerned.

The difference between the total discounted costs of scenarios 1 and 2 represents the maximum benefit that the West African region can expect regarding power generation.

Second stage: to determine the regional interconnection projects to be developed:

Starting from Scenario 2, the reference scenario 3 will then be built by introducing in the techno-economic simulations (model PRELE) the maximum transit capacities of the various interconnections. The results will possibly lead to revise the list of the priority generation projects and to consider additional regional interconnection projects that will come up to be necessary to achieve international exchanges in an optimal way.

These studies will make it possible to determine the regional interconnection projects to be developed.

Indeed, each regional interconnection project:

- On the one hand, implies operation and capital costs;
- On the other hand, involves power exchanges between the countries and in that way makes regional generation projects feasible, and enables to approach the theoretical optimum of regional generation established previously.

The considered regional interconnections projects considered to start the economic study are mentioned hereafter in Table 3. This economic study will put afterwards in the light other possible regional projects.

Project	
Dorsal link 330kV	Volta (GH) - Sakete (BN)
	Riviera (Ci) - Prestea (GH)
CLSG	
	225kV Ivory Coast - Liberia - Sierra Leone - Guinea
OMVG	Mesh 225kV Senegal-Guinea
NORTHERN corridor	
	330kV Nigeria-Niger-Benin-Burkina Faso
	330kV North-South Ghana
HUB	225kV Ghana-Burkina
INTRA-	225kV Ghana-Burkina-Mali
ZONAL	225kV Mali - Ivory Coast
	225kV Guinea - Mali
OMVS	Extension of the 225kV network
Median dorsal link	Median dorsal link 330kV Nigeria-Benin-Togo-Ghana
Guinea	225kV Linsan - Fomi

Table 3 – Regional interconnection projects when starting the economic study (excluding additional priority projects deducted from the economic study)

A sensitivity study compared to the reference scenario 3 will then be carried out by modifying a number of key parameters (investment delays, demand growth, renewables, fuel prices, discount rate, etc.).

The techno-economic simulations will be completed with the performance checks of the transmission network operation. This analysis will include:

- Static simulations (load-flows, optimized load-flows, simulations of incidents, etc);
- Dynamic simulations (stability of the interconnected network, dynamic reliability taking into account the voltage transients in case of outage or short-circuit, identification of the maximum transmissible capacity of the regional interconnections, etc).

Resulting from the performance checks and stability studies of the network, the list of priority projects will possibly be updated if necessary.

2.2.5. Phase 4: list of priority projects

One will establish the list of priority investment projects in generation and transmission starting from the results of the economic and technical analyzes of phase 3, from the refinement of the economic and financial analysis of the interconnection projects and from the results of a preliminary environmental analysis.

2.2.5.1. FINANCIAL, LEGAL AND INSTITUTIONAL CONTEXT

One will also take into account the financial, legal and institutional background of the electric utilities.

The following aspects will be in particular taken into account:

- The financial status of the electric utilities, to evaluate their investment capability in the short, average and long-term;
- The schedule of the capital expenditures and of the benefits due to the interconnections between the countries, and the use of an average tariff (postage stamp) to the users of the interconnections.

2.2.5.2. ENVIRONMENTAL ANALYSIS

The objectives of the environmental analysis are:

- To make a preliminary evaluation of the main impacts of generation and transmission infrastructures on the environment;
- To propose solutions to limit the detected negative impacts;
- To identify if necessary compensation measures to be proposed for the negative impacts whose mitigation is not possible;

The general methodology proposed to analyze the environmental impacts is based on the elaboration of matrices.

A specific methodology will be applied to each priority project and will include 4 parts;

- A brief description of the priority project;
- A description of the initial state of the environment;
- The evaluation of the impacts of the priority projects on the environment and the social sphere;
- Solutions enabling to reduce the impacts.

2.2.6. Phase 5: The final program of priority investments and the strategy of project implementation

Two different approaches already exist for project implementation in the WAPP countries:

- In the first approach, each country finances, owns and operates the part of the infrastructures that lies on its territory. Examples: the interconnections Nigeria-Niger, Ghana-Togo-Benin and Ivory Coast- Ghana (on the coastal dorsal link).
- In the second approach, a distinct regional entity (Single Purpose Company - SPC) develops, owns and operates the equipment, allowing a regional collaboration. Example: the OMVS between Senegal, Mali and Mauritania.

The applied methodology will take account of the decision to adopt the concepts of Single Purpose Company (SPC) and Private Public Partnership (PPP).

It includes notably:

- Visits on the field in countries having cross-border projects;
- The review of the decisions and complementary acts adopted by WAPP and ECOWAS;
- The review of the institutional and legal framework, of the tariff policies and of the financial status of the electric utilities;
- Etc…

3. DATA FOR THE ECONOMIC STUDY

3.1. Data

This chapter describes the data used within the framework of the economic study. These data relate to the fuel (cost and availability), the load forecast and the production and transmission projects.

3.1.1. General data

The actualisation rate proposed is 10%.

The foreign exchange rates considered in the study are:

- 1€ =1.35 US$
- 1€=650FCFA

3.1.2. Fuels

Currently in West Africa, a broad variety of fuels are used such as, diesel oil (DDO), light crude oil (LCO), heavy fuel oil (HFO), natural gas (NG) and to a lesser extent coal. Among the planned units, apart from the hydroelectrical units, the majority of them will use NG for the countries of zone A and HFO or DDO for the countries of zone B. Several studies also propose the use of coal.

The natural gas used by the countries of zone A comes either from local gas resources or from imported through the Wescircuit African Gas Pipeline (WAGP). The liquid fuels come mainly from Nigeria.

For the sake of a diversification of energy mix, of reducing the dependence to liquid fuel and reducing the fuel cost, other fuels will be considered for the electrical production within the framework of the master plan, in particular coal.

3.1.2.1. PRICE OF FUEL

The crude oil prices (thus also the price of its derivatives) and of natural gas are closely dependant. Coal as a primary energy source for the electrical production, is also related to the crude oil price. Nevertheless, the correlation between the prices of coal and crude oil is less important than the one linking the derivatives of oil, natural gas and crude oil.

In this study, it was agreed that the incircuitational fuel prices will be used. In this way, opportunity costs of locally available fuel will be taken into account and it prevents the local market of electricity of being skewed by “subsidized” fuels. In case of power exchange between countries, it is then avoided that a country subsidizes another country by selling electricity for a lower price than the real one (or market price).

In this study, a great attention is paid to the relative difference between fuels prices and not on their absolute level. For this reason, the crude oil price is considered constant during all the study.

However, several scenarios are studied according to the standard price of crude oil. Indeed, the crude oil price was extremely volatile during the last years with a strong increase until August 2008, then a strong reduction until the end of 2008, followed by a low rate of recovery. Recently, the events in the Arab world and in Japan caused a big and rapid raise of the oil prices. As it is impossible to draw a long-term tendency on which all the experts agree, various crude oil prices are studied:

- Low scenario: 75 USD/bbl;
- Base scenario (corresponding to the current location): 100 USD/bbl;
- High scenario: 125 USD/bbl.

The fuel prices in West Africa are presented for two specific conditions, delivered to the coast or to the continent. The “coastal” price corresponds to the fuel delivery for all the coastal countries from Senegal to Nigeria while the “continental” price corresponds to the delivery for Mali, Burkina Faso and Niger. For each delivery, average fuel costs exempted from taxes and subsidies are presented.

The fuel prices at the borders of an exporting country are estimated based on a correlation study. It is thus necessary to add the prices of maritime transport to have the coastal price and the prices of surface transport for the continental price.

The transport costs are estimated based on the experience of the Consultant and the publications of the IEA in the following way:

- The maritime liquid fuel transport costs per tanker of 30 000 tons are estimated to 5.9 USD/kton/mile;
- The maritime transport costs of coal between South Africa or Colombia and West Africa are estimated to 20 USD/ton for a ship of 40 000 tons;
- The terrestrial transport costs of liquid fuel by tanker are estimated to 0.11USD/ton/km;
- Regarding the cost of transport of natural gas, three different prices are to be considered according to the source:
    - WAGP (WAGP): 2 USD/MMBTU;
    - Native gas: about 0.1 USD/MMBTU;
    - LNG: Liquefaction: 0.9 - 1.3 USD/MMBTU; transport: 0.4 - 1.1 USD/MMBTU; Gasification & Storage: 0.3 - 0.5 USD/MMBTU.

Taking into account these costs of transport and the relations rising from the correlation study, it is possible to consider averages for coastal and continental prices for various fuels (taxes and subsidies exempted):

COST OF LIQUID FUELS "DELIVERED TO THE COAST"						
OPEC	HFO - 3.5%		DDO		LCO	
[USD/bbl]	[USD/bbl]	[USD/GJ]	[USD/bbl]	[USD/GJ]	[USD/bbl]	[USD/GJ]
75	58.8	9.7	92.6	16.2	75.9	13.3
100	78.2	12.9	125.1	21.9	101.2	17.8
125	97.6	16.0	157.7	27.6	126.5	22.3

Table 4 - Price of liquid fuels – coastal

COST OF LIQUID FUELS "DELIVERED TO THE CONTINENT"						
OPEC	HFO - 3.5%		DDO		LCO	
[USD/bbl]	[USD/bbl]	[USD/GJ]	[USD/bbl]	[USD/GJ]	[USD/bbl]	[USD/GJ]
75	79.7	13.1	111.1	19.5	92.3	15.1
100	99.1	16.3	143.6	25.2	115.8	18.9
125	118.5	19.5	176.2	30.9	139.3	22.8

Table 5 - Price of liquid fuels – continental

COST OF NATURAL GAS "DELIVERED TO THE COAST"						
OPEC	WAGP		Local Gas		LNG	
[USD/bbl]	[USD/MMBTU]	[USD/GJ]	[USD/MMBTU]	[USD/GJ]	[USD/MMBTU]	[USD/GJ]
75	8.6	8.2	6.7	6.4	9.4	8.9
100	10.9	10.3	8.9	8.5	11.6	11.0
125	13.1	12.4	11.2	10.6	13.8	13.1

Table 6 - Price of natural gas - coastal

COST OF COAL "DELIVERED TO THE COAST"		
OPEC [USD/bbl]	[USD/ton]	[USD/GJ]
75	86.3	3.8
100	105.4	4.6
125	124.5	5.4

Table 7 - Price of coal - coastal

3.1.2.2. AVAILABILITY OF FUELS

3.1.2.2.1. Availability of natural gas

This chapter presents the various possibilities of natural gas supply for the different countries of the ECOWAS. Three sources are currently possible: the Nigerian gas transported by the Wescircuit African Gas Pipeline (WAGP), the indigenous resources of certain countries and, in the long term, the LNG.

Wescircuit African Gas Pipeline

Three countries are currently served by the Wescircuit African Gas Pipeline: Benin, Togo and Ghana. This gas pipeline transporting the Nigerian gas on a distance of 678 km is used commercially since the beginning of 2011. In March 2011, the first compressor plant of Lagos was commissioned allowing a gas provisioning under pressure.

In the years to come, additional investments are going to be carried out in the compressor plants and the gas production. These investments will make it possible to increase the quantity of gas available in the gas pipeline. The figure below shows the expected steps.

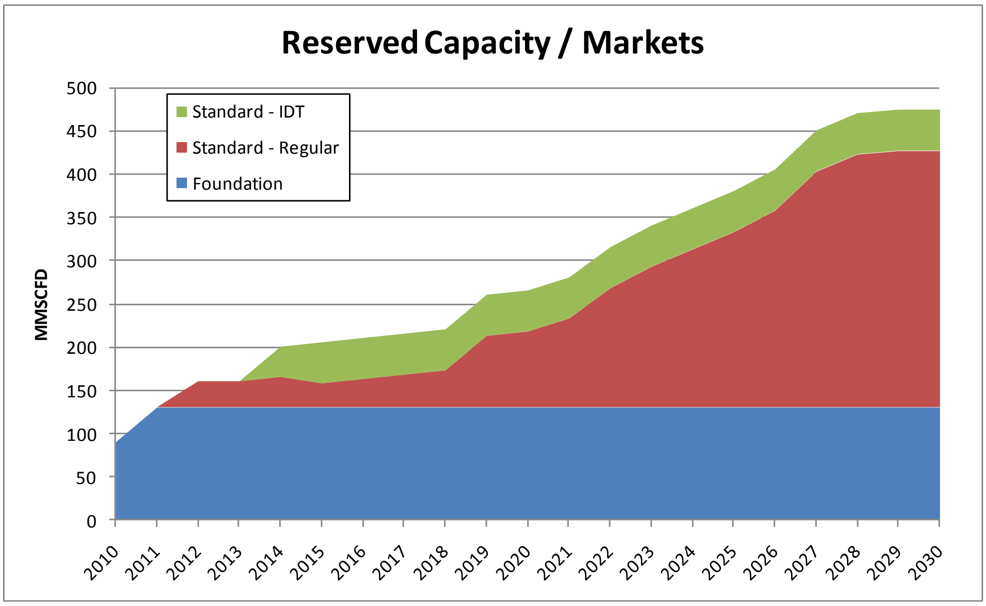


Figure 2 - Gas available - WAGP

Currently, only Ghana is supplied by Nigeria according to a contract of 120 MPC/D. As founding members, Togo and Benin can also claim a supply (5 MPC/D per country). However, technical problems in Nigeria limit the available gas and at the beginning of 2011, only 90 MPC/D towards Ghana were available.

The consultant supposes that the situation will be restored before the end of 2011 and that the investment plan announced by the WAGP will be respected, allowing to increase the available gas.

In addition to the quantities of gas reserved to the founding members, respectively 120, 5 and 5 MPC/D for Ghana, Togo and Benin, the additional quantities will be available for sale on an open market. The Consultant proposes to distribute the available quantities according to the capacity of the stations of the concerned countries: Ghana (234MPC/D + 130 MPC/D), Benin (100 MPC/D) and Togo (100 MPC/D).

This distribution is illustrated in the graph below.

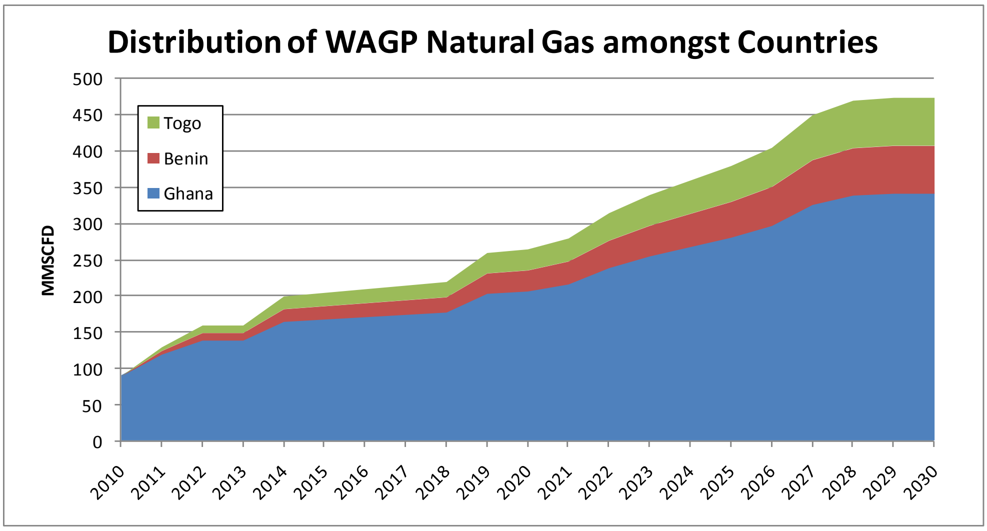


Figure 3 - Distribution of WAGP gas among the founding countries

Local gas

Another source of gas considered in the master plan corresponds to the local reserves of the producer countries. Nigeria, Ivory Coast and Ghana have offshore reserves. Senegal has small one shore reserves.

Nigeria is by far the country which has the greatest gas reserves in West Africa. The figure below shows the forecasts of gas production and the gas distribution by use.

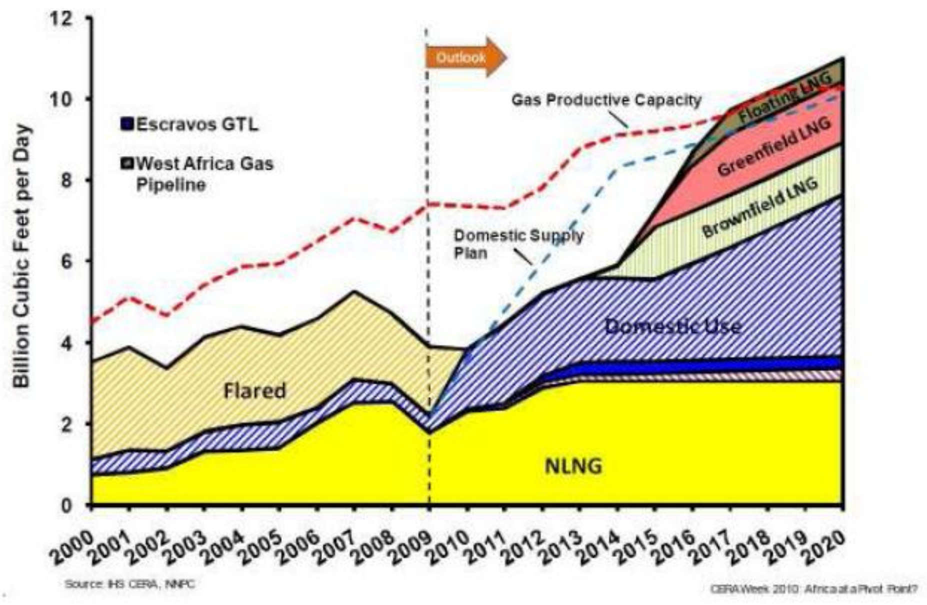


Figure 4 - Forecast of production and consumption of the Nigerian gas by use

Ghana recently put in production its first offshore oil field (Jubilee Field) which produces associated gas. This associated gas will be available at the coast in the surroundings of Domini at the end of 2011. Following the discovery of important oil and gas layers during the last years, the oil company of Ghana, GNPC, envisages a big raise of gas production in the years to come going from 80 MPC/D in 2011 to 300 to 500 MPC/D in 2026.

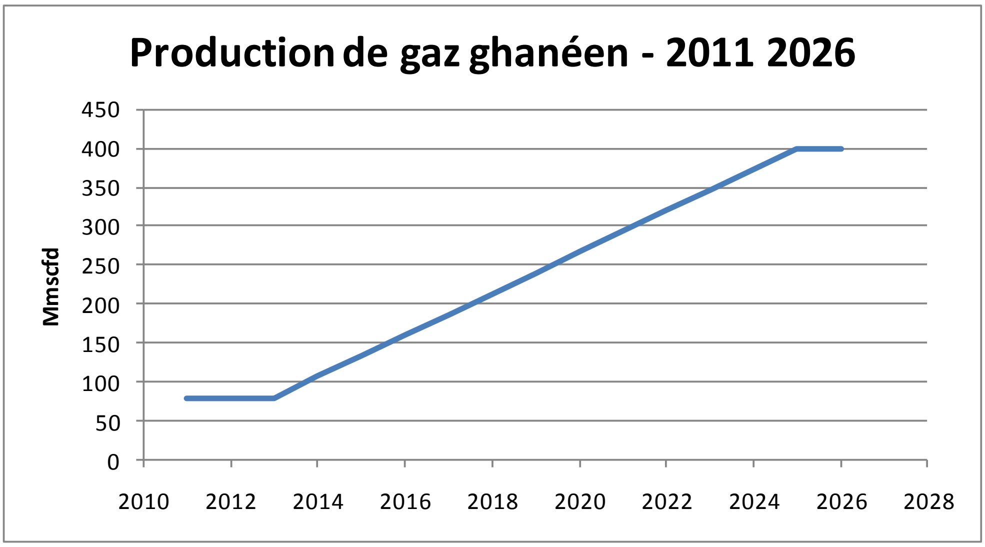


Figure 5 - Production of local gas in Ghana - 2011-2026

For 2011, gas production capacities in Ivory Coast are estimated to 205 Mpc/d. Three oil fields provide this production namely: CNR (40 Mpc/d), FOCTROT (130 Mpc/d) and AFREN (35 Mpc/d). In addition, the restitutions of the Mines and Energy seminar organized in Yamoussoukro in June 10th and 11th 2011 give a report on 750 Billion pc of residual reserve of gas and 1500 Billion pc of proven reserve in Ivory Coast.

In a conservative way, the consultant supposed that a quantity of 1000 billion pc could be consumed by Ivory Coast at the horizon of the study, among which 90% by the electric production. This estimate takes into account the need to invest in the increase of the gas production capacity, which could be a brake for the natural gas supply of Ivory Coast

The quantities of gas produced in Senegal are relatively marginal today and will remain marginal in the years to come.

LNG

Certain countries such as Ghana consider in the long term a provisioning of LNG in their energy mix.

No limitation applies to the quantities of LNG available for the African market; the main limitation is the non-existence of infrastructures for LNG regasification. There exists thus an important entry cost to allow a provisioning of LNG.

Between now and 2025, the commissioning of the LNG infrastructure is nevertheless not justified from a purely economic point of view for the supply of the power plants of the area taking into account the limited gas quantities to export on relatively short distances.

3.1.2.2.2. Availability of coal

No important coal center is currently exploited in West Africa.

During the optimization of the production plan, a series of coal centres are regarded as investment option in the countries where this technology is considered in the national plans of development, namely Senegal and Niger. These two countries have as a common point few hydroelectric and gas resources. Moreover, Niger has coal mines.

3.1.2.2.3. Solar potential

West Africa has particularly favourable areas for the development of solar technologies. The chart hereafter shows the potential of the countries. If it were decided to invest in renewable technologies in West Africa, Burkina Faso, Mali and Niger would be good candidates for CSP solar energy.

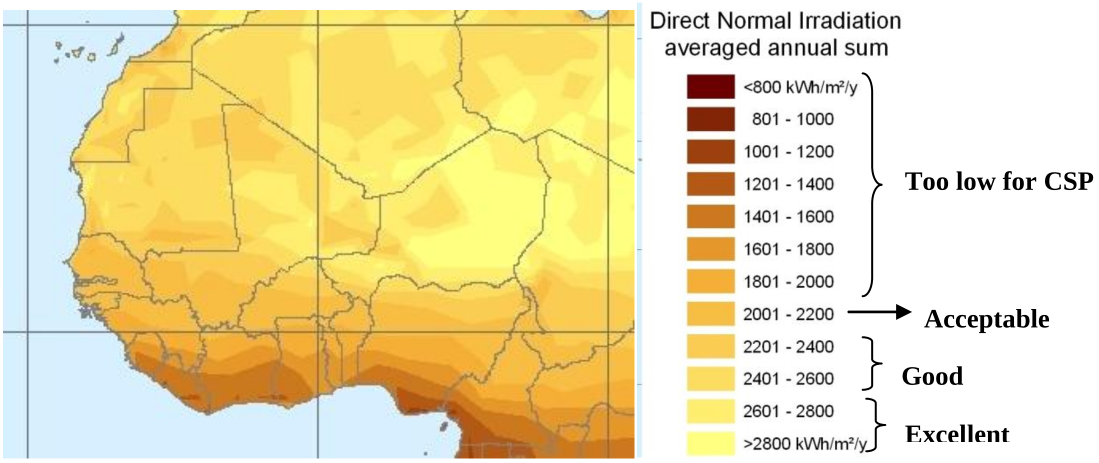


Figure 6 - DNI and the latitude of the area of interest (www.dlr.de)

3.1.2.2.4. Wind potential

The Consultant used the wind cartography software INTERFACES VORTEX recognized incircuitationally by the wind sector. This software makes it possible to model the winds in various parts of the world with the objective of leading orientation studies.

The model was used for each one of the 14 countries of the WAPP in order to identify in each country the areas having a wind potential. The table below represents the mean potential production for the best sites of each country.

Country	Wind resources of best identified sites (see maps in appendix)		
	Average wind speed (m/s)	Generation (MWh/an/MW)	Comment
Senegal	6	2588	
Gambie	6	2588	
Guinea-Bissau	5	1717	This generation level is usually considered to low for investment
Guinea	8	4051	
Sierra Leone	too low	x	No feasable wind project
Liberia	too low	x	No feasable wind project
Mali	7.2	3531	
Ivory Coast	4.8	1565	This generation level is usually considered to low for investment
Ghana	6	2588	
Burkina Faso	6.5	2999	
Togo	5.8	2451	
Benin	6.5	3006	
Nigeria	7.8	3933	
Niger	8	4051	

Table 8 - Wind potential by country (best identified sites)

3.1.3. Load forecast

The first part of the load forecast study consists in estimating, in collaboration with the local companies of electricity, the served and not served demand. This estimate is done based on historical data of loads, on shedding statistics and on average time of load supply.

The second part consists in analyzing the demand forecasts, in the short and medium term, worked out by the companies of electricity of each country and/or of the scenarios established by independent consultants during former studies.

The third part of the demand forecast consists, based on macro-economic parameters (GDP, Population) and existing programs of resorption of the not served demand, in establishing three scenarios framing the probable evolution of the demand for each country. This phase is based on a causal forecast of the electricity demand establishing correlations between the histories of electricity demand and macro-economic indicators. Two complementary approaches are considered: comprehensive approach and semi-comprehensive approach. The comprehensive approach analyzes the correlations between the national demand for a country and global macro-economic parameters (GDP, population, rate of electrification…) while the semi-total approach breaks up the demand into branches of industry and/or geographical areas.

In addition, the load estimated in the various scenarios and for the various countries is the load of the complete system including the incircuital consumptions and the losses.

A base scenario of the load forecast was established. It is used as reference scenario. In addition, a lower growth scenario is also presented and will be exploited in an alternative of the reference scenario.

Senegal

Between 2000 and 2010 the annual growth rate of the population in Senegal was estimated to 2.4% by the Incircuitational Monetary Fund. The population of Senegal is estimated today to 13.4 millions.

The GDP of Senegal (at constant price) grew on average of 4% per year over the last 10 years according to the Incircuitational Monetary Fund. In the future, the annual GDP growth should reach 4.5% to 5%.

These two parameters must be weighed against in order to take into account the various types of consumers (domestic, industrial, tertiary, tourism…)

In addition, it is important to announce and take into account the efforts made by Senegal in terms of load management. Senegal took important actions in this field and in particular the systematic replacement of the incandescent lamps by low energy lamps. 550 000 lamps were replaced in 2010 (profit of 9MW estimated and confirmed by measurements). The plan in the long term considers (at the end of 2012) the replacement of 3.5 billion lamps which should lead to a load reduction of 70 MW.

Finally, the load forecast is carried out by considering two aspects:

- the load increase in the existing interconnected network (correlation study);
- the connection of isolated centers and rural electrification (cfr study SNC Lavalin).

	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	2654	2561	456	440
2012	2991	2845	510	485
2013	3147	2966	532	502
2014	3319	3098	557	520
2015	3744	3428	629	575
2016	4311	3879	724	651
2017	4536	4050	761	680
2018	4774	4229	801	710
2019	5026	4417	844	741
2020	5306	4623	891	776
2021	5624	4853	944	815
2022	5933	5074	996	852
2023	6261	5306	1051	891
2024	6611	5549	1110	932
2025	6983	5806	1172	975

Table 9 - Forecast of the consumption of the interconnected network in Senegal in agreement with the SNC Lavalin study of 2010

The Gambia

The population growth in The Gambia is evaluated by the Incircuitational Monetary Fund to 2.6% per year. The population of The Gambia is estimated to 1.7 millions in 2011.

Between 2000 and 2005, the GDP growth of The Gambia was fluctuating a lot from one year to the other (between -3% and +7% of annual growth according to the Incircuitational Monetary Fund). Since 2006, the GDP growth was stabilized around 5.4%, a growth which is considered constant for the future by this Fund.

In The Gambia, the load growth is limited by the availability of supply. For this reason, it is difficult to establish a correlation between the growth of socio-economic parameters and the demand growth.

The revision of the forecast contains a plan of resorption of the not served demand during 5 years. In addition, the electrification of the isolated centers is taken into account.

	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	239	219	50	46
2012	337	268	61	49
2013	414	317	70	54
2014	496	385	79	62
2015	586	414	94	66
2016	747	455	119	73
2017	771	496	123	79
2018	796	609	127	97
2019	821	658	131	105
2020	847	703	135	112
2021	879	722	141	115
2022	912	742	146	119
2023	945	763	151	122
2024	980	784	157	125
2025	1.017	806	163	129

Table 10 - Load forecast in The Gambia

Guinea Bissau

The population growth in Guinea Bissau is evaluated by the Incircuitational Monetary Fund to 2.4% per year during the last 10 years and is forecasted to be of 2.9% per year for the coming years. The population of Guinea Bissau is estimated to 1.7 millions in 2011.

Since 2001, the annual GDP growth in Guinea Bissau is around 3% except for the year 2003 when a negative growth was observed according to the IMF. This growth should continue in the future.

Nevertheless, the load growth is limited by the degradation of quality of service. For this reason, it is difficult to establish a correlation between the growth of socio-economic parameters and the load growth.

Within the framework of the update of the master plan of the Wescircuit African area, it is important to consider not only the customers currently connected to the network but also the potential customers. Consequently, the load forecast in Bissau, the connection of new customers and the connection of isolated centers are taken into account in the load forecast. Lastly, the mining demand is considered.

	Base scenario [GWh]	Low scenario [GWh]	Mines [GWh]	Base scenario [MW]	Low scenario [MW]	Mines [MW]
2011	141	141		29	29	
2012	149	147		32	31	
2013	157	153		34	32	
2014	167	160		36	33	
2015	176	167		38	35	
2016	187	174	351	40	36	50
2017	233	182	351	50	38	50
2018	281	221	351	60	46	50
2019	332	263	351	71	54	50
2020	385	306	701	83	64	100
2021	441	352	701	95	73	100
2022	465	399	701	100	83	100
2023	491	418	701	106	87	100
2024	517	438	701	111	91	100
2025	545	458	701	117	95	100

Table 11 - Load forecast in Guinea Bissau

Guinea

Between 2000 and 2010, the annual growth rate of the population in Guinea did not stop increasing. This rate was estimated by the Incircuitational Monetary Fund to 1.9% per year in the beginning of the year 2000 and to 2.5% in 2010. Today, the population of Guinea is estimated to 10.6 millions.

The GDP of Guinea (at constant price) grew on average of 2.95% per year over the last 10 years according to the Incircuitational Monetary Fund.

Nevertheless, the load growth is limited by the degradation of quality of service. For this reason, it is difficult to establish a correlation between the growth of socio-economic parameters and the load growth.

The load forecast in Guinea is thus established by taking into account various aspects:

- Resorption of the unserved demand over one 5 years period;
- The connection of isolated centers:
  - The center of Nzerekoré should be connected to the interconnected network thanks to the CLSG line;
  - The center of Kankan will be connected to the interconnected network with the commissioning of the Guinea-Mali interconnection;
  - The center of Faranah is located near the routing of the Linsan-Fomi line.
- The mining sector.

	Base scenario [GWh]	Low scenario [GWh]	Mines [GWh]	Base scenario [GWh]	Low scenario [GWh]	Mines
2011	608	608		139	139	
2012	760	687		164	148	
2013	934	760		190	155	
2014	1102	934		221	181	
2015	1563	1131		287	216	
2016	1718	1406	2643	302	247	377
2017	1766	1622	2682	311	286	383
2018	1819	1666	2723	321	293	389
2019	1875	1712	4864	330	302	694
2020	1937	1763	4936	340	309	704
2021	2032	1842	5011	357	324	715
2022	2101	1899	5086	369	334	726
2023	2170	1955	5162	381	343	737
2024	2238	2012	5239	393	353	748
2025	2308	2067	5318	405	363	759

Table 12 - Load forecast in Guinea

Sierra Leone

Between 2000 and 2005, the population growth in Sierra Leone was estimated by the Incircuitational Monetary Fund to 3.7% per year. Today the population growth is rather estimated to 2.6% per year. The population of Sierra Leone is estimated to 6 millions in 2011.

The GDP of Sierra Leone (at constant price) has risen in a spectacular way these last 10 years (more than 9% per year on average according to the Incircuitational Monetary Fund).

The majority of electrical installations were destroyed during the civil war in Sierra Leone. The rebuilding is underway but the majority of the areas located inside the country do not have access to electricity.

Today, the demand is primarily urban (residential and tertiary). Consumption follows the availability of the production.

Consequently, the load forecast in Sierra Leone takes 3 aspects into account:

- The load growth in the already interconnected areas;
- the rural electrification;
- the mining load (considered with a load factor of 80%).

	Base scenario [GWh]	Low scenario [GWh]	Mines [GWh]	Base scenario [MW]	Low scenario [MW]
2011	202	162	350	38	30
2012	267	214	350	50	40
2013	363	291	631	68	54
2014	486	389	911	91	73
2015	587	470	911	110	88
2016	715	572	1612	134	107
2017	789	631	2313	148	118
2018	828	663	3013	155	124
2019	868	694	4135	162	130
2020	907	726	5256	170	136
2021	957	766	5256	179	143
2022	1007	806	5256	188	151
2023	1057	846	5256	198	158
2024	1107	886	5256	207	166
2025	1157	926	5256	217	173

Table 13 -Load forecast in Sierra Leone

Liberia

Today the annual GDP growth is very high in Liberia. It is between 5 and 12% per year according to the IMF.

The population growth in Liberia is estimated between 3 and 4% by the IMF depending on the years. Today, there are little less than 4.5 millions inhabitants in Liberia.

Nevertheless, very few customers are connected to the electrical network. In 2009, 1645 consumers were connected to 4 isolated sub-networks. The growth forecast of the load is very high for the first years. It is not a matter of natural growth of consumption but well of an increase in the number of customers connected to the network. Later on, the rural electrification and the expected increase in the macro-economic parameters are the key factors of the load growth.

Finally, two types of customers must be considered:

- The customers of Monrovia who are primarily residential and commercial and for which the load profile is equivalent to the already connected customers;
- The mining consumers who will connect themselves to the network in the future and who have an important load factor.

	Base scenario [GWh]	*Low scenario [GWh]*	*Mines [GWh]*	Base scenario [MW]	Low scenario [MW]	Mines [MW]
2011	47	34		9	6	
2012	105	57	33	20	11	5
2013	163	90	131	31	17	20
2014	226	125	657	43	24	100
2015	263	180	1.183	50	34	180
2016	279	226	1.840	53	43	280
2017	296	263	1.840	56	50	280
2018	314	275	1.840	60	53	280
2019	334	288	1.840	63	54	280
2020	355	301	1.840	68	58	280
2021	378	316	1.840	72	60	280
2022	402	332	1.840	77	64	280
2023	428	349	1.840	82	67	280
2024	455	367	1.840	87	70	280
2025	484	387	1.840	93	74	280

Table 14 - Forecast of the dermande in Liberia

Mali

Between 2000 and 2010, the population growth in Mali was estimated by the Incircuitational Monetary Fund to 2.3% per year, while the administrative census with vocation of civil registery (RAVEC) of Mali estimates the growth to 3.6% per year. Today, the population of Mali is estimated to 14.5 millions.

The GDP of Mali (at constant price) grew on average of 5% per year during the last 10 years according to the Incircuitational Monetary Fund.

The population growth is the main motor of the residential and tertiary growth of electricity consumption and the load forecast is consequently correlated to the evolution of the population.

In addition, the current growth of consumption on the electrified network contains rural electrification. For the future, the growth rate of rural electrification is supposed to be identical to the one of today.

Finally, the isolated centers must be considered because part of these centers will be connected to the interconnected network in a near future. Moreover, self-producers Malian Company for the Development of Textile Fibers (CMDT) and the gold mines are interested by a connection of their load to the interconnected network.

	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	1.136	1.098	199	192
2012	1.232	1.174	216	206
2013	1.382	1.233	240	216
2014	2.111	1.294	346	227
2015	2.226	1.434	366	249
2016	2.896	2.144	464	352
2017	2.997	2.239	482	368
2018	3.153	2.930	509	470
2019	3.248	2.999	525	482
2020	3.398	3.085	550	497
2021	3.567	3.155	577	509
2022	3.740	3.279	605	529
2023	3.916	3.405	634	549
2024	4.097	3.534	663	570
2025	4.282	3.665	693	591

Table 15 -Load forecast in Mali

Ivory Coast

Between 2000 and 2010, the growth rate of the population in Ivory Coast was estimated to nearly 3% per year by the Incircuitational Monetary Fund. Today the population of Ivory Coast is estimated to 22.7 millions.

The GDP of Ivory Coast (at constant price) has suffered a period of stagnation and even of decrease in the beginning of the year 2000. Today, it is believed to be of approximately 3% per year according to the Incircuitational Monetary Fund.

According to the bulletin of annual statistics of the ICE, nearly 55% of the produced energy is consumed by the residential sector. The rest is consumed by the private and public services (15%) and industries (30%). Consequently, in Ivory Coast, the increase in population and the increase in the GDP must be weighed against in order to take into account the various types of consumers.

Lastly, the electric sector undertook several projects for the electrification and connection to the interconnected network of the isolated centers. The increase in the level of service by means of the progressive connection of isolated centers with the interconnected network should result in stabilization, or at least to a fall of the production in the isolated centers.

	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	6.005	5.859	968	945
2012	6.390	6.131	1.030	989
2013	6.799	6.410	1.096	1.034
2014	7.245	6.696	1.168	1.080
2015	7.731	6.990	1.247	1.127
2016	8.197	7.291	1.322	1.176
2017	8.680	7.600	1.400	1.225
2018	9.182	7.917	1.480	1.276
2019	9.703	8.241	1.564	1.329
2020	10.244	8.574	1.652	1.382
2021	10.807	8.915	1.742	1.437
2022	11.391	9.265	1.837	1.494
2023	11.998	9.624	1.934	1.552
2024	12.628	9.992	2.036	1.611
2025	13.284	10.369	2.142	1.672

Table 16 - Load forecast in Ivory Coast

Ghana

Between 2000 and 2010, the population growth in Ghana was estimated by the Incircuitational Monetary Fund to 2.5% per year. Today, the population of Ghana is estimated to 24 millions.

The GDP of Ghana (at constant price) grew on average of 5% per year over the last 10 years according to the Incircuitational Monetary Fund.

Given the importance of the industrial customer VALCO, the Consultant proposes to consider separately the domestic load and VALCO.

The historical data used in the study of correlation of the load of the country are the population, the GDP, the GDP per capita, the produced energy, the consumed energy of the country and the total consumed energy. The GDP per capita was used to approach the income per capita that was not available.

The forecast of the industrial load for the base case is based on the assumption that two production lines would be exploited at VALCO in 2011. VALCO would also be able to bring into service three lines in 2013. For the low scenario, the assumption has been made that a production line would be exploited at VALCO in 2011. VALCO would also be able to bring two lines into service in 2013.

	Base scenario		*Low scenario*		*Base scenario*		*Low scenario*	
	Domestic consumption [GWh]	VALCO [GWh]	Domestic consumption [GWh]	VALCO [GWh]	Domestic consumption [MW]	VALCO [MW]	Domestic consumption [MW]	VALCO [MW]
2011	9.793	1.314	9.239	657	1.479	150	1.395	75
2012	10.421	1.314	9.652	657	1.573	150	1.457	75
2013	11.093	1.971	10.096	1.314	1.675	225	1.524	150
2014	11.764	1.971	10.522	1.314	1.780	225	1.590	150
2015	12.484	1.971	10.971	1.314	1.888	225	1.657	150
2016	13.252	1.971	11.440	1.314	2.007	225	1.730	150
2017	14.070	1.971	11.932	1.314	2.130	225	1.804	150
2018	14.941	1.971	12.446	1.314	2.262	225	1.881	150
2019	15.869	1.971	12.984	1.314	2.401	225	1.962	150
2020	16.857	1.971	13.547	1.314	2.550	225	2.047	150
2021	17.908	1.971	14.135	1.314	2.708	225	2.136	150
2022	19.027	1.971	14.750	1.314	2.877	225	2.228	150
2023	20.218	1.971	15.393	1.314	3.056	225	2.325	150
2024	21.485	1.971	16.065	1.314	3.247	225	2.426	150
2025	22.832	1.971	16.768	1.314	3.450	225	2.532	150

Table 17 - Forecast of the load demand in Ghana

Togo-Benin

In Benin, the GDP growth was relatively constant these ten last years with an annual growth rate between 3% and 5% according to the IMF.

The growth of the population of Benin reached 3.3% per year until 2005 and 2.8% per year since 2006. The population of Benin is of nearly 10 millions inhabitants.

In Togo, the GDP growth was negative in the beginning of the year 2000. Since 2003, the GDP grows on average of 2.5% per year.

In Togo, the annual population growth is of nearly 2.5%. There are currently a little more than 7 millions inhabitants in Togo according to the estimates of the IMF.

The electricity sector in Togo and Benin is governed by the Incircuitational Agreement and Benino-Togolese Code for electricity signed between the two states in 1968 and creating a community of interest between the two countries in the field of electrical energy.

This code gave to the Electric Community of Benin the monopoly of the production, transport and the imports/exports of electrical energy on the whole territory of the two states.

Nevertheless, the Incircuitational Agreement and Benino-Togolese Code signed in 1968 were revised in 2003. The clauses of the new agreement and Code of 2003 are hence now on in force. In accordance with the clauses of this new agreement and revised Benino-Togolese Code of 2003, the CEB does not have the monopoly of the electrical production anymore. The segment of the electrical production is opened to independent producers but the CEB remains the single purchaser of their production everywhere where their network is present.

For this reason, the energy data are available for both states together and not for each one independently from the other. The study of the demand relates hence to the Togo-Benin community based on information from the CEB.

The five main customers of the CEB are:

- In Togo:
  - CEET: Electrical Energy Company of Togo, national company of distribution of electricity;
  - WACEM: Wescircuit African Cement, producer of cement;
  - SNPT: New Company of Phosphates of Togo, phosphate producer.
- In Benin:
  - SBEE: Beninese company of Electrical energy, national company of distribution of electricity;
  - SCB - Lafarge: Cement producer.

The main industrial customers account for approximately 15% of the demand for electricity. The rest of the demand is transferred to the Togolese and Beninese supply firms that act partially as self-producers since they have their own means of production. The demand of these customers is primarily residential and tertiary.

In the north of Benin, the SBEE works in collaboration with the Beninese Agency for Rural electrification and Energy Control (ABERME) to develop the 33kV network between localities and to try to connect the new loads and the isolated places. Thus, in the short term, Togo and Benin (to a lesser extent) envisage a considerable growth of the number of customers connected to the interconnected network. This tendency results in a strong growth of the load which started in 2009 and which should continue until 2012 according to the document "Load forecasts horizon 2020".

Currently, Benin consumes more than half of the demand for electricity of the community. Nevertheless, for several years a more important increase in the load in Togo than Benin has been observed. The increase in the number of customers connected to the interconnected network of the CEET should confirm the tendency and Togo should occupy an increasingly important place in the consumption of electricity of the community.

Taking into account all these aspects, the load forecast for Togo and Benin are presented hereafter.

	Togo				Benin			
	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*	*Base scenario [GWh]*	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	1042	1035	170	169	1341	1333	219	217
2012	1294	1286	211	210	1469	1460	240	238
2013	1440	1405	235	229	1564	1526	255	249
2014	1571	1503	256	245	1697	1624	277	265
2015	1712	1608	279	262	1835	1723	299	281
2016	1873	1728	305	282	1968	1816	321	296
2017	2046	1856	334	303	2105	1910	343	311
2018	2230	1990	364	325	2248	2006	366	327
2019	2426	2131	395	348	2396	2105	391	343
2020	2609	2257	426	368	2576	2229	420	364
2021	2801	2387	457	389	2766	2358	451	385
2022	3004	2523	490	412	2967	2492	484	407
2023	3217	2664	525	435	3178	2632	518	429
2024	3442	2812	561	458	3400	2777	555	453
2025	3680	2965	600	484	3634	2928	593	477

Table 18 - Load forecast in Togo and Benin

Burkina Faso

At the beginning of the year 2000, the annual growth of the population in Burkina Faso was higher than 3%. Since 2005, the growth slowed down to 2.3% per year according to the Incircuitational Monetary Fund. Today, the population of Burkina Faso is estimated to 15 millions.

The GDP in Burkina Faso (at constant price) grew on average of 5% per year during the last 10 years according to the Incircuitational Monetary Fund.

Until 2009, Burkina Faso had two networks independent from each other. Since 2009, these two networks are interconnected (Interconnected National Network: RNI).

In Burkina Faso, the demand growth is strongly related to the electrification rate. This electrification rate is correlated to the wealth of the country. For this reason, the principal macro-economic parameter which guides the evolution of the yearly consumption of electricity is the GDP.

The energy not served in the areas connected to the interconnected networks was very low until a few years ago. Nevertheless, it increased in a considerable way these last years. The main causes for load sheddings are:

- An important increase in demand and a massive connection of new customers to the CRCO interconnected network not compensated by an increase in the means of production;
- An increased unavailability of the interconnection with Ivory Coast.

In addition, rural electrification is a major concern for the SONABEL. The electrification of the new centers includes a part of construction of the local network and the construction of a connection line to the nearest electrical center. The aim is to achieve a goal of electrification of 60% in 2015. The current growth of consumption on the electrified network takes into account rural electrification. For the future, the rate of increase in rural electrification is supposed to be identical to today.

Finally, an ambitious connection programme of the isolated centers is envisaged in the short and medium term.

Taking into account these aspects leads to the following forecast:

	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	873	873	178	178
2012	934	929	190	189
2013	1.006	987	205	201
2014	1.087	1.048	222	214
2015	1.173	1.112	239	227
2016	1.265	1.179	258	240
2017	1.362	1.250	278	255
2018	1.466	1.324	299	270
2019	1.576	1.402	321	286
2020	1.694	1.484	345	303
2021	1.820	1.570	371	320
2022	1.953	1.661	398	338
2023	2.095	1.755	427	358
2024	2.247	1.855	458	378
2025	2.408	1.959	491	399

Table 19 - Load forecast in Burkina Faso

Niger

The historical analysis of the demographical and economical data and of electricity consumptions is the preliminary stage to the projections of demand.

Between 2000 and 2010 the population growth in Niger was estimated by the Incircuitational Monetary Fund to 3.1% per year. Today, the population of Niger is estamated to 15.2 million (source: INS-Niger).

The GDP of Niger (at constant price) grew on average of 4.8% per year over the last 10 years according to the Incircuitational Monetary Fund.

There are 4 zones in Niger:

- The River area, around Niamey, supplied by Birnin Kebbi in Nigeria;
- The Center-Eascircuit area, supplied by Katsina in Nigeria;
- The Eascircuit area: 33 kV zone, supplied by Nigeria in 33 kV;
- The Northern area, close to Agadez.

The three first are supplied by Nigeria and are synchronous. There are emergency power plants (cold reserve). The fourth one is supplied by a coal plant.

In Niger, the demand is primarily residential and tertiary. The residential sector accounts for 47% of electric consumption, while services account for 13% of this consumption. In addition, industries account for 39% of the load, according to the 2007 annual report of the Energy Information System of Niger (EIS).

In addition, in Niger, the connection of new customers following the implementation of the special program of the President of the Republic and the execution of the Development project of the interconnected electrical network of Niger DREIN made it possible to electrify several rural localities. The consumption of electricity in the interconnected network consequently grew steadily these last years. A rise of 88% of the demand in terms of "demanded energy" (524 GWh in 2008) has been recorded between years 2000 and 2008.

Finally, the connection of a cement factory of 20MW is considered in the Center-Eascircuit area as from 2015.

	Base scenario					*Low scenario*				
	River	**Center East**	**East**	**North**	**Total**	**River**	**Center East**	**East**	**North**	**Total**
	[GWh]	**[GWh]**	**[GWh]**	**[GWh]**	**[GWh]**	**[GWh]**	**[GWh]**	**[GWh]**	**[GWh]**	**[GWh]**
2011	429	249	62	109	849	422	245	61	107	835
2012	461	267	67	117	912	446	258	65	113	882
2013	494	286	72	125	977	470	273	68	119	931
2014	528	306	76	134	1.044	496	287	72	126	980
2015	535	433	132	136	1.235	494	409	126	125	1.154
2016	569	452	141	144	1.306	518	423	133	131	1.205
2017	604	473	149	153	1.379	544	438	139	138	1.258
2018	640	493	158	162	1.454	570	453	146	144	1.312
2019	677	515	167	172	1.530	596	468	152	151	1.368
2020	715	537	177	181	1.609	623	484	159	158	1.424
2021	754	559	187	191	1.691	651	500	166	165	1.482
2022	794	583	197	201	1.774	679	516	174	172	1.541
2023	835	607	207	212	1.860	707	533	181	179	1.601
2024	877	631	217	223	1.948	737	550	188	187	1.662
2025	921	656	228	234	2.039	767	567	196	194	1.725
	Base scenario					*Low scenario*				
	River	**Center East**	**East**	**North**	**Total**	**River**	**Center East**	**East**	**North**	**Total**
	[MW]	**[MW]**	**[MW]**	**[MW]**	**[MW]**	**[MW]**	**[MW]**	**[MW]**	**[MW]**	**[MW]**
2011	86	22	3	38	149	85	21	3	37	146
2012	93	23	4	41	160	90	22	4	39	154
2013	99	25	4	43	171	94	24	4	41	163
2014	106	26	4	46	183	99	25	4	44	172
2015	113	48	5	49	215	105	46	4	46	181
2016	120	51	5	53	229	110	48	4	48	190
2017	127	54	5	56	243	115	51	5	50	199
2018	135	58	5	59	257	121	53	5	53	208
2019	143	61	6	63	272	126	56	5	55	218
2020	151	64	6	66	287	132	58	5	58	228
2021	159	68	6	70	303	138	61	6	60	238
2022	168	72	7	73	319	144	63	6	63	248
2023	176	75	7	77	336	150	66	6	66	259
2024	185	79	7	81	353	156	69	6	68	270
2025	195	83	8	85	370	163	72	7	71	280

Table 20 - Load forecast in Niger

Nigeria

The population growth in Nigeria is evaluated by the Incircuitational Monetary Fund to 2.7% per year. The population of Nigeria reached 160 millions in 2011.

Since 2001, the annual GDP growth in Nigeria varied between 5% and 10% except for the year 2002 when an exceptional growth of 21% was observed according to the IMF.

Given the quantity of energy not served in Nigeria, it is difficult to draw up a correlation study between the demand and the macro-economic parameters over the last 10 years.

The park of production has not been reinforced in Nigeria since 2006. The resorption of the demand could consequently not start. On the contrary, not served energy did nothing but increase given the constant decrease of the energy produced since 2006.

PHCN (Power Holding Company of Nigeria) estimates the demand to be supplied in Nigeria in 2011 to 9 GW. Nevertheless, PHCN has very ambitious development plans of production park in the short-term which will allow, if they are carried out, to reabsorb the unserved demand very quickly.

Taking into account the investment plans in means of production in the short-term in order to estimate the resorption of the load, the forecast of the served demand should follow the following tendency, if referred to the vision of PHCN.

	Base scenario [GWh]	*Low scenario [GWh]*	*Base scenario [MW]*	*Low scenario [MW]*
2011	39.102	25.524	6.376	4.162
2012	58.069	34.570	9.471	5.638
2013	61.321	43.624	10.000	7.114
2014	64.964	56.272	10.595	9.177
2015	68.830	65.178	11.225	10.629
2016	72.926	69.058	11.892	11.261
2017	77.258	72.339	12.599	11.797
2018	81.856	75.784	13.348	12.358
2019	86.717	79.383	14.142	12.946
2020	91.873	83.159	14.983	13.562
2021	98.732	88.365	15.874	14.207
2022	104.604	92.569	16.818	14.883
2023	110.821	96.969	17.818	15.591
2024	117.412	101.584	18.877	16.333
2025	124.393	106.415	20.000	17.110

Table 21 - Load forecast in Nigeria

3.1.4. Generation data

3.1.4.1. CHARACTERISTICS AND COSTS OF NEW TECHNOLOGIES

Gas Turbines and Combined Cycles

Several countries of the ECOWAS currently have gas turbines (GT) and combined cycles (CC) running either on natural gas (Ivory Coast, Ghana, Nigeria) or on liquid fuel (Togo, Ghana, Ivory Coast, Senegal…). The majority of these GT and CC are dual fuel allowing burning either gas or liquid fuels. Various manufacturers are represented on the continent (GE, Siemens, Alstom…) and different sizes of gas turbines are installed from 7.9 MW to 150 MW. In the same way, different CC are installed presenting powers varying from 50 MW (Senegal) to 450 MW (Nigeria).

During the optimization of the production plan a series of GT and CC known as standard are regarded as investment option. This serie of GT and CC is proposed in order to cover a broad range of size and technology.

The sizes suggested for the combined cycles are 60 MW, 300 MW and 450 MW. These sizes correspond to the orders of magnitude of the standards used in certain countries of the ECOWAS like Senegal (50MW), Ghana (90MW and 300 MW) and Nigeria or Ivory Coast (project) (450 MW). No size higher than 450 MW was proposed for systemic considerations. Indeed, a CC of 450 MW presents a dimensioning incident of 225 MW (1 GT and ½ ST) which is consequent considering the size of the West African networks.

The sizes suggested for the GT correspond to the GT of the combined cycles suggested namely: 45 MW, 100 MW and 150 MW.

In terms of technology, the selection of the GT and CC were made in order to facilitate maintenance and to minimize the capital costs rather than to maximize the output. It would be possible to reach one or two additional points of output but at a very high cost.

For the CC, two cooling methods are proposed, by cooling tower and by direct oulet. The direct outlet makes it possible to increase by one to two points the total output.

The Consultant used the Thermoflow software to estimate the investments and the operation costs of the different configurations. This software simulates the thermodynamic cycle of the power plant based on selected component of the power plant. It informs of the net expected efficiency and thus of the specific consumption. The principal assumptions are summarized hereafter:

- Room temperature of 33°C;
- All the GT and CC are dual fuel;
- All the CC have a by-pass chimney to allow running the GT while the ST are unavailable;
- Planned and unplanned unavailabilities were adapted to the local conditions.

The fuels modelled in Thermoflow are on the one hand the natural gas and on the other hand the distillate #2. This distillate permits to represent the performances of the power plant burning diesel or LCO.

The table below presents the investment data of GT and CC technologies.

Plant characteristics	Unit	THERMOFLOW CASES								
		1	2	3	4	5	6	7	8	9
		CCGT (300MW) 2GT + 1ST	CCGT (300MW) 2GT + 1ST	CCGT (450MW) 2GT+1ST	CCGT (450MW) 2GT+1ST	CCGT (60MW) 1GT+1ST	CCGT (60MW) 1GT+1ST	OCGT (45MW)	OCGT (100MW)	OCGT (150MW)
Cooling method		**Air cool**	**Direct Water cool**	**Air cool**	**Direct Water cool**	**Air cool**	**Direct Water cool**			
GT Manufacturer + Model	-	GE 9E	GE 9E	Siemens SGT5-2000E	Siemens SGT5-2000E	Siemens SGT800	Siemens SGT800	ALSTOM GT8C2	Alstom GT11N2	Siemens SGT5-2000E
Alternative GT Manufacturer + Model	-	Alstom GT11N2	Alstom GT11N2	Ansaldo AE94.2 GE 9C	Ansaldo AE94.2 GE 9C	ALSTOM GT8C2	ALSTOM GT8C2		GE 9E	
Gross GT Power (Site condition)	MW	110	110	145	145	39/38	39/38	49	101	146
Number of GT	-	2	2	2	2	1	1	1	1	1
ST Manufacturer + Model	-	Siemens SST-900	Siemens SST-900	Siemens SST-900	Siemens SST-900	SST-300	SST-300	NA	NA	NA
Number of ST	-	1	1	1	1	1	1	NA	NA	NA
Gross ST power (Site condition)	MW	123	138	155	173	15	18	NA	NA	NA
Total Nominal (Gross) Power NG/ Oil	MW	342/-	357/ -	445	463	54/53	57/55	49/47	101	146
Total Nominal (net) Power NG/Oil	MW	332/ -	348/	432	452	53/51	55/54	48/46,5	100	144
Net Efficiency	%	49,1	51,5	49,3	51,6	47.9	50.2	32,1	31,6	33,1
Total investment cost	MUSD	334	320	404	386	73	72	41	69	88
Total investment cost / kW	USD/kw	977	896	908	834	1352	1263	837	683	603
Schedule of investment payment				16/34/50	16/34/50	20/50/30	20/50/30	50/50	50/50	50/50
(from EPC or EPC(M) contract signature)	%/year	16/34/50	16/34/50	over 3 years	over 3 years	over 2,5 years	over 2,5 years	over 2 years	over 2 years	over 2 years
Life duration	years	25	25	25	25	25	25	25	25	25
Fixed O&M cost	USD/kW	34	31	32	29	38	37	8.4	7	6
Variable O&M Cost (excl fuel)	USD/MWh	1.83	1.68	1.71	1.57	2.03	2.00	2.51	2.05	1.81
Fuel 1		Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
LHV net heat rate - Fuel 1	kJ/kWh	7331	6996	7247	6930	7522	7169	11225	11404	10869
Fuel 2		Distillate #2	Distillate #2	Distillate #2	Distillate#2	Distillate #2	Distillate #2	Distillate #2	Distillate #2	Distillate #2
LHV net heat rate - Fuel 2	kJ/kWh	7379	7039	7293	6970	7601	7240	11435	11620	11014
emission level CO2	T/h	134	134	173	173	22	29	30	62	86
emission level S02 (Distillate Oil)	T/h	0 563	0 563	0,727	0,727	0.92	0.92	0,125	0/0.263	0/0.362
emission level Nox (Without SCR)	ppmV (dry)	15	15	25/?	25/?	15/42	15/42	25/?	25/42 (wet)	25/?
emission level Nox with SCR	ppmV (dry)	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A.	N.A.
Planned availability (maintenance)	pu	7%	7%	7%	7%	7%	7%	7%	7%	7%
Unplanned availability (forced outage)	pu	8%	8%	8%	8%	8%	8%	8%	8%	8%

Table 22 - GT and CC – investment data

Coal

The investments decided, planned and under consideration in Niger and Senegal concern small units (125MW in Senegal and 4*50 MW in Niger).

In the absence of concrete data on the technology used, standard investment data were proposed. The units were selected in order to facilitate maintenance and to minimize the capital costs rather than to maximize the output. It would be possible to reach one or two additional points of output but at a very high cost.

In a general way, two technologies would be considered:

- "Circulating Fluidised Bed" (CFB) Technology;
- "Pulverized Coal" (PC) Technology.

The Consultant used the Thermoflow software to estimate the investments and the operation costs of the various configurations. This software simulates the thermodynamic cycle of the power plant based on selected component of the power plant. It informs of the net efficiency expected and thus of the specific consumption. The principal assumptions can be summarized hereafter:

- Room temperature of 33°C;
- Planned and unplanned unavailabilities were adapted to the local conditions.

The table below presents the investment data of coal technologies. Being given the size of the investments suggested for Senegal and Niger, it is the CFB technology that has been selected.

		Thermoflow Cases	
		10	11
Plant characteristics	**Unit**	**Coal (125MW) Type: CFB**	**Coal (250MW) Type: PC**
Number of ST	-	1	1
Gross ST power (Site condition)	MW	125	250
Total Nominal (Gross) Power NG/ Oil	MW	125	250
Total Nominal (net) Power NG/Oil	MW	116	230
Net Efficiency	%	37.6	39
Total investment cost	MUSD	314	540
Total investment cost / kW	USD/kw	2512	2160
Schedule of investment payment		16/32/32/20	16/32/32/20
(from EPC or EPC(M) contract signature)	%/year	over 3,3 years	over 3,3 years
Life duration	years	35	35
Fixed O&M cost	USD/kW	75	65
Variable O&M Cost (excl fuel)	USD/MWh	3.14	2.7
Fuel 1		Coal	Coal
LHV net heat rate - Fuel 1	kJ/kWh	9574	9231
Fuel 2		Oil, biomass	Oil, biomass
LHV net heat rate - Fuel 2	kJ/kWh		
emission level CO2	T/h	106	206
emission level S02 (Distillate Oil)	T/h	0,053	0,103
emission level Nox (Without SCR)	ppmV (dry)	N.A	N.A
emission level Nox with SCR	ppmV (dry)	97 (SNCR)	96 (SNCR)
Planned availability (maintenance)	pu	7%	7%
Unplanned availability (forced outage)	pu	8%	8%

Table 23 - Coal center – Investment data

High speed and medium-speed diesel

A vast majority of the ECOWAS countries uses high-speed or medium-speed diesel groups running on diesel (DDO) or heavy fuel oil (HFO). These groups present powers varying from less than 1 MW to approximately 20 MW.

The advantages of these diesel groups are their relatively low capital cost, the construction speed and the facility of storage and supply of fuels. Their big disadvantages are the high fuels costs, their relatively high specific consumption and expensive maintenance.

During the optimization of the production plan a series of high-speed and medium-speed diesels groups known as standard are regarded as an investment option. This series of diesels groups is proposed in order to cover a broad range in terms of size and technology.

The table below presents the investment data for diesel technologies.

Plant characteristics	Unit	HFO 10MW	HFO 20MW	DDO 10MW
Total Nominal (net) Power	MW	10	20	10
Net Efficiency	%	40%	40%	36%
Total investment cost	MUSD	14.5	27	10.7
Total investment cost / kW	USD/kw	1450	1350	1070
Schedule of investment payment		50%/50%	50%/50%	50%/50%
(from EPC or EPC(M) contract signature)	%/year	over 2 years	over 2 years	over 2 years
Life duration	year	20	20	20
Fixed O&M cost	USD/kW	16.8	16.8	8.4
Variable O&M Cost (excl fuel)	USD/MWh	7.1	7.1	10.1
Fuel 1		HFO	HFO	DDO
LHV net heat rate - Fuel 1	kJ/kWh	9000	9000	10000
emission level CO2	kg/MWh	712.8	712.8	741
emission level S02 (Distillate Oil)	kg/MWh	4.1	4.1	0.9
Planned availability (maintenance)	pu	7%	7%	7%
Unplanned availability (forced outage)	pu	10%	10%	10%

Table 24 - Diesel - Investment data

Biomass

Some countries such as Senegal, Liberia and Sierra Leone consider biomass in their energy mix.

In the absence of concrete data on the technology used, standard investment data were proposed. The units were selected in order to facilitate maintenance and to minimize the capital costs rather than to maximize the output. It would be possible to reach one or two additional points of output but at a very high cost.

The table below presents the investment data of technologies using biomass. Given the size of the investments suggested for Senegal, Liberia and Sierra Leone, it is the CFB technology that has been selected. According to the size of the projects, the data are variable.

Type of equipment	Unit	Large Biomass Plant (100MWe)	Medium Biomass Plant (40MWe)	Small Biomass Plant (5MWe)
Manufacturer + Model	-	CFB Boiler	CFB Boiler	Grate Furnace
Number of ST	-	1	1	1
nominal capacity of ST at site condition (32°)	MW	100	40	5
Total Nominal Power	MW	100	40	5
Total investment cost	MUSD	324	136	34
Schedule of investment payment	%/year	Y0-3: 45% Y0-2: 25% Y0-1: 10% Y0 : 20%	Y0-3: 45% Y0-2: 25% Y0-1: 10% Y0 : 20%	Y0-1: 55% Y0 : 45%
Total investment / kW	USD/kW	3240	3400	6800
Life duration	years	30	30	30
Discount rate	%	12	12	12
Fixed O&M cost (OPEX)	USD/kW/y	130	136	272
Variable O&M Cost (excl fuel)	USD/MWh	included	included	included
Fuel 1		Wood Chips	Wood Chips	Wood Chips
LHV net heat rate (32°) - Fuel 1	kJ/kWh	9600	9600	15000
emission level CO2	mg/Nm3	0	0	0
emission level S02	mg/Nm3	-	-	-
emission level Nox without DeNox	mg/Nm3	250	250	250
emission level Nox with DeNox (SNCR)	mg/Nm3	125	125	125
Planned availability (maintenance)	pu	7%	7%	7%
Unplanned availability (forced outage)	pu	8%	8%	8%
Pecularities				
- Average Available Energy	GWh	745	300	37
- Fuel consumption	t/year	510 000	204 000	40 000
- Fuel cost in Africa if available on site	USD/GJ	3.6	3.6	3.6
- Fuel cost in Africa if transport needed	USD/GJ	5.1	5.1	5.1

Table 25 - Biomass Production unit - Investment data

Hydroelectricity

One of the objectives of this master plan and of the national Master plans of the majority of Wescircuit African countries is the development of the not yet exploited hydroelectric resources. These resources are very abundant and are mainly distributed in the basins of the Senegal, Niger, The Gambia and Konkouré Rivers.

These projects are taken into account as investment options during the optimization of the production plan and are thus put in competition with the other technologies presented in this chapter.

Nevertheless, it should be noted that the projects suggested in the countries of zone B can not reasonably be all set up by 2025 even if many of them are profitable from an economic point of view. Indeed, the financial limits of the countries, the environmental impacts, and the difficulties of accessibility are as many brakes to the massive development of the hydroelectricity. Moreover, a certain number of these projects could be dedicated to the local supply of the mining sector.

In the first two scenarios (without limits of interconnection and national development), no constraint was forced on the model in order to take these aspects into account.

Nevertheless, in order to obtain a reference case which can be used as a basis for the development of a list of priority investments, some constraints were forced based on the limits evoked herebefore and limiting the disproportionate investments in the countries having many hydroelectric resources.

The characteristics of the projects were determined based on the last available study for each work. When certain data such as the capital cost or the annual potential production were not available, the Consultant proposed values based on the site location, the type of installation and the power of the groups. These values are showed in italic.

Node	Name Power Plant	Status	Installed capacity	Total costs	Spec. Invest. costs	Average energy	Guaranteed energy
			[MW]	[M$]	[$/kW]	[GWh/an]	[GWh/an]
Burkina Faso	Bougouriba	Candidate	12	122	10125	30	*22.8*
Burkina Faso	Bagre Downstream		14	106	7536	36	*27.36*
Ivory Coast	Soubré	Candidate	270	620	2296	1116	*848*
Ivory Coast	Gribo Popoli	Candidate	112	364	3249	515	*391*
Ivory Coast	Boutoubre	Candidate	156	*401*	*2570*	785	*597*
Ivory Coast	Louga	Candidate	280	1330	4751	1330	*1011*
Ivory Coast	Tiassale	Candidate	51	*207*	*4068*	215	*163*
Ivory Coast	Aboisso Comoe	Candidate	90	*248*	*2756*	392	*298*
Ghana	Juale	Candidate	87	372	4276	405	*308*
Ghana	Pwalugu	Candidate	48	209	4361	184	*140*
Ghana	Daboya	Candidate	43	241	5611	194	*147*
Ghana	Hemang	Candidate	93	304	3270	340	*258*
Ghana	Kulpawn	Candidate	36	345	9587	166	*126*
Guinea	Amaria	Candidate	300	377	1256	1435	1057
Guinea	Bonkon Diaria	Candidate	174	211	1213	451	315
Guinea	Diaraguela	Candidate	72	178	2472	400	298
Guinea	Fetore	Candidate	124	160	1290	322	232
Guinea	Fomi	Candidate	90	156	1728	374	320
Guinea	Frankonedou	Candidate	36	83	2306	173	140
Guinea	Gozoguezia	Candidate	48	110	2292	259	200
Guinea	Grand Kinkon	Candidate	291	298	1024	720	618
Guinea	Kaleta	Decided	240	267	1114	946	228
Guinea	KassaB	Candidate	135	214	1585	528	467
Guinea	Kogbedou	Candidate	14	71	5083	111	99
Guinea	Kouravel	Candidate	135	185	1370	350	240
Guinea	Kouya	Candidate	86	156	1814	334	315
Guinea	Lafou	Candidate	98	128	1306	255	210
Guinea	Morisakano	Candidate	100	260	2600	523	438
Guinea	Nzebela	Candidate	48	94	1958	225	210
Guinea	Poudalde	Candidate	90	150	1667	342	319
Guinea	Souapiti	Candidate	515	692	1344	2518	2403
Guinea	Tiopo	Candidate	120	295	2458	590	480
Liberia	MtCoffee (+via)	Decided	66	383	5803	435	344
Liberia	St Paul 1B	Candidate	78	*244*	*3123*	*512*	*389*
Liberia	St Paul 2	Candidate	120	*375*	*3123*	*788*	*599*
Liberia	St Paul V1	Candidate	132	*412*	*3123*	*569*	*433*
Liberia	Mount Coffee (+V1)	Candidate	66	*234*	*3546*	*285*	*216*
Liberia	St Paul 1B (+V1)	Candidate	65	*203*	*3123*	*280*	*213*
Liberia	St Paul 2 (+ V1)	Candidate	100	*312*	*3123*	*431*	*328*
Liberia	Lofa To rivet	Candidate	29	*141*	*4861*	*125*	*95*
Liberia	St John To rivet	Candidate	67	*287*	*4280*	*289*	*220*
Liberia	CestosRiver	Candidate	41	*234*	*5707*	*177*	*480*

Table 26 - Hydroelectric projects Investment data (1/2)

Node	Name Power Plant	Status	Installed capacity	Total costs	Spec. Invest. costs	Average energy	Guaranteed energy
			[MW]	[M$]	[$/kW]	[GWh]	[GWh]
Mali	Kénié	Candidate	34.4	126	3671	199	163
Mali	Taoussa	Candidate	25	209	8340	*108*	*82*
Mali	Sotuba 2	Candidate	6	48	7943	39	37
Mali	Markala	Candidate	10	40	4025	53	*40*
Niger	Kandadji	Decided	130	405	3115	629	478
Niger	Gambou	Candidate	122.5	*577*	*4712*	*528*	*402*
Niger	Dyodyonga	Candidate	26	*60*	*2293*	*112*	*85*
Nigeria	Mambilla	Candidate	2600	4000	1538	*11214*	*8522*
Nigeria	Zungeru	Candidate	700	*1077*	*1538*	*3019*	*2295*
Sierra Leone	Bumbuna II	Candidate	350	*520*	*1486*	1245	996
Sierra Leone	Gummed II	Candidate	6	*40*	*6709*	*31*	*1*
Sierra Leone	Benkongor	Candidate	200	*490*	*2447*	1164	959
Sierra Leone	Kuse II	Candidate	91.8	*235*	*2561*	680	549
Sierra Leone	Kambatibo	Candidate	52.5	*164*	*3120*	269	212
Sierra Leone	Bitmai I	Candidate	52.5	*164*	*3120*	268	212
Sierra Leone	Bitmai II	Candidate	36.6	*130*	*3543*	250	211
Togo	Adjarala	Decided	147	333	2265	366	237
Togo	Tététou	Candidate	50	*159*	*3174*	148	*112*
Benin	Kétou	Candidate	160	*337*	*2105*	490	*372*
Burkina /Ghana	Noumbiel	Candidate	60	286	4767	203	*154*
C Iv /Liberia	Tiboto	Candidate	225	*578*	*2570*	1200	*912*
Libéria/S.L	ManoRiver	Candidate	180	473	2625	795	612
OMVG Guinea	Digan	Candidate	93.3	112	1200	243	24
OMVG Guinea	FelloSounga	Candidate	82	285	3474	333	286
OMVG Senegal	Sambangalou	Decided	128	433	3386	402	208
OMVG G. Bissau	Saltinho	Candidate	20	83	4273	82	24
OMVS Guinea	Balassa	Candidate	181	171	945	470	401
OMVS Guinea	Boureya	Candidate	160	373	2331	717	455
OMVS Guinea	Diaoya	Candidate	149	332	2228	581	389
OMVS Guinea	Koukoutamba	Candidate	281	404	1438	858	507
OMVS Guinea	Tene I	Candidate	76.4	122	1597	199	129
OMVS Mali	Felou	Decided	60	170	2828	350	320
OMVS Mali	Gouina	Decided	140	328	2343	565	227
OMVS Mali	Gourbassi	Candidate	21	*91*	*4311*	104	*79*
OMVS Mali	Badoumbe	Candidate	70	*197*	*2818*	410	*312*
OMVS Mali	Bindougou	Candidate	49.5	*158*	*3185*	289	*220*
OMVS Mali	Moussala	Candidate	30	*114*	*3801*	175	*133*

Table 27 - Hydroelectric projects Investment data (2/2)

Characteristics of the power plants	Units	Hydropower
Life duration	year	50
Variable O&M Cost (excl fuel)	USD/MWh	2
Fixed O&M cost	%.	Included in variable
Planned unavailability (maintenance)	pu	4%
Unplanned unavailability	pu	2%

Table 28 - Hydroelectric projects standard Parameters

Solar energy

For CSP technologies, the normal direct irradiation (NDI in kWh/m ² /y) is an essential criterion to define the potential of the sites. Consequently, in the area of interest, 4 ranges of DNI were defined:

- Nonsuitable < 2.000 kWh/m2/a
- Acceptable 2.001 - 2.200 kWh/m2/a
- Good 2.201 - 2.600 kWh/m2/a
- Excellent >2.600 kWh/m2/a

This scale is specific to the area and is defined based on DNI data available for the area.

Another key parameter is the latitude which influences the unit losses. The latitudes considered are of 15°, 20° and 25°. The latitudes of less than 10° are not considered because they are classified as “nonsuitable” in the DNI scale.

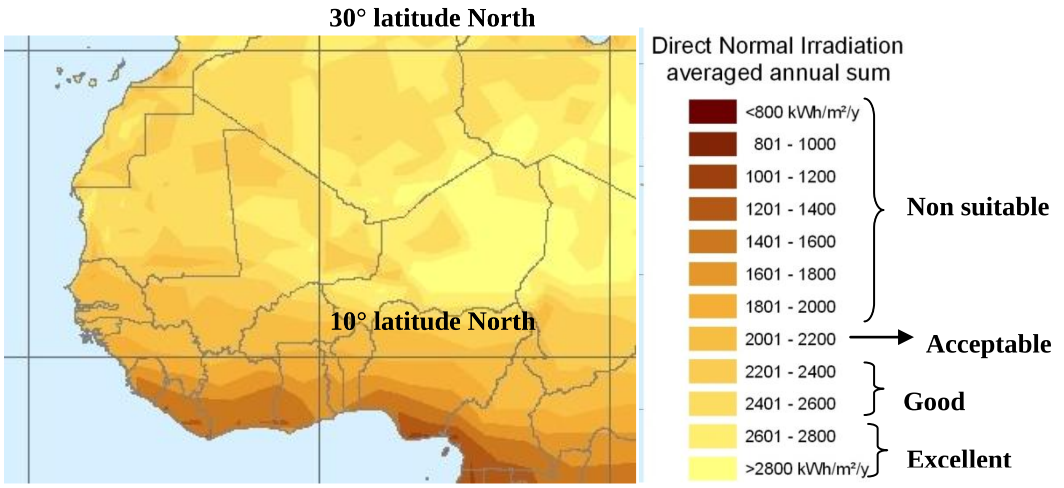


Figure 7 - DNI and the latitude of the area of interest (www.dlr.de)

By using Andasol3 as typical unit (50 MW with 7.5h of storage in Spain), we obtain the data of Table 26 for a DNI of 2400 kWh/m2/a and a latitude of 20 ° North. The costs considered in Table 26 are the costs for 2009/2010.

Characteristics of the power plants	*Units*	*Solar thermics (CSP)*
Nominal output (local conditions)	MW	50
Average available energy available	GWh	206
Bill book of payment	%/year	70% Y0-1 30% Y0
Capital cost	MUSD	507
Capital cost/kW	USD/kW	10138
lifespan	year	25
Operation cost and maintenance - fixed	USD/kW/year	254
Operation cost and maintenance - variable	USD/MWh	-
Output	%	17%
Planned unavailability (maintenance)	pu	2%
Unplanned unavailability	pu	-
Characteristics		
- storage	H	7.5
- DNI	kWh/m ² /y	2400
- No. of loops	-	152
- Surface of the mirrors	m ²	497000

Table 29 - Solar production unit CSP- Given of investment

Traditional investment data for a photovoltaic installation in Europe with an operating time ratio adapted to the area are presented in Table 27. The costs considered in Table 27 are costs for 2010/2011.

Characteristics of the power plants	*Units*	*Solar PV*
Nominal nominal output (local conditions)	MW	1
Energy available average	GWh	2
Bill book of payment	%/year	100% Y0
Capital cost	MUSD	3.66
Capital cost/kw	USD/kW	3660
lifespan	year	20
Operation cost and maintenance - fixed	USD/kW/year	20
Operation cost and maintenance - variable	USD/MWh	-
Output	%	15%
Planned unavailability (maintenance)	pu	0.50%
Unplanned unavailability	pu	0.75%
Characteristics		
- storage	H	
- DNI	kWh/m ² /y	
- No. of loops	-	
- Surface of the mirrors	m ²	

Table 30 - Solar production PV unit - Investment data

Wind energy

Two wind technologies are proposed as an investment option for the master plan. The first technology corresponds to the current state of art in terms of wind turbines. It is a turbine of approximately 2 MW proposed by all the manufacturers (GE, REPower, Vestas, Gamesa, Siemens, Nordex, Enercon…). This technology is currently the most widespread.

The second technology suggested consists of a smaller structure, more flexible which can be installed more easily in distant areas where the traditional wind turbines are difficult to install. Typically, this technology is proposed by the Vergnet Company.

Type of equipment	Unit	Wind turbine (25x2MW)	Wind turbine (50x1MW)
Total Nominal Power	MW	50	50
Average available Energy (2000 hours)	GWh	100	100
Total investment cost	MUSD	69	81
Schedule of investment payment	%/year	70% Y0-1 30% Y0	70% Y0-1 30% Y0
Total investment cost / kW	USD/kW	1485	1750
Life duration	years	20	20
Discount rate	%	12	12
Fixed O&M cost	USD/kW/y	17	17
Variable O&M Cost	USD/MWh	9.5	9.5
Planned availability (maintenance)	pu	1%	1%
Unplanned availability (forced outage)	pu	4%	4%

Table 31 - Wind - Investment data

3.1.4.2. DEVELOPMENT PLANS OF THE PARK OF PRODUCTION

For each country, the development plans of the national park of production discussed at the time of data collection missions and the big incircuitational projects are considered.

For each Member State, a list of electric production units was drawn up, distinguishing the existing units from the future units (decided or candidates):

- Existing units: production units having been commissioned before March 2011;
- Decided units: units whose construction is undergoing or was decided for an exact date of commissioning (study finished and guaranteed financing);
- Candidates units: units for which the studies are not finished yet or for which the financing was not found yet.

Among the projects suggested by the countries, those which are decided are not questionable in the production master plan. On the other hand, the candidate projects belong to the investment options optimized by the software.

In addition to the projects under consideration by the countries, a series of “standard” investments are also proposed as investment option. The standard gas turbines and the combined cycles proposed permit to cover a broad range in terms of size and technology.

Senegal

- Decided projects:
  - The hydroelectric plant of Félou within the framework of the OMVS. It is a power plant of 60 MW and, according to the agreements with the OMVS, Senegal will have 25% of the power. That will ensure 15 MW additional as from 2013 on the condition that the network of the OMVS allows the transfer of this additional capacity;
  - Within the framework of the OMVS also, the power plant of Gouina, for 140 MW is planned in 2017. The share of Senegal is 25% or 35 MW;
  - Through the OMVG, Senegal should benefit from 40% of production of the hydroelectric plant of Sambangalou in 2017, or 51MW;
  - A coal plant on the site of Sendou (total of 875 MW) till 2016;
  - The hiring of a 50 MW diesel unit in 2011 for a one year duration, with possibility of renting an additional 100MW;
  - The rehabilitation of the C3 and C4 groups of Bel Air (+30MW in 2011 and 25MW in 2012);
  - Extension of the C6 group of Bel-Air: 2 x 15 MW in 2012;
  - The commissioning of Koudi II (2 x 15 MW) in 2012;
  - A Biomass unit of 2 x 15 MW with Ross Bethio in 2014. Produced energy estimated per year: 236 GWh.

- Candidates projects:
  - The installation of mobile units on HFO of 40 MW in Tobin (with option for an extra 30MW) and 70MW in the harbour of Bel-Air (one second barge of 70MW is considered) in 2012;
  - The following units are planned for the isolated centers:
    - 2012:2 x 5 MW HFO in Ziguinchor which will make it possible to stop the hirings of power in this area;
    - 2012:2 x 4 MW HFO in Tambacounda.
  - A wind site of 125 MW from 2014 onwards;
  - A solar park of 7.5 MW in Ziguinchor;
  - Several diesel units of 30 or 60 MW could be built by independent producers.

The Gambia

- Decided projects:
  - Complete commissioning of the units of Kotu;
  - The rehabilitation of the unit G6 of Kotu in 2011;
  - The rehabilitation of the unit G2 (HFO) in Kotu (3 MW) in 2012;
  - The installation of 2 new diesel units of 6.5 MW running on HFO, at the power plant of Brikama at the end of 2011;
  - The installation of an extra 9 MW in Brikama running on HFO also at the end of 2011;
  - 4 units of 2 MW running on HFO for the isolated centers;
  - Construction of a wind farm of 1 MW in Tanji in 2012.

Area	*Current load*	*New Units*	*Connection to Banjul*
Farafenni & Mansa Konko	1.8 MW	2 MW in 2013	2013
Bansang	0.6 MW	2 MW in 2013	2014
EASSAN/Barria	0.46 MW		OMVG
KEREWAN	0.22 MW	2 MW in 2013	
LOW	1.8 MW	2 MW in 2013	2014
KANIR	0.18 MW		

- Candidates projects:
  - Extension of the power plant of Brikama to 2 x 10 MW in 2013;
  - A project of an additional 4MW of wind in 2014;
  - Through the OMVG, The Gambia should profit from 12% of the power of the hydroelectric plans of Sambangalou in 2017, that is 15 MW;
  - A solar project of 10MW;
  - Extension of the wind farm of 6 MW;
  - A combined cycle of 60MW after 2014;
  - The second phase of the projects of the OMVG.

Guinea Bissau

- Decided projects:
  - The installed capacity at this moment is of approximately 5.6 MW. But the capacity available uninterrupted is of 5 MW (2.5 MW EAGB and 2.5 MW of hiring);
  - 2 groups of 2.5MW financed by the World Bank and installed in 2012. Regarding the commissioning of these units, the leasing agreements of 2.5MW will be broken;
  - Financing of 15 MW HFO for the town of Bissau supported by the UEMOA and the BOAD. Envisaged in several stages of 5 MW between 2012 and 2014;
  - Rehabilitation of the power plant of EAGB in Bissau (2MW);
  - Rehabilitation of the power plant of Bafatà (5MW);
  - Commissioning of the power plant of Buba (5MW);
  - Through the OMVG, Guinea Bissau should benefit from 8% of power from the hydroelectric plant of Sambangalou in 2017, that is 10 MW;
  - It is supposed that when the means of production become sufficient, the self-producers will stop using their own means of production.
- Candidates projects
  - Power plant HFO of 55MW.

Guinea

- Decided projects:
  - 106 MW with the project of thermal plant of Manéah running on HFO. The commissioning is supposed to happen in 2014 and 2015;
  - Commitioning of additional 100MW at Tombo plant;
  - The hydroelectric run-of-river plant of Kaléta which will include three units of 80 MW and will produce on average 946 GWh per year.
  - The rehabilitation of the thermal and hydroelectric units of Guinea;
  - Through the OMVG, Guinea should benefit from 40% of power from the hydroelectric plant of Sambangalou in 2017, i.e. 51 MW.
- Candidates projects:
  - In addition to the second phases of the OMVS and OMVG projects, the sites mentioned below are also considered in Guinea.
    - The site of Souapiti presents an installable power of 515 MW and is planned for 2019. It could be associated with a project of aluminum foundry that would not leave power for other uses. If the aluminum factory is not built, it will be useful for the supply of the mines and export;
    - The site of Kassa B (135MW) is planned for 2021;
    - The site of Poudaldé on the Cogan River close to Tiopo is under feasibility study. It is planned for 2017. Its installed capacity is of 90 MW for a producible of 350 GWh.
    - Finally, the Grand-Kinkon project has an installed capacity of 291 MW for an annual producible of 735 GWh and an estimated cost of 298M$

The list of projects is presented hereafter:

Site	Localization	Capacity [MW]	Annual Producible [GWh]
Souapiti	Maritime Guinea	515	2518
Amaria		300	1435
Poudadlé		90	350
Tiopo		120	590
Grand Kinkon		291	735
Kassa B	Mid-Guinea	135	528
Kouya		86	334
Bonkon-Diaria		174	451
Fetore		124	322
Lafou		98	255
Kouravel		135	350
Fomi	Upper Guinea	90	374
Diareguela		72	400
Frankonédou		36	173
Kogbédou		14	96
Morisanako		100	523
Nzébéla	Forested Guinea	48	225
Gozoguézia		48	259

Table 32 - Hydroelectric sites under consideration in Guinea except OMVS/OMVG

- In addition, the connection of the production units of the isolated centers from Nzerekore (3MW), Kankan (3MW) and Faranah (1.5 MW) is planned for 2016 with the interconnection projects of CLSG and Guinea-Mali.

Sierra Leone

- Candidates projects:
  - Extension of the Bumbuna dam by the second phase:
    - Addition of 350 MW thanks to the Yiben dam, envisaged in 2017;
  - The addition of a new dam upstream of the current dam of Goma and the installation of additional turbines for a total of 6 MW envisaged in 2015;
  - New hydroelectric dam of Benkongor with 3 possible phases:
    - Phase 1:34.8 MW;
    - Phase 2:80 MW;
    - Phase 3:85.5 MW.
  - A project of power plant of 100 MW using the biomass as fuel;
  - A sugar project which could produce 15 MW starting of bagasse;
  - A project of solar power plant of 5 MW;
  - The hydroelectric installations mentioned in the following table are also considered in Sierra Leone.

Site	Capacity [MW]	Annual producible [GWh]
Kuse 2	91.8	679.7

Kambatibo	52.5	268.5
Bitmai 1	52.5	268
Bitmai 2	36.6	249.5
Mano To rivet	180	795

Table 33 - Hydroelectric sites under consideration in Sierra Leone

For the site located on the Mano River on the border with Liberia, an equal division of the power and the producible between the two countries is planned. The total necessary investment is estimated to 473 M$.

Liberia

- Decided projects:
  - 10 MW of high-speed diesel groups (10 x 1MW) running on DDO on the site of Bushrod. The commissioning is envisaged in 2011;
  - 10 MW of medium-speed diesel groups (2 x 5MW) running on HFO on the site of Bushrod. The commissioning is envisaged in 2013;
  - The rehabilitation of the hydroelectric installation of Mount Coffee (66 MW could be available in 2014).
- Candidates projects:
  - The Buchanan project of 35 MW (2 x 17.5 MW) located in Kakata. The commissioning is envisaged in 2013;
  - 30 MW of medium-speed diesel groups (6 x 5MW) running on HFO on the site of Bushrod. The commissioning is envisaged in 2015;
  - The development of the St Paul River with the creation of the SPRA (Saint Paul River Authority) with the hydroelectric sites of
    - Saint Paul - 1B: 78 MW and 512 GWh of annual producible;
    - Saint Paul - 2:120 MW and 788 GWh of annual producible.

    These sites could be commissioned by 2018;
  - The construction of an additional tank ("Ultimate" Via Storage) on the Saint Paul River upstream of the above mentioned sites. 132 MW could be produced locally by the V-1 power plant thanks to this tank. Moreover, the construction of a channel connecting it with the tank Via of Mount Coffee would make it possible to increase the capacities of the hydroelectric plants located downstream in the following proportions:
    - Mount Coffee: possible addition of 66 MW;
    - Saint Paul - 1B: possible addition of 65 MW;
    - Saint Paul - 2: possible addition of 100 MW.
  - A hydroelectric dam of 180 MW on the Mano River on the border with Sierra Leone with a Annual producible of 795 GWh. This site would be divided for a total value of 50% for each country. The necessary total investment is estimated to 473 M$;
  - A hydroelectric dam of 225 MW on the Cavally River at the border with Ivory Coast with an annual producible of 1200 GWh. This site would also be shared for a total value of 50% per country;
  - Hydroelectric sites identified on the rivers Lofa (total of 29 MW), Holy John (total of 67 MW) and Cestos (total of 41 MW).

Mali

- Decided projects:

- 60 MW of the BID project (6 diesel groups of 10 MW each) running on HFO in Balingué. 40 MW were commissioned in 2010. The commissioning of the remaining 20 MW is envisaged in 2011;
- 92 MW through the IP Albatross thanks to diesels groups running on HFO in the mining zone of Kayes. The commissioning is envisaged in 2012;
- The hydroelectric project of installation of Félou carried out within the framework of the OMVS. The share allocated to Mali is of 45%, or 27MW. Construction is undergoing and the commissioning is envisaged in 2013;
- The hydroelectric project of installation of Gouina carried out within the framework of the OMVS. The share allocated to Mali is of 45%, or 63MW. The commissioning is planned for 2017;
- Connection with the interconnected network of isolated diesel groups for a total of 30.4 MW in the horizon of the study;
- A 10 MW solar project in Mopti is installed in 2012 and connected to the interconnected network in 2019.
- A project of combined cycle of 400 MW envisaged with Aboadze (Ghana) by the Emergency and security supply plan of Electric Energy of the WAPP. A part of its energy should be importe by Mali.

- Candidates projects:
  - The hydroelectric project of installation to the Sotuba 2 (6 MW). The commissioning is envisaged in 2014;
  - The agro-industrial project of the sugar company of Markala (SoSumar) will contain a power plant of cogeneration from which 3MW will be extra and transferred to the interconnected network. The commissioning is envisaged in 2014;
  - The project of a small hybrid power plant for a total of 0.75MW (0.25 solar + 0.5 diesel) with Ouelessebougou in 2016;
  - The hydroelectric project of installation to the current of Kenié (42 MW). The commissioning is envisaged in 2015;
  - A combined cycle of 150 MW is planned by the Emergency and Security Supply Plan in electrical energy of the ECOWAS;
  - Extension of the PV solar Mopti of 50 MW which will be connected to the interconnected network;
  - A PV solar project of 20 MW to be installed as from 2013;
  - The hydraulic project of Taoussa on the Niger River close to WAGP, mainly dedicated to agriculture with a supplement of hydroelectricity of 25 MW;
  - The project of hydroelectric plant of 10 MW (3 Kaplan turbines) in Markala on the Niger river with an annual producible of 53 GWh;
  - Within the framework of the projects of the OMVS, Mali should benefit from part of the production of the Guinean sites of Koukoutamba (281MW, 858 GWh), Boureya (160 MW, 717 GWh) and Balassa (181 MW, 470 GWh) all three located on the Bafing;
  - In a more remote horizon, the OMVS projects of Gourbassi (21 MW, 104 GWh) and Badoumbe (70 MW, 410 GWh), then of Bindougou (50 MW, 289 GWh) and Moussala (30MW, 175GWh) could also be implemented in Mali.

Ivory Coast

- Decided projects:
  - Addition of 222 MW on the site of independent producer CIPREL which will form a combined cycle with the gas turbine of 111 MW commissioned in 2010. The commissioning of the new gas turbine is envisaged in July 2012 and that of the steam turbine in July 2013;
  - Emergency addition of an extra 250 MW (total= 450MW) on the site of CIPREL or Vridi thanks to a new gas turbine and a new steam turbine in 2012;

- A combined cycle of 450 MW (2 gas turbines and a steam turbine of 150 MW each) on the site of Abbata. The commissionings are envisaged in 2014 (1st gas turbine), 2015 (2nd gas turbine) and 2016 (steam turbine);
- A project of combined cycle of 400 MW envisaged with Aboadze (Ghana) by the Emergency and security supply plan of Electric Energy of the WAPP. A part of its energy should be importe by Ivory Coast.

- Candidates projects:
  - The project of 270 MW of the Soubré dam. The commissioning is envisaged in 2018;
  - A combined cycle of 450 MW (2 gas turbines and a steam turbine of 150 MW each one) on the site of Bassam which will constitute the 5th thermal plant of Abidjan. The commissionings would be envisaged in 2020 (1st gas turbine), 2023 (2nd gas turbine) and 2025 (steam turbine);
  - The capacities of the hydroelectric sites are indexed in the table below:

Basins	*Sites*	*Capacity [MW]*	*Annual producible [GWh]*
SASSANDRA	Louga	280	1.330
	Gribo Popoli	112	515
	Boutoubre	156	785
BANDAMAN	Tiassalé	51	215
CAVALLY	Tiboto	225	1.200
COMOE	Aboisso-Comoé	90	392

Table 34 - Hydroelectric installations under consideration in Ivory Coast

For the site of Tiboto a distribution of 50% for the Ivory Coast and 50% for Liberia can be assumed within sight of the more or less equal distribution of the basin of the Cavally river between the two countries.

Ghana

- Decided projects:
  - Phase 1 of power plant T3 of Aboadze (in construction), which will consist of a combined cycle of 120 MW. Its commissioning is planned for 2012;
  - A second gas turbine of 110MW on the site of Tema T1 with commissioning envisaged in 2012. The addition of a steam turbine of 110 MW is envisaged in 2015 to create a combined cycle of a total of 330 MW;
  - Hydroelectric dam of 400 MW in Bui on the Black Volta with an annual producible of 1000 GWh. The commissioning is planned for mid 2013;
  - Two gas turbines of 110 MW each one envisaged in Domini by BTPP (central Domini T1) in order to benefit from the offshore gas resources discovered. Their commissioning is envisaged in 2013;
  - Addition of a steam turbine of 110 MW on the power plant of Aboadze T2 to pass to a combined cycle of 330 MW in total. The commissioning is envisaged in 2014;
  - A project of combined cycle of 400 MW envisaged with Aboadze (T4) by the Emergency and security supply plan of Electric Energy of the WAPP.
  - 2x5MW solar PV in 2012 and 2013;
  - Wind: 50 MW in 2014 and 100 MW in 2015;

- A project of combined cycle of 450 MW (2 gas turbines of 150 MW each one and a steam turbine of 150 MW) on the site of Maria Gléta in Benin decided by the Emergency and Security supply plan of Electric Energy supply of the WAPP. A part should be dedicated to the Ghana.

- Candidates projects:
  - Phase 2 of the power plant of Aboadze T3 with similar characteristics to phase 1 described previously. The commissioning is envisaged in 2016;
  - GT on barge: 2x50 MW;
  - SAP project of CC 2x163.6 MW;
  - The power plant of Cempower on the Tema T2 site initially made up of 2 gas turbines of 110 MW to which a steam turbine of 110 MW will be added to create a combined cycle of 330 MW;
  - Addition of a steam turbine of 110 MW to the power plant of Domini T1 by BTPP to create a combined cycle of a total of 330 MW;
  - 5 hydroelectric sites at the stage of feasibility studies, led by the VRA (Juale, Pwalugu, Kulpawn, Daboya) and the ministry for energy (Hemang):

Site	Capacity [MW]	Annual producible [GWh]
Juale	87	405
Pwalugu	48	184
Kulpawn	36	166
Daboya	43	194
Hemang	93	340

Table 35 - Hydroelectric sites under consideration in Ghana

There also is a project of dam with hydroelectric plant of 60 MW (3 Kaplan turbines of 20MW) at the border with Burkina Faso on the site of Noumbiel (also called Koulbi in Ghana) on the Black Volta. The total annual producible is estimated to 203 GWh with a distribution of 80% of the energy produced for Burkina and 20% for Ghana.

Togo

The sector of electricity in Togo and Benin is governed by the Incircuitational agreement and Benino-Togolese Codes electricity signed between the 2 states in 1968 and creating a community of interest between the 2 countries in the field of electrical energy.

This code conferred to the Electric Community of Benin the monopoly of the production, transport and the imports/exports of electrical energy on the entire territory of the two states.

Nevertheless, the Incircuitational Agreement and Benino-Togolese Code signed in 1968 were revised in 2003. It is hence the clauses of the new agreement and Code of 2003 that are now in force. According to the clauses of this new agreement and revised Benino-Togolese Code of 2003, the CEB does not have the monopoly of the electrical production anymore. The segment of the electrical production is opened to the independent producers but the CEB remains the single purchaser of their production everywhere where their network is present.

- Decided projects:
  - The project of 147 MW Adjarala dam with an annual producible of 366 GWh. The commissioning is envisaged in 2017 by the CEB.

- A project of combined cycle of 450 MW (2 gas turbines of 150 MW each one and a steam turbine of 150 MW) on the site of Maria Gléta in Benin decided by the Emergency and Security supply plan of Electric Energy supply of the WAPP. A part should be dedicated to the Togo.

- Candidates projects:
  - A wind project of 20 MW to be set up with a guaranteed annual energy of 40 GWh whose commissioning is envisaged in 2013;
  - 100 MW of thermal production with a guaranteed annual energy of 350 GWh in 2013 (commissioning) and of 700 GWh as from 2014;
  - A solar project of 5 MW of the CEB with a guaranteed annual energy of 10 GWh whose commissioning is envisaged in 2015;
  - A project of dam with hydroelectric plant of 50 MW in Tététou on the Mono River which would be located between the Nangbeto and Adjarala dams with an annual producible of 148 GWh. A feasibility study was carried out in 1984.

Benin

- Decided projects:
  - The project of 147 MW Adjarala dam (Togo) with an annual producible of 366 GWh that should be shared between Togo and Benin.
  - 80 MW on the site of Maria Gleta in Cotonou. The commissioning is envisaged in 2011;
  - A project of combined cycle of 450 MW (2 gas turbines of 150 MW each one and a steam turbine of 150 MW) on the site of Maria Gléta in Cotonou decided by the Emergency and Security supply plan of Electric Energy supply of the WAPP. The power plant should be operational in 2014.
- Candidates projects:
  - A 20 MW solar project to be set up with a guaranteed annual energy of 40 GWh whose commissioning is envisaged in 2012;
  - A 5 MW solar project of the CEB with a guaranteed annual energy of 10 GWh whose commissioning is envisaged in 2015;
  - A solar project of 5 MW financed by the AFD in the North-East of Benin. (commissioning supposed: 2014);
  - A project of dam with hydroelectric plant of 160 MW in Kétou on the Ouémé River with an annual producible estimated to 490 GWh. A feasibility study was carried out in 1992.

Burkina Faso

- Decided projects:
  - 18 MW running on HFO and forming the first phase of the power plant of Komsilga. The commissioning is envisaged in 2011;
  - 37.5 MW (3 diesel groups of 12.5 MW running on HFO and forming the 2nd phase of the power plant of Komsilga. The commissioning is envisaged in 2011;
  - 36 MW (2 diesel groups of 18 MW) running on HFO which will form the 3rd phase of the power plant of Komsilga (total 90MW). The commissioning is envisaged in 2013;
  - 20 MW (2 diesel groups of 10 MW running on HFO and forming the 2nd phase of the power plant of Sore 2. The commissioning is envisaged in 2012.
  - A project of combined cycle of 400 MW envisaged with Aboadze (Ghana) by the Emergency and security supply plan of Electric Energy of the WAPP. A part of its energy should be importe by Burkina Faso.
- Candidates projects:
  - A solar project of 20 MW of which 16 MW would be dedicated to the mining company Semafo. The commissioning is envisaged in 2012;
  - A photovoltaic solar project of 1.5MW (extensible with 3MW) in Ouagadougou. The commissioning is supposed to take place in 2012 (already committed financing);
  - A photovoltaic solar project of 20MW (extensible with 40MW) in Ouagadougou. The commissioning is supposed to intervene in 2014;
  - The connection of isolated centers between 2011 and 2013 for a total of 13.5 MW installed and 9.5 MW available;
  - A project of dam with hydroelectric plant of 60 MW (3 Kaplan turbines of 20 MW) at the border with Ghana on the site of Noumbiel (called Koulbi in Ghana) on the river Mouhoun (Black Volta). The total annual producible estimated to 203 GWh with a distribution of 80% of the energy produced for Burkina and 20% for Ghana;
  - A project of dam with hydroelectric plant of 12 MW (3 turbines of 4MW) in Bougouriba with producible of 30 GWh;
  - A project of dam with hydroelectric plant of 14 MW (2 Kaplan turbines of 7MW) to Bagré-downstream with an average annual producible of 37.3 GWh.

Niger

- Decided projects:
  - In 2011, seven 2.2 MW diesel units each will be installed with the power plant of Niamey 2, to replace the old diesel units;
  - In 2012, 2 units of 2MW each will be installed in Maradi and 2 others of 2 MW will be installed in Zinder, in Centre-East Niger area;
  - In the river area, an additional power of 70MW diesel will be installed in Niamey in 2013.
  - In the River zone, the Kandadji dam will be completed by 2015. This 130 MW dam should bring 629 GWh annualy to Niger;

- Candidates projects:
  - The coal center of Salkadamna would add up 200 MW. This power plant would be localized between the River, Centre-Eascircuit and Northern areas, close to a coal deposit and would be built by sections of 50MW between 2015 and 2016;
  - In the River area, a 30 MW wind farm is planned in 2014. The site has still to be defined;
  - In the River area, a thermal solar power plant of 50 MW is planned for 2014. The site still has to be defined;

- In the Centre-Eascircuit area, Zinder, a combined cycle of 60 MW is expected in 2013;
- Other hydro units are mentioned in the River area:
  - Gambou for 122.5 MW;
  - Dyodonga for 26 MW.

Nigeria

- Decided projects:
  - A project of combined cycle of 450 MW (2 gas turbines of 150 MW each one and a steam turbine of 150 MW) on the site of Maria Gléta in Benin decided by the Emergency and Security supply plan of Electric Energy supply of the WAPP. A part should be dedicated to Nigeria.
  - FGN phase 1:1408 MW of which 1055 MW were commissioned in 2007. There remain 353 MW planned for 2011;
  - NIPP: 2599 MW planned for 2011;
  - FGN phase 2:2148 MW envisaged including 696 MW for 2012 and 1452 MW for 2013.

  For all that, the oil companies envisaged the following investments:

  - The power plant of Afam 6, by Shell: 5 units of 150 MW in 2012;
  - The power plant of Bonny, by Mobil: 3 units of 130 MW in 2012;
  - The Chevron Texaco power plant with 3 units of 250 MW by 2012;
  - The power plant of TotalFinaElf with 4 units of 125 MW by 2012.

  Moreover, some IPP are expected:

  - Alscon with 6 units of 90 MW by 2012;
  - Power plant IBOM Power 2 with 500 MW in 2012.
- Candidates projects:

Important hydroelectric projects are considered in Nigeria:

- The rehabilitation of Kainji;
- The project of Zungeru (700MW);
- The project of Mambilla (8x325MW).

Some IPP are also expected of which

- ICS Power: 6 units of 100 MW in 2015;
- WESTCOM power plant of 500 MW in 2015;
- The Farm Electric power plant of 150 MW in 2015;
- The Supertek power plant of 1000 MW in 2017;
- The Ethiope power plant of 2800 MW in 2017.

Comments concerning the OMVS

The OMVS is an organization having for purpose to organize the actions of four countries for the development of the Senegal River and its basin. Its members are Guinea, Mali, Mauritania and Senegal.

The first realization of the OMVS is the Manantali dam located in Mali on the Bafing (affluent of Senegal) whose construction was completed in 1988. A hydroelectric plant of 205MW (4 groups of 41 MW) was installed offering an annual producible of 800GWh. The production of the site was made available for 3 of the countries of the OMVS thanks to a 225 kV interconnection line from Bamako to Dakar along the border of Senegal with Mauritania.

The OMVS considers many projects with horizons going from short to the long term. They are summarized in the following table:

River	*Site*	*Country*	*Capacity* *[MW]*	*Annual producible* *[GWh]*	*Estimated cost* *[M$]*	*Status*	*Commissioning supposed*
Senegal	Félou	Mali	60	350	170	EC.	2013
	Gouina	Mali	140	589	329	APD	2017
Bafing	Koukoutamba	Guinea	281	858	440	APD	CT
	Boureya	Guinea	160	717	373	APS	CT
	Balassa	Guinea	181	470	171	F	CT
	Bindougou	Mali	50	289		PF	MT
	Diaoya	Guinea	149	581	332	PF	LT
Falémé	Gourbassi	Mali Senegal	21	104		F	MT
	Moussala	Mali	30	175		PF	MT
Bakoye	Badoumbe	Mali	70	410		F	MT
Tene	Tene I	Guinea	76	199	122	PF	LT

Table 36 - hydroelectric Projects of the OMVS

EC.: In construction; APD: Detailed preliminary draft; APS: Summary preliminary draft; F: Feasibility; PF: Pre-feasibility; CT/MT/LT: short/middle to long term.

Comments concerning the OMVG

The OMVG is an organization which aims at coordinating the actions of the four countries concerned with the basin of The Gambia River: Senegal, Guinea, The Gambia and Guinea Bissau. By extension, other rivers of the area are concerned by this organization.

Up to now, the OMVG has two big projects.

The first big project is composed of two parts and is planned for 2016:

- The hydroelectric plant of Sambangalou which will include 4 units of 32 MW and will produce on average 402 GWh per year.
- A 225 kV interconnection which will cross 1677 km to connect 15 sub-stations, for an investment of 576.5 million dollars. It will allow the evacuation of the energy of Guinea, and the interconnection of the 4 countries of the OMVG.

The second big project is composed of four parts and is envisaged later on:

- The run-of-river power plant of Saltinho in Guinea Bissau. Of a power of 20 MW (3 units of 6.5 MW), it will have an average producible estimated to 82 GWh.
- The run-of-river power plant of Digan in Guinea. With a power of 93.3 MW, will have an average producible of 242.5 GWh.
- Fello-Sounga dam, in Guinea, with its two units of 41 MW. It will ensure the annual production of 333 GWh.
- Reinforcement of the 225 kV interconnection line built at the time of the first project. 500 new kilometers of line should be built. There will be 4 new sub-stations. That will cost 145.4 million dollars.

3.1.5. Data of transport

The purpose of this chapter is to synthesize the data of transport which were introduced into the optimization tool PRELE.

The decided projects have a set commissioning date. The planned projects are not questionned but the possibility of a delay of 2 years is considered. Finaly, the projects considered are left free with optimization. In addition, investments other than the big projects of interconnections are proposed to the optimization tool.

3.1.5.1. DECIDED PROJECTS

This section shows the decided projects for which the studies are finished and for which the financing was or is about to be obtained.

"330kV Coastal Backbone" project

The project consists of a 330 kV axis along the coast interconnecting Ivory Coast (Riviera), Ghana (Prestea and Volta), Togo (Lome C), Benin (Sakété) and Nigeria (Ikeja West). 2 sections are planned to complete the 2 already existing sections

- The Volta (Ghana) - Sakété (Benin) section passing by Lome which should be commissioned in 2013;
- The Riviera (Ivory Coast) - Ghana (Prestea) section. It should be commissioned by 2017.

OMVG project

The OMVG project includes a 225 kV interconnection simple line simple circuit crossing Guinea, Senegal, Guinea-Bissau and The Gambia to share the hydroelectric production of the sites of Kaléta and Sambangalou. The commissioning is envisaged in 2017.

CLSG project (Ivory Coast - Liberia - Sierra Leone - Guinea)

A single circuit 225 kV interconnection line is envisaged between the stations Man (Ivory Coast) - Yekepa (Liberia) - Nzérékoré (Guinea) - Buchanan (Liberia) - Monrovia (Liberia) - Bumbuna (Sierra Leone) - Linsan (Guinea). Its commissioning is envisaged in 2015. In the short-term, only a single circuit line will be installed. Nevertheless, the pylons are designed to accommodate a second circuit in a longer-term.

Interconnection Mali - Ivory Coast

This 225 kV interconnection will connect the stations of Ferkéssédougou (Ivory Coast) - Sikasso (Mali) - Koutiala (Mali) and Ségou (Mali). It is under development and 40% have already been realised. The commissioning is expected during 2012.

Please note that the 225 kV single circuit line internal to Ivory Coast which is planned between Laboa and Ferkéssédougou supplements this project while making it possible to close the 225 kV loop inside Ivory Coast and to secure the interconnections towards the North.

Interconnection Ghana-Burkina Faso

A 225 kV interconnection line between Bolgatanga (Ghana) and Ouagadougou (Burkina Faso) will be commissioned in 2013.

Interconnection Ghana - Burkina Faso-Mali

This interconnection 225 kV envisages to connect the Bolgantaga (Ghana) - Bobo Dioulasso (Burkina Faso) - Sikasso (Mali) - Bamako (Mali) substations by 2015. It is envisaged in double circuit on the Bamako-Sikasso section. In Sikasso, a circuit goes towards Ferkessedougou and a second continues towards Bobo Dioulasso.

3.1.5.2. PLANNED PROJECTS

This section shows projects already quite detailed and having been subject of feasibility studies but for which complementary studies are still to be done and/or for which part of the financing still remains to be found.

Interconnection Guinea - Mali

The project of Guinea-Mali interconnection is registered among the priority projects identified by the Revised Master plan of the ECOWAS. It is conceived to evacuate the production of the future hydroelectric plant of 90MW of Fomi (Guinea). The project includes the construction of a 225 kV line between Fomi (Guinea) and Nzérékoré (Guinea) then between Fomi (Guinea) and Bamako (Mali) and between Fomi (Guinea) and Linsan (Guinea). It is planned for 2016.

These transmission lines will not only allow the interconnection of Guinea and Mali, but also the interconnection between the Member States of the OMVS and with the future line of interconnection of Ivory Coast - Liberia - Sierra Leone - Guinea (CLSG).

Project "Northcore"

The project uses again a 330 kV interconnection line between Birnin Kebbi (Nigeria) - Bembéréké (Benin) - Niamey (Niger) - Ouagadougou (Burkina Faso). Several variants are considered in terms of number of circuits (1 or 2) by section. The commissioning of this line is planned in 2016.

330 kV North-South axis in Ghana

This project, although inside the network of Ghana, is an important link of the framework of the WAPP interconnected network strongly improving the capacities of export towards Burkina Faso. This 330 kV interconnection line connects the station of Domini (at the border with the Ivory Coast) to the station of Bolgatanga at the border with Burkina Faso. The commissioning of this axis is planned for 2015. Reinforcement project of the Nigeria-Benin interconnection

This project of a double circuit line between Sakété (Benin) and Omotosho is planned (commissioning date considered: 2016).

3.1.5.3. PROJECTS CONSIDERED

This section shows various projects which are evoked in the collected documents or during the discussions carried out during the data collection missions in the various countries. The studies of prefaisability of these projects were not started yet or are in hand.

Median backbone project

This project is considered by the CEB in its priority development projects. This interconnection would connect Yendi (Ghana) - Kara (Togo) - Bembereke (Benin) and Kaindji (Nigeria). It would be expected by 2020. This project could be justified to reinforce and evacuate the power produced by the site of Kaindji towards the northern zones of these countries.

Nevertheless this project requires to be further specified and studied in details in particular on the following points:

- The station of Yendi in Ghana is rather remote with a relatively low load and there is no project of extension of the 330 kV network of Ghana to connect this 161 kV sub-station. It would be more logical to extend this line to the 330 kV axis crossing Ghana from North to South;
- The other variant is to carry out the median backbone in 161kV, except for the Kainji-Bembereke section, which would be in 330 kV.

Interconnections Liberia – Ivory Coast

A coastal interconnection between Monrovia in Liberia and San Pedro in Ivory Coast is evoked by the concerned countries. This project would allow in particular the evacuation of the hydroelectric project of Tiboto (Cavally), at the border between the two countries.

OMVS interconnections

Regarding the commissioning of the hydraulic site of Gouina (decided project, commissioning estimated in 2017), it will possibly be necessary to reinforce the 225kV network towards Dakar. A loop by the interior of the country is considered via Tambacounda which would also allow a connection with the OMVG network.

A Linsan-Manantali link is also considered to interconnect the dams in project on the territory of Guinea: Boureya and Koukoutamba.

3.1.5.4. OTHER INVESTMENT OPTIONS

In addition to the projects under consideration by previous studies, new projects are left for the PRELE optimization from 2018 on.

- A new interconnection between **Guinea** and the **north of Ivory Coast** (Fomi-Odienne-Boundiala-Ferkessedougou) is proposed. Such an axis would make it possible to directly evacuate the hydroelectric energy produced in Guinea towards the northern areas having few means of production with low operation costs. The layout of this line will be discussed in order to limit its environmental impact.
- In the same optic, a variant of this layout would consist of a line connecting **Guinea** to the area of **Sikasso in Mali**.
- The various installations under consideration for the **median backbone** are proposed as an investment option

Finally, the reinforcement of the existing decided or planned axes is also considered

4. DATA FOR THE ELECTRICAL NETWORK STUDIES

4.1. Actual situation of transmission system per country

This section presents the existing network considering transmission lines, transformers and shunts (capacitive and inductive).

The various collected documents were centralized and synthesized in tables by country. Symbol N/A (*not available*) replaces the missing data.

4.1.1. Senegal

The Senegal's actual electrical network is shown on the two following tables (lines, transformers).

The operating voltage considered for the lines was over 90 kV. The system has 24 transmission lines, 36 transformers and no shunt.

LINES - SENEGAL				
Name of line		**Length [km]**	**Operating Voltage [kV]**	**Thermal Limit [MVA]**
From	**To**			
Dagana	Matam	267	225	250
Kaolack	Touba	70	225	250
Kayes	Manantali (MALI)	184	225	250
Matam	Kayes	256	225	250
Sakal	Dagana	114	225	250
Tobène	Sakal	124,5	225	250
Touba	Tobène	105	225	250
Bel-Air	Hann	5,00,	90	91.9
Bel-Air	Hann	5,50	90	132.9
Bel-Air	Hann	5,50	90	132.9
Cap-Des-Biches	Hann	18,19	90	132.9
Cap-Des-Biches	Hann	16,15	90	86.5
Cap-Des-Biches	Kounoune	6,47	90	91.9
Cap-Des-Biches	Sococim	6,60	90	91.9
Hann	Mbao	10,95	90	86.5
Hann	Kounoune	22,99	90	132.9
Kounoune	Sococim	4,68	90	86.5
Mbao	Cap-Des-Biches	7,18	90	91.9
Sococim	Mbour	46,60	90	139.3
Sococim	Thiona	35,40	90	86.5
Thiona	Tobène	31,35	90	71.7
Tobène	Taïba	13,00	90	132.9
Tobène	Méckhé	35,79	90	86.5
Tobène	Kounoune	55,37	90	132.9

Table 37 – Transmission lines – Senegal

TRANSFORMERS - SENEGAL								
Substation	**V1 (kV)**	**V2 (kV)**	**Sn (MVA)**		**Substation**	**V1 (kV)**	**V2 (kV)**	**Sn (MVA)**
Bel-Air	90	30	80		Cap-des-Biches	7	95	26.5
Bel-Air	90	30	80		Hann	90	33.5	80
Bel-Air	90	6.6	36		Hann	90	33.5	80
Bel-Air	90	6.6	10		Hann	90	33.5	80
Bel-Air	90	6.6	10		Kaolack	225	15	50
Bel-Air	15	90	50		Kaolack	225	15	50
Bel-Air	15	90	50		Kaolack	225	33	40
Bel-Air	11	90	52		Kaolack	225	33	40
Bel-Air	7	6.6	20		Mbao	90	33	40
Cap-des-Biches	90	33.5	33		Mbao	90	33	40
Cap-des-Biches	90	33.5	33		Mbour	90	33	40
Cap-des-Biches	13	90	36		Thiona	90	33	40
Cap-des-Biches	13	93.6	33		Thiona	90	33	40
Cap-des-Biches	13	93.6	33		Tobene	225	90	75
Cap-des-Biches	12	90	40		Tobene	225	90	75
Cap-des-Biches	12	97.2	27		Tobene	90	30	20
Cap-des-Biches	7	95	30		Touba	225	33	40
Cap-des-Biches	7	95	26.5		Touba	225	33	40

Table 38 – Transformers – Senegal

4.1.2. Gambia

The Gambia's actual electrical network is shown on the two following tables (lines, transformers).

The operating voltage considered for the lines was over 33 kV. The system has 10 transmission lines, 12 transformers and no shunt.

LINES - GAMBIA				
Name of line		**Length [km]**	**Operating Voltage [kV]**	**Thermal Limit [MVA]**
From	**To**			
Bijilo	Kotu	8	33	N/A
Brikama	Bijilo	40	33	N/A
Brikama	Medina	N/A	33	N/A
Brikama	Medina	N/A	33	N/A
Brikama	Wellingara	22	33	N/A
Kotu	Mile5	6	33	N/A
Kotu	Wellingara	10	33	N/A
Mile2	Wellingara	17	33	N/A
Mile5	Mile2	6	33	N/A
Kotu	Mile5	6	11	N/A

Table 39 – Transmission lines – Gambia

TRANSFORMERS - GAMBIA			
Substation	V1 (kV)	V2 (kV)	Sn (MVA)
Brikama	33	11	N/A
Brikama	33	11	N/A
Brikama	33	11	N/A
Brikama	33	11	N/A
Bijilo	33	11	N/A
Kotu	33	11	N/A
Kotu	33	11	N/A
Kotu	33	11	N/A
Mile5	33	11	N/A
Mile2	33	11	N/A
Medina	33	11	N/A
Wellingara	33	11	N/A

Table 40 – Transformers – Gambia

4.1.3. Guinea Bissau

The Guinea Bissau's actual electrical network is shown on the two following tables (lines, transformers).

The operating voltage considered for the lines was over 30kV. The system has 2 transmission lines, 4 transformers and no shunt.

LINES - GUINEA BISSAU				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Antula	Centrale	N/A	30	N/A
Centrale	Bra	N/A	30	N/A

Table 41 – Transmission Lines – Guinea Bissau

TRANSFORMERS - GUINEA BISSAU			
Substation	V1 (kV)	V2 (kV)	Sn (MVA)
Antula	30	10	15
Bra	30	10	15
Centrale	30	10	15
Centrale	30	10	15

Table 42 – Transformers – Guinea Bissau

4.1.4. Guinea

The Guinea's actual electrical network is shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 15kV. The system has 24 transmission lines, 37 transformers, one capacitor shunt and three reactor shunts.

LINES - GUINEA				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Linsan	Kindia	65	110	97
Kindia	Gdes Chutes	30,4	110	90
G.chte	Matoto	69	110	97
G.chte	Matoto	69	110	97
G.chte	Matoto	66	110	90
Donkea	Gdes Chutes	13	110	90
G.chtes	Yessoulou	37	60	49
Yessoulou	Manéah	5	60	49
Manéah	Sonfonéah	13	60	49
Sonfonéah	Matoto	10	60	49
Matoto	Libraport	16	60	49
Libraport	Tombo	1	60	40
Dabola	Bissikrima	24	30	N/A
Dabola	Faranah	102	30	N/A
Dalaba	Mamou	43	30	N/A
Derivation	Labé	26	30	N/A
Derivation en T	Dinguiraye	71	30	N/A
Pita	Timbi Madina	10	30	N/A
Pita	Dalaba	48	30	N/A
Timbi Madina	Dervation	10	30	N/A
Usine	Dabola	7	30	N/A
Usine	Pita	5	30	N/A
Donkea	Baneah (Ancienne)	8	15	N/A
Donkea	Baneah (Nouvelle)	8	15	N/A
Grandes Chutes	Donkea	13	15	N/A

Table 43 – Transmission Lines – Guinea

TRANSFORMERS - GUINEA							
Substation	**V1 (kV)**	**V2 (kV)**	**Sn (MVA)**	**Substation**	**V1 (kV)**	**V2 (kV)**	**Sn (MVA)**
Centrale Banéah	15	3.15	2.78	Poste 110 kV Garafiri	114	5.65	31.5
Centrale Banéah	15	3.15	2.78	Poste 110 kV Garafiri	114	5.65	31.5
Centrale Donkéa	110	6.3	8.5	Poste 110 kV Garafiri	114	5.65	31.5
Centrale Donkéa	110	6.3	8.5	Poste CE Sonfonia	60	6.2	4.6
Centrale G.chutes	65	5.5	11	Poste G.cutes	110	60	12.5
Centrale G.chutes	65	5.5	11	Poste Kindia	110	15	15
Centrale G.chutes	60	3.3	6.3	Poste Mamou	110	31.5	15
Centrale G.chutes	60	3.3	6.3	Poste Manéah	55.44	16.5	10
Centrale Tombo1	20	6	6.25	Poste Manéah	20	16.5	8
Centrale Tombo1	20	6.6	6.25	Poste Matoto	121	63	25
Centrale Tombo1	20	6.6	6.25	Poste Matoto	110	20	50
Centrale Tombo1	20	11	3	Poste Matoto	110	20	15
Centrale Tombo2	20	11	6	Poste Matoto	110	20	15
Centrale Tombo2	20	11	6	Poste Sonfonia	55.44	22	10
Centrale Tombo3	20	6.3	16	Poste Tombo	60	20	50
Centrale Tombo3	20	6.3	16	Poste Tombo	55.6	20	15
Centrale Tombo3	20	6.3	16	Poste Tombo	55.6	20	15
Centrale Tombo3	20	6.3	16	Poste Yessoulou	60	0.4	0.3
CentraleGarafiri	110	21	6.3				

Table 44 – Transformers – Guinea

SHUNT CAPACITORS AND REACTORS - GUINEA					
Substation	**Type**	**Voltage (kV)**	**Steps**	**Rating / bank**	**Capacity (MVAr)**
Matoto	Capa.	20	2	-5	-10
Matoto	Ind.	20	2	3.84	7.68
Sonfonéa	Ind.	20	1	3.84	3.84
Tombo	Ind.	20	4	3.84	15.36

Table 45 – Shunts – Guinea

4.1.5. Sierra Leone

The Sierra Leone's actual electrical network is shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 161kV. The system has 6 transmission lines, 9 transformers and 6 reactor shunts.

The nominal power of the transformers is always 100 MVA, regardless their voltages. These values are in red on the table and seem to be not realistic.

LINES - SIERRA LEONE				
Name of line		**Length [km]**	**Operating Voltage [kV]**	**Thermal Limit [MVA]**
From	**To**			
Bumbuna	Goma	142	225	327
Kamakwie	Yonibana	60	225	327
Kenema	Bo	116	225	327
Kenema	Goma	95	225	327
Yonibana	Bumbuna	76	225	327
Freetown	Bumbuna	205	161	201

Table 46 – Transmission Lines – Sierra Leone

TRANSFORMERS - SIERRA LEONE			
Substation	V1 (kV)	V2 (kV)	Sn (MVA)
Bo	225	33	100
Bumbuna	225	161	100
Bumbuna	161	13.8	100
Freetown	225	161	100
Freetown	161	11.8	100
Kamakwie	225	33	100
Kenema	225	33	100
Kenema	33	11	100
Yonibana	225	33	100

Table 47 – Transformers – Sierra Leone

SHUNT CAPACITORS AND REACTORS - SIERRA LEONE					
Substation	Type	Voltage (kV)	Steps	Rating / bank	Capacity (MVAr)
Freetown	cap.	11	-	-	-15
Bo	ind.	225	-	-	10
Bo	ind.	225	-	-	10
Bumbuna	ind.	225	-	-	5
Bumbuna	ind.	225	-	-	10
Kenema	ind.	225	-	-	5

Table 48 – Shunts – Sierra Leone

4.1.6. Liberia

The Liberia's actual electrical network is shown on the two following tables (lines, transformers).

The operating voltage considered for the lines was over 66kV. The system has 4 transmission lines, 4 transformers and no shunt.

LINES - LIBERIA				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Bushrod	Kru Town	7	66	40
Bushrod	Stockton Creek	3	66	40
Stockton Creek	Capitol	5	66	40
Stockton Creek	Paynesville	12	66	40

Table 49 – Transmission Lines – Liberia

TRANSFORMERS - LIBERIA			
Substation	V1 (kV)	V2 (kV)	Sn (MVA)
Bushrod Island	66	22	10
Capitol	66	22	10
Kru Town	66	22	10
Paynesville	66	22	10

Table 50 – Transformers – Liberia

4.1.7. Mali

The Mali's actual electrical network is shown on the two following tables (lines, transformers).

The operating voltage considered for the lines was over 33kV. The system has 24 transmission lines, 47 transformers and no shunt.

LINES - MALI				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Manantali	Kayes (SENEGAL)	184	225	250
Manantali	Kodialani	306	225	N/A
Fana	Ségou	109	150	N/A
Kalabancoro	Sirakoro	17	150	N/A
Kodialani	Lafiabougou	6.42	150	N/A
Kodialani	Kalabancoro	5	150	N/A
Sirakoro	Sélingué	118	150	N/A
Sirakoro	Balingué	12	150	N/A
Sirakoro	Fana	112	150	N/A
Sélingué	Yanfolila	68.5	63	N/A
Balingué	Koulikoro	49.5	33	N/A
Balingué	Sotuba	4.4	33	N/A
Balingué	Pont des Martryr1	3.5	33	N/A
Balingué	Pont des Martryr2	3.5	33	N/A
Darsalam	Martyr 1(aérien)	4	33	N/A
Darsalam	Martyr 2	4.9	33	N/A
Fana	Dioïla	35.7	33	N/A
Lafiabougou	Darsalam	8.385	33	N/A
Lafiabougou	Badalabougou	6	33	N/A
Pont Martyr	Badalabougou (ancien)	1.9	33	N/A
Pont Martyr	Badalabougou (nouveau)	1.9	33	N/A
Ségou(Pélengana)	Markala	40	33	N/A
Sotuba	Badalabougou	7.7	33	N/A
Yanfolila	Kalana	48.5	33	N/A

Table 51 – Transmission Lines – Mali

TRANSFORMERS - MALI							
Substation	V1 (kV)	V2 (kV)	Sn (MVA)	Substation	V1 (kV)	V2 (kV)	Sn (MVA)
Badalabougou	16.5	31.5	20	Kalabancoro	7.045	150	10
Badalabougou	0.4	15	0.16	Kalabancoro	0.4	15	0.15
Balingué	16.5	31.5	7.5	Kalana	6.6	33	5
Balingué	16.5	31.5	6	Koulikoro	15	30	7.5
Balingué	15	150	60	Lafiabougou	15.5	150	30
Balingué	15	150	54	Lafiabougou	7.045	150	10
Balingué	15	30	24	Lafiabougou	0.4	15	0.15
Balingué	10	150	20	Ségou	15.5	150	10
Balingué	6.6	15	2.8	Ségou	15	30	5
Balingué	0.4	15.5	3	Ségou	15	30	5
Balingué	0.4	15	2	Ségou	15	400	0.15
Darsalam	16.5	31.5	10	Ségou	0.4	15	0.8
Darsalam	11	33	30	Sélingué	33	63	12/16
Darsalam	5.5	16.5	8	Sélingué	8.66	150	39/54
Darsalam	5.5	15.5	7	Sélingué	8.66	33	14/20
Darsalam	5.5	15.5	5.3	Sirakoro	15.5	150	22.5
Darsalam	0.4	15.5	1.6	Sotuba	16.5	31.5	8.3
Darsalam	0.4	15.5	1.6	Sotuba	15	30	7.5
Darsalam	0.4	15.5	1.6	Sotuba	2	31.5	3.4
Dioila	0.41	30	1	Sotuba	2	31.5	3.4
Fana	15.5	150	10	Sotuba	0.41	31.5	0.315
Fana	15	30	5	Yanfolila	33	63	12
Fana	15	400	0.15	Yanfolila	0.4	33	0.25
Kalabancoro	15.5	150	30				

Table 52 – Transformers – Mali

4.1.8. Ivory Coast

The Ivory Coast's actual electrical network is shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 90kV. The system has 71 transmission lines, 44 transformers, 8 shunt capacitors and 5 shunt reactors.

LINES - IVORY COAST				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Abobo	Azito	16.7	225	327
Abobo	Azito	16.7	225	327
Abobo	Azito	16.7	225	327
Abobo	Yopougon	8.4	225	327
Azito	Vridi	12.2	225	330
Bouake	Kossou	109.9	225	327
Buyo	Soubre	82.2	225	327
Ferke	Bouake	233.8	225	327
Ferke	Kodeni (BF)	221.8	225	327
Kossou	Taabo	124	225	246
Man	Buyo	193.2	225	327
Man	Laboa	152	225	246
Prestea (GHN)	Abobo	220	225	327
Riviera	Vridi	19.6	225	327
Soubre	Taabo	196	225	327
Soubre	San Pedro	117	225	327
Taabo	Abobo	170	225	246
Taabo	Abobo	170	225	327
Yopougon	Azito	8.4	225	327
Abobo	Bianord	5	90	72
Abobo	Bianord	5	90	72
Abobo	Bongo	58.1	90	75
Abobo	Plateau	2.5	90	75
Abobo	Dabou	58	90	75
Abobo	Yopougon	13.8	90	72
Agboville	Yopougon	34	90	75
Agnibilikro	Abengourou	53	90	75
Attakro	Abengourou	40	90	75
Ayame	Ayame	4	90	72
Ayame	Abrobakro	59	90	72
Bassam	Abrobakro	25	90	72
Bianord	Riviera	10.3	90	72
Biasud	Riviera	11	90	72
Biasud	Riviera	11	90	72
Bongo	Ayame	65.7	90	72
Bouake	Marabadiasa	82	90	75
Bouake	Serebou	132	90	75
Bouake	Bouake	26.4	90	75
Bouake	Kossou	115.3	90	72
Boundiali	Korhogo	103.5	90	75
Buyo	Daloa	112	90	75
Daloa	Kossou	110.6	90	75
Dimbokro	Attakro	103.9	90	75
Divo	Hire	32	90	75
Gagnoa	Kossou	120	90	72
Gagnoa	Divo	81	90	75
Hire	Taabo	32	90	75
Korhogo	Ferke	48.3	90	72
Kossou	Yamoussokro	53.3	90	72
Laboa	Seguela	82	90	75
Laboa	Man	152	90	132
Man	Danane	76.8	90	75
Odienne	Boundiali	123.1	90	75
Odienne	Laboa	122.2	90	75
Plateau	Treichville	3.8	90	75
Plateau	Treichville	3.8	90	75
Plateau	Bianord	2.5	90	75
Riviera	Bassam	28.6	90	72
San Pedro	Faye	38	90	75
Sir	Vridi	7	90	75
Soubre	San Pedro	117	90	132
Taabo	Dimbokro	72.2	90	75
Taabo	Agboville	119	90	75
Treichville	Vridi	6.5	90	100
Treichville	Vridi	6.5	90	100
Vridi	Biasud	8	90	72
Vridi	Biasud	8	90	72
Yamoussokro	Dimbokro	67.4	90	72
Yopougon	Abobo	34	90	75
Yopougon	Vridi	15.7	90	72
Zuenoula	Kossou	92.7	90	75

Table 53 – Transmission Lines – Ivory Coast

TRANSFORMERS - IVORY COAST								
Substation	V1 (kV)	V2 (kV)	Sn (MVA)		Substation	V1 (kV)	V2 (kV)	Sn (MVA)
Abobo	225	93	70		Laboa	225	93	50
Abobo	225	93	70		Man	225	93	70
Abobo	225	93	70		Riviera	225	90	70
Abobo	225	93	70		San Pedro	225	93	65
Ayame	5.5	90	15		San Pedro	225	93	70
Ayame	5.5	90	19		Soubre	225	93	70
Ayame	5.5	90	15		Taabo	225	93	70
Ayame	5.5	90	19		Taabo	225	93	70
Azito	15.75	230	190		Taabo	13.8	235	82.5
Azito	15.75	230	190		Taabo	13.8	235	82.5
Azito	15.75	230	190		Taabo	13.8	235	82.5
Bouake	225	93	70		Vridi	225	93	70
Buyo	225	93	70		Vridi	225	93	70
Buyo	10.5	235	61		Vridi	225	93	70
Buyo	10.5	235	61		Vridi	11	97	51
Buyo	10.5	95	82.5		Vridi	11	97	51
Ciprel	11	97	151		Vridi	11	97	51
Ferke	225	96	65		Vridi	11	235	61
Kossou	225	96	65		Vridi	11	235	61
Kossou	17	240	72		Vridi	15	236	151
Kossou	17	240	72		Yopougon	225	93	100
Kossou	17	95	72		Yopougon	225	93	100

Table 54 – Transformers – Ivory Coast

SHUNT CAPACITORS AND REACTORS - IVORY COAST					
Substation	Type	Voltage (kV)	Steps	Rating / bank	Capacity (MVAr)
Abobo	Capa.	15	3	-7.2	-14.4
Bia - Nord	Capa.	15	5	-7.2	-21.6
Bia - Sud	Capa.	15	4	-7.2	-21.6
Plateau	Capa.	15	2	-7.2	-14.4
Riviera	Capa.	15	1	-7.2	-7.2
Treichville	Capa.	15	3	-7.2	-21.6
Vridi	Capa.	15	3	-7.2	-21.6
Yopougon	Capa.	15	5	-7.2	-21.6
Bouake	Ind.	90	1	20	0
Ferke	Ind.	225	1	40	40
Laboa	Ind.	225	1	20	20
Man	Ind.	225	1	20	20
Soubre	Ind.	225	1	40	40

Table 55 – Shunts – Ivory Coast

4.1.9. Ghana

The Ghana's actual electrical network is shown on the four following tables (lines, transformers, capacities, reactors).

The operating voltage considered for the lines was over 69kV. The system has 82 transmission lines, 99 transformers, 29 shunts.

LINES - GHANA									
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]	Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To				From	To			
Akosombo	Kpong SS-1	16.1	161	213	Tarkwa	New Tarkwa	8.3	161	170
Akosombo	Kpong SS-2	16.1	161	213	Prestea	Abobo (IC)	220	225	327
Kpong SS	Volta-1	51.5	161	213	Border	Abobo	145.6	225	327
Kpong SS	Volta-2	51.5	161	213	Prestea	Bogoso	13	161	150
Akosombo	Volta-1	67.6	161	213	Bogoso	Dunkwa	66	161	150
Akosombo	Volta-2	67.6	161	213	Bogoso	Wexford	51	161	182
Akosombo	Volta-3	67.6	161	213	Dunkwa	Asawinso	69.2	161	142
Akosombo	Volta-4	67.6	161	213	Dunkwa	New Obuasi	24.9	161	170
Akosombo	Kpong GS	24.6	161	213	New Obuasi	Obuasi	7.1	161	170
Kpong GS	Volta	63.2	161	273	Kumasi	Tow26-2	10	161	364
Akosombo	Tafo-1	61.2	161	170	Tow26-2	Kenyasi	94	161	244
Akosombo	Tafo-2	61.2	161	182x2	Obuasi	Tow26-1	43.1	161	170
Akosombo	Asiekpe	54.7	161	128	Tow26-1	Kenyasi	94	161	244
Asiekpe	Lome (TOG)	54.7	161	128	Kumasi	New Obuasi	-	161	364
Akosombo	Aflao	124.8	161	128	Prestea	Obuasi	112.2	161	182x2
Aflao	Lome (TOG)	3.9	161	128	New Obuasi	Akwatia	110	161	244
Akosombo	Kumasi	226.3	161	182x2	Kumasi	Konogo	51.5	161	170
Volta	Smelter-1	5.2	161	213	Konogo	Nkawkaw	53.1	161	170
Volta	Smelter-2	5.2	161	213	Nkawkaw	Tafo	59.5	161	170
Volta	Smelter-3	5.2	161	213	Tafo	Akwatia	54.7	161	170
Volta	Smelter-4	5.2	161	213	Kumasi	Techiman	115	161	182x2
Volta	Smelter-5	5.2	161	213	Techiman	Sunyani	54.9	161	244
Volta	Smelter-6	5.2	161	213	Techiman	Tamale	248.1	161	182x2
Volta	New Tema-1	3.2	161	182x2	Techiman	Teselima	89.1	161	182x2
Volta	New Tema-2	3.2	161	182x2	Teselima	Sawla	128.6	161	182
Volta	Achimota-1	25.7	161	213	Tamale	Bolgatanga	158.1	161	244
Volta	Achimota-2	25.7	161	213	Tamale	Yendi	100	161	182
Volta	Achimota-3	25.7	161	213	Sunyani	Kenyasi	40	161	182x2
Achimota	Mallam	15	161	170	Aboadze	Volta	215	330	500x2
Achimota	Winneba	57.9	161	170	Sawla	Wa	95	161/34.5	182/39
Mallam	Cape Coast	116.9	161	150	Asiekpe	Ho	44	69	57
Winneba	Aboadze	132	161	150	Ho	Kpeve	22	69	57
Cape Coast	Aboadze	58	161	150	Kpeve	Kpandu	35.6	69	57
Aboadze	Prestea	83	161	182x2	Asiekpe	Sogakofe	31.2	69	57
Aboadze	Takoradi-1	15	161	170	Sunyani	Mim	60	161/34.5	182/39
Aboadze	Takoradi-2	15	161	170	Bolgatanga	Bawku	80	161/34.5	182/39
Takoradi	Essiama	70.5	161	182	Bawku	Dapaong (TOG)	65	161/34.5	182/39
Essiama	Barge (OPB)	-	161	364	Volta	Asogli (Dum)	-	161	213
Barge (OPB)	Elubo	-	161	364	New Tema	TT1P	-	161	213
Takoradi	Tarkwa	51.5	161	170	Afloa	DCEM	-	161	180
New Tarkwa	Prestea	21.9	161	170	Asogli	Asogli (Dum)	-	161	324

Table 56 – Transmission Lines – Ghana

TRANSFORMERS - GHANA				
Substation	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**
Achimota	161	34.5		66
Aboadze	13.8	169		155
Aboadze	13.8	169		155
Aboadze	13.8	169		155
Aboadze	13.8	161		155
Aboadze	13.8	161		155
Achimota	161	34.5		66
Achimota	161	34.5		66
Achimota	161	34.5		66
Achimota	161	34.5		66
Aflao	161	34.5		33
Ahafo	161	11.5		40/53
Ahafo	161	11.5		40/53
Akosombo	14.4	161		200
Akosombo	14.4	161		200
Akosombo	14.4	161		200
Akosombo	14.4	161		200
Akosombo	14.4	161		200
Akosombo	14.4	161		200
Akosombo	161	11.5		13.3
Akwatia	161	11.5	6.63	5
Akwatia	161	34.5		13.3
Asawinso	161	34.5		13.3
Asawinso	161	34.5		33
Asiekpe	161	74.29	11.7	33
Asiekpe	161	74.29	11.7	33
Bogoso	161	34.5		33
Bogoso	161	34.5		33
Bolgatanga	161	36	11.5	20
Cape Coast	161	11.5	6.64	13.3
Cape Coast	161	34.5	11.5	33
Dunkwa	161	11.5	6.63	5
Elubo	225	161		200
Essiama	161	34.5		33
Ho	69	11.65		7
Konongo	161	11.5	6.63	5
Konongo	161	11.5	6.63	5
Kpando	69	34.95	6.6	20
Kpeve	69	34.95		7
Kpong Gs	13.8	169		51
Kpong Gs	13.8	169		51
Kpong Gs	13.8	169		51
Kpong Gs	13.8	169		51
Kpong Gs	161	11.5		5
Kumasi	161	11.5	6.6	18.2
Kumasi	161	11.5	6.6	18.2
Kumasi	161	34.5		66
Kumasi	161	34.5		66
Kumasi	161	34.5		33
Mallam	161	34.5		66
Mallam	161	34.5		66
New Obuasi	161	11.5	6.58	33
New Obuasi	161	11.5	6.58	33
New Obuasi	161	11.5	6.58	33
New Tarkwa	161	11.5	6.6	33
New Tarkwa	161	11.5	6.6	33
New Tema	161	11.5	3.3	20
New Tema	161	34.5		66
New Tema	161	34.5		33
New Tema	161	34.5		66
New Tema	161	34.5		66
Nkawkaw	161	11.5	6.64	13.3
Obuasi	161	6.64	11.5	20
Obuasi	161	6.64	11.5	20
Obuasi	161	6.64	11.5	20
Old Kpong	161	34.5		33
Old Kpong	161	34.5		33
Prestea	161	55	6.63	13.3
Prestea	161	55	6.63	20
Prestea	225	161	13.2	200
Prestea	225	161	13.2	200
Prestea	13.2	161		26.7
Sawla	161	36		13.3
Smelter	161	13.8		18
Smelter	161	13.8		18
Smelter	161	13.8		85
Smelter	161	13.8		85
Smelter	161	13.8		85
Smelter	161	13.8		85
Smelter	161	13.8		85
Smelter	161	13.8		85
Sogakope	69	34.5		15
Sunyani	161	36	11.5	20
Sunyani	161	36	11.5	20
Tafo	161	11.5	6.64	13.3
Tafo	161	34.5		33
Takoradi	161	34.5		33
Takoradi	161	34.5		33
Tamale	161	36	11.5	20
Tamale	161	36	11.5	20
Tarkwa	161	34.5		33
Tarkwa	161	34.5		33
Techiman	161	36	11.5	20
Techiman	161	34.5		20
Wexford	161	34.5		33
Winneba	161	11.5	6.63	5
Winneba	161	11.5	6.64	20
Yendi	161	34.5		13.3
Zebila	161	34.5		33

Table 57 – Transformers – Ghana

SHUNT CAPACITORS - GHANA					
Substation	**Type**	**Voltage (kV)**	**Steps**	**Rating / bank**	**Capacity (MVAr)**
Achimota	Capa.	34.5	2	-22.6	-45.2
Achimota	Capa.	34.5	2	-21.6	-43.2
Asawinso	Capa.	34.5	1	-10.8	-10.8
Cape Coast	Capa.	11.5	1	-1.2	-1.2
Kenyase	Capa.	11	1	SVC	-40
Kpando	Capa.	34.5	1	-5.4	-5.4
Kumasi	Capa.	11.5	2	-1.8	-1.8
Kumasi	Capa.	11.5	1	-5.4	-5.4
Kumasi	Capa.	34.5	2	-10.8	-21.6
Kumasi	Capa.	34.5	1	-12	-12
Kumasi	Capa.	161	1	-25	-25
Kumasi	Capa.	34.5	1	-21.6	-21.6
Mallam	Capa.	34.5	2	-10.8	-21.6
New Obuasi	Capa.	11.5	3	-5.4	-16.2
New Tema	Capa.	34.5	1	-10.8	-10.8
Obuasi	Capa.	6.6	4	-1.8	-7.2
Prestea	Capa.	6.6	4	-1.2	-4.8
Prestea	Capa.	13.2	2	-20	-40
Smelter	Capa.	14.4	4	-21.6	-86.4
Suniany	Capa.	34.5	2	-5.4	-10.8
Suniany	Capa.	11.5	2	-5.4	-10.8
Takoradi	Capa.	34.5	3	-10.8	-32.4
Techiman	Capa.	34.5	1	-10.8	-5.4
Winneba	Capa.	34.5	2	-10.8	-21.6

Table 58 – Capacities Shunt – Ghana

SHUNT REACTORS - GHANA				
Substation	**Voltage (kV)**	**Steps**	**Reactive shunt (MVAr)**	
			Min	**Max**
Bolga	161	16	8.5	17
Tamale	161	16	8.5	17
Tamale	161	16	8.5	17
Techiman	161	16	8.5	17
Sawla	161	16	8.5	17

Table 59 – Self-service shunt – Ghana

4.1.10. Togo/Benin

The Togo' and Benin's actual electrical networks are shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 63kV. The system has 42 transmission lines, 64 transformers, 3 shunts.

LINES - TOGO/BENIN									
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]	Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To				From	To			
Ikeja West (NIG)	Sakete	75	330	686	Momé Hagou	Lomé Aflao 2	56	161	105
Atakpamé	Nangbéto	36.5	161	120	Momé Hagou	Nangbéto	116	161	120
Ava	Momé Hagou	54	161	105	Nangbéto	Bohicon	80.3	161	120
Bohicon	Onigbolo	75	161	120	Parakou	Onigbolo	300	161	120
Dapaong	Bawku (GHN)	65	161	182	Sakété	Maria Gréta 1	55	161	120
Djougou	Parakou	131	161	120	Sakété	Maria Gréta 2	55	161	120
Kara	Atakpamé	239	161	120	Sakété	Tanzoun1	28	161	120
Kara	Djougou	58	161	120	Sakété	Tanzoun2	28	161	120
Kara	Mango	137	161	120	Sakété	Onigbolo	47	161	120
Lomé Aflao	Asiekpe (GHN)	54.7	161	128	Sakété	Cotonou Vêdoko	N/A	161	N/A
Lomé Aflao	Aflao (GHN)	3.9	161	128	Birnin-Kebbi (NIG)	Niamey	252	132	84.6
Lomé Port	Lomé Aflao 1	17.2	161	120	Kara	Sokodé	76	66	30
Lomé Port	Lomé Aflao 2	17.2	161	120	CAK	PNO	33	63	65
Mango	Dapaong	75	161	120	CGB	CAK	5.5	63	90
Maria Gréta	Cotonou Vêdoko 1	11	161	120	Cotonou Vêdoko	CGB	4.43	63	90
Maria Gréta	Cotonou Vêdoko 2	11	161	120	Momé Hagou	CIMAO	10	63	40
Maria Gréta	Cotonou Vêdoko 3	11	161	120	Momé Hagou	Anfouin	20	63	90
Maria Gréta	Cotonou Vêdoko 4	11	161	120	Momé Hagou	Lokossa	29	63	90
Maria Gréta	Ava	38	161	105	Momé Hagou	Scantogo	15	63	40
Maria Gréta	Momé Hagou	92	161	105	TAN	PNO	70	63	90
Momé Hagou	Lomé Aflao 1	56	161	105	TAN	PNO	70	63	90

Table 60 – Transmission Lines – Togo/Benin

TRANSFORMERS - TOGO/BENIN									
Substation	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**	**Substation**	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**
Anfoin	161	20		16.6	Lomé Aflao	161	21	10.5	35
Atakpamé	161	20		16	Lome Port	161	20		35
Atakpamé	161	20		16	Lome Port	161	20		25
Avakpa	155	15		19	Lome Port	11	161		35
Bembereke	161	34	20	12.5	Lomé Port GT CEB	11	166		32
Bembereke	161	34	20	12.5	Lomé Port Sub	161	20		
Bohicon	161	20		20	Lomé Port Sub	161	20		
Bohicon	161	63		20	Malanville	161	34	20	12.5
CIN	161	20		35	Malanville	161	34	20	12.5
ContorGlobal	15	161		63	Mango	161	20		12.5
ContorGlobal	15	161		63	Mango	161	20		12.5
ContorGlobal	15	20		20	Maria Gléta	161	15		19
Cotonou Apkapka	63	15		20	Maria Gléta GT CEB	11	161		32
Cotonou Apkapka	63	15		20	Mome Hagou	161	63		50
Cotonou Apkapka	5.5	63		10.2	Mome Hagou	161	63		50
Cotonou Apkapka	5.5	63		10.2	Nangbéto	10.3	166		35.5
Cotonou Apkapka	5.5	15		4	Nangbéto	10.3	166		35.5
Cotonou Apkapka	5.5	15		4	Nangbéto	10.3	161		35.5
Cotonou Gbegamey	62	15		20	Nangbéto	10.3	161		35.5
Dapaong	161	34	20	12.5	Onigbolo	161	20		35
Dapaong	161	34	20	12.5	Onigbolo	161	20		35
Djougou	161	34	20	20	Parakou	161	34	20	20
Kandi	161	34	20	12.5	Sakete	330	161		200
Kandi	161	34	20	12.5	Sakete	330	161		200
Kara	161	34	22	20	Sakete	161	20		35
Kara	161	34	22	20	Sokode	161	66	20	50
Legbassito	161	20		50	Sokode	161	66	20	50
Legbassito	161	20		50	Tanzoun	161	63	20-15	80
Lokossa	63	20		16.5	Tanzoun	161	63	20-15	80
Lokossa	63	20		16.5	Vedoko	161	63		80
Lomé Aflao	161	21	10.5	50	Vedoko	161	63	15	55
Lomé Aflao	161	21	10.5	50	Vedoko	161	15		40

Table 61 – Transformers – Togo/Benin

SHUNT CAPACITORS AND REACTORS - TOGO/BENIN					
Substation	**Type**	**Voltage (kV)**	**Steps**	**Rating / bank**	**Capacity (MVAr)**
Kara	ind.	161	-	-	18
Onigbolo	ind.	161	3	3	9
Parakou	ind.	161	3	3	9

Table 62 – Shunts – Togo/Benin

4.1.11. Burkina Faso

The Burkina Faso's actual electrical network is shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 33kV. The system has 40 transmission lines, 76 transformers, 19 shunts.

LINES - BURKINA FASO				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Ferke (IC)	Kodeni	221	225	327
Kodeni	Pa	134	225	327
Pa	Zagtouli	204	225	327
Bagre	Zano	32	132	110
Kompienga	Zano	140	132	110
Zano	Patte D'Oie	143	132	110
Zagtouli	Koudougou	82	90	75
Ouaga1	Ouaga2	5	90	75
Ouaga1	P.C	4	90	75
Patte D'Oie	Zagtouli	32	90	75
P.C	Kossodo	4	90	72
Zagtouli	Ouaga2	15	90	72
Kossodo	Ziniaré	30	33	21
Koupèla	Tenkodogo	55	33	21
Kombissiri	Manga	56	33	21
Tenkodogo	Zano	10	33	21
Ziga	Ziniaré	52	33	21
Ziniaré	Kaya	90	33	21
Zano	Koupèla	42	33	21
Bobo1	Bobo2	4	33	17
Kodeni	Bobo2	4	33	17
Kodeni	Bobo2	4	33	17
Koua	Bobo1	8	33	17
Koua	Kodeni	12	33	17
Kodeni	P.D	64	33	17
P.D	Banfora	18	33	17
P.D	Orodara	32	33	17
Banfora	Niofila	42	33	17
Niofila	Tourni	10	33	17
Komsilga	Ouaga 2000	7	33	17
Kossodo	Ouaga1	7	33	17
Kossodo	Ouaga2	12	33	17
Ouaga 2000	Patte D'Oie	5	33	17
Ouaga1	Ouaga2	5	33	17
Patte D'Oie	Ouaga2	14	33	17
Patte D'Oie	Kossodo	13	33	17
Zagtouli	Komsilga	15	33	17
Kompienga	Pama	35	33	11
Ouaga 2000	Kombissiri	53	33	11
Banfora	Niangoloko	49	33	8

Table 63 – Transmission Lines – Burkina Faso

TRANSFORMERS - BURKINA FASO									
Substation	**V1 (kV)**	**V2 (kV)**	**Sn (MVA)**		**Substation**	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**
BAGRE	132	6.6	10		KOUA	33	15		10
BAGRE	132	6.6	10		KOUA	33	15		10
BAGRE	6.6	132	10		KOUDOUGOU	33	15		6
BAGRE	6.6	132	10		KOUDOUGOU	5.5	15		2
BANFORA	33	20	5		KOUDOUGOU	5.5	15		2
BOBO1	33	15	10		KOUDOUGOU	5.5	15		2.5
BOBO1	33	15	10		KOUDOUGOU	0.4	15		1
BOBO1	5.5	15.75	2		KOUDOUGOU	0.4	15		0.8
BOBO1	5.5	15.75	2		NIOFILA	0.4	33		1
BOBO1	5.5	15	2		NIOFILA	0.4	33		1
BOBO1	5.5	15	2		OUAGA 1	90	33		30-40
BOBO2	33	15	10		OUAGA 1	33	16		15
BOBO2	33	15	10		OUAGA 1	33	16		15
BOBO2	5.5	34.5	5		OUAGA 1	33	16		15
BOBO2	5.5	34.5	5		OUAGA 1	6.3	15.75		4
BOBO2	5.5	34.5	5		OUAGA 1	6.3	15.75		4
BOBO2	5.5	15	4.75		OUAGA 1	5.5	16.68		5
BOBO2	5.5	15	4.75		OUAGA 2	90	33		30-40
KODENI	225	35.5	40		OUAGA 2	35.5	15		15
KODENI	225	35.5	40		OUAGA 2	35.5	15		15
KODENI	33	34.5	5		OUAGA 2	5.5	16.4		6.6
KOMPIENGA	132	6.6	10		OUAGA 2	5.5	16.4		6.6
KOMPIENGA	132	6.6	10		OUAGA 2	5.5	16.4		6.6
KOMPIENGA	6.6	132	10		OUAGA 2	5.5	16.4		10.65
KOMSILGA	11	33	25		OUAGA 2	5.5	16.4		10.65
KOSSODO	90	33	30-40		OUAGA 2000	33	15		15
KOSSODO	90	33	30-40		OUAGA 2000	33	15		15
KOSSODO	33	16	15		PA	225	33	34.5	10/5/5
KOSSODO	33	16	15		PATTE D'OIE	132	33		10
KOSSODO	33	15	15		PATTE D'OIE	132	33		10
KOSSODO G1	11	34.5	5		PATTE D'OIE	132	33		10
KOSSODO G2	15	33	8		PATTE D'OIE	33	15.89		15
KOSSODO G3	15	33	8		PATTE D'OIE	33	15.89		15
KOSSODO G4	11	33	8		TOURNI	0.4	33		1
KOSSODO G5	11	33	8		ZAGTOULI	225	90		70
KOSSODO G6	11	35	10.5		ZAGTOULI	225	90		70
KOSSODO G7	11	35	10.5		ZAGTOULI	90	33	34.5	20/15/5
KOSSODO G8	11	34.5	23		ZANO	132	33		5

Table 64 – Transformers – Burkina Faso

SHUNT CAPACITORS AND REACTORS - BURKINA FASO					
Substation	**Type**	**Voltage (kV)**	**Steps**	**Rating / bank**	**Capacity (MVAr)**
BANFORA	Capa.	20.0	4	-0.6	-2.4
KOSSODO	Capa.	15.0	1	-0.9	-0.9
KOSSODO	Capa.	15.0	2	-0.7	-1.4
KOSSODO	Capa.	15.0	1	-4.8	-4.8
OUAGA1	Capa.	15.0	1	-0.3	-0.3
OUAGA1	Capa.	15.0	1	-0.6	-0.6
OUAGA1	Capa.	15.0	1	-4.8	-4.8
OUAGA1	Capa.	15.0	5	-1.2	-6.0
OUAGA2	Capa.	15.0	1	-3.0	-3.0
OUAGA2	Capa.	15.0	2	-1.5	-3.0
OUAGA2	Capa.	15.0	4	-4.8	-19.2
OUAGA2000	Capa.	15.0	1	-4.8	-4.8
PATTE D'OIE	Capa.	15.0	1	-4.8	-4.8
KODENI	Ind.	225.0	21	1.4	30.0
KOMPIENGA	Ind.	132.0	1	4.5	4.5
PA	Ind.	225.0	1	30.0	30.0
PATTE D'OIE	Ind.	132.0	1	4.5	4.5
PATTE D'OIE	Ind.	33.0	1	3.5	3.5
ZAGTOULI	Ind.	225.0	2	15.0	30.0

Table 65 – Shunts – Burkina Faso

4.1.12. Niger

The Niger's actual electrical network is shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 66kV. The system has 11 transmission lines, 21 transformers and 3 shunts.

LINES - NIGER				
Name of line		**Length [km]**	**Operating Voltage [kV]**	**Thermal Limit [MVA]**
From	**To**			
Dosso	Niamey 2	132	132	N/A
Gazoua	Kastina (NIG)	72	132	84.6
Gazoua	Dosso	78	132	N/A
Goudel	Karma	32	66	N/A
Goudel	Niamey Nord	9	66	N/A
Karma	Lossa	41	66	N/A
Kollo	Say	22	66	N/A
Lossa	Tillabéry	30	66	N/A
Niamey 2	Kollo	31	66	N/A
Niamey 2	Niamey Nord	13	66	N/A
Niamey Nord	Goudel	4	66	N/A

Table 66 – Transmission Lines – Niger

TRANSFORMERS - NIGER				
Substation	V1 (kV)	V2 (kV)	V3 (kV)	Sn (MVA)
Dosso	132	20	0.38	5
Goudel	66	20		10
Goudel	66	20		10
Goudel	20	5.65		16
Karma	66	20		2
Kollo	66	20		2
Lossa	66	20		2
Lossa	66	33		10
Niamey 2	132	66		15
Niamey 2	132	66		10
Niamey 2	132	20		20
Niamey 2	132	20		20
Niamey 2	20	10.5		16
Niamey 2	20	10.5		16
Niamey 2	20	5		4
Niamey 2	20	5		4
Niamey 2	20	5		4
Niamey 2	20	5		4
Niamey Nord	66	20		10
Say	66	20		6.3
Tillabéry	66	20		6.3

Table 67 – Transformers – Niger

SHUNT CAPACITORS AND REACTORS - NIGER					
Substation	Type	Voltage (kV)	Steps	Rating / bank	Capacity (MVAr)
Goudel	ind.	20	-	-	4
Niamey 2	ind.	20	-	-	5
Niamey 2	ind.	20	-	-	5

Table 68 – Shunts – Niger

4.1.13. Nigeria

The Nigeria's actual electrical network is shown on the three following tables (lines, transformers, shunts).

The operating voltage considered for the lines was over 132kV. The system has 191 transmission lines, 286 transformers and 18 shunts.

LINES - NIGERIA									
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]	Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To				From	To			
Afam	Alaoji	25	330	777	Afam	Alaoji	29	132	91
Afam	Alaoji	25	330	777	Afam	Alaoji	29	132	91
Aja	Egbin	14	330	777	Afam	P.H. Main	33	132	91
Aja	Egbin	14	330	777	Afam	P.H. Main	33	132	91
Ajaokuta	Benin	195	330	777	Agbara	Ikeja West	22	132	126
Ajaokuta	Benin	195	330	777	Agbara	Ikeja West	22	132	126
Akangba	Ikeja West	18	330	777	Agbara	Ojo	16	132	126
Akangba	Ikeja West	18	330	777	Agbara	Ojo	16	132	126
Aladja	Delta	32	330	777	Aja	Alagbon	20	132	N/A
Aladja	Sapele	63	330	777	Aja	Alagbon	20	132	N/A
Alaoji	Onitsha	138	330	777	Ajaokuta	Ajaokuta Town	10	132	91
Ayede	Oshogbo	119	330	777	Ajaokuta	Itakpe	45	132	91
Ayede	Ikeja West	137	330	777	Ajaokuta Town	Okene	60	132	91
Benin	Delta	107	330	777	Akangba	Ijora	5	132	91.5
Benin	Sapele	50	330	777	Akangba	Ijora	5	132	91.5
Benin	Sapele	50	330	777	Akangba A	Isolo	6	132	91.5
Benin	Sapele	50	330	777	Akangba A	Isolo	6	132	91.5
Benin	Ikeja West	280	330	777	Akangba B	Amuwo-Odofin	5	132	126
Benin	Ikeja West	280	330	777	Akangba B	Itire	3	132	126
Benin	Onitsha	137	330	777	Akangba B	Itire	3	132	126
Benin	Oshogbo	251	330	777	Akangba C	Apapa-Road	8	132	N/A
Birnin-Kebbi	Kainji	310	330	720	Akoka	Alagbon	13	132	126
Egbin	Ikeja West	62	330	777	Akoka	Ijora	10	132	126
Egbin	Ikeja West	62	330	777	Akoka	Oworonshoki	4	132	126
Gombe	Jos	265	330	720	Akoka	Oworonshoki	4	132	126
Ikeja West	Sakete (BEN)	75	330	686	Akure	Oshogbo A	92	132	70
Ikeja West	Oshogbo	235	330	777	Akwanga	Keffi	62	132	N/A
Jebba G.S.	Jebba T.S.	8	330	N/A	Alagbon	Ijora	4	132	126
Jebba G.S.	Jebba T.S.	8	330	N/A	Alaoji	Owerri	60	132	91
Jebba T.S.	Kainji	81	330	720	Alaoji	Owerri	60	132	91
Jebba T.S.	Kainji	81	330	720	Alausa	Ogba	2	132	126
Jebba T.S.	Shiroro	244	330	720	Alausa	Ogba	2	132	126
Jebba T.S.	Shiroro	244	330	720	Aliade	Makurdi	50	132	N/A
Jebba T.S.	Oshogbo	157	330	720	Aliade	Oturkpo	39	132	N/A
Jebba T.S.	Oshogbo	157	330	720	Aliade	Yandev	60	132	N/A
Jebba T.S.	Oshogbo	157	330	720	Alimosho	Ikeja West	3	132	126
Jos	Kaduna	197	330	720	Alimosho	Ikeja West	3	132	126
Kaduna	Kano	230	330	720	Alimosho	Ogba	9	132	126
Kaduna	Shiroro	95	330	720	Alimosho	Ogba	9	132	126
Kaduna	Shiroro	95	330	720	Amuwo-Odofin	Apapa-Road	7	132	126
Katampe	Shiroro	150	330	720	Amuwo-Odofin	Ojo	8	132	126
Katampe	Shiroro	150	330	720	Amuwo-Odofin	Ojo	8	132	126
New Haven	Onitsha	96	330	777	Ashaka Cements	Gombe	84	132	84.5
Aba	Alaoji	8	132	91	Ashaka Cements	Potiskum	94	132	84.5
Aba	Alaoji	8	132	91	Awka	Oji River	33	132	N/A
Aba	Itu	64	132	91	Awka	Onitsha	30	132	N/A
Abakaliki	Nkalagu	54	132	91	Ayede	Ibadan North	2	132	91
Abeokuta	Papalanto	35	132	91.5	Ayede	Jericho	2	132	91
Abuja	Katampe	15	132	N/A	Ayede	Sagamu	54	132	91
Abuja	Katampe	15	132	N/A	Bauchi	Gombe	146	132	84.6
Abuja	Keffi	51	132	N/A	Bauchi	Jos	118	132	84.6
Abuja Central	Abuja Gr. Cable	4	132	N/A	Benin	Delta	96	132	126
Abuja Central	Abuja Gr. Cable	4	132	N/A	Benin	Delta	96	132	126
Abuja Gr. Cable	Katampe	6	132	N/A	Benin	Irrua	81	132	91
Abuja Gr. Cable	Katampe	6	132	N/A	Benin	Okene	183	132	91

Table 69 – Transmission Lines – Nigeria (1/2)

LINES - NIGERIA				
Name of line		Length [km]	Operating Voltage [kV]	Thermal Limit [MVA]
From	To			
Bida	Minna	90	132	N/A
Birnin-Kebbi	Niamey (BEN)	252	132	84.6
Birnin-Kebbi	Sokoto	130	132	84.6
Biu	Damboa	142	132	66.3
Biu	Dadinkowa	82	132	66.3
Calabar	Itu	70	132	N/A
Dadinkowa	Gombe	44	132	84
Dakata	Kano	18	132	N/A
Damboa	Maiduguri	71	132	66.3
Dan-Agundi	Kano	9	132	84.6
Delta	Effurun	36	132	N/A
Egbin	Ikorodu	18	132	N/A
Egbin	Ikorodu	18	132	N/A
Ejigbo	Ikeja West	13	132	126
Ejigbo	Ikeja West	13	132	126
Ejigbo	Itire	8	132	126
Ejigbo	Itire	8	132	126
Eket	Uyo	44	132	91
Funtua	Gusau	110	132	84.6
Funtua	Zaria	70	132	84.6
Gazaoua (NIGER)	Katsina	72	132	84.6
Gcm	Onitsha	18	132	N/A
Gombe	Savannah	92	132	66.3
Gusau	Talata-Mafara	85	132	84.6
Hadejia	Kano	247	132	66
Ibadan North	Iwo	18	132	91
Ife	Ilesa Tee	15	132	91
Ife	Ondo	58	132	91
Ijebu-Ode	Sagamu	40	132	N/A
Ikeja West	Ilupeju	17	132	126
Ikeja West	Ilupeju	17	132	126
Ikeja West	Otta	10	132	126
Ikeja West	Otta	10	132	126
Ikeja West	Oworonshoki	10	132	126
Ikeja West	Oworonshoki	10	132	126
Ikorodu	Maryland	20	132	126
Ikorodu	Maryland	20	132	126
Ikorodu	Sagamu Cements	40	132	N/A
Ilesa	Ilesa Tee	20	132	91
Ilesa Tee	Oshogbo B	15	132	91
Ilorin	Ofa	55	132	70
Ilupeju	Maryland	2	132	95.5
Ilupeju	Maryland	2	132	95.5
Irrua	Ukpilla	43	132	N/A
Iseyin	Iwo	71	132	91
Itu	Uyo	20	132	91
Iwo	Oshogbo A	80	132	66.3
Jos	Makeri	50	132	84.5
Jos	Makeri	50	132	84.5
Kaduna	Kaduna Town	20	132	N/A
Kaduna	Kaduna Town	20	132	N/A
Kaduna	Zaria	62	132	N/A
Kankia	Kano	113	132	84.6
Kankia	Katsina	69	132	84.6
Kano	Zaria	145	132	84.6
Katampe	Kubwa	55	132	84.6
Katampe	Suleija	55	132	85
Kontagora	Tegina	90	132	N/A
Kontagora	Yelwa	88	132	N/A
Kubwa	Suleija	55	132	84.6
Makeri	Pankshin	90	132	84.5
Minna	Shiroro	68	132	84.6
Minna	Shiroro	68	132	84.6
Minna	Suleija	99	132	84.6
Minna	Suleija	99	132	84.6
New Haven	Nkalagu	39	132	91
New Haven	Nkalagu	39	132	91
New Haven	Oji River	44	132	91
New Haven	Oturkpo	156	132	91
Numan	Savannah	85	132	66.3
Numan	Yola	50	132	66.3
Ofa	Omu-Aran	47	132	N/A
Ofa	Oshogbo B	44	132	70
Ogba	Otta	14	132	91.5
Okene	Ukpilla	33	132	91
Otta	Papalanto	10	132	91.5
P.H. Main	P.H. Town	3	132	91
P.H. Main	P.H. Town	3	132	91
Sagamu	Sagamu Cements	9	132	91
Shiroro	Tegina	65	132	N/A
Sokoto	Talata-Mafara	125	132	84.6

Table 70 – Transmission Lines – Nigeria (2/2)

TRANSFORMERS - NIGERIA										
Substation	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**		**Substation**	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**
Aja	330	132		150		Abuja	132	33	11	45
Aja	330	132		150		Abuja	132	33	11	45
Ajaokuta	330	132	33	162		Abuja	132	33	11	45
Ajaokuta	330	132	33	162		Abuja Central	132	33		60
Ajaokuta	330	132	33	162		Abuja Central	132	33		60
Akangba A	330	132	13.8	90		Agbara	132	33		45
Akangba A	330	132	13.8	90		Agbara	132	33		45
Akangba B	330	132	13.8	90		Aja	132	33		60
Akangba B	330	132	13.8	90		Aja	132	33		60
Akangba C	330	132	33	150		Ajaokuta Town	132	11		15
Alaoji	330	132	33	150		Ajaokuta Town	132	11		15
Alaoji	330	132	33	150		Akangba A	132	33		60
Ayede	330	132	33	150		Akangba B	132	33		60
Ayede	330	132	33	150		Akoka	132	11		45
Benin	330	132	33	150		Akoka	132	11		30
Benin	330	132	33	150		Akoka	132	11		30
Birnin-Kebbi	330	132	13.8	90		Akure	132	33		15
Egbin	330	132		150		Akure	132	33		30
Egbin	330	132		150		Akure	132	33		60
Gombe	330	132	33	150		Akwanga	132	33		40
Gombe	330	132	33	150		Alagbon	132	33		60
Ikeja West	330	132	33	150		Alagbon	132	33		60
Ikeja West	330	132	33	150		Alausa	132	33		45
Ikeja West	330	132	33	150		Alausa	132	33		60
Ikeja West	330	132	33	150		Alimosho	132	33		30
Jebba T.S.	330	132	13.8	60		Alimosho	132	33		60
Jos	330	132	33	150		Alimosho	132	33		30
Kaduna	330	132	13.8	60		Amuwo-Odofin	132	33		30
Kaduna	330	132	13.8	60		Amuwo-Odofin	132	33		30
Kaduna	330	132		90		Apapa-Road	132	33		45
Kaduna	330	132	33	150		Apapa-Road	132	33		45
Kano	330	132	33	150		Apapa-Road	132	33		15
Kano	330	132	33	150		Ashaka Cements	132	33		15
Katampe	330	132	33	150		Ashaka Cements	132	33		15
Katampe	330	132	33	150		Awka	132	33		30
New Haven	330	132	33	150		Awka	132	33		30
New Haven	330	132	33	150		Ayede	132	33		30
Onitsha	330	132	13.8	90		Ayede	132	33		30
Onitsha	330	132	13.8	90		Ayede	132	33		60
Oshogbo B	330	132	33	150		Ayede	132	33		45
Oshogbo A	330	132	13.8	90		Bauchi	132	11		7.5
Oshogbo B	330	132	33	150		Bauchi	132	11		45
Shiroro	330	132	33	150		Bauchi	132	11		30
Shiroro	330	132	33	150		Benin	132	33		60
Aba	132	33		30		Benin	132	33		60
Aba	132	6.6		7.5		Benin	132	33		30
Aba	132	33		30		Bida	132	33		30
Aba	132	33		60		Bida	132	33		30
Aba	132	33		45		Birnin-Kebbi	132	33		5
Abakaliki	132	33		30		Birnin-Kebbi	132	33		15
Abakaliki	132	33		15		Birnin-Kebbi	132	33		30
Abeokuta	132	33		30		Biu	132	33		7.5
Abeokuta	132	33		30		Calabar	132	33		30
Abeokuta	132	33		30		Calabar	132	33		30

Table 71 – Transformers – Nigeria (1/3)

TRANSFORMERS - NIGERIA									
Substation	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**	**Substation**	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**
Calabar	132	33		60	Isolo	132	11		15
Dakata	132	33		30	Isolo	132	11		15
Dakata	132	33		60	Isolo	132	11		15
Dakata	132	33		30	Itakpe	132	33		30
Damboa	132	33		30	Itakpe	132	33		30
Dan-Agundi	132	33		60	Itire	132	33		30
Dan-Agundi	132	33		30	Itire	132	33		40
Dan-Agundi	132	33		60	Itu	132	33		15
Delta	132	33		30	Jebba T.S.	132	33		30
Delta	132	33		30	Jericho	132	33		30
Effurun	132	33		30	Jericho	132	11		15
Effurun	132	33		60	Jos	132	33		60
Effurun	132	33		60	Jos	132	33		60
Ejigbo	132	33		30	Kaduna	132	33		30
Ejigbo	132	33		30	Kaduna	132	33		60
Eket	132	33		45	Kaduna	132	33		30
Eket	132	33		45	Kaduna Town	132	11		15
Funtua	132	11		5	Kaduna Town	132	33		30
Funtua	132	11		7.5	Kaduna Town	132	33		30
Funtua	132	11		30	Kaduna Town	132	11		15
Gcm	132	33		15	Kaduna Town	132	33		60
Gombe	132	33		15	Kankia	132	33		75
Gombe	132	33		15	Kano	132	33		30
Gusau	132	33		15	Kano	132	33		40
Gusau	132	33		30	Kano	132	33		30
Gusau	132	11		7.5	Katampe	132	33		60
Gusau	132	11		7.5	Katampe	132	33		60
Hadejia	132	33		15	Katsina	132	33		7.5
Ibadan North	132	33		40	Katsina	132	33		30
Ibadan North	132	33		40	Katsina	132	33		30
Ife	132	33		30	Keffi	132	33		30
Ife	132	33		30	Kontagora	132	33		30
Ijebu-Ode	132	33		30	Kubwa	132	33		40
Ijebu-Ode	132	33		30	Maiduguri	132	33	11	45
Ijora	132	33		30	Maiduguri	132	33	11	45
Ijora	132	33		30	Maiduguri	132	11		15
Ijora	132	33		45	Makeri	132	33		15
Ijora	132	33		30	Makeri	132	33		15
Ikorodu	132	33		60	Makurdi	132	33		40
Ikorodu	132	33		60	Maryland	132	33		30
Ilesa	132	33		30	Maryland	132	33		40
Ilesa	132	33		30	Maryland	132	33		30
Ilorin	132	33		60	Minna	132	33		30
Ilorin	132	33		30	Minna	132	33		30
Ilupeju	132	11		15	New Haven	132	33		30
Ilupeju	132	11		25	New Haven	132	33		30
Ilupeju	132	11		15	New Haven	132	33		60
Ilupeju	132	11		30	Niamey	132			
Irrua	132	33		30	Nkalagu	132	33		30
Irrua	132	33		60	Nkalagu	132	33		30
Iseyin	132	33		45	Ofa	132	33		30
Isolo	132	33		30	Ogba	132	33		60
Isolo	132	11		15	Ogba	132	33		60
Isolo	132	33		30	Ogba	132	11		30

Table 72 – Transformers – Nigeria (2/3)

TRANSFORMERS - NIGERIA									
Substation	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**	**Substation**	**V1 (kV)**	**V2 (kV)**	**V3 (kV)**	**Sn (MVA)**
Ogba	132	33		25	Pankshin	132	33		15
Ogba	132	11		45	Papalanto	132	33		15
Oji River	132	66		15	Papalanto	132	33		15
Oji River	132	66		15	Papalanto	132	33		30
Ojo	132	33		30	Potiskum	132	33		30
Ojo	132	33		30	Potiskum	132	33		30
Okene	132	33		7.5	Sagamu	132	33		30
Okene	132	33		30	Sagamu	132	33		30
Omu-Aran	132	33		30	Sagamu Cements	132	33		15
Ondo	132	33		30	Sagamu Cements	132	33		15
Ondo	132	33		30	Savannah	132	33		15
Onitsha	132	33	11	45	Shiroro	132	33		30
Onitsha	132	11		15	Sokoto	132	33		30
Onitsha	132	33		60	Sokoto	132	33		30
Onitsha	132	33		15	Sokoto	132	33		30
Onitsha	132	33		60	Suleija	132	11		7.5
Oshogbo B	132	33		30	Suleija	132	11		7.5
Oshogbo B	132	33	11	45	Talata-Mafara	132	33		30
Oshogbo B	132	33		30	Tegina	132	33		30
Otta	132	33		45	Ukpilla	132	33		15
Otta	132	33		60	Ukpilla	132	33		7.5
Oturkpo	132	33		30	Uyo	132	33		40
Oturkpo	132	33		7.5	Uyo	132	33		40
Owerri	132	33		40	Yandev	132	33		15
Owerri	132	33	11	45	Yandev	132	33		15
Owerri	132	33	11	45	Yandev	132	33	11	45
Oworonshoki	132	33		30	Yelwa	132	33		30
Oworonshoki	132	33		30	Yola	132	33		30
P.H. Main	132	33	11	45	Yola	132	33		30
P.H. Main	132	33		60	Yola	132	11		15
P.H. Main	132	33	11	45	Zaria	132	11		15
P.H. Town	132	11		12.5	Zaria	132	11		15
P.H. Town	132	33		30	Zaria	132	33	11	45
P.H. Town	132	11		10	Zaria	132	33		40
P.H. Town	132	33		45					

Table 73 – Transformers – Nigeria (3/3)

SHUNT CAPACITORS AND REACTORS - NIGERIA					
Substation	**Type**	**Voltage (kV)**	**Steps**	**Rating / bank**	**Capacity (MVAr)**
Alaoji	ind.	330	-	-	75
Benin	ind.	330	-	-	75
Gombe	ind.	330	-	-	50
Gombe	ind.	330	-	-	50
Ikeja West	ind.	330	-	-	75
Jebba T.S.	ind.	330	-	-	75
Jebba T.S.	ind.	330	-	-	75
Kaduna	ind.	330	-	-	75
Kaduna	ind.	330	-	-	30
Kaduna	ind.	330	-	-	30
Kano	ind.	330	-	-	75
Katampe	ind.	330	-	-	75
Oshogbo	ind.	330	-	-	75
Ajaokuta	ind.	132	-	-	30
Alaoji	ind.	33	-	-	30
Benin	ind.	33	-	-	30
Gombe	ind.	33	-	-	30
Gombe	ind.	33	-	-	30

Table 74 – Shunts – Nigeria

4.2. Existing interconnections

The table here below synthesizes the existing HV lines (> 100kV).

HV Line		***Length [km]***	***Voltage [kV]***	***Capacity [MVA]***
Interconnection OMVS		1200	225	250
Prestea (GHN)	Abobo (IC)	220	225	327
Akosombo (GHN)	Lome (TOG)	128.7	161	128
Akosombo (GHN)	Lome (TOG)	128.7	161	128
Ferkéssédougou (IC)	Kodeni (BF)	221.8	225	327
Dapaong (TOG)	Bawku (GHN)	65	161 (exploited in 34.5kV)	182
Nangbéto (TOG)	Bohicon (BEN)	80.3	161	120
Kid Hagou (TOG)	Avakpa (BEN)	54	161	105
Kara (TOG)	Djougou (BEN)	58	161	120
IKEJA WEST (NIG)	SAKETE (BEN)	75	330	686
BIRNIN-KEBBI (NIG)	NIAMEY (NIGER)	252	132	84.6
KATSINA (NIG)	GAZAOUA (NIGER)	72	132	84.6

Table 75 – Existing interconnections

4.2.1. Interconnections Zone B

The only HV interconnection existing in the zone B is the 225kV OMVS line which interconnects the hydroelectric site of Manantali (located in Mali) to Senegal, Mali and Mauritania. This single circuit line of 1200 km, whose 945 km in Senegal, has a maximum capacity estimated at 150 MW but in practice the transit is limited to 110 MW.

The capacity of this interconnection should make it possible to evacuate the additional power of the new hydroelectric project under construction: Félou (60MW, commissioned in 2013).

As soon as the future hydraulic site of Gouina will be in service (decided project, it should be in service by 2017), it will be necessary to reinforce the 225kV network towards Dakar. The projects under consideration for this reinforcement are exposed to section 5.5.3 presenting the considered projects.

4.2.2. Interconnections Zone A

The following zone A countries are operated synchronously thanks to their interconnection in 330kV, 225kV and 161kV: Burkina Faso, Ivory Coast, Ghana, Togo and Benin.

Nigeria and a part of Benin remains for the moment not synchronised even if the interconnection exists (see explanations of the next section).

4.2.2.1. PROJECT "330KV COASTAL BACKBONE"

The project consists of a 330kV axis along the coast interconnecting the Ivory Coast (Riviera), Ghana (Aboadze and Volta), Togo (Lome C), Benin (Sakété) and Nigeria (Ikeja West). Two sections are already in service:

- The internal section in Ghana of 215 km, Aboadze - Volta, which was recently commissioned (2010);

- An already operational section between Sakété (Benin) and Nigeria (Ikeja West) which is in service since 2007 and allows an important importation from Nigeria to Togo/Benin (agreement of an importation of 150 MW since January 2011).

Let us note that since the commissioning of this last section, the network of Togo/Benin is operated in 2 non-synchronous parts: the first one synchronously operated with Ghana and the second one with Nigeria. The separation point of the both network parts is changing according to the level of importation coming from Nigeria (basis of 150 MW agreed upon since the beginning of 2011) and Ghana. The Nangbeto hydraulic site is regularly shared between the 2 networks to compensate the load fluctuation of CEB.

These two networks are not synchronized due to problems of frequency control on Nigeria side where the normal frequency under operation is not maintained in a predefined range around 50Hz (typically +/- 50mHz). The WAPP envisages launching a specific study aiming at proposing solutions with this operation problem of operation by end of 2011.

4.2.2.2. 225KV INTERCONNECTIONS

A 225kV single circuit line interconnects the Ivory Coast and Burkina Faso since 2009. It connects the substations of Ferkéssédougou (IC) and Kodeni (BF).

A 225kV single circuit line interconnects Ghana and the Ivory Coast between the substations of Abobo and Prestea (intermediate station with Elubo in Ghana).

4.2.2.3. 161 KV INTERCONNECTIONS

Ghana is inter-connected with Togo via the following 161kV single circuit lines:

- Ghana - Togo: 2 lines between Lome and Akosombo of approximately 130 km (one passing via Asiekpe and the other by Aflao)
- Ghana - Togo: a line interconnecting the Northern parts of the 2 countries. This line operated in 34.5kV and connects Bawku and Dapoang.
-

Benin is interconnected with the neighbouring countries with the following 161kV single circuit lines:

- A line interconnecting the North of Togo and Benin between Djougou and Kara
- A line in the South between Kid Hagou (Togo) and Avakpa (Benin)
- A line from Nangbéto (Togo) towards Bohicon in Benin.

4.2.2.4. 132KV INTERCONNECTIONS

Niger and Nigeria are interconnected with two 132kV lines:

- A line of 250 km connecting Birnin Kebbi (Nigeria) and Niamey (Niger);
- A line of 70 km connecting Katsina (Nigeria) to Gazaoua (Niger).

4.3. Survey of transmission equipments

An analysis of the state of the power system of West Africa was carried out on the basis of specific mission in 4 representative countries. These networks are those of Senegal, the Ivory Coast and Togo/Benin. They were selected because they are important networks localized in different areas of West Africa and being quite central in their area. This study also takes into a Table the information coming from previous project made by Tractebel in the region (Ghana, Mali and Nigeria).

4.3.1. General state of VHV network

The concerned voltage levels are the 330kV and the 225kV.

In a general way, the very high voltage grid of West Africa is recent, and so it is in good state.

This level of voltage is rather not very loaded. The single circuit is privileged for reasons of cost. Loops are sometimes set up.

The maintenance plans of VHV transmission network in general are well established and respected. There is an inventory control of the spare parts. The main problem is the robbery and vandalism on the network. The national companies of electricity try to solve this issue by maintaining the network as well as possible.

All in all, the VHV cables are few impacted by pollution. They are ACSR or AAAC cables with a maximum temperature of operation of about 70°C to 75°C. The faults are rare and transitory most of the time.

The exceptional use of cables ASTER 228mm² for VHV (225kV) must be seen as an error of design because the diameter is too low for such voltage level.

The insulators are in aerodynamic or normal tempered glass. The state of the armaments is, in general, rather good even if, locally, usury was detected.

Lastly, since network VHV of West Africa is very recent, limited number of rehabilitations is considered.

4.3.2. General state of HV network

The concerned voltage levels are the 161kV and the 90kV.

Certain parts of HV network of West Africa are relatively old and, consequently, relatively decayed. For example, in Senegal, 25% of the 90kV network is more than 30 years old.

HV Network is overall rather loaded but is only exceptionally overloaded. This kind of overloads could arrive in the future with the increase of the urban load. For example, the axis Akosombo-Lome knew a saturation during 2010 because of the load increase in the Ghanaian cities.

The single and double circuit lines are coexisting in HV grid. The single circuit is regularly privileged for a question of cost but in urban environment, the double circuit is not rare.

Figure 8 – Single circuit and double circuit towers (zone "Cap des Biches" - Senegal)

According to the areas, the maintenance plans are organized and followed or, on the contrary, a little more delicate. The main difficulty is the inventory control in the countries where the construction of the network was spread out over many years and where technologies used are disparate.

HV Networks are relatively subjected to pollution. This pollution is of three types

- Pollution from sea in the coastal areas;
- Dust in the more desert areas;
- Industrial and chemical very locally (near the cement factories for example).
- One of the consequences of this pollution is the corrosion of the towers.

The cables are of AAAC and ACSR types. The maximum temperature of operation is between 65°C and 70°C. The faults are mainly transitory. They are exceptionally permanent because of the pollution of the environment.

The insulators are in aerodynamic or normal tempered glass. The state of the armaments is, in general, rather good even if, locally, usury is detected.

The "Cap des Biches" substation in Senegal is a good example of the problems encountered in the area. An important pollution is observed as well on the insulators as on the towers. One also notes a great diversity in the types of towers (single or double circuit, tubular, "Tête de chat" structure…).

Figure 9 – 90kV substation of "Cap des Biches" (Senegal)

Moreover, one over-isolation is carried out in the zones of pollution; this over-isolation was observed during field visit at the "Cap des Biches" substation.

Figure 10 – 90kV chain at "Cap des Biches" with 15 insulators (over-isolated)

Lastly, certain rehabilitations are considered on HV level. In the lines to be rehabilitated there is in general no problem of overload, but this rehabilitation is mainly required due to the outdatedness of these lines located for the majority in strong pollution zones (marine or dust).

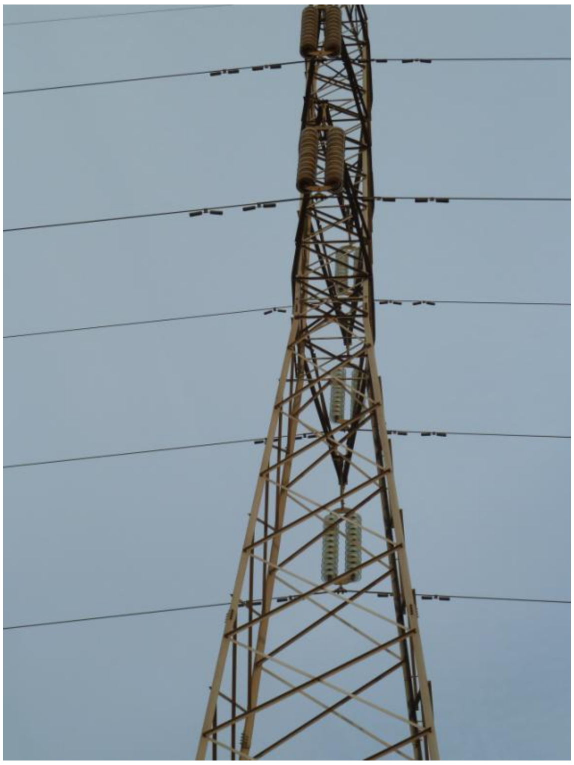


Figure 11 – Lome-Cotonou line - to be rehabilitated

4.4. National projects

This section presents the transmission lines which will be developed inside the countries. These projects are specific to the countries and independent of WAPP projects, OMVG and OMVS.

Table 160 describes these lines, their expected commissioning date, their nominal voltage, their length and their rated capacity.

In case of lacking data, standard parameters based on existing similar lines were used.

FUTURE TRANSMISSION LINES INSIDE THE COUNTRIES						
Country	**Planned Year**	**Voltage (kV)**	**From**	**To**	**Length**	**Thermal Capacity**
Burkina Faso	N/A	225	Ouagadougou	Tambao	250	327
Gambia	N/A	225	Brikama	Willengara	15	327
	N/A	225	Willengara	Kotu	15	327
	N/A	225	Willengara	Brufut	15	327
Ghana	2013	330	Prestea	Kumasi	173	1000
	2015	330	Kumasi	Kintampo	180	1000
	2015	330	Domini	Prestea	91	1000
	2015	330	Kintampo	Bolgatanga	287	1000
	2016	330	Aboadze	Domini	120	1000
	2019	330	Prestea	Kumasi	173	1000
	2016	330	Domini	Prestea	91	1000
Ivory Coast	2012	225	Laboa	Ferke	285	327
Mali	2017	150	Koutiala	Mopti	100	N/A
Niger	N/A	132	Zinder	Diffa	410	84.6
	N/A	132	Zinder	Tchirozerine	486	84.6
Nigeria	N/A	330	Makurdi	Jos	286	777
	N/A	330	New Haven	Makurdi	245	777
	N/A	330	New Haven	Ekpene	249	777
	N/A	330	New Haven	Ekpene	249	777
	N/A	330	Ekpene	Afam	150	777
	N/A	330	Omoku	Onitsha	195	777
	N/A	330	Abasi	Ekpene	78	777
	N/A	330	Ajaokuta	Lokoja	250	777
Togo/Benin	2013	161	Onigbolo	Parakou	250	120
	2016	161	Bembereke	Guene	180	120
	2016	161	Guene	Malanville	40	120
	2016	161	Guene	Dydyonga	100	120
	2016	161	Kara	Dapaong	200	120

Table 76 – Future transmission lines inside the countries

4.5. Unit prices of the equipment

The unitary prices proposed to calculate the cost of the transmission equipment are presented hereafter in Table 162. These prices result from the experience of the Consultant in various development studies and in particular in Africa. These unitary prices were synthesized so as to ensure consistency between the various voltage levels and the various capacities of the transmission and transformation equipment.

	Equipment description		Assessed price MUSD
330/225 kV	transformer 500 MVA		8.400
330/161 kV	transformer 500 MVA		7.980
330/161 kV	transformer 200 MVA		4.609
330/132 kV	transformer 90 MVA		2.720
330/132 kV	transformer 150 MVA		3.605
330/132 kV	transformer 300 MVA		5.500
330 kV	GIS bay		2.500
330 kV	AIS conventional bay		1.500
330 kV	opening site/general services		4.500
330 kV	OHL 1c/1 500 MVA		0.197
330 kV	OHL 1c/2 500 MVA		0.247
330 kV	OHL 2c/2 2x500 MVA		0.296
330 kV	OHL 2d 500 MVA		0.064
330 kV	OHL 1c/1 1750A 1000 MVA bundle of 2	per km	0.216
330 kV	OHL 1c/2 1750A 1000 MVA bundle of 2	per km	0.270
330 kV	OHL 2c/2 1750A 2x1000 MVA bundle of 2	per km	0.360
330 kV	OHL 2d 1750A 1000 MVA bundle of 2	per km	0.090
330 kV	coupling 330 kV GIS		2.500
330 kV	coupling 330 kV AIS		1.500
225/161 kV	transformer 500 MVA		7.182
225/161 kV	transformer 200 MVA		4.148
225/69 kV	transformer 125 MVA		2.250
225/69 kV	transformer 175 MVA		2.800
225/11 kV	transformer 100 MVA		2.000
225/11 kV	transformer 40 MVA		1.150
225 kV	GIS bay		1.000
225 kV	AIS conventional bay		0.590
225 kV	coupling 220 kV GIS		1.000
225 kV	coupling 220 kV AIS		0.590
225 kV	opening site/general services		4.000
225 kV	OHL 1c/1 839A 327 MVA 604 mm2	per km	0.181
225 kV	OHL 1c/2 839A 327 MVA	per km	0.226
225 kV	OHL 2c/2 839A 2x327MVA	per km	0.271
225 kV	OHL 2d 839A 327 MVA	per km	0.059
225 kV	OHL 1c/1 460 MVA		0.190
225 kV	OHL 1c/2 460 MVA	per km	0.238
225 kV	OHL 2c/2 2x460 MVA	per km	0.285
225 kV	OHL 2d 460 MVA	per km	0.062
225 kV	underground câble 1200 cu 417 MVA (1)	per km	2.273

Table 77 – Unitary costs proposed for transmission and transformation equipment (1/2)

	Equipment description		Assessed price MUSD
161 kV	GIS bay		0.900
161 kV	AIS bay		0.531
161 kV	GIS coupling		0.900
161 kV	AIS coupling		0.531
161 kV	opening site/general services		3.600
161 kV	OHL 1c/1 364 MVA	per km	0.181
161 kV	OHL 1c/2 364 MVA		0.226
161 kV	OHL 2c/2 2x364MVA		0.271
161 kV	OHL 2d 364 MVA		0.059
161 kV	OHL 1c/1 182 MVA 265 mm2		0.128
161 kV	OHL 1c/2 182 MVA 265 mm2		0.160
161 kV	OHL 2c/2 182 MVA 2x265 mm2		0.192
161 kV	OHL 2d 182 MVA 265 mm2		0.042
132 kV	GIS bay		0.855
132 kV	AIS conventional bay		0.504
132 kV	opening site/general services		3.600
132 kV	OHL 1c/1 Panther 250MVA 2*250mm2	per km	0.150
132 kV	OHL 1c/2 Panther 250MVA 2*250mm2	per km	0.173
132 kV	OHL 2c/2 Panther 250MVA 2*250mm2	per km	0.231
132 kV	OHL 2d Panther 250MVA 2*250mm2	per km	0.052
	capacitor shunt	per Mvar	0.007
	Reactor shunt	per Mvar	0.030
	SVC (static Var compensator)	per Mvar	0.072

Table 78 – Unitary costs proposed for transmission and transformation equipment (2/2)

5. FINANCIAL, LEGAL AND INSTITUTIONAL ASPECTS

5.1. Assignment objectives

The objectives pursued concerning financial, legal and institutional aspects are :

- The data collection regarding financial, legal and institutional aspects
- Financial and Economic Evaluation of projects in the priority investment programme to establish their benefits to WAPP and the financial viability of participating utilities,
- And propose strategies for accelerated implementation of the priority projects.

5.2. Scope of work

The scope of work consists in:

Collect for each WAPP member country, data on the:

- Institutional (public/private, governance, power generation /transmission /distribution companies, etc.)
- Financial status and performance of the power utilities (tariff adequacy, recovery...);
- The legal and institutional frameworks, governance structure and reforms in the electricity sector;

Suggest regional strategies for implementing WAPP priority projects and, where appropriate, through public private partnerships to enable easier mobilization of funds from multilateral and bilateral institutions and attract private investment with optimal financing conditions. This should be done in the framework of the supplementary acts adopted by the ECOWAS Heads of State and Government, as well as, the various decisions and resolutions adopted by the WAPP General Assembly relating to the implementation of WAPP Emergency Power Supply Security Plan and Transmission Line Projects. Special consideration will also be given to ownership and operation of generation and transmission infrastructures, with particular focus on the institutional and financial situation of the national power utilities.

5.3. Approach to the assignment

The first part of the assignment above involves:

- Field visits to selected ECOWAS Member countries to collect relevant data and hold discussions with appropriate decision makers and stakeholders in these areas.
- Identification of key success indicators used by prospective investors to appraise the financial viability of investments in the energy sector (Long term stability, Short term liquidity, Debt Servicing capacity etc.,)
- Modelling of the financial performance of the utilities over the life period of priority projects included in the Master Plan to assess the level of the key success indicators, and
- Making appropriate recommendations.

The second part of the assignment involves:

- Field visits to selected countries that have executed cross border transmission and regional generation projects in the past to review the implementation approaches adopted for regional projects and how effective they have been.
- Review the various decisions and supplementary acts adopted by WAPP and ECOWAS in respect of project development and implementation to identify the differences between the new and old approaches
- Assess whether the new approach would address the difficulties associated with the old approach in order to improve the ability of WAPP to attract investments and accelerate project implementation.
- Assess whether the legal and governance frameworks in the various countries would have any impact on the adoption of the new approach, and
- Make appropriate recommendations.

5.4. Summary of data collected at this stage

5.4.1. Past financial data

Data collected are summarized by country as follows:

WAPP Member Country	Type of Information Collected
Senegal	• Senelec Annual and Financial Reports (2007-09) • Tariff Structure 2009-10
Gambia	• NAWEC 2009 Annual Report • Tariff Evolution
Guinea Bissau	• Tariff Schedule 2004 – 2010 • EAGB Financial reports
Guinea	• EDG – Financial Reports 2007 to 2009 • Tariff Study Report 2009 • Approved Tariffs for 2010
Sierra Leone	• No Financial Statements from the NPA
Liberia	• Tariff Structure • Only 2010 LEC Balance Sheet
Mali	• No Financial Statements • Tariff Study Report & Annexes 2008 • Manatali project Tariff Agreement
Ivory Coast	• No Financial Statements from the CIE
Ghana	• Annual & Financial Reports of VRA (2007-2010), • Ghana Grid Company (Corporate Budget) • ECG (2004-2009).
Togo-Benin	• CEB Annual & Financial Report 2009 • SBEE Annual Report 2009
Burkina Faso	• Tariff Study Report 2005 and Financial Model • Sonabel Annual and Financial Reports (2005-08)
Niger	• Nigelec Financial Reports 2008-2009 • Tariff structure for 2010
Nigeria	• No Financial Statements from the Utilities • Tariff Schedule for 2011.

5.4.2. Electricity Sector Institutions, Governance and legal framework

WAPP Member Country	Type of Information Collected
Senegal	• Senegal Electricity Regulatory Law – 1998 • National Economic policy Report 2007 • Public Debt Report 2007. • Strategy for Rural Electrification
Gambia	• NAWEC 2009 Annual Report • Reform and Investment Report Oct 2010 • Feasibility Report-COTECO • Cost Summary of Dams
Guinea Bissau	• No Information on Legal, Institutional and Technical Framework
Guinea	• No Information on Legal, Institutional and Technical Framework
Sierra Leone	• No Information on Legal, Institutional and Technical Framework
Liberia	• National Energy Policy 2009 • National Energy Sector White paper on Power sector Reform and Regional cooperation – 2007
Mali	• Energy Du Mali - Annual Reports (2009) • Transmission Line Costs Data • Technical Paper on Felou HEP • Mali-Cote D'Ivoire Interconnection Study Report & Annexes • Manatali-SOGEM Annual Report 2009.
Ivory Coast	• No Information on Legal, Institutional and Technical Framework
Ghana	• Write up on Legal, Institutional and Technical Framework. • Act 541 • 2010 Energy Outlook
Togo-Benin	• Financing Rural Electrification Report – Oct. 2005 • CEB Annual Report 2009 • CEB Electricity Code – March 2007 • Strategic Development Plan of Benin – 2003 & Sept 2008 • SBEE Annual Report 2009
Burkina Faso	• Decrees 279 & 280 on Electricity – 2007 & 8 • White Paper on Millennium Development Projects. • Mainstreaming Energy for Poverty Reduction - 2008. • Sonabel Annual Reports (2005-08)
Niger	• Electrical Energy Code 2003 • Regulatory Law 1999 • Ministry of Mines & Energy Policy July 2004 • Energy Information System Report 2007 (SIE-Niger)

Nigeria	• Procedural Guidelines for EIA. • National Policy on Environment. • EIA Guidelines for Infrastructure – 2005 • Reliability Improvement of Power System Report • Road Map for Power Sector Reform

5.4.3. Supplementary acts & WAPP Resolutions

Background

The WAPP Secretariat coordinated the preparation and approval of a WAPP Master Plan aimed at the development of the initial generation and transmission infrastructure required to establish a power pool which was approved adopted in 2005.

Significant delays however continue to occur in the execution of these projects and therefore widespread energy deficits continue to persist in the sub-region. The WAPP Secretariat had to commission the Emergency Power Supply Security Plan Study in 2006 to find a solution to the widespread energy deficits in the region. The results of the study as well as other proposals aimed at accelerating the implementation of WAPP priority projects were discussed at the 33rd Summit of the Heads of States and Governments of ECOWAS held in Ouagadougou in January 2008, and Supplementary Acts A/SA.3/01/08 and A/SA.4/01/08 adopting The West African Power Pool Transmission Line Implementation Strategy and Emergency Power Supply Security Plan Study recommendations, respectively, were signed and adopted.

Both Acts require that the regional power projects of WAPP must be implemented using the Specific Purpose Company (SPC) model. This project implementation approach involves the creation of a distinct regional entity through a public/private partnership to own and operate all the assets required for regional project. It was used for the development of the Manantali hydro electric project by OMVS-SOGEM between Mali-Senegal-Mauritania.

5.4.4. Other documents

The Final study Report on the Emergency Power Supply Plan by Arthur Energy Advisors, a paper titled “Understanding the Regional Environment; Challenges of the WAPP SPC and The Diagnostic Report on Institutional and regulatory Frameworks of ECOWAS Member Countries are other relevant documents available to us.

5.5. Approach to financial and economic evaluation and formulation of project implementation strategy

5.5.1. Financial and Economic Evaluation

5.5.1.1. OBJECTIVE OF THE FINANCIAL AND ECONOMIC EVALUATION

As indicated in the chapter describing the general study methodology, the economic and technical studies will enable to develop a least cost generation and transmission priority investment program. These analyses will generate a load demand and supply forecast, generation and transmission investment costs and generation and transmission operating and maintenance costs. The main objective of the Financial and Economic evaluation is to ensure that the selected priority projects bring economic benefits to both the energy importing and exporting countries, financial benefits to the participating utilities and/or specific purpose companies (SPC), using the Net Present Value (NPV), Economic Internal Rate of Return (EIRR) and the Financial Internal Rate of Return (FIRR) principles. The financial viability of the participating utilities and/or SPCs is further evaluated using the Rate of Return on Average Net Fixed Assets to assess its profitability, the Current Ratio to assess its liquidity and the Debt Service Cover Ratio to measure its ability to pay maturing principal and interest on timely basis.

Two excel spreadsheets have been developed to assess:

- the economic and financial viability of the priority projects and their benefits to the participating countries and utilities
- the financial performance of the utilities participating in the implementation of the priority projects.

5.5.1.2. PROJECT EVALUATION MODEL

The model to assess the economic and financial viability of the priority projects and their benefits to the participating countries and utilities comprises three main modules as follows:

- Energy Demand and Supply Module
- Capital and operating costs associated with energy generation and transmission.
- Tariffs, Sales Revenue and Other Benefits

Energy demand and supply module

The first block derives the energy supply and demand of the various countries from the results of the economic and technical studies.

Energy Generation and Transmission Costs Module

The second block also derives the Investment costs in generation transmission as well as the operations, maintenance, management, administration and the cost of energy lost during transmission from the results of the economic and technical studies. It will also have the total capital required to implement each project and a financing plan, including debt and equity to be used to finance each project. Loan inflows expected to be received by the project and the repayments to be made are determined and taken into account in the years in which they are anticipated to occur.

Benefits Module

This block computes the benefits from each project as income from the sale of energy generated and/or transmitted from the project and any other direct or indirect benefits accruing from the project. It also computes the net benefits for each year in the planning period as the difference between costs incurred in that year and the benefits, which is used to compute the NPV, EIRR and FIRR for purposes of assessing the viability of the project.

Cases, Sensitivities and Scenarios to be considered

The evaluation would be made based on assumptions about various parameters/inputs that are relevant to the project. These assumptions relate to the future and therefore cannot be predicted with absolute certainty and we acknowledge that there could be changes/deviations of the actual values of these variables from the basic assumptions underlying the analysis. This section assesses the impact of any deviations in these assumptions from the actual values on the viability of the project. It forms a basis for the project implementers to build in contingencies for the management of the project. The issues and factors for which uncertainties can be analysed include:

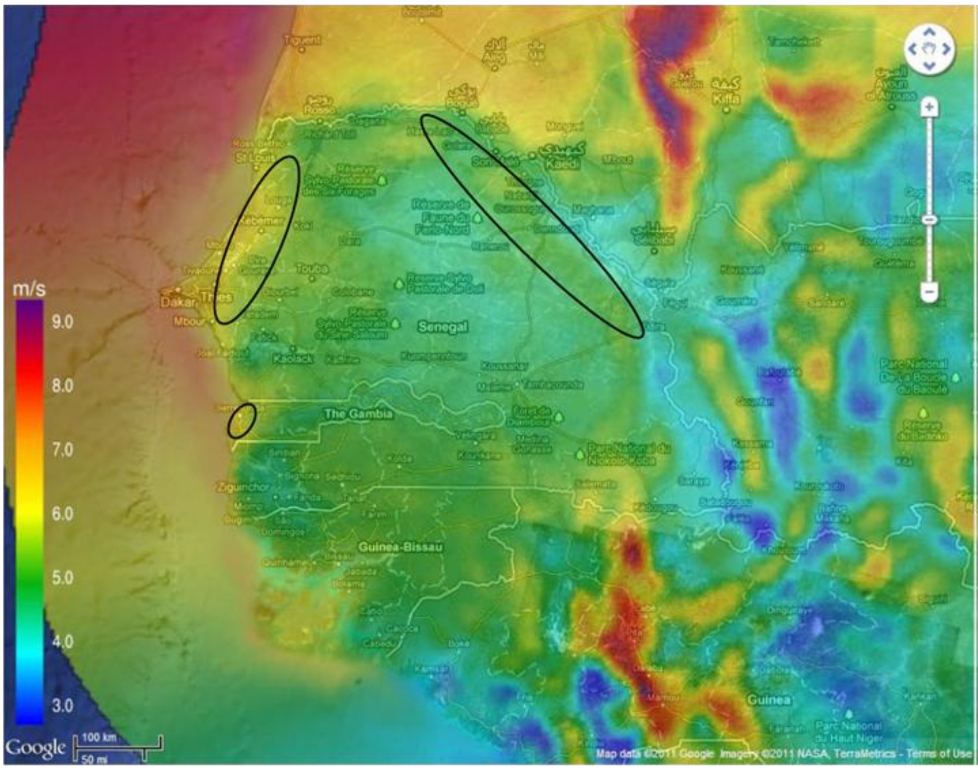
- Project Cost
- Energy Demand Forecast
- Possible Project Delays
- National Energy Security Policy
- Cost of Energy Supply (esp. Fuel)
- Discount rate
- Electricity Tariffs

5.5.1.3. MODEL FOR ASSESSING THE FINANCIAL PERFORMANCES OF THE UTILITIES

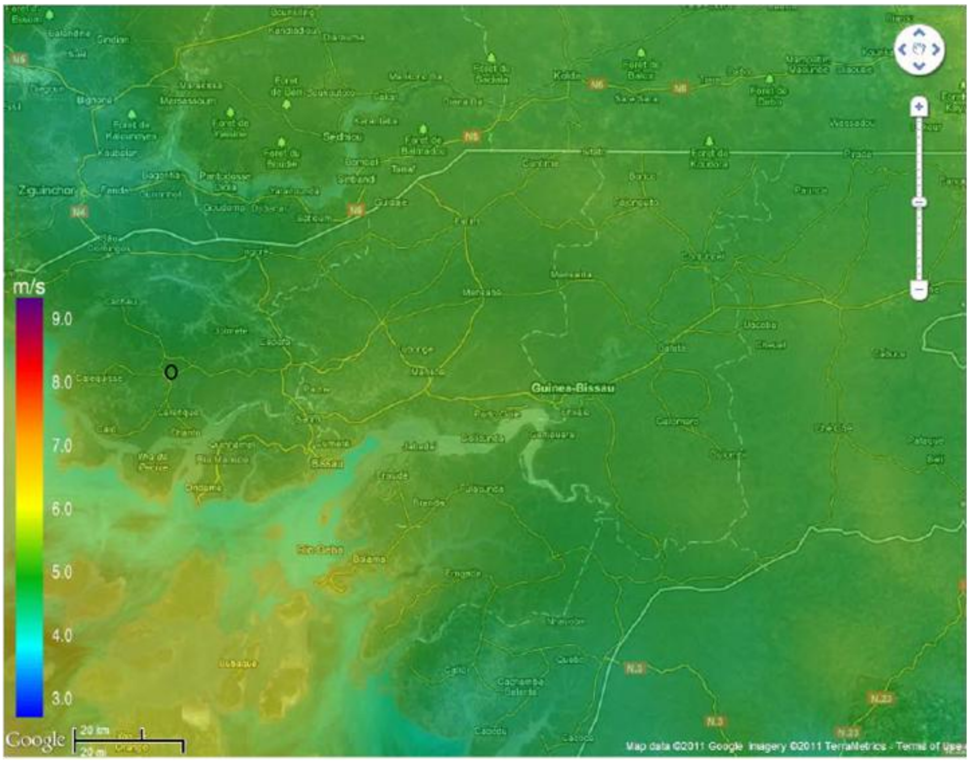
The model for assessing the financial performance of the utilities participating in the implementation of the priority projects is designed to forecast the traditional financial statements comprising the income statement, the cash flow statement and the Balance Sheet. It also computes key financial performance indicators that will be used to assess the financial viability of the entities participating in the implementation of the priority projects.

6. APPENDIX - ZONES WITH STRONG WIND RESOURCES BY COUNTRY

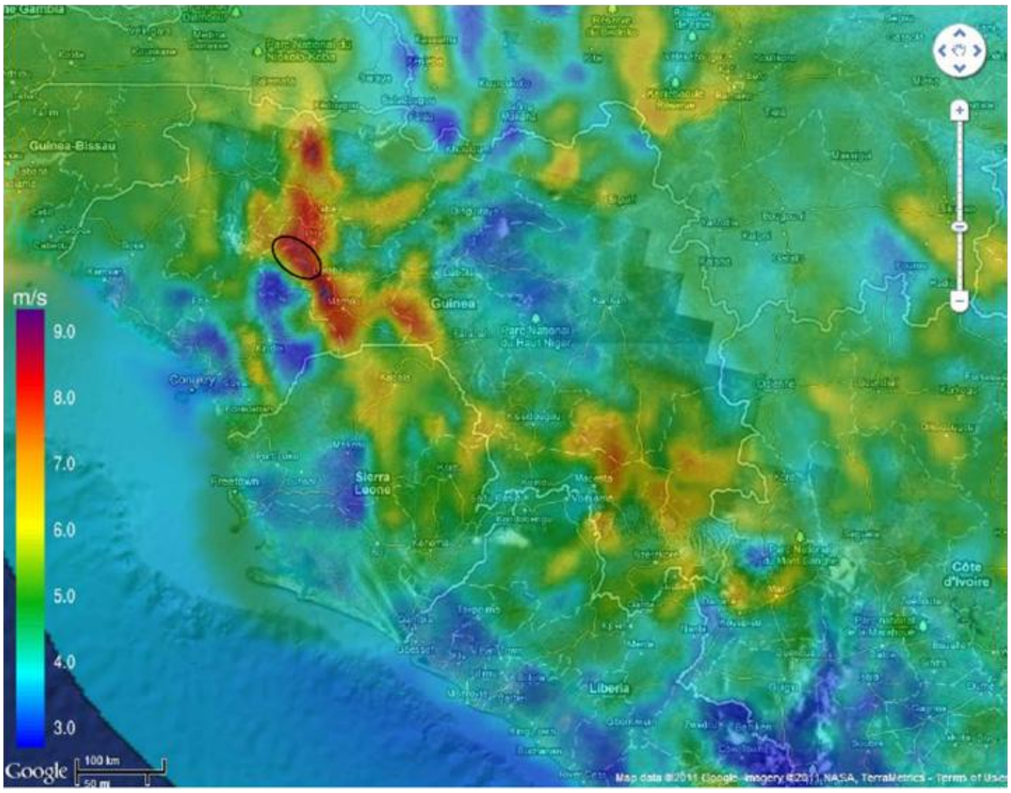
Senegal and Gambia



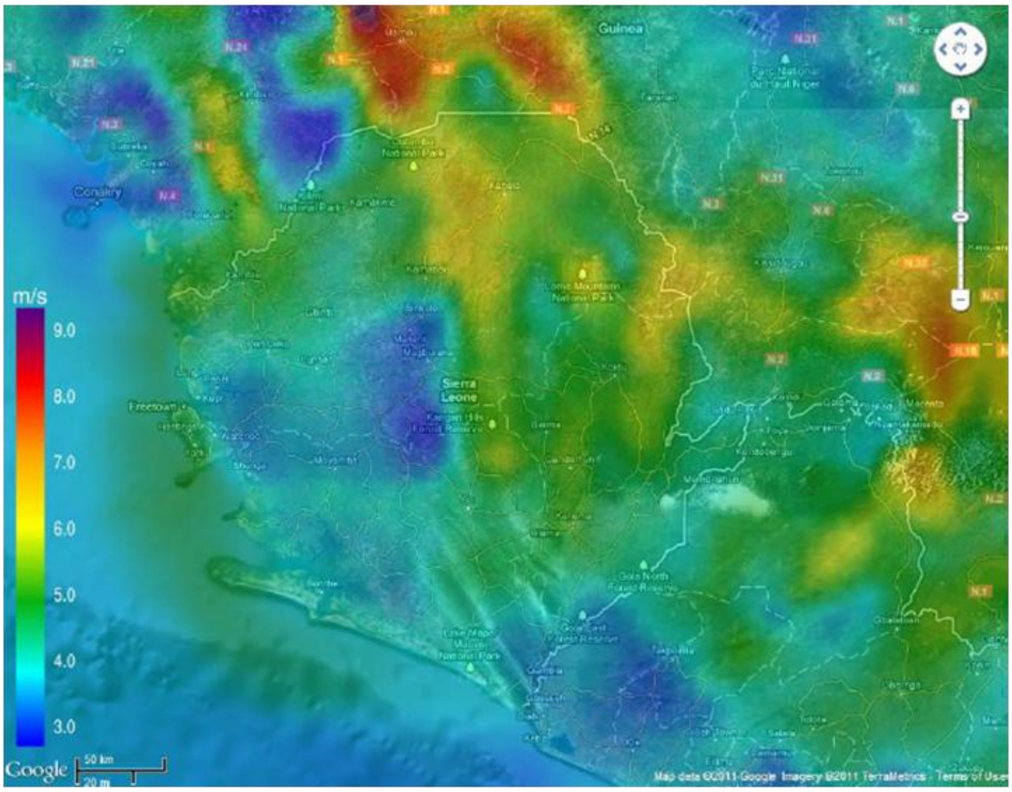
Guinea Bissau



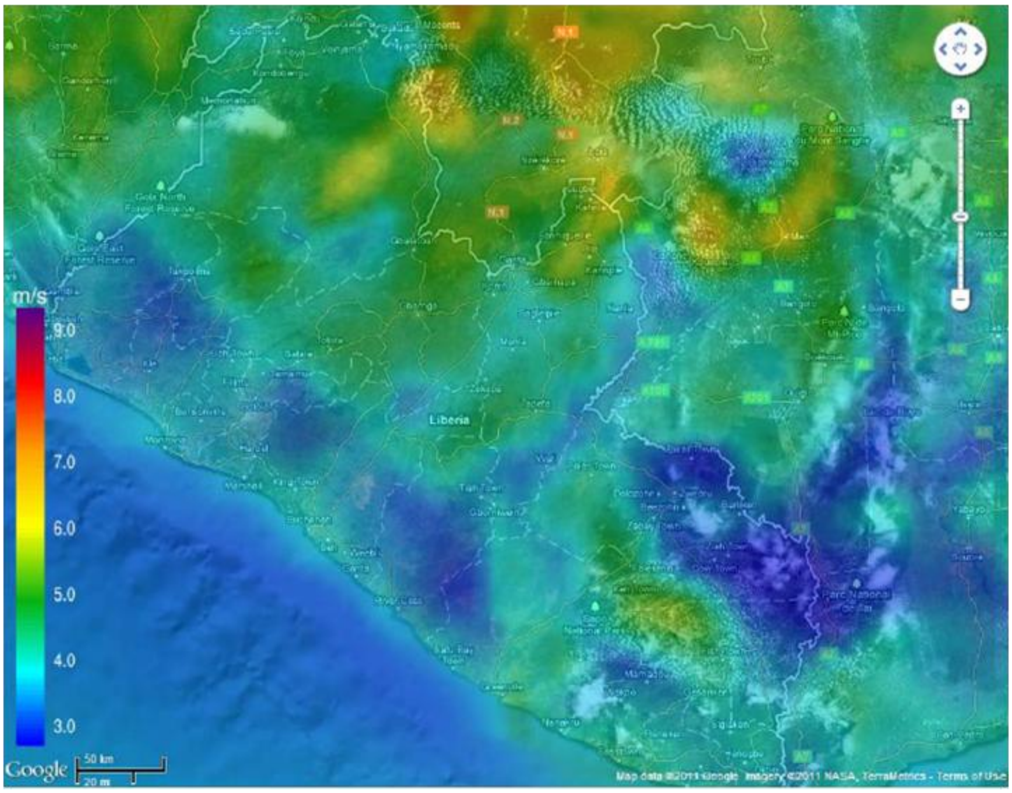
Guinea



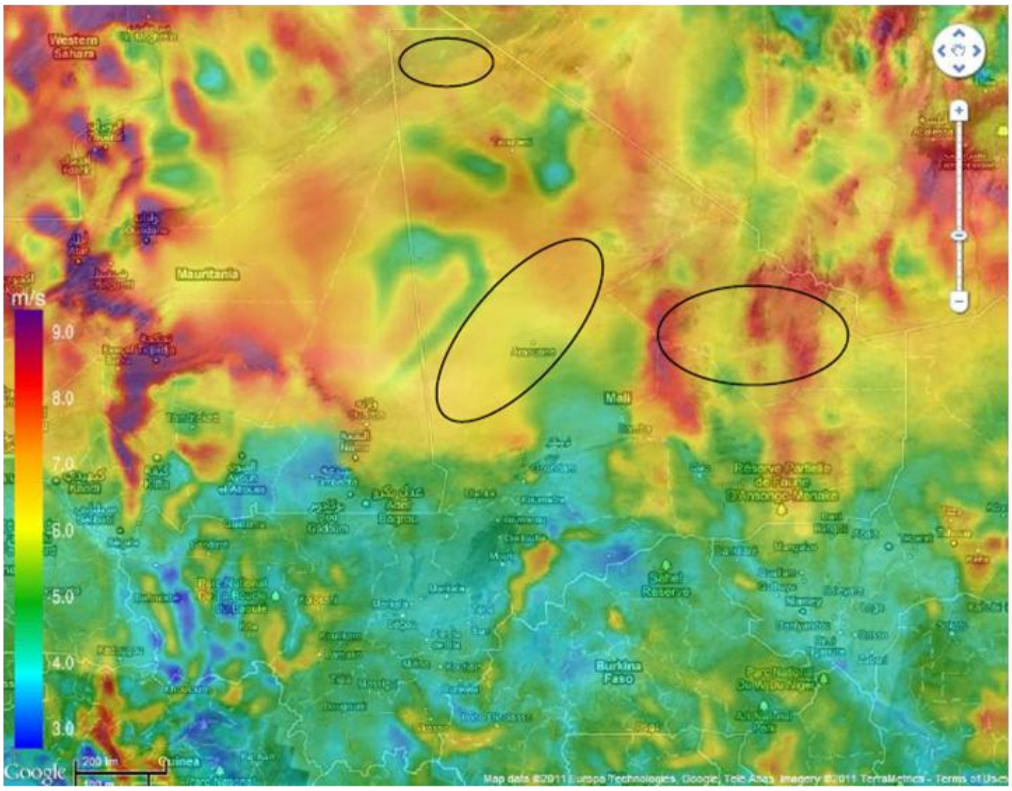
Sierra Leone



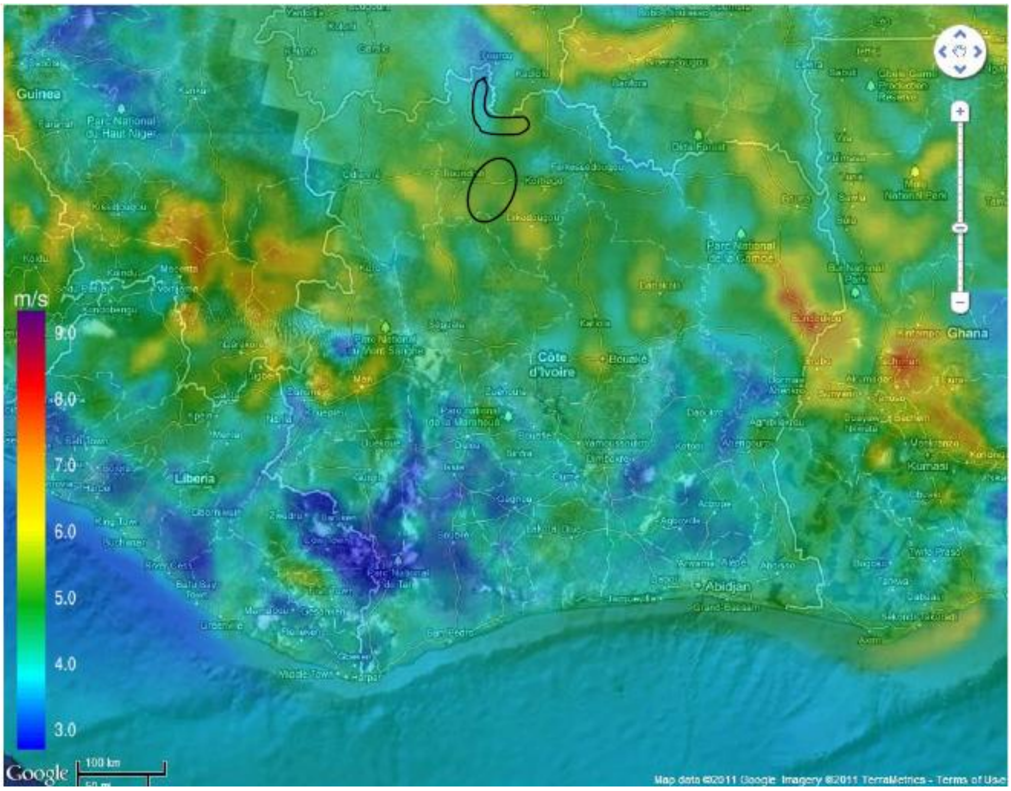
Liberia



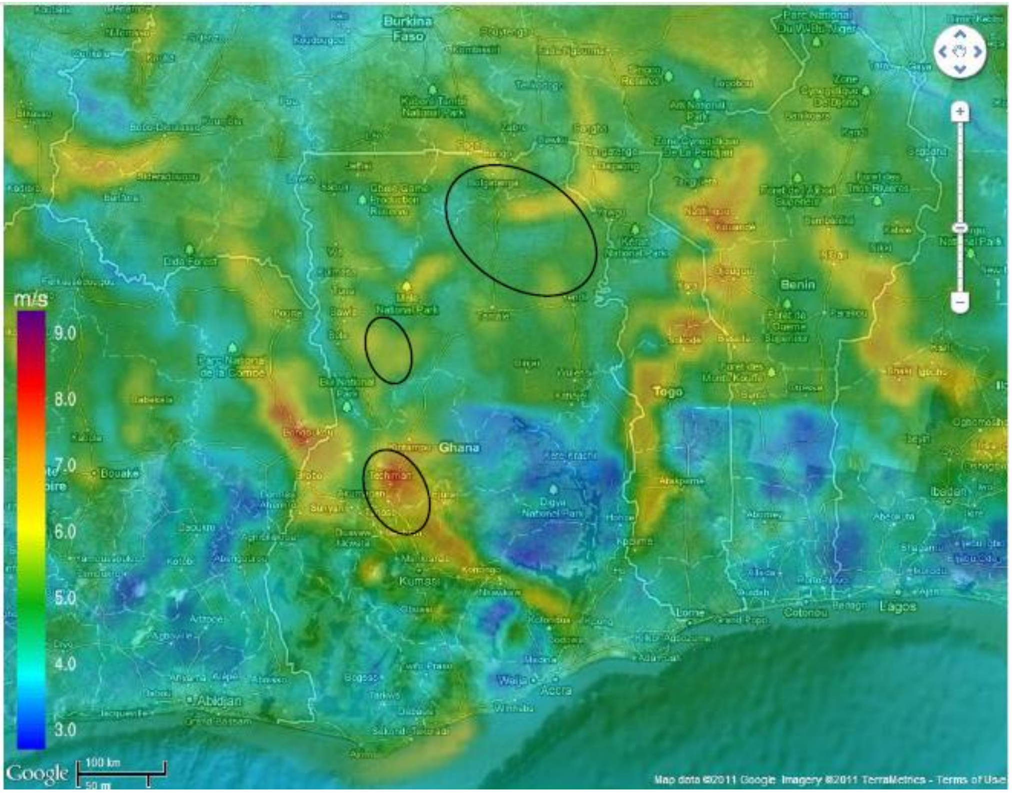
Mali



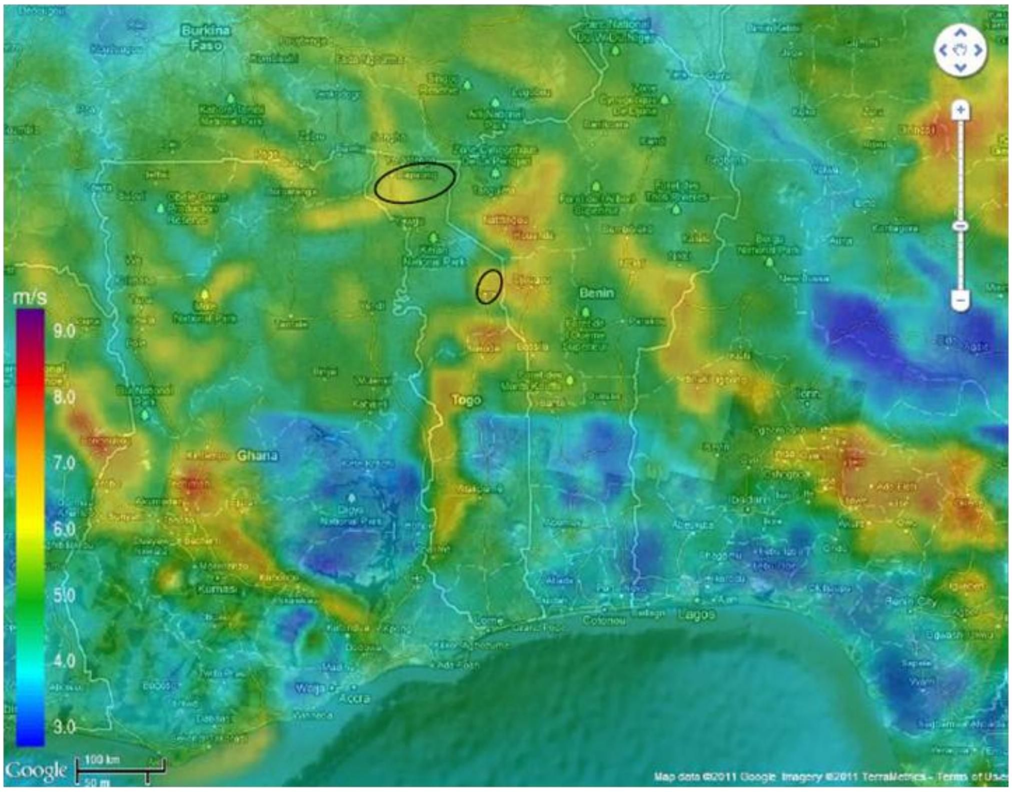
Ivory Coast



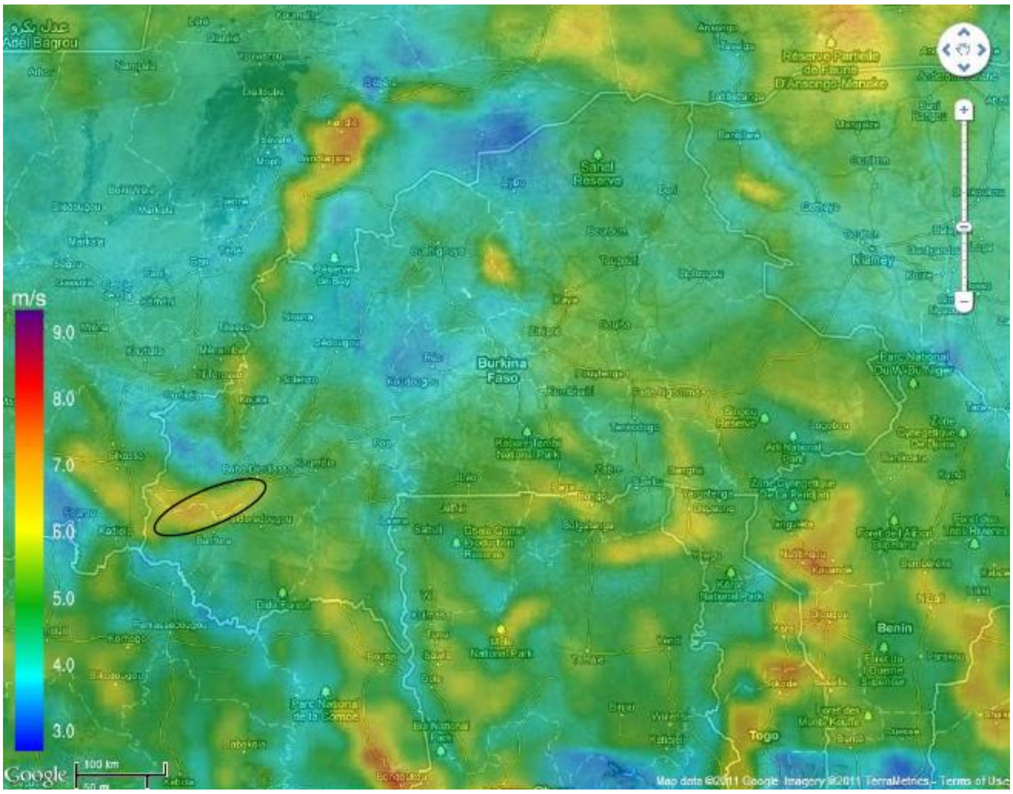
Ghana



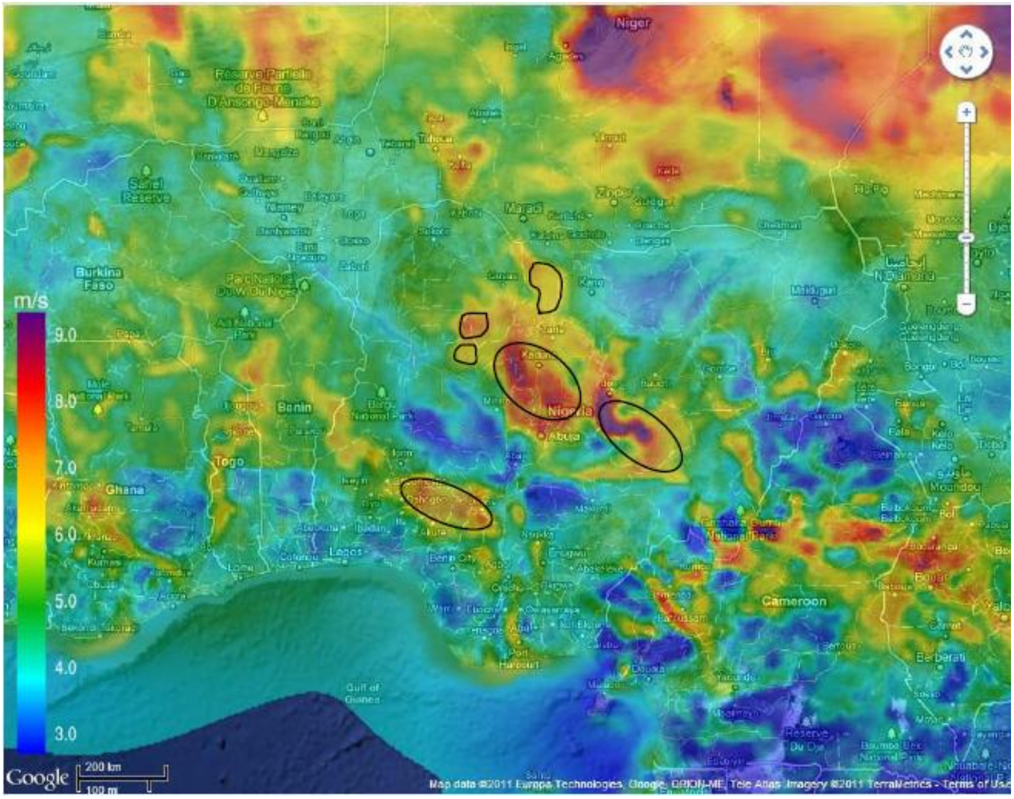
Togo and Benin



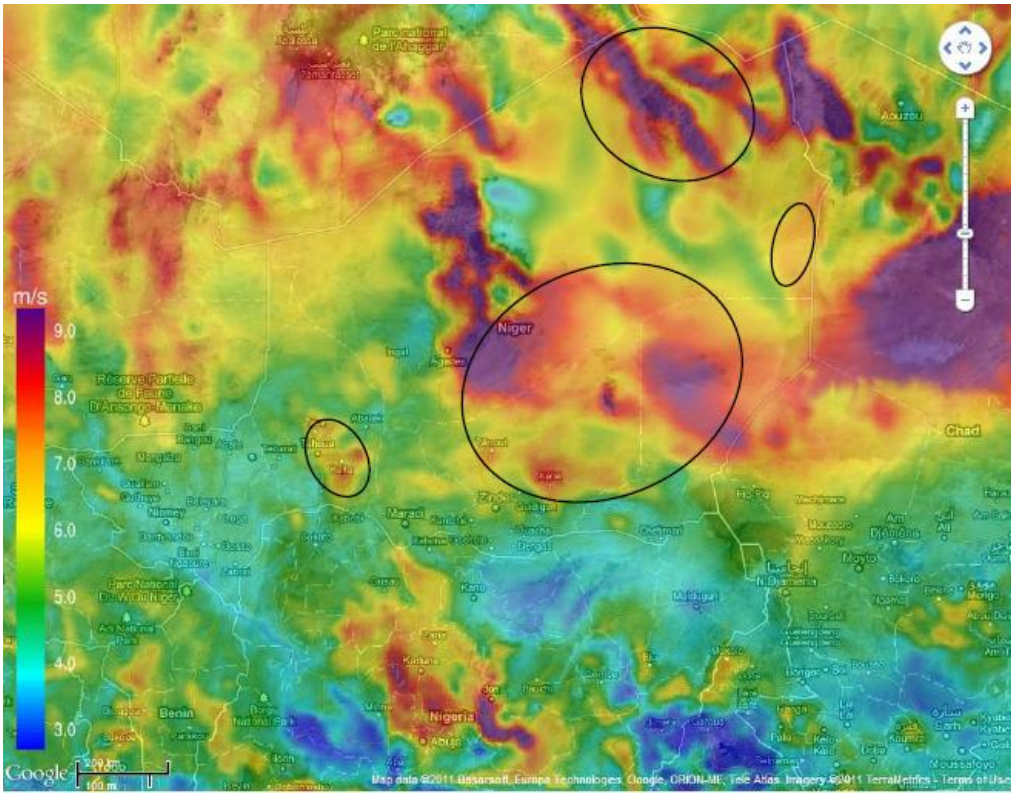
Burkina Faso



Nigeria



Niger



7. APPENDIX: SIMULATIONS "THERMOFLOW" GAS AND COAL

TRACTEBEL Engineering GDF SUEZ				WAPP Power Generation Simulation Hypothesis and Comments	
Rev: B	Latest revision date :		01/04/2011		
Item Nr.	**Keyword**	**Thermoflow case**	**Subject/Item**	**Comment**	
1	Temperature	general	ambiant temp	33 °C	
2	Rh	general	Relative humidity	70%	
3	Frequency	general	Elec Network	50 Hz	
4	SW T°	general	SW temperature	25 °C. T° difference between Sw in and outlet :Sw out -SW in = 7°C	
5	Cost	general	Regional Cost considered	South Africa, no other african country available within Thermoflow library.	
6	Indoor/outdoo	general	Site configuration	GT + ST are indoor. HRSG outdoor as well as utilities.	
7	Pressure Level	general (Except 5-6)	Cycle configuration	3 pressure levels reheat	
8	Fuel	general	Fuel	Natural Gaz with sufficient network pressure. (No additional fuel gas compressor)	
9	Fuel	general	Fuel	Dual fuel package included. Base case is Natural Gas not Diesel Oil.	
10	Fuel	general	Fuel	Distillated Oil as standard selection in Thermoflow library. No other option available.	
11	CAPEX	general	CAPEX philosphy	Based on low cost calculation and not on efficiency optimisation which leads to higher investment (among other in the number of aero condenser)	
12	HRSG	all	Performances	Pinch set at 10 - 15 -15 for LP and IP and HP respectively.	
13	HRSG	all	Availability	By pass stack	
14	ST Condenser		water cooling	Seawater	
15	CAPEX options	all	Spare Parts	2% of total EPC cost	
16	ALSTOM GT	1-2		In case of ALSTOM GT the net power generated is 319MW. Rem: Silo combustor (high fuel flexibility)	

WAPP Power Generation Simulation
Hypothesis and Comments

Item Nr.	Keyword	Thermoflow case	Subject/Item	Comment	
17	Gas Turbine	1-2	Main characteristics of Gas Turbine selected	- Low NOX (dry low Nox combustor) - Reliable, robust and proven technology. - High Fuel flexibility (Crude Oil),	
18	Air-cooled condenser	1-3-5	Air cooled Condenser	This solution has the following advantage and desadvantages: - No need of water consumption (especially at location where water is not easily available), - Higher electrical consumption, - Higher footprint, - Higher capex, - lower efficiency, Improved solutions (e.g.: wet tower, hybrid cooling systems, Heller systems) could be used instead but depends on the site location and specifications.	
19	Air-cooled condenser	1-3-5	Design point	Condenser pressure fixed at 200 mbar following the site conditions.	
20	Pressure level HRSG	5-6	Cycle configuration	2 pressure levels (2P) but only HP connected to the Steam Turbine. LP is routed directly to the Deaerator. HP Steam temperature limited to 520 °C.	
21	GT type	5-6	GT selection	Aero-derivative GT not selected because of higher technical complexity for small power generated. The selected GT's are limited to the use of Natural Gas of Distalaate Oil #2 as combustion fuel.	
22	GT type	3-4	GT Selection	GT 7FA with Gross output of 171MW with 9 ppm Nox emission should also be suitable.	
23	Coal fire	10	Defintion of "CFB" See figure 2.	Circulating Fluidised Bed technology means that in fluidised bed, coal is burned in a self mixing suspension of gas and solid bed material in which air for combustion enters from below. In circulating (fluidisation velocity of about 8m/s) fluidised bed combustion (CFBC) the captured solids including any unburned carbon are re-injected directly back into the combustion chamber without passing through an external recirculation. The internal solids ciculation in CFB provides longer residence time for fuel and limestone, resulting in good combustion and improved sulphur capture.	
24	Coal fire	11	Defintion of "PC" See figure 1.	Pulverised Coal technology means that the raw coal in the silos is conducted to the coal mills where it is dried up , finely pulverised (<80μm) and the size classified using preheated primary air.The pulverised coal is directly injected with primary air in the burners located at different levels of the boiler.	

Item Nr.	Keyword	Thermoflow case	Subject/Item	Comment	

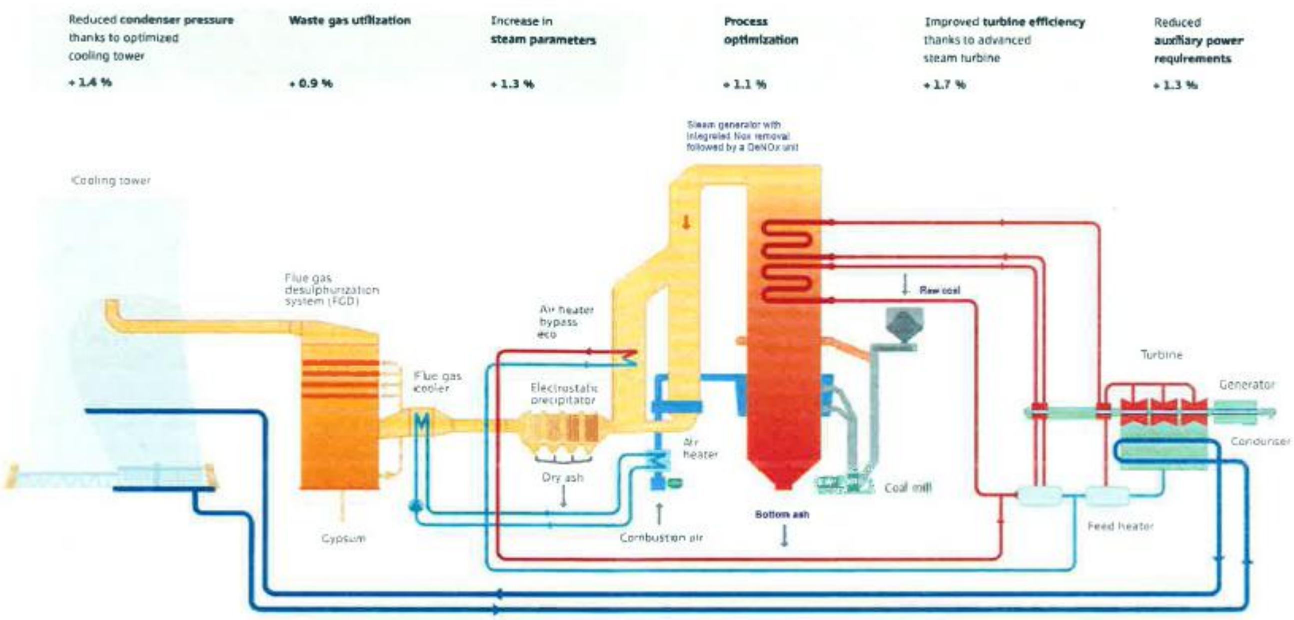


FIGURE 1.- Pulverised Coal fire plant technology

Item Nr.	Keyword	Thermoflow case	Subject/Item	Comment	

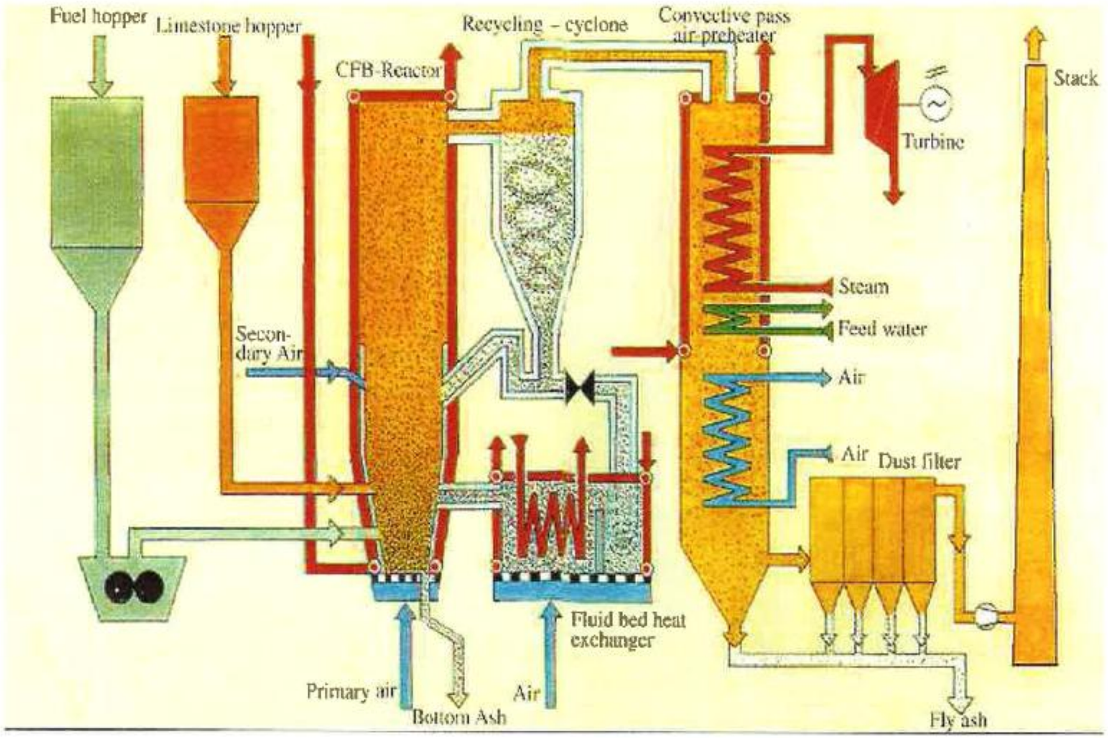


FIGURE 2. Circulating Fluidised Bed Coal Fire Plant

8. APPENDIX: STABILITY STUDY: PSA MODEL FOR YEAR 2025, PEAK LOAD SITUATION

8.1. Nodes

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
TOBENE03	SE	SE	225		SENDOU3G	SE	SE	6.6
KAOLAC03	SE	SE	225		MAURIT03	MT	MT	225
TOUBA_03	SE	SE	225		SOMA__03	GA	GA	225
KAHO1_03	SE	SE	225		BRIKAM03	GA	GA	225
KAHO2_03	SE	SE	225		BRIKAM1G	GA	GA	30
DAGANA03	SE	SE	225		MANSOA03	GB	GB	225
MATAM_03	SE	SE	225		BISSAU03	GB	GB	225
SAKAL_03	SE	SE	225		BAMBAD03	GB	GB	225
TAMBAC03	SE	SE	225		SALTHI03	GB	GB	225
TANAF_03	SE	SE	225		BISSAU1G	GB	GB	30
KOUNOU03	SE	SE	225		LINSAN03	GU	GU	225
ZIGUIN03	SE	SE	225		NZEREK03	GU	GU	225
SENDOU03	SE	SE	225		FOMI__03	GU	GU	225
MBOUR_03	SE	SE	225		BOKE__03	GU	GU	225
THIONA08	SE	SE	90		KALETA03	GU	GU	225
TOBENE08	SE	SE	90		LABE__03	GU	GU	225
HANN__08	SE	SE	90		MALI__03	GU	GU	225
BELAIR08	SE	SE	90		SAMBAG03	GU	GU	225
CAPEBI08	SE	SE	90		BEYLA_03	GU	GU	225
KOUNOU08	SE	SE	90		KANKAN03	GU	GU	225
MBAO__08	SE	SE	90		KOROUS03	GU	GU	225
SOCOCI08	SE	SE	90		DABOLA03	GU	GU	225
GTIIPP08	SE	SE	90		SIGUIR03	GU	GU	225
MECKHE08	SE	SE	90		AMARYA03	GU	GU	225
MATAM_08	SE	SE	90		MATOTO03	GU	GU	225
SIBA__08	SE	SE	90		KOUKOU03	GU	GU	225
SOMETA08	SE	SE	90		BOUREY03	GU	GU	225
FICT1_08	SE	SE	90		DONKEA07	GU	GU	110
FICT2_08	SE	SE	90		GARAFI07	GU	GU	110
UNIVER08	SE	SE	90		GRCHUT07	GU	GU	110
AEROPO08	SE	SE	90		MATOTO07	GU	GU	110
PATTED08	SE	SE	90		LINSAN07	GU	GU	110
TAIBA_08	SE	SE	90		MAMOU_07	GU	GU	110
SAKAL_10	SE	SE	30		KINDIA07	GU	GU	110
KAHONE1G	SE	SE	15		GRCHUT_D	GU	GU	60
KAHONE2G	SE	SE	15		MATOTO_D	GU	GU	60
BELAIR11	SE	SE	15		MANEAH_D	GU	GU	60
KOUNOU11	SE	SE	15		SONFON_D	GU	GU	60
TAMBAC11	SE	SE	15		YESSOU_D	GU	GU	60
DAGANA11	SE	SE	15		NZEREK_D	GU	GU	33
CAPEB11G	SE	SE	15		TOMBO__D	GU	GU	20
TAMBAC12	SE	SE	15		BANEAH_D	GU	GU	15
BELAIR1G	SE	SE	11		DONKEA_D	GU	GU	15
CAPEBI1G	SE	SE	11		SAMBANG1	GU	GU	13.2
GTI___1G	SE	SE	11		SAMBANG2	GU	GU	13.2
CAPEBI2G	SE	SE	6.6		SAMBANG3	GU	GU	13.2
CAPEBI3G	SE	SE	6.6		SAMBANG4	GU	GU	13.2
CAPEBI4G	SE	SE	6.6		TB5G3	GU	GU	11
CAPEBI5G	SE	SE	6.6		TB5G1	GU	GU	11
CAPEBI6G	SE	SE	6.6		TB5G2	GU	GU	11
CAPEBI7G	SE	SE	6.6		MANEAHG1	GU	GU	11
CAPEBI8G	SE	SE	6.6		MANEAHG2	GU	GU	11
CAPEBI9G	SE	SE	6.6		MANEAHG3	GU	GU	11
CAPEB10G	SE	SE	6.6		KALETAG1	GU	GU	10.3
SENDOU1G	SE	SE	6.6		KALETAG2	GU	GU	10.3
SENDOU2G	SE	SE	6.6		KALETAG3	GU	GU	10.3

Substation Node name	Country	Zone	Voltage level kV		Substation Node name	Country	Zone	Voltage level kV
FOMI__G1	GU	GU	10.3		KENIE_05	MA	MA	150
FOMI__G2	GU	GU	10.3		BALING10	MA	MA	30
FOMI__G3	GU	GU	10.3		BALI1_11	MA	MA	15
DIGAN__G	GU	GU	10.3		BALI2_11	MA	MA	15
AMARYAG1	GU	GU	10.3		MANANT1G	MA	MA	11
AMARYAG2	GU	GU	10.3		MANANT2G	MA	MA	11
AMARYAG3	GU	GU	10.3		MANANT3G	MA	MA	11
AMARYAG4	GU	GU	10.3		MANANT4G	MA	MA	11
KASSAB_G	GU	GU	10.3		MANANT5G	MA	MA	11
LAFOU__G	GU	GU	10.3		DARSATAC	MA	MA	11
GOZOGUEG	GU	GU	10.3		FELOU_1G	MA	MA	11
BONKONDG	GU	GU	10.3		FELOU_2G	MA	MA	11
FRANKO_G	GU	GU	10.3		FELOU_3G	MA	MA	11
POUDADLG	GU	GU	10.3		ALBATR1G	MA	MA	11
BALASSAG	GU	GU	10.3		GOUINA1G	MA	MA	11
KOUKOUTG	GU	GU	10.3		GOUINA2G	MA	MA	11
BOUREYAG	GU	GU	10.3		GOUINA3G	MA	MA	11
DIAREGUG	GU	GU	10.3		BADOUMG1	MA	MA	11
NZEBELAG	GU	GU	10.3		BADOUMG2	MA	MA	11
KOURAVEG	GU	GU	10.3		SELING1G	MA	MA	8.66
KOUYA__G	GU	GU	10.3		SOPAM_1G	MA	MA	8.66
FETORE_G	GU	GU	10.3		KENIE_1G	MA	MA	8.66
GRKINKOG	GU	GU	10.3		KENIE_2G	MA	MA	8.66
TB3G1	GU	GU	6.3		KENIE_3G	MA	MA	8.66
TB3G2	GU	GU	6.3		SIKASSO1	MA	MA	8.66
TB3G4	GU	GU	6.3		KOUTIA1G	MA	MA	8.66
TB3G3	GU	GU	6.3		VICABO1G	MA	MA	8.66
DONKEAG2	GU	GU	6.3		KOUTIA2G	MA	MA	8.66
DONKEAG1	GU	GU	6.3		BALING1G	MA	MA	6.6
GARAFIG1	GU	GU	5.65		BALING2G	MA	MA	6.6
GARAFIG2	GU	GU	5.65		BALING3G	MA	MA	6.6
GARAFIG3	GU	GU	5.65		BALING4G	MA	MA	6.6
GRCHUTG3	GU	GU	5.5		DARSAL1G	MA	MA	5.5
GRCHUTG4	GU	GU	5.5		DARSAL5G	MA	MA	5.5
GRCHUTG2	GU	GU	3.3		DARSAL6G	MA	MA	5.5
GRCHUTG1	GU	GU	3.3		DARSAL7G	MA	MA	5.5
BANEAHG1	GU	GU	3.15		SOTU1_1G	MA	MA	2
BANEAHG2	GU	GU	3.15		NIONO_1G	MA	MA	2
MANANT03	MA	MA	225		BOUGO_1G	MA	MA	2
TKITA_03	MA	MA	225		SOSUMA1G	MA	MA	2
KODIAL03	MA	MA	225		MARKALAG	MA	MA	2
KAYES_03	MA	MA	225		DARSAL8G	MA	MA	0.4
KOUTIA03	MA	MA	225		KAMAKW03	SL	SL	225
SIKASS03	MA	MA	225		KENEMA03	SL	SL	225
SEGOU_03	MA	MA	225		BUMBUN03	SL	SL	225
OULESS03	MA	MA	225		YIBEN_03	SL	SL	225
SELING03	MA	MA	225		BIKONG03	SL	SL	225
BADOUM03	MA	MA	225		BUMBUN04	SL	SL	161
FANA__05	MA	MA	150		FRTOWN04	SL	SL	161
SEGOU_05	MA	MA	150		KAMAKW_D	SL	SL	33
KALABA05	MA	MA	150		KENEMA_D	SL	SL	33
SIRAKO05	MA	MA	150		YIBEN__D	SL	SL	33
KODIAL05	MA	MA	150		BIKONG_D	SL	SL	33
LAFIA_05	MA	MA	150		BUMBU1G1	SL	SL	13.8
SELING05	MA	MA	150		BUMBU1G2	SL	SL	13.8
BALING05	MA	MA	150		BUMBUN2G	SL	SL	13.8

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
BENKONGG	SL	SL	10.3		2041KOSS	CI	CI	90
BUMBUN3G	SL	SL	10.3		2330ZUEN	CI	CI	90
BUMBU45G	SL	SL	10.3		2300SERE	CI	CI	90
MONROV03	LI	LI	225		2250YAMO	CI	CI	90
YEKEPA03	LI	LI	225		2260DIMB	CI	CI	90
MANO__03	LI	LI	225		2270ATAK	CI	CI	90
BUCHAN03	LI	LI	225		2280ABEN	CI	CI	90
STPAUL03	LI	LI	225		2290AGNE	CI	CI	90
MONROV09	LI	LI	66		2031TAAB	CI	CI	90
YEKEPA_D	LI	LI	33		2120AGBO	CI	CI	90
BUCHAN_D	LI	LI	33		2320GAGN	CI	CI	90
MONROV_D	LI	LI	33		2310DIVO	CI	CI	90
MANO___D	LI	LI	33		2011ABOB	CI	CI	90
MTCOFFG1	LI	LI	10.5		2150PLAT	CI	CI	90
MTCOFFG2	LI	LI	10.5		2160BIAN	CI	CI	90
MTCOFFG3	LI	LI	10.5		2140BONG	CI	CI	90
BUCHANG1	LI	LI	10.5		2170AYAM	CI	CI	90
BUCHANG2	LI	LI	10.5		2240TREI	CI	CI	90
MTCOFFG4	LI	LI	10.5		2180AYAM	CI	CI	90
MANORIG1	LI	LI	10.3		2220BIAS	CI	CI	90
MANORIG2	LI	LI	10.3		2021VRID	CI	CI	90
SPAULG11	LI	LI	10.3		2210RIVI	CI	CI	90
SPAULG12	LI	LI	10.3		2200BASS	CI	CI	90
SPAULG21	LI	LI	10.3		2190ABRO	CI	CI	90
SPAULG22	LI	LI	10.3		2081PEDR	CI	CI	90
RIVIER02	CI	CI	330		20FAYE90	CI	CI	90
2060FERK	CI	CI	225		200SIR90	CI	CI	90
2100MAN-	CI	CI	225		2000HIRE	CI	CI	90
2090BUYO	CI	CI	225		2231YOPO	CI	CI	90
2070SOUB	CI	CI	225		2130DABO	CI	CI	90
2050BOUA	CI	CI	225		2230YOPO	CI	CI	90
2040KOSS	CI	CI	225		2044KOSS	CI	CI	17
2030TAAB	CI	CI	225		2043KOSS	CI	CI	17
2010ABOB	CI	CI	225		2042KOSS	CI	CI	17
2500AZIT	CI	CI	225		2501AZI	CI	CI	15.75
2020VRID	CI	CI	225		2502AZI	CI	CI	15.75
2209RIVI	CI	CI	225		2NEWCC-1	CI	CI	15.75
2110LABO	CI	CI	225		2NEWCC-2	CI	CI	15.75
2080S-PE	CI	CI	225		20NGTAG8	CI	CI	15
2229YOPO	CI	CI	225		2027VRID	CI	CI	15
2371BUND	CI	CI	225		2028VRID	CI	CI	15
TIBOTO03	CI	CI	225		2029VRID	CI	CI	15
2061FERK	CI	CI	90		20NTAG82	CI	CI	15
2360KORH	CI	CI	90		20NTAG83	CI	CI	15
2370BUND	CI	CI	90		2032TAAB	CI	CI	13.8
2380ODIE	CI	CI	90		2033TAAB	CI	CI	13.8
2111LABO	CI	CI	90		2034TAAB	CI	CI	13.8
2390SEGU	CI	CI	90		2023VGT-	CI	CI	11
2101MAN-	CI	CI	90		2022VGT-	CI	CI	11
2400DANA	CI	CI	90		2024VRID	CI	CI	11
2071SUBR	CI	CI	90		2025VRID	CI	CI	11
2091BUYO	CI	CI	90		2026VRID	CI	CI	11
2410DALO	CI	CI	90		2093BUYO	CI	CI	10.5
2340BOUA	CI	CI	90		2094BUYO	CI	CI	10.5
2350MARA	CI	CI	90		2092BUYO	CI	CI	10.5
2051BOUA	CI	CI	90		SOUBREG1	CI	CI	10.5

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
SOUBREG2	CI	CI	10.5		KOMSILG4	BU	BU	11
SOUBREG3	CI	CI	10.5		KOMSILG3	BU	BU	11
BOUTOUBG	CI	CI	10.5		KOMSILG2	BU	BU	11
GRIBOPOG	CI	CI	10.5		KOMSILG1	BU	BU	11
TIBOTOG1	CI	CI	10.5		BOB2_2G1	BU	BU	11
TIBOTOG2	CI	CI	10.5		BOB2_2G2	BU	BU	11
TIBOTOG3	CI	CI	10.5		4BAGRE_6	BU	BU	6.6
2172AYAM	CI	CI	5.5		4KOMPI_6	BU	BU	6.6
2181AYAM	CI	CI	5.5		4OUA11_6	BU	BU	6.3
2171AYAM	CI	CI	5.5		4OUA12_6	BU	BU	6.3
2182AYAM	CI	CI	5.5		4BOB11_5	BU	BU	5.5
ABOCOMG1	CI	CI	5.5		4BOB12_5	BU	BU	5.5
ABOCOMG2	CI	CI	5.5		4BOB13_5	BU	BU	5.5
ABOCOMG3	CI	CI	5.5		4BOB14_5	BU	BU	5.5
OUAGAE02	BU	BU	330		4BOB21_5	BU	BU	5.5
4KODE225	BU	BU	225		4BOB22_5	BU	BU	5.5
4_PA_225	BU	BU	225		4BOB23_5	BU	BU	5.5
4ZAGT225	BU	BU	225		4BOB24_5	BU	BU	5.5
OUAGAE03	BU	BU	225		4BOB25_5	BU	BU	5.5
4BAGR132	BU	BU	132		4OUA13_6	BU	BU	5.5
4KOMP132	BU	BU	132		4OUA21_5	BU	BU	5.5
4PTDO132	BU	BU	132		4OUA22_5	BU	BU	5.5
4ZANO132	BU	BU	132		4OUA23_5	BU	BU	5.5
4KOSSO90	BU	BU	90		4OUA24_5	BU	BU	5.5
4OUAG190	BU	BU	90		4OUA25_5	BU	BU	5.5
4OUAG290	BU	BU	90		SMALLHYD	BU	BU	0.4
4_PC_090	BU	BU	90		1029VOLT	GH	GH	330
4ZAGTO90	BU	BU	90		ABOA_330	GH	GH	330
OUAGAE08	BU	BU	90		1591KIN3	GH	GH	330
PATDOI08	BU	BU	90		BOLGA330	GH	GH	330
4ZAGTO34	BU	BU	34.5		PRES330	GH	GH	330
4ZAGTO35	BU	BU	34.5		KSI330	GH	GH	330
4KODEN33	BU	BU	33		1758BON3	GH	GH	330
4BOB1_33	BU	BU	33		1700ASO2	GH	GH	330
4BOB2_33	BU	BU	33		1115DUNK	GH	GH	330
4KOMSI33	BU	BU	33		1560A4BS	GH	GH	330
4KOSSO33	BU	BU	33		CAPE330	GH	GH	330
4KOUA_33	BU	BU	33		1109PRES	GH	GH	225
4OUAG333	BU	BU	33		1809ELUB	GH	GH	225
4OUAG133	BU	BU	33		12951BOL	GH	GH	225
4OUAG233	BU	BU	33		1010AKOS	GH	GH	161
4PTDOI33	BU	BU	33		1020VOLT	GH	GH	161
4ZAGTO33	BU	BU	33		1031SMEL	GH	GH	161
4BOB1_15	BU	BU	15		1032SMEL	GH	GH	161
4BOB2_15	BU	BU	15		1033SMEL	GH	GH	161
4KOSSO15	BU	BU	15		1034SMEL	GH	GH	161
4OUAG115	BU	BU	15		1035SMEL	GH	GH	161
4OUAG215	BU	BU	15		1036SMEL	GH	GH	161
4KOS1_11	BU	BU	11		1040TEMA	GH	GH	161
4KOS2_11	BU	BU	11		1050ACHI	GH	GH	161
4KOS3_11	BU	BU	11		1060WINN	GH	GH	161
4KOS4_11	BU	BU	11		1070C-CO	GH	GH	161
4KOS5_11	BU	BU	11		1080TAKO	GH	GH	161
4KOS6_11	BU	BU	11		1090TARK	GH	GH	161
KOMSILG5	BU	BU	11		1100PRES	GH	GH	161
KOMSILG6	BU	BU	11		1110DUNK	GH	GH	161

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
1120OBUA	GH	GH	161		1221ASIE	GH	GH	69
1130KUMA	GH	GH	161		1230HO	GH	GH	69
1140NKAW	GH	GH	161		1240KPEV	GH	GH	69
1150TAFO	GH	GH	161		1250KPAN	GH	GH	69
1160AKWA	GH	GH	161		1255KADJ	GH	GH	69
1170KPON	GH	GH	161		1310SOGA	GH	GH	69
1180KONO	GH	GH	161		1103APRE	GH	GH	55
1190KPON	GH	GH	161		1103BPRE	GH	GH	55
1200ASAW	GH	GH	161		1241KPEV	GH	GH	34.5
1210N-OB	GH	GH	161		1251KPAN	GH	GH	34.5
1220ASIE	GH	GH	161		1311SOGA	GH	GH	34.5
1280TAMA	GH	GH	161		1341WA	GH	GH	34.5
1300BOGO	GH	GH	161		1351YEND	GH	GH	34.5
1320ABOA	GH	GH	161		1361ESSI	GH	GH	34.5
1360ESSI	GH	GH	161		1381SAWL	GH	GH	34.5
1370MALL	GH	GH	161		13091WEX	GH	GH	34.5
1390DCEM	GH	GH	161		1291BOLG	GH	GH	34.5
1392 AFT	GH	GH	161		1481Z-LV	GH	GH	34.5
1600OPB-	GH	GH	161		1279MIM	GH	GH	34.5
1800ELUB	GH	GH	161		1041T-LV	GH	GH	34.5
1470TT1P	GH	GH	161		1042T-LV	GH	GH	34.5
1260TECH	GH	GH	161		1051ACH	GH	GH	34.5
1270SUNY	GH	GH	161		1052ACH	GH	GH	34.5
1350YEND	GH	GH	161		1053ACH	GH	GH	34.5
1380SAWL	GH	GH	161		1054ACH	GH	GH	34.5
1290BOLG	GH	GH	161		1055ACH	GH	GH	34.5
1413KENY	GH	GH	161		1061AWIN	GH	GH	34.5
1309WEXF	GH	GH	161		1061BWIN	GH	GH	34.5
1095NEWT	GH	GH	161		1071BCCO	GH	GH	34.5
1700ASOG	GH	GH	161		1072C-CO	GH	GH	34.5
1900TESI	GH	GH	161		1081TAKO	GH	GH	34.5
1138T261	GH	GH	161		1082TAKO	GH	GH	34.5
1138T262	GH	GH	161		1092ATAR	GH	GH	34.5
1480ZEB	GH	GH	161		1092BTAR	GH	GH	34.5
1139K2BS	GH	GH	161		1111DUNK	GH	GH	34.5
1500BUI	GH	GH	161		1131KUMA	GH	GH	34.5
1901TES2	GH	GH	161		1132KUMA	GH	GH	34.5
1610BUIP	GH	GH	161		1133KUM1	GH	GH	34.5
1590KIN	GH	GH	161		1133KUM2	GH	GH	34.5
15533BSP	GH	GH	161		1151TAF0	GH	GH	34.5
1278MIM	GH	GH	161		1152TAFO	GH	GH	34.5
1580N_AB	GH	GH	161		1161AKWA	GH	GH	34.5
1750BONY	GH	GH	161		1162AKWA	GH	GH	34.5
1990AYAN	GH	GH	161		1171KPON	GH	GH	34.5
1630HAN	GH	GH	161		1181AKON	GH	GH	34.5
1340WA	GH	GH	161		1181BKON	GH	GH	34.5
1620TUMU	GH	GH	161		1201ASAW	GH	GH	34.5
1850ATEB	GH	GH	161		1202ASAW	GH	GH	34.5
1252KPAN	GH	GH	161		1261TECH	GH	GH	34.5
1210JUAB	GH	GH	161		1271SUNY	GH	GH	34.5
1021SME2	GH	GH	161		1281ATAM	GH	GH	34.5
1070CCO3	GH	GH	161		1281BTAM	GH	GH	34.5
BAWKU_04	GH	GH	161		1301BOGO	GH	GH	34.5
1561A4BS	GH	GH	161		1371MALL	GH	GH	34.5
1850BERE	GH	GH	161		1391DCEM	GH	GH	34.5
1870CAPE	GH	GH	161		1327ABOA	GH	GH	34.5

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
11391K2L	GH	GH	34.5		1701ASO6	GH	GH	13.8
11392K2L	GH	GH	34.5		ABOA3CC1	GH	GH	13.8
1143NKAW	GH	GH	34.5		1758G	GH	GH	13.8
1293BOLG	GH	GH	34.5		1757G	GH	GH	13.8
1511BUIL	GH	GH	34.5		1473TT1P	GH	GH	13.8
15543BLV	GH	GH	34.5		1326ABOA	GH	GH	13.8
15553BLV	GH	GH	34.5		SASO2CC1	GH	GH	13.8
1591KIN	GH	GH	34.5		SASO2CC2	GH	GH	13.8
1611BUIP	GH	GH	34.5		HEMANGG	GH	GH	13.8
17501BON	GH	GH	34.5		PWALUGUG	GH	GH	13.8
1621TUMU	GH	GH	34.5		JUALE__G	GH	GH	13.8
1631HAN	GH	GH	34.5		BTPP__G1	GH	GH	13.8
1852ATEB	GH	GH	34.5		CEMPOWEG	GH	GH	13.8
1372MALL	GH	GH	34.5		SASOCC3	GH	GH	13.8
1022SM2L	GH	GH	34.5		1102APRE	GH	GH	13.2
1211DNOB	GH	GH	34.5		1102BPRE	GH	GH	13.2
1211JUAB	GH	GH	34.5		1102CPRE	GH	GH	13.2
1282ATAM	GH	GH	34.5		1222ASIA	GH	GH	11.5
1562A4BS	GH	GH	34.5		1222ASIB	GH	GH	11.5
1851BERL	GH	GH	34.5		1231HO-1	GH	GH	11.5
1871CAPL	GH	GH	34.5		10951NTA	GH	GH	11.5
1011AKOS	GH	GH	14.4		1292BOLG	GH	GH	11.5
1012AKOS	GH	GH	14.4		1071ACCO	GH	GH	11.5
1013AKOS	GH	GH	14.4		1073C-CO	GH	GH	11.5
1014AKOS	GH	GH	14.4		1121AOBU	GH	GH	11.5
1015AKOS	GH	GH	14.4		1121BOBU	GH	GH	11.5
1016AKOS	GH	GH	14.4		1121COBU	GH	GH	11.5
1501G1	GH	GH	14.4		1141NKAW	GH	GH	11.5
1502G2	GH	GH	14.4		1163AKWA	GH	GH	11.5
1503G3	GH	GH	14.4		1195KPON	GH	GH	11.5
1191KPON	GH	GH	13.8		1211ANOB	GH	GH	11.5
1192KPON	GH	GH	13.8		1211BNOB	GH	GH	11.5
1193KPON	GH	GH	13.8		1211CNOB	GH	GH	11.5
1194KPON	GH	GH	13.8		1272SUNY	GH	GH	11.5
1321ABOA	GH	GH	13.8		1273SUNY	GH	GH	11.5
1322ABOA	GH	GH	13.8		1017AKOS	GH	GH	11.5
1323ABOA	GH	GH	13.8		1294BOLG	GH	GH	11.5
1324ABOA	GH	GH	13.8		1998AYAN	GH	GH	11.5
1325ABOA	GH	GH	13.8		1164AKWA	GH	GH	11.5
10311VAL	GH	GH	13.8		1995AYAN	GH	GH	11.5
10312VAL	GH	GH	13.8		1412KENY	GH	GH	11
10313VAL	GH	GH	13.8		1581N-AB	GH	GH	11
10314VAL	GH	GH	13.8		1414KENY	GH	GH	11
10315VAL	GH	GH	13.8		1040TGEN	GH	GH	11
10316VAL	GH	GH	13.8		1101APRE	GH	GH	6.63
10317VAL	GH	GH	13.8		1101BPRE	GH	GH	6.63
10318VAL	GH	GH	13.8		1142NKAW	GH	GH	6.63
1601OPB-	GH	GH	13.8		1122AOBU	GH	GH	6.6
1602OPB-	GH	GH	13.8		1122BOBU	GH	GH	6.6
1471TT1P	GH	GH	13.8		1122COBU	GH	GH	6.6
1472TT1P	GH	GH	13.8		1212ANOB	GH	GH	6.6
1701ASO5	GH	GH	13.8		1212BNOB	GH	GH	6.6
1701ASO1	GH	GH	13.8		1212CNOB	GH	GH	6.6
1701ASO2	GH	GH	13.8		MALANV02	TB	BN	330
1701ASO3	GH	GH	13.8		SAKETE02	TB	BN	330
1701ASO4	GH	GH	13.8		3030COTO	TB	BN	161

Substation Node name	Country	Zone	Voltage level kV	Substation Node name	Country	Zone	Voltage level kV
3BOHI161	TB	BN	161	ADJARAG3	TB	TO	10.3
3050ONIG	TB	BN	161	GAZAOU06	NR	CE	132
3040SAKA	TB	BN	161	MARADI06	NR	CE	132
3DJOU161	TB	BN	161	ZINDER06	NR	CE	132
PARAKO04	TB	BN	161	DIFFA_02	NR	EA	330
MA_GLE04	TB	BN	161	ZABORI02	NR	FL	330
AVA___04	TB	BN	161	NIAMRD02	NR	FL	330
TANZOU04	TB	BN	161	SALKAD02	NR	FL	330
BEMBER04	TB	BN	161	DOSSO02	NR	FL	330
KANDI_04	TB	BN	161	NIAM2_06	NR	FL	132
GUENE_04	TB	BN	161	NIAM2C06	NR	FL	132
MALANV04	TB	BN	161	DOSSO_06	NR	FL	132
NATITI04	TB	BN	161	FRONT_06	NR	FL	132
AKPAKP1G	TB	BN	15	NIAMRD06	NR	FL	132
NATITI1G	TB	BN	15	SALKAD06	NR	FL	132
PORTON1G	TB	BN	15	KANDAD06	NR	FL	132
PARAKO1G	TB	BN	15	NIAM22_D	NR	FL	20
CAI___1G	TB	BN	15	NIAM21_D	NR	FL	20
CAI___2G	TB	BN	15	NIAM2C_D	NR	FL	20
CAI___3G	TB	BN	15	GOUDELG1	NR	FL	20
CAI___4G	TB	BN	15	GOUDELG2	NR	FL	20
CAI___5G	TB	BN	15	GOUDELG3	NR	FL	20
CAI___6G	TB	BN	15	GOUDELG4	NR	FL	20
CAI___7G	TB	BN	15	DYODYONG	NR	FL	20
CAI___8G	TB	BN	15	KANDADG1	NR	FL	20
IPPSOL1G	TB	BN	15	KANDADG2	NR	FL	20
IPPTHE1G	TB	BN	15	KANDADG3	NR	FL	20
SOLBEN1G	TB	BN	15	KANDADG4	NR	FL	20
ADFSOL1G	TB	BN	15	SALKAD_G	NR	FL	10.5
MA_GLE1G	TB	BN	15	SALKADG2	NR	FL	10.5
MA_GLE2G	TB	BN	15	SALKADG3	NR	FL	10.5
MA_GLE3G	TB	BN	15	MAMBIL01	NI	BA	760
30101LOM	TB	TO	330	JALING01	NI	BA	760
3010LOME	TB	TO	161	GOMBE_01	NI	BA	760
3020MOME	TB	TO	161	GOMBE_02	NI	BA	330
3060NANG	TB	TO	161	JOS___02	NI	BA	330
3ATAK161	TB	TO	161	YOLA__02	NI	BA	330
3LOME161	TB	TO	161	DAMATU02	NI	BA	330
3KARA161	TB	TO	161	MAIDUG02	NI	BA	330
DAPAON04	TB	TO	161	JALING02	NI	BA	330
MANGO_04	TB	TO	161	MAMBIL02	NI	BA	330
ADJARA04	TB	TO	161	MAMBIG01	NI	BA	15
CONTOU1G	TB	TO	15	MAMBIG02	NI	BA	15
LOME__1G	TB	TO	15	MAMBIG03	NI	BA	15
KARA__1G	TB	TO	15	MAMBIG04	NI	BA	15
SOLTOG1G	TB	TO	15	MAMBIG05	NI	BA	15
CCTOGOG1	TB	TO	15	MAMBIG06	NI	BA	15
CCTOGOG2	TB	TO	15	MAMBIG07	NI	BA	15
CCTOGOG3	TB	TO	15	MAMBIG08	NI	BA	15
3NGLOG12	TB	TO	11	AJAOKU01	NI	BE	760
3NEWIPP	TB	TO	11	BENINN01	NI	BE	760
3061NANG	TB	TO	10.3	AJAOKU02	NI	BE	330
3062NANG	TB	TO	10.3	ALADJA02	NI	BE	330
KETOU__G	TB	TO	10.3	BENINC02	NI	BE	330
ADJARAG1	TB	TO	10.3	DELTA_02	NI	BE	330
ADJARAG2	TB	TO	10.3	SAPELE02	NI	BE	330

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
OMOTOS02	NI	BE	330		CALABA02	NI	EN	330
BENINN02	NI	BE	330		KWALE_02	NI	EN	330
GEREGU02	NI	BE	330		NEWHAV02	NI	EN	330
EYAEN_02	NI	BE	330		ONITSH02	NI	EN	330
DELTA_06	NI	BE	132		OWERRI02	NI	EN	330
SAPELST1	NI	BE	15.75		MAKURD06	NI	EN	330
SAPELST2	NI	BE	15.75		PORTHA02	NI	EN	330
SAPELST3	NI	BE	15.75		EGBEMA02	NI	EN	330
SAPELST4	NI	BE	15.75		OMOKU_02	NI	EN	330
SAPELST5	NI	BE	15.75		NEWHAS02	NI	EN	330
SAPELST6	NI	BE	15.75		ALIADE02	NI	EN	330
GEREGGT1	NI	BE	15.75		IKOTEK02	NI	EN	330
GEREGGT2	NI	BE	15.75		IKOTAB02	NI	EN	330
GEREGGT3	NI	BE	15.75		AHOADA02	NI	EN	330
GEREGGT4	NI	BE	15.75		YENAGO02	NI	EN	330
GEREGGT5	NI	BE	15.75		GBARAN02	NI	EN	330
GEREGGT6	NI	BE	15.75		NNEWI_02	NI	EN	330
OMOT2GT1	NI	BE	15		IKOTAB06	NI	EN	132
OMOT2GT2	NI	BE	15		OMOKU_06	NI	EN	132
OMOT2GT3	NI	BE	15		GBARAN06	NI	EN	132
OMOT2GT4	NI	BE	15		ALAOCCG1	NI	EN	17
EYAENGT1	NI	BE	15		ALAOCCG2	NI	EN	17
EYAENGT3	NI	BE	15		ETHIOPG1	NI	EN	17
EYAENGT4	NI	BE	15		ETHIOPG2	NI	EN	17
EYAENGT2	NI	BE	15		ETHIOPG3	NI	EN	17
SAPELGT4	NI	BE	15		ETHIOPG4	NI	EN	17
SAPELGT2	NI	BE	15		KWALCC1	NI	EN	15.75
SAPELGT3	NI	BE	15		KWALCC2	NI	EN	15.75
SAPELGT1	NI	BE	15		KWALCC3	NI	EN	15.75
DELTAG03	NI	BE	11.5		AFAMGT19	NI	EN	15.75
DELTAG04	NI	BE	11.5		AFAMGT20	NI	EN	15.75
DELTAG05	NI	BE	11.5		IBOMGT03	NI	EN	15
DELTAG06	NI	BE	11.5		AFAM6GT1	NI	EN	15
DELTAG07	NI	BE	11.5		AFAM6GT2	NI	EN	15
DELTAG08	NI	BE	11.5		AFAM6GT3	NI	EN	15
DELTAG09	NI	BE	11.5		AFAM6GT4	NI	EN	15
DELTAG10	NI	BE	11.5		AFAM6GT5	NI	EN	15
DELTAG11	NI	BE	11.5		CALABGT2	NI	EN	15
DELTAG12	NI	BE	11.5		CALABGT3	NI	EN	15
DELTAG13	NI	BE	11.5		CALABGT4	NI	EN	15
DELTAG14	NI	BE	11.5		CALABGT5	NI	EN	15
DELTAG15	NI	BE	11.5		CALABGT1	NI	EN	15
DELTAG16	NI	BE	11.5		EGBEMGT1	NI	EN	15
DELTAG17	NI	BE	11.5		EGBEMGT2	NI	EN	15
DELTAG18	NI	BE	11.5		EGBEMGT3	NI	EN	15
DELTAG19	NI	BE	11.5		ALAOJGT1	NI	EN	15
DELTAG20	NI	BE	11.5		ALAOJGT2	NI	EN	15
OMOTGT12	NI	BE	10.5		ALAOJGT3	NI	EN	15
OMOTGT34	NI	BE	10.5		ALAOJGT4	NI	EN	15
OMOTGT56	NI	BE	10.5		GBARAGT1	NI	EN	15
OMOTGT78	NI	BE	10.5		GBARAGT2	NI	EN	15
DELTT1	NI	BE	1		IKOTAGT1	NI	EN	15
MAKURD01	NI	EN	760		IKOTAGT2	NI	EN	15
EGBEMA01	NI	EN	760		IKOTAGT3	NI	EN	15
AFAM__02	NI	EN	330		ALSCOGT1	NI	EN	15
ALAOJI02	NI	EN	330		ALSCOGT2	NI	EN	15

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
ALSCOGT3	NI	EN	15		OSHOGB01	NI	LA	760
ALSCOGT4	NI	EN	15		ERUNKA01	NI	LA	760
ALSCOGT5	NI	EN	15		AIYEDE02	NI	LA	330
ALSCOGT6	NI	EN	15		AJA___02	NI	LA	330
OMOKUGT2	NI	EN	15		AKANGB02	NI	LA	330
OMOKUGT1	NI	EN	15		EGBIN_02	NI	LA	330
ICSPOWG1	NI	EN	15		IKEJAW02	NI	LA	330
ICSPOWG2	NI	EN	15		OSHOGB02	NI	LA	330
ICSPOWG3	NI	EN	15		ERUNKA02	NI	LA	330
ICSPOWG4	NI	EN	15		GANMO_02	NI	LA	330
ICSPOWG5	NI	EN	15		ALAGBO02	NI	LA	330
ICSPOWG6	NI	EN	15		PAPALA02	NI	LA	330
BONMOBG1	NI	EN	15		EPE___02	NI	LA	330
BONMOBG2	NI	EN	15		EGBIN_06	NI	LA	132
BONMOBG3	NI	EN	15		EGBINST1	NI	LA	16
TOTALFG1	NI	EN	15		EGBINST2	NI	LA	16
TOTALFG2	NI	EN	15		EGBINST3	NI	LA	16
TOTALFG3	NI	EN	15		EGBINST4	NI	LA	16
TOTALFG4	NI	EN	15		EGBINST5	NI	LA	16
WESTCOG1	NI	EN	15		EGBINST6	NI	LA	16
WESTCOG2	NI	EN	15		CHEVROG1	NI	LA	16
WESTCOG3	NI	EN	15		CHEVROG2	NI	LA	16
WESTCOG4	NI	EN	15		CHEVROG3	NI	LA	16
IBOMP2G4	NI	EN	15		PAPA2GT4	NI	LA	15
IBOMP2G3	NI	EN	15		PAPA2GT2	NI	LA	15
IBOMP2G2	NI	EN	15		PAPA2GT3	NI	LA	15
IBOMP2G1	NI	EN	15		PAPA2GT1	NI	LA	15
FARMELEG	NI	EN	15		EGBINGT1	NI	LA	10.5
IBOMGT01	NI	EN	11.5		EGBINGT2	NI	LA	10.5
IBOMGT02	NI	EN	11.5		EGBINGT3	NI	LA	10.5
AFAMGT15	NI	EN	11.5		EGBINGT4	NI	LA	10.5
AFAMGT16	NI	EN	11.5		EGBINGT5	NI	LA	10.5
AFAMGT17	NI	EN	11.5		EGBINGT6	NI	LA	10.5
AFAMGT18	NI	EN	11.5		EGBINGT7	NI	LA	10.5
OMOKURG1	NI	EN	11.5		EGBINGT8	NI	LA	10.5
OMOKURG2	NI	EN	11.5		EGBINGT9	NI	LA	10.5
AFAMGT13	NI	EN	10.5		PAPAGT12	NI	LA	10.5
AFAMGT14	NI	EN	10.5		PAPAGT34	NI	LA	10.5
IKOTABT1	NI	EN	1		PAPAGT56	NI	LA	10.5
OMOKU_T1	NI	EN	1		PAPAGT78	NI	LA	10.5
GBARANT1	NI	EN	1		EGBINT1	NI	LA	1
IKOTABT2	NI	EN	1		EGBINT2	NI	LA	1
GBARANT2	NI	EN	1		ABUJA_01	NI	SH	760
IKOTABT3	NI	EN	1		BIRNIN02	NI	SH	330
KADUNA01	NI	KD	760		JEBBA_02	NI	SH	330
KANO__01	NI	KD	760		JEBBAP02	NI	SH	330
KADUNA02	NI	KD	330		KAINJI02	NI	SH	330
KANO__02	NI	KD	330		KATAMP02	NI	SH	330
KATSIN02	NI	KD	330		SHIROR02	NI	SH	330
GUSAU_02	NI	KD	330		GWAGWA02	NI	SH	330
ZARIA_02	NI	KD	330		LOKOJA02	NI	SH	330
KANKIA06	NI	KD	132		SOKOTO02	NI	SH	330
KATSIN06	NI	KD	132		ZUNGER02	NI	SH	330
KANO__06	NI	KD	132		BIRNIN06	NI	SH	132
KANOT1A	NI	KD	1		JEBBGH1	NI	SH	16
KATSINT1	NI	KD	1		JEBBGH2	NI	SH	16

Substation	Country	Zone	Voltage level		Substation	Country	Zone	Voltage level
Node name			kV		Node name			kV
JEBBGH3	NI	SH	16					
JEBBGH4	NI	SH	16					
JEBBGH5	NI	SH	16					
JEBBGH6	NI	SH	16					
KAING05	NI	SH	16					
KAING06	NI	SH	16					
KAING07	NI	SH	16					
KAING08	NI	SH	16					
KAING09	NI	SH	16					
KAING10	NI	SH	16					
KAING11	NI	SH	16					
KAING12	NI	SH	16					
SHIRGH1	NI	SH	15.65					
SHIRGH2	NI	SH	15.65					
SHIRGH3	NI	SH	15.65					
SHIRGH4	NI	SH	15.65					
ZUNGERG1	NI	SH	15.65					
ZUNGERG2	NI	SH	15.65					
ZUNGERG3	NI	SH	15.65					
ZUNGERG4	NI	SH	15.65					
BIRNT1	NI	SH	1					

8.2. Loads

Load	Connection node	Country	Active power	Reactive power		Load	Connection node	Country	Active power	Reactive power
Name	Name		MW	Mvar		Name	Name		MW	Mvar
MBOUR_03	MBOUR_03	SE	46.8	22.7		TOMBO__D	TOMBO__D	GU	89	43.1
THIONA08	THIONA08	SE	61.7	29.9		MANEAH_D	MANEAH_D	GU	50	24.2
TAIBA_08	TAIBA_08	SE	40	19.4		SONFON_D	SONFON_D	GU	35	17
TOBENE08	TOBENE08	SE	86.3	41.8		GARAFI07	GARAFI07	GU	5	2.4
KAOLAC03	KAOLAC03	SE	64.4	31.2		GRCHUT_D	GRCHUT_D	GU	10	4.8
TOUBA_03	TOUBA_03	SE	75.2	36.4		NZEREK_D	NZEREK_D	GU	5	2.4
DAGANA03	DAGANA03	SE	20.5	9.9		BALI1_11	BALI1_11	MA	79.4	38.5
MATAM_08	MATAM_08	SE	30.5	14.8		BALKOU15	BALING05	MA	21	10.2
SAKAL_10	SAKAL_10	SE	66.9	32.4		KOULIK15	BALING05	MA	12.9	6.2
AEROPORT	AEROPO08	SE	42.7	20.7		FANA__15	FANA__05	MA	2.5	1.2
HANN__08	HANN__08	SE	143.7	69.6		FANA__30	FANA__05	MA	3.3	1.6
BELAIR08	BELAIR08	SE	150.6	72.9		KALAB_15	KALABA05	MA	46.4	22.5
CAPEBI08	CAPEBI08	SE	108.5	52.5		DIAMOU33	KAYES_03	MA	11.5	5.6
MBAO__08	MBAO__08	SE	51.3	24.8		SADIOL33	KAYES_03	MA	39	18.9
MECKHE08	MECKHE08	SE	8.5	4.1		KOUTI_33	KOUTIA03	MA	21.1	10.2
SIBA__08	SIBA__08	SE	8.5	4.1		LAFIA_15	LAFIA_05	MA	44.5	21.6
SOMETA08	SOMETA08	SE	8.5	4.1		LAFIA_30	LAFIA_05	MA	29.6	14.3
UNIVERSI	UNIVER08	SE	59	28.6		LOULO	TKITA_03	MA	61.3	29.7
ZIGUIN03	ZIGUIN03	SE	31.9	15.4		TABAKOTO	MANANT03	MA	26.7	12.9
SOCOCI08	SOCOCI08	SE	2.8	1.4		SEGO1_15	SEGOU_05	MA	14.4	7
TANAF_03	TANAF_03	SE	12.6	6.1		SEGO2_15	SEGOU_05	MA	14.4	7
TAMBAC03	TAMBAC03	SE	51.3	24.8		KALANA_6	SELING05	MA	3.5	1.7
MAURITA1	MAURIT03	MT	48	23.2		SELING33	SELING05	MA	4	1.9
SOMA__03	SOMA__03	GA	17.3	8.4		YANFOL33	SELING05	MA	3.8	1.8
BRIKAM_D	BRIKAM1G	GA	145.7	70.6		SIKASS33	SIKASS03	MA	21.1	10.2
MANSOA03	MANSOA03	GB	4	1.9		SIKASS03	SIKASS03	MA	47.9	23.2
BAMBAD03	BAMBAD03	GB	4	1.9		SIRAK_15	SIRAKO05	MA	28.7	13.9
SALTHI03	SALTHI03	GB	4	1.9		TKITA_15	TKITA_03	MA	3.6	1.7
BISSAU03	BISSAU1G	GB	105	50.9		BALI1_30	BALING10	MA	8.5	4.1
KINDIA07	KINDIA07	GU	12	5.8		TIENFA30	BALING10	MA	12.7	6.2
MAMOU_07	MAMOU_07	GU	21	10.2		BADA1_15	BALING10	MA	21.3	10.3
BANEAH_D	BANEAH_D	GU	5	2.4		BADA2_15	LAFIA_05	MA	21.3	10.3
DONKEA07	DONKEA07	GU	6	2.9		DARS1_15	BALING10	MA	25.1	12.2
MATOTO_D	MATOTO_D	GU	167	80.9		DARS2_15	LAFIA_05	MA	25.1	12.2

Load	Connection node	Country	Active power	Reactive power	Load	Connection node	Country	Active power	Reactive power
Name	Name		MW	Mvar	Name	Name		MW	Mvar
KAYEPA15	KAYES_03	MA	18.7	9.1	1041-1	1041T-LV	GH	417	203.2
SOTU1_15	BALING10	MA	9.8	4.7	1042-1	1042T-LV	GH	50.1	24.3
SOTU2_15	BALING10	MA	9.8	4.7	1051-1	1051ACH	GH	92.5	44.8
KAMAKW_D	KAMAKW_D	SL	4	1.9	1052-1	1052ACH	GH	92.5	44.8
YIBEN__D	YIBEN__D	SL	4	1.9	1053-1	1053ACH	GH	92.5	44.8
BIKONG_D	BIKONG_D	SL	4	1.9	1054-1	1054ACH	GH	92.5	44.8
KENEMA_D	KENEMA_D	SL	12	5.8	1055-1	1055ACH	GH	92.5	44.8
BUMBUN04	BUMBUN04	SL	20	9.7	1061-A	1061AWIN	GH	11.3	5.5
FRTOWN04	FRTOWN04	SL	173	83.8	1061-B	1061BWIN	GH	11.3	5.5
YEKEPA_D	YEKEPA_D	LI	9	4.4	1071-B	1071BCCO	GH	45	21.8
BUCHAN_D	BUCHAN_D	LI	6	2.9	1072-2	1072C-CO	GH	45	21.8
MONROV_D	MONROV_D	LI	74	35.8	1081-1	1081TAKO	GH	47.3	22.9
MANO___D	MANO___D	LI	4	1.9	1082-1	1082TAKO	GH	47.3	22.9
2061FERK	2061FERK	CI	59.9	29	1092-A	1092ATAR	GH	57.1	27.7
2360KORH	2360KORH	CI	32.6	15.8	1092-B	1092BTAR	GH	57.1	27.7
2370BUND	2370BUND	CI	17.3	8.4	10951-1	10951NTA	GH	100.4	48.6
2380ODIE	2380ODIE	CI	8.8	4.3	1101-2	1101APRE	GH	3.6	1.7
2111LABO	2111LABO	CI	11.7	5.7	1101-1	1101BPRE	GH	3.6	1.7
2390SEGU	2390SEGU	CI	20.1	9.7	1102-2	1102APRE	GH	7.2	3.5
2101MAN-	2101MAN-	CI	37.4	18.1	1111-1	1111DUNK	GH	4.4	2.1
2400DANA	2400DANA	CI	19	9.2	1121-1	1121AOBU	GH	14.5	7
2071SUBR	2071SUBR	CI	16.7	8.1	1121-2	1121BOBU	GH	14.5	7
2091BUYO	2091BUYO	CI	3.1	1.5	1121-3	1121COBU	GH	14.5	7
2410DALO	2410DALO	CI	46.2	22.4	1122-1	1122AOBU	GH	6.5	3.1
2340BOUA	2340BOUA	CI	23	11.1	1122-2	1122BOBU	GH	6.5	3.1
2350MARA	2350MARA	CI	6.2	3	1122-3	1122COBU	GH	6.5	3.1
2051BOUA	2051BOUA	CI	81.8	39.6	1211-1	1211ANOB	GH	28.3	13.7
2041KOSS	2041KOSS	CI	23.5	11.4	1211-2	1211BNOB	GH	28.3	13.7
2330ZUEN	2330ZUEN	CI	10.8	5.2	1211-3	1211CNOB	GH	28.3	13.7
2300SERE	2300SERE	CI	10.2	4.9	1211-4	1211DNOB	GH	4	1.9
2250YAMO	2250YAMO	CI	35.7	17.3	1131-1	1131KUMA	GH	129.1	62.5
2260DIMB	2260DIMB	CI	10.4	5	1132-2	1132KUMA	GH	64.5	31.2
2270ATAK	2270ATAK	CI	25.2	12.2	1133-1	1133KUM1	GH	64.5	31.2
2280ABEN	2280ABEN	CI	12.5	6.1	1133-2	1133KUM2	GH	64.5	31.2
2290AGNE	2290AGNE	CI	15.7	7.6	11391	11391K2L	GH	53.8	26.1
2031TAAB	2031TAAB	CI	14.7	7.1	11392	11392K2L	GH	53.8	26.1
2120AGBO	2120AGBO	CI	35.7	17.3	1143	1143NKAW	GH	24.9	12.1
2320GAGN	2320GAGN	CI	38	18.4	1151-1	1151TAF0	GH	21	10.2
2310DIVO	2310DIVO	CI	36.2	17.5	1152-2	1152TAFO	GH	21	10.2
2150PLAT	2150PLAT	CI	54.6	26.4	1161-1	1161AKWA	GH	13.9	6.7
2160BIAN	2160BIAN	CI	136.6	66.2	1162-2	1162AKWA	GH	13.9	6.7
2140BONG	2140BONG	CI	12.6	6.1	1171-1	1171KPON	GH	50.6	24.5
2240TREI	2240TREI	CI	118.6	57.4	1181-A	1181AKON	GH	7.4	3.6
2180AYAM	2180AYAM	CI	8.5	4.1	1181-B	1181BKON	GH	7.4	3.6
2220BIAS	2220BIAS	CI	294	142.4	1195-1	1195KPON	GH	0.6	0.3
2021VRID	2021VRID	CI	112.5	54.5	1201-1	1201ASAW	GH	39.7	19.2
2210RIVI	2210RIVI	CI	79.4	38.5	1202-2	1202ASAW	GH	39.7	19.2
2200BASS	2200BASS	CI	10.4	5	1222-1	1221ASIE	GH	1.8	0.9
2190ABRO	2190ABRO	CI	20.7	10	1231-1	1231HO-1	GH	11	5.3
2081PEDR	2081PEDR	CI	55	26.6	1241-1	1241KPEV	GH	7	3.4
200SIR90	200SIR90	CI	0	0	1251-1	1251KPAN	GH	17.9	8.7
20FAYE90	20FAYE90	CI	0	0	1261-1	1261TECH	GH	24.8	12
2130DABO	2130DABO	CI	28.5	13.8	1271-1	1271SUNY	GH	26.3	12.7
2011ABOB	2011ABOB	CI	226	109.5	1272-1	1272SUNY	GH	26.3	12.7
2230YOPO	2230YOPO	CI	268.7	130.1	1279-1	1279MIM	GH	26.9	13
2231YOPO	2231YOPO	CI	46.6	22.6	1281-A	1281ATAM	GH	29.2	14.1
2000HIRE	2000HIRE	CI	16.7	8.1	1281-B	1281BTAM	GH	29.2	14.1
4BAGR132	4BAGR132	BU	2.5	1.2	1290_1	1291BOLG	GH	5.3	2.6
4_PA_225	4_PA_225	BU	31.7	15.4	1290_2	1292BOLG	GH	5.3	2.6
4KOSSO90	4KOSSO90	BU	45.9	22.2	1293	1293BOLG	GH	5.3	2.6
4OUAG190	4OUAG190	BU	125.3	60.7	1294	1294BOLG	GH	5.3	2.6
4OUAG290	4OUAG290	BU	101.3	49.1	1301-1	1301BOGO	GH	78.2	37.9
4ZAGTO90	4ZAGTO90	BU	27	11.5	13091-1	13091WEX	GH	21.7	10.5
4KOMP132	4KOMP132	BU	1.6	0.8	1311-1	1311SOGA	GH	19	9.2
4PTDOI33	4PTDOI33	BU	53.2	25.8	1327-1	1327ABOA	GH	0.3	0.1
4OUAG333	4OUAG333	BU	4.1	2	1341-1	1341WA	GH	11.1	5.4
4BOB1_33	4BOB1_33	BU	44.7	21.6	13511	1351YEND	GH	12.8	6.2
4BOB2_33	4BOB2_33	BU	35.4	17.1	1361-1	1361ESSI	GH	30.7	14.9
4ZAGTO33	4ZAGTO33	BU	3.6	1.7	1371-1	1371MALL	GH	146.9	71.1
4KODEN33	4KODEN33	BU	16.9	8.2	13811	1381SAWL	GH	2.8	1.4
4ZAGTO34	4ZAGTO34	BU	1.1	0.5	1391-1	1391DCEM	GH	26.4	12.8
1017-1	1017AKOS	GH	9.9	4.8	1412-1	1412KENY	GH	65.8	31.9
1022	1022SM2L	GH	29.4	14.2	1481-1	1481Z-LV	GH	11.9	5.8
103111	10311VAL	GH	0	0	1511	1511BUIL	GH	1.8	0.9
103121	10312VAL	GH	121.7	58.9	15543	15543BLV	GH	147.6	71.5
103131	10313VAL	GH	121.7	58.9	15553	15553BLV	GH	147.6	71.5
103141	10314VAL	GH	121.7	58.9	1581-1	1581N-AB	GH	65.3	31.6
103151	10315VAL	GH	0	0	1591	1591KIN	GH	7	3.4
103161	10316VAL	GH	0	0	1611	1611BUIP	GH	24.3	11.8
103171	10317VAL	GH	0	0	1621	1621TUMU	GH	7.4	3.6
103181	10318VAL	GH	0	0	1631	1631HAN	GH	0.9	0.4

Load	Connection node	Country	Active power	Reactive power	Load	Connection node	Country	Active power	Reactive power
Name	Name		MW	Mvar	Name	Name		MW	Mvar
17501	17501BON	GH	1.7	0.8	GANMO_02	GANMO_02	NI	271	131.3
1852-1	1852ATEB	GH	3.5	1.7	OSHOGB02	OSHOGB02	NI	1106	535.7
1998-1	1998AYAN	GH	19.3	9.3	KANO__06	KANO__06	NI	675	326.9
1211JUAB	1211JUAB	GH	1.7	0.8	BIRNIN02	BIRNIN02	NI	317	153.5
3ATAK161	3ATAK161	TB	22.3	10.8	JEBBA_02	JEBBA_02	NI	43	20.8
3BOHI161	3BOHI161	TB	44.8	21.7	KATAMP02	KATAMP02	NI	691	334.7
3020MOME	3020MOME	TB	74.8	36.2	GWAGWA02	GWAGWA02	NI	389	188.4
3LOME161	3LOME161	TB	116.3	56.3	LOKOJA02	LOKOJA02	NI	158	76.5
3010LOME	3010LOME	TB	346.3	167.7	SHIROR02	SHIROR02	NI	448	217
3040SAKA	3040SAKA	TB	6.3	3.1	OMOTOS02	OMOTOS02	NI	279	135.1
3030COTO	3030COTO	TB	418.6	202.7	BENINN02	BENINN02	NI	242	117.2
3KARA161	3KARA161	TB	33.2	16.1	BENINC02	BENINC02	NI	491	237.8
3DJOU161	3DJOU161	TB	0.1	0	ALADJA02	ALADJA02	NI	175	84.8
AVA___04	AVA___04	TB	19.2	9.3	AJAOKU02	AJAOKU02	NI	85	41.2
DAPAON04	DAPAON04	TB	7.1	3.4	PORTHA02	PORTHA02	NI	404	195.7
MALANV04	MALANV04	TB	2	1	AFAM__02	AFAM__02	NI	263	127.4
MA_GLE04	MA_GLE04	TB	48.4	23.4	ALAOJI02	ALAOJI02	NI	1030	498.9
PARAKO04	PARAKO04	TB	53.5	25.9	CALABA02	CALABA02	NI	202	97.8
GAZAOU06	GAZAOU06	NR	5	2.4	MAKURD02	MAKURD06	NI	202	97.8
MARADI06	MARADI06	NR	10	4.8	NEWHAV02	NEWHAV02	NI	568	275.1
ZINDER06	ZINDER06	NR	34	16.5	ONITSH02	ONITSH02	NI	619	299.8
NIAM22I	NIAM22_D	NR	50	24.2	OWERRI02	OWERRI02	NI	202	97.8
DOSSO	DOSSO_06	NR	7	3.4	GOMBE_02	GOMBE_02	NI	317	153.5
NIAM	NIAM2_06	NR	138	66.8	DAMATU02	DAMATU02	NI	138	66.8
DIFFA_02	DIFFA_02	NR	8	3.9	MAIDUG02	MAIDUG02	NI	258	125
KATS4D	KATSIN06	NI	300	145.3	JOS___02	JOS___02	NI	317	153.5
DELTA_06	DELTA_06	NI	179	86.7	YOLA__02	YOLA__02	NI	186	90.1
IKEJAW02	IKEJAW02	NI	2099	1016.6	JALING02	JALING02	NI	138	66.8
ERUNKA02	ERUNKA02	NI	702	340	EGBIN_02	EGBIN_02	NI	995	481.9
AJA___02	AJA___02	NI	795	385	PAPALA02	PAPALA02	NI	298	144.3
ALAGBO02	ALAGBO02	NI	542	262.5	SOKOTO02	SOKOTO02	NI	252	122
AKANGB02	AKANGB02	NI	1559	755.1	KADUNA02	KADUNA02	NI	858	415.5
AIYEDE02	AIYEDE02	NI	914	442.7	ZARIA_02	ZARIA_02	NI	293	141.9

8.3. Shunts

Bank	Connection node	Country	Voltage level	Power rating	bank	Bank	Connection node	Country	Voltage level	Power rating	bank
Name	Name	Name	kV	Mvar/step	#steps	Name	Name	Name	kV	Mvar/step	#steps
REAC 1	TOBENE03	SE	225	-20	1	DABOLA03	DABOLA03	GU	225	-15	2
REAC 4	DAGANA03	SE	225	-20	1	LINSANGM	LINSAN03	GU	225	-15	2
REAC 6	MATAM_03	SE	225	-20	1	MALI__SS	MALI__03	GU	225	-20	1
REAC 8	SAKAL_03	SE	225	-20	1	LABE__SS	LABE__03	GU	225	-20	1
KAOLACSS	KAOLAC03	SE	225	-20	1	BOKE__SS	BOKE__03	GU	225	-20	1
TANAF_SS	TANAF_03	SE	225	-20	1	SAMBANSS	SAMBAG03	GU	225	-20	1
TAMBACSS	TAMBAC03	SE	225	-20	1	KALETASS	KALETA03	GU	225	-20	1
REAC 5	DAGANA03	SE	225	-25	1	LINSANSS	LINSAN03	GU	225	-20	1
REAC 7	MATAM_03	SE	225	-25	1	FOMIBUND	FOMI__03	GU	225	-20	2
KAOLACOL	KAOLAC03	SE	225	-25	3	MALI__OL	MALI__03	GU	225	-25	2
TANAF_OL	TANAF_03	SE	225	-25	2	LABE__OL	LABE__03	GU	225	-25	2
TAMBACOL	TAMBAC03	SE	225	-25	2	BOKE__OL	BOKE__03	GU	225	-25	2
CAPTHION	THIONA08	SE	90	10	2	KALETAOL	KALETA03	GU	225	-25	2
CAPTOB90	TOBENE08	SE	90	10	4	SAMBANOL	SAMBAG03	GU	225	-25	2
CAPBELAI	BELAIR08	SE	90	10	3	LINSANOL	LINSAN03	GU	225	-25	2
COND 2	BELAIR08	SE	90	8	1	REACAMAR	AMARYA03	GU	225	-25	1
COND 3	BELAIR08	SE	90	8	1	MAMOU_07	MAMOU_07	GU	110	3.84	1
CAPTAIBA	TAIBA_08	SE	90	5	3	SONFON_D	SONFON_D	GU	60	3.84	3
SOMA__SS	SOMA__03	GA	225	-20	1	MANEAH_D	MANEAH_D	GU	60	3.84	1
BRIKAMSS	BRIKAM03	GA	225	-20	1	MATOTO_D	MATOTO_D	GU	60	3.84	25
SOMA__OL	SOMA__03	GA	225	-25	2	TOMBO__D	TOMBO__D	GU	20	3.84	10
BRIKAMOL	BRIKAM03	GA	225	-25	1	SELING03	SELING03	MA	225	-15	2
MANSOASS	MANSOA03	GB	225	-20	1	KODIALGM	KODIAL03	MA	225	-15	2
BISSAUSS	BISSAU03	GB	225	-20	1	REAC 11	KAYES_03	MA	225	-20	1
BAMBACSS	BAMBAD03	GB	225	-20	1	REAC 9	MANANT03	MA	225	-25	1
SALTINSS	SALTHI03	GB	225	-20	1	MANANTA1	MANANT03	MA	225	-25	1
MANSOAOL	MANSOA03	GB	225	-25	2	KODIALA1	KODIAL03	MA	225	-25	1
BISSAUOL	BISSAU03	GB	225	-25	1	KOUTIA03	KOUTIA03	MA	225	-25	1
BAMBACOL	BAMBAD03	GB	225	-25	2	REACSIKA	SIKASS03	MA	225	-25	1
SALTINOL	SALTHI03	GB	225	-25	2	REAC 10	KAYES_03	MA	225	-30	1
CAPABISS	BISSAU1G	GB	30	10	2	CAPLAFIA	LAFIA_05	MA	150	10	3
NZEREK03	NZEREK03	GU	225	-5	1	CAPBALIN	BALING10	MA	30	10	3
SIGUIR03	SIGUIR03	GU	225	-15	2	CA2BALIN	BALI1_11	MA	15	10	3
KANKAN03	KANKAN03	GU	225	-15	2	FRTOWN04	FRTOWN04	SL	161	5	15
BEYLA_03	BEYLA_03	GU	225	-15	2	YEKEPA03	YEKEPA03	LI	225	-5	1
NZEREKGM	NZEREK03	GU	225	-15	2	RIVIER02	RIVIER02	CI	330	20	1
FOMI__03	FOMI__03	GU	225	-15	2	CAPAFERK	2060FERK	CI	225	10	8
KOROUS03	KOROUS03	GU	225	-15	2	CAPABUND	2371BUND	CI	225	10	2

Bank Name	Connection node Name	Country Name	Voltage level kV	Power rating Mvar/step	bank #steps
CAPAMAN-	2100MAN-	CI	225	-20	1
CAPALABO	2110LABO	CI	225	-20	1
2371BUND	2371BUND	CI	225	-20	1
CSLGREAC	2100MAN-	CI	225	-25	1
REACSOUB	2070SOUB	CI	225	-40	1
REACFERK	2060FERK	CI	225	-40	1
2270ATAK	2270ATAK	CI	90	12	1
2280ABEN	2280ABEN	CI	90	12	1
CAPAYAMO	2250YAMO	CI	90	12	1
CAPADYMB	2260DIMB	CI	90	12	1
CAPADIVO	2310DIVO	CI	90	12	1
CAPADABO	2130DABO	CI	90	12	1
2320GAGN	2320GAGN	CI	90	10	2
CAPAVRID	2021VRID	CI	90	7.2	3
CAPABIAN	2160BIAN	CI	90	7.2	5
CAPAPLAT	2150PLAT	CI	90	7.2	2
CAPARIVI	2210RIVI	CI	90	7.2	1
CAPATREI	2240TREI	CI	90	7.2	3
CAPAABOB	2011ABOB	CI	90	7.2	8
CAPAYOPO	2230YOPO	CI	90	7.2	15
CAPABIAS	2220BIAS	CI	90	7.1	14
CAPAAGNE	2290AGNE	CI	90	6	1
CAPADALO	2410DALO	CI	90	5	3
CAPABOUA	2360KORH	CI	90	5	3
CAPA51BO	2051BOUA	CI	90	5	7
REACBOU2	2340BOUA	CI	90	-20	1
INTOUA02	OUAGAE02	BU	330	-30	4
CAPAZAGT	4ZAGT225	BU	225	10	2
4KODE225	4KODE225	BU	225	-1.43	21
4ZAGT225	4ZAGT225	BU	225	-15	2
4_PA_225	4_PA_225	BU	225	-30	1
4KOMP132	4KOMP132	BU	132	-4.5	1
4PTDO132	4PTDO132	BU	132	-4.5	1
CAPOUA19	4OUAG190	BU	90	10	3
CAPOUG29	4OUAG290	BU	90	10	3
4OUAG333	4OUAG333	BU	33	4.8	1
4PTDOI1	4PTDOI33	BU	33	4.8	1
4PTDOI2	4PTDOI33	BU	33	-3.5	1
4KOS1_1	4KOSSO15	BU	15	4.8	1
4OUAG11	4OUAG115	BU	15	4.8	1
4OUAG21	4OUAG215	BU	15	4.8	4
4OUAG22	4OUAG215	BU	15	3	1
4OUAG23	4OUAG215	BU	15	1.5	2
4OUAG12	4OUAG115	BU	15	1.2	5
4KOS2_1	4KOSSO15	BU	15	0.9	1
4KOS3_1	4KOSSO15	BU	15	0.69	2
4OUAG13	4OUAG115	BU	15	0.6	1
4OUAG14	4OUAG115	BU	15	0.3	1
1130KUM5	1130KUMA	GH	161	25	1
1350YEND	1350YEND	GH	161	2	1
1280TAMA	1280TAMA	GH	161	-8.5	4
1380SAWL	1380SAWL	GH	161	-8.5	2
1260TECH	1260TECH	GH	161	-8.5	2
1290BOLG	1290BOLG	GH	161	-12	2
1051ACH	1051ACH	GH	34.5	21.6	2
1052ACH	1052ACH	GH	34.5	21.6	2
1053ACH	1053ACH	GH	34.5	21.6	1
1054ACH	1054ACH	GH	34.5	21.6	2
1055ACH	1055ACH	GH	34.5	21.6	1
1041T-LV	1041T-LV	GH	34.5	21.6	7
15543BLV	15543BLV	GH	34.5	21.6	2
15553BLV	15553BLV	GH	34.5	21.6	1
11392K2L	11392K2L	GH	34.5	21.6	1
11391K2L	11391K2L	GH	34.5	18	1
1071BCCO	1071BCCO	GH	34.5	10.8	1
1072C-CO	1072C-CO	GH	34.5	10.8	1
1131KUMA	1131KUMA	GH	34.5	10.8	2
1132KUMA	1132KUMA	GH	34.5	10.8	2
1133KUM1	1133KUM1	GH	34.5	10.8	2
1133KUM2	1133KUM2	GH	34.5	10.8	2
1092TARK	1092ATAR	GH	34.5	10.8	1
1371MALL	1371MALL	GH	34.5	10.8	4
1271SUNY	1271SUNY	GH	34.5	10.8	1
1202ASAW	1202ASAW	GH	34.5	10.8	2
1092BTAR	1092BTAR	GH	34.5	10.8	1
1081TAKO	1081TAKO	GH	34.5	10.8	2
1082TAKO	1082TAKO	GH	34.5	10.8	1
1061BWIN	1061BWIN	GH	34.5	10.8	1
1611BUIP	1611BUIP	GH	34.5	10.8	1
1301BOGO	1301BOGO	GH	34.5	10.8	1
1261TECH	1261TECH	GH	34.5	5.4	2
1251KPAN	1251KPAN	GH	34.5	5.4	2
1261TEC2	1261TECH	GH	34.5	5.4	1
10312V12	10312VAL	GH	13.8	20	2
10313V12	10313VAL	GH	13.8	20	2
10314V12	10314VAL	GH	13.8	20	2
10315VAL	10315VAL	GH	13.8	18	1
1102BPRE	1102BPRE	GH	13.2	20	1
1102CPRE	1102CPRE	GH	13.2	20	1
1211ANOB	1211ANOB	GH	11.5	5.4	1
1211BNOB	1211BNOB	GH	11.5	5.4	1
1211CNOB	1211CNOB	GH	11.5	5.4	1
1272SUNY	1272SUNY	GH	11.5	5.4	1
1231HO-1	1231HO-1	GH	11.5	5.4	1
1581N-AB	1581N-AB	GH	11	5.4	2
1101APRE	1101APRE	GH	6.63	1.2	2
1101BPRE	1101BPRE	GH	6.63	1.2	2
1122AOBU	1122AOBU	GH	6.6	1.8	1
1122BOBU	1122BOBU	GH	6.6	1.8	1
1122C0BU	1122COBU	GH	6.6	1.8	2
INTMAL02	MALANV02	TB	330	-30	1
3030COTO	3030COTO	TB	161	50	1
3LOME161	3LOME161	TB	161	5	1
3050ONIG	3050ONIG	TB	161	-3	3
PARAKO04	PARAKO04	TB	161	-3	3
3KARA161	3KARA161	TB	161	-18	1
SALKAD02	SALKAD02	NR	330	-30	3
INTNIA02	NIAMRD02	NR	330	-58.7	3
DOSSO	DOSSO_06	NR	132	16	1
NIAM2C06	NIAM2C06	NR	132	2.5	1
GAZAO106	GAZAOU06	NR	132	-5	1
GAZAO206	GAZAOU06	NR	132	-5	1
NIAM22	NIAM22_D	NR	20	10	1
NIAM2N1	NIAM2C_D	NR	20	4	7
EGBEMA01	EGBEMA01	NI	760	-75	3
BENIN012	BENINN01	NI	760	-75	3
BENIN011	BENINN01	NI	760	-75	3
ERUNKA01	ERUNKA01	NI	760	-75	2
BENIN013	BENINN01	NI	760	-75	3
AJAOK011	AJAOKU01	NI	760	-75	3
AJAOK012	AJAOKU01	NI	760	-75	3
ABUJA011	ABUJA_01	NI	760	-75	3
MAKUR011	MAKURD01	NI	760	-75	8
AJAOK013	AJAOKU01	NI	760	-75	5
MAKUR012	MAKURD01	NI	760	-75	10
MAMBI011	MAMBIL01	NI	760	-75	10
MAMBI012	MAMBIL01	NI	760	-75	10
JALIN011	JALING01	NI	760	-75	10
JALIN012	JALING01	NI	760	-75	7
GOMBE_01	GOMBE_01	NI	760	-75	7
ABUJA012	ABUJA_01	NI	760	-75	3
KADUN011	KADUNA01	NI	760	-75	3
KADUN012	KADUNA01	NI	760	-75	3
KANO_011	KANO__01	NI	760	-75	3
OSHOG011	OSHOGB01	NI	760	-75	3
OSHOG012	OSHOGB01	NI	760	-75	2
MAMBI013	MAMBIL01	NI	760	-75	10
MAMBI014	MAMBIL01	NI	760	-75	10
JALIN013	JALING01	NI	760	-75	10
AKANGB02	AKANGB02	NI	330	100	6
ALAGBO02	ALAGBO02	NI	330	100	2
AJA___02	AJA___02	NI	330	100	2
IKEJAWCR	IKEJAW02	NI	330	100	5
MAKURD06	MAKURD06	NI	330	60	1
AYEDE08	AIYEDE02	NI	330	20	10
KADUR2	KADUNA02	NI	330	-30	1
KADUR3	KADUNA02	NI	330	-30	1
AJAOR1	AJAOKU02	NI	330	-30	1
GOMBR3	GOMBE_02	NI	330	-30	1
GOMBR4	GOMBE_02	NI	330	-30	1
BENIR2	BENINC02	NI	330	-30	1
ALAOR1	ALAOJI02	NI	330	-30	1
INTBIR02	BIRNIN02	NI	330	-33	4
GOMBR1	GOMBE_02	NI	330	-50	1
GOMBR2	GOMBE_02	NI	330	-50	1
BENIR1	BENINC02	NI	330	-75	1
IKEWR1	IKEJAW02	NI	330	-75	1
JEBBR1	JEBBA_02	NI	330	-75	1
JEBBR2	JEBBA_02	NI	330	-75	1
KADUR1	KADUNA02	NI	330	-75	1
KANOR1	KANO__02	NI	330	-75	1
KATAR1	KATAMP02	NI	330	-75	1
KATS4DC1	KATSIN06	NI	132	20	1

8.4. Lines

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
MBOUR_03	SE	SE	SENDOU03	SE	SE	2.200	9.600	0.555	93.5
THIONA08	SE	SE	TOBENE08	SE	SE	5.815	15.704	0.357	101.3
TOBENE03	SE	SE	TOUBA_03	SE	SE	1.652	4.397	4.042	233.8
KAOLAC03	SE	SE	TOUBA_03	SE	SE	1.814	4.830	2.575	250.0
BELAIR08	SE	SE	HANN__08	SE	SE	0.756	2.346	0.000	93.5
BELAIR08	SE	SE	HANN__08	SE	SE	0.618	2.716	2.149	93.5
BELAIR08	SE	SE	HANN__08	SE	SE	0.618	2.716	2.149	93.5
HANN__08	SE	SE	KOUNOU08	SE	SE	2.680	6.530	0.645	93.5
HANN__08	SE	SE	MBAO__08	SE	SE	2.074	6.802	0.289	93.5
CAPEBI08	SE	SE	HANN__08	SE	SE	2.574	8.444	0.358	93.5
CAPEBI08	SE	SE	FICT1_08	SE	SE	1.100	4.900	0.200	86.5
CAPEBI08	SE	SE	KOUNOU08	SE	SE	1.180	5.185	0.209	93.5
CAPEBI08	SE	SE	MBAO__08	SE	SE	0.501	1.638	0.821	93.5
CAPEBI08	SE	SE	SOCOCI08	SE	SE	1.502	3.111	2.463	93.5
KOUNOU08	SE	SE	SOCOCI08	SE	SE	2.680	4.926	3.265	93.5
KOUNOU03	SE	SE	TOBENE03	SE	SE	6.516	28.642	14.321	133.0
SOCOCI08	SE	SE	FICT2_08	SE	SE	2.900	8.900	0.400	101.3
MECKHE08	SE	SE	TOBENE08	SE	SE	5.399	16.748	0.687	93.5
DAGANA03	SE	SE	MATAM_03	SE	SE	6.276	15.295	35.820	233.8
DAGANA03	SE	SE	SAKAL_03	SE	SE	2.680	6.530	15.294	233.8
SAKAL_03	SE	SE	TOBENE03	SE	SE	1.052	2.802	4.439	233.8
KAOLAC03	SE	SE	TAMBAC03	SE	SE	2.640	15.990	24.240	250.0
KAOLAC03	SE	SE	SOMA__03	SE	SE	1.190	7.210	10.930	250.0
HANN__08	SE	SE	FICT1_08	SE	SE	1.100	4.900	0.200	86.5
SIBA__08	SE	SE	FICT1_08	SE	SE	1.100	4.900	0.200	86.5
THIONA08	SE	SE	FICT2_08	SE	SE	2.900	8.900	0.400	101.3
SOMETA08	SE	SE	FICT2_08	SE	SE	2.900	8.900	0.400	101.3
KAOLAC03	SE	SE	MBOUR_03	SE	SE	4.400	19.240	0.840	93.5
TANAF_03	SE	SE	ZIGUIN03	SE	SE	1.200	7.300	11.100	250.0
BELAIR08	SE	SE	UNIVER08	SE	SE	0.800	3.500	0.200	132.9
UNIVER08	SE	SE	AEROPO08	SE	SE	1.400	6.200	0.300	132.9
AEROPO08	SE	SE	PATTED08	SE	SE	1.000	4.400	0.200	132.9
PATTED08	SE	SE	CAPEBI08	SE	SE	1.800	7.900	0.300	132.9
PATTED08	SE	SE	HANN__08	SE	SE	0.200	1.000	0.000	132.9
TAIBA_08	SE	SE	TOBENE08	SE	SE	1.460	6.420	0.280	132.9
TANAF_03	SE	SE	MANSOA03	SE	SE	0.740	4.480	0.860	250.0
SENDOU03	SE	SE	KOUNOU03	SE	SE	0.500	2.200	0.100	93.5
SENDOU03	SE	SE	KOUNOU03	SE	SE	0.500	2.200	0.100	93.5
KOUNOU08	SE	SE	HANN__08	SE	SE	2.680	6.530	0.645	93.5
SENDOU03	SE	SE	KOUNOU03	SE	SE	0.500	2.200	0.100	93.5
SENDOU03	SE	SE	KOUNOU03	SE	SE	0.500	2.200	0.100	93.5
SENDOU03	SE	SE	KOUNOU03	SE	SE	0.500	2.200	0.100	93.5
KOUNOU08	SE	SE	HANN__08	SE	SE	2.680	6.530	0.645	93.5
TAMBAC03	SE	SE	KAYES_03	SE	SE	2.640	15.990	24.240	250.0
SOMA__03	GA	GA	TANAF_03	GA	GA	0.980	5.900	8.950	250.0
SOMA__03	GA	GA	BRIKAM03	GA	GA	1.560	9.460	14.340	250.0
BRIKAM03	GA	GA	SOMA__03	GA	GA	1.560	9.460	14.340	250.0
BISSAU03	GB	GB	MANSOA03	GB	GB	0.350	2.150	3.260	250.0
BAMBAD03	GB	GB	MANSOA03	GB	GB	0.550	3.310	5.010	250.0
BAMBAD03	GB	GB	SALTHI03	GB	GB	0.560	3.410	5.180	250.0
BISSAU03	GB	GB	MANSOA03	GB	GB	0.350	2.150	3.260	250.0
SALTHI03	GB	GB	BOKE__03	GB	GB	0.980	5.920	8.970	250.0
BAMBAD03	GB	GB	SALTHI03	GB	GB	0.560	3.410	5.180	250.0
BAMBAD03	GB	GB	MANSOA03	GB	GB	0.550	3.310	5.010	250.0
GRCHUT07	GU	GU	KINDIA07	GU	GU	3.668	10.552	0.502	76.0
KINDIA07	GU	GU	GRCHUT07	GU	GU	3.668	10.552	0.502	76.0
LINSAN07	GU	GU	KINDIA07	GU	GU	7.795	22.423	1.067	76.0
LINSAN07	GU	GU	KINDIA07	GU	GU	7.795	22.423	1.067	76.0
YESSOU_D	GU	GU	GRCHUT_D	GU	GU	19.830	40.890	0.200	32.0
MATOTO_D	GU	GU	SONFON_D	GU	GU	5.550	11.440	0.057	32.0
SONFON_D	GU	GU	MATOTO_D	GU	GU	5.550	11.440	0.057	32.0

Node 1	Country	Zone	Node 2	Country	Zone	Resistance	Reactance	Half susceptance	Power rating
Name	Name	Name	Name	Name	Name	%pu	%pu	%pu	MVA
SONFON_D	GU	GU	MATOTO_D	GU	GU	5.55	11.44	0.057	32
SONFON_D	GU	GU	MATOTO_D	GU	GU	5.55	11.44	0.057	32
SONFON_D	GU	GU	MANEAH_D	GU	GU	7.05	14.54	0.07	32
MANEAH_D	GU	GU	SONFON_D	GU	GU	7.05	14.54	0.07	32
MANEAH_D	GU	GU	SONFON_D	GU	GU	7.05	14.54	0.07	32
MANEAH_D	GU	GU	SONFON_D	GU	GU	7.05	14.54	0.07	32
MANEAH_D	GU	GU	YESSOU_D	GU	GU	2.92	6.02	0.03	32
GRCHUT07	GU	GU	GARAFI07	GU	GU	17.25455	49.63636	2.360994	76
MATOTO07	GU	GU	GRCHUT07	GU	GU	10.56579	21.78512	1.088039	58
GRCHUT07	GU	GU	MATOTO07	GU	GU	8.265289	23.77686	1.130966	76
GRCHUT07	GU	GU	MATOTO07	GU	GU	8.265289	23.77686	1.130966	76
GRCHUT07	GU	GU	DONKEA07	GU	GU	2.084298	4.297521	0.214636	58
DONKEA_D	GU	GU	BANEAH_D	GU	GU	0.56	0.28	0.01	15
LINSAN07	GU	GU	GARAFI07	GU	GU	5.791736	16.66116	0.792502	76
LINSAN07	GU	GU	GARAFI07	GU	GU	5.791736	16.66116	0.792502	76
LINSAN07	GU	GU	MAMOU_07	GU	GU	5.18843	14.92562	0.709949	76
BOKE__03	GU	GU	KALETA03	GU	GU	1.31	7.92	12.01	250
KALETA03	GU	GU	LINSAN03	GU	GU	1.13	6.86	10.4	250
LINSAN03	GU	GU	LABE__03	GU	GU	1.36	8.22	12.47	250
LABE__03	GU	GU	MALI__03	GU	GU	0.82	4.96	7.52	250
MALI__03	GU	GU	SAMBAG03	GU	GU	0.45	2.75	4.17	250
SAMBAG03	GU	GU	TAMBAC03	GU	GU	2.64	15.96	24.2	250
SIGUIR03	GU	GU	FOMI__03	GU	GU	1.31	7.95	12.05	250
FOMI__03	GU	GU	KANKAN03	GU	GU	0.71	4.28	6.49	250
KANKAN03	GU	GU	BEYLA_03	GU	GU	2.53	15.28	23.17	250
BEYLA_03	GU	GU	NZEREK03	GU	GU	1.41	8.56	12.98	250
FOMI__03	GU	GU	KOROUS03	GU	GU	0.61	3.67	5.56	250
KOROUS03	GU	GU	DABOLA03	GU	GU	1.82	11	16.68	250
DABOLA03	GU	GU	LINSAN03	GU	GU	1.92	11.61	17.61	250
KALETA03	GU	GU	LINSAN03	GU	GU	1.13	6.86	10.4	250
BOKE__03	GU	GU	KALETA03	GU	GU	1.31	7.92	12.01	250
BOKE__03	GU	GU	SALTHI03	GU	GU	0.98	5.92	8.97	250
FOMI__03	GU	GU	2371BUND	GU	GU	5	30	46	250
KALETA03	GU	GU	AMARYA03	GU	GU	1.31	7.92	12.01	250
AMARYA03	GU	GU	MATOTO03	GU	GU	1.31	7.92	12.01	250
LINSAN03	GU	GU	DABOLA03	GU	GU	1.92	11.61	17.61	250
DABOLA03	GU	GU	KOROUS03	GU	GU	1.82	11	16.68	250
KOROUS03	GU	GU	FOMI__03	GU	GU	0.61	3.67	5.56	250
LINSAN03	GU	GU	KOUKOU03	GU	GU	1.66	10.2	15.45	250
KOUKOU03	GU	GU	BOUREY03	GU	GU	0.83	5.1	7.72	250
BOUREY03	GU	GU	MANANT03	GU	GU	2.5	15.3	23.2	250
BOUREY03	GU	GU	MANANT03	GU	GU	2.5	15.3	23.2	250
BOUREY03	GU	GU	KOUKOU03	GU	GU	0.83	5.1	7.72	250
KOUKOU03	GU	GU	LINSAN03	GU	GU	1.66	10.2	15.45	250
KAYES_03	MA	MA	MANANT03	MA	MA	6.676	16.269	38.1004	233.8
KAYES_03	MA	MA	MATAM_03	MA	MA	6.018	14.665	34.344	233.8
MANANT03	MA	MA	TKITA_03	MA	MA	1.99	12.04	18.26	250
TKITA_03	MA	MA	KODIAL03	MA	MA	1.1	6.66	10.1	250
FANA__05	MA	MA	SEGOU_05	MA	MA	7.85	21.01	3.32	100
KALABA05	MA	MA	SIRAKO05	MA	MA	1.22	3.29	0.52	100
KODIAL05	MA	MA	LAFIA_05	MA	MA	0.58	1.55	0.24	100
KODIAL05	MA	MA	KALABA05	MA	MA	0.36	0.97	0.15	100
SIRAKO05	MA	MA	SELING05	MA	MA	8.6	20.45	3.64	100
SIRAKO05	MA	MA	BALING05	MA	MA	0.9	2.13	0.38	100
SIRAKO05	MA	MA	BALING05	MA	MA	0.9	2.13	0.38	100
SIRAKO05	MA	MA	FANA__05	MA	MA	8.6	21.65	3.4	100
SIKASS03	MA	MA	KOUTIA03	MA	MA	3.291	8.02	18.78	250
KOUTIA03	MA	MA	SEGOU_03	MA	MA	3.761	9.166	21.47	250
SIKASS03	MA	MA	2060FERK	MA	MA	1.646	4.01	9.391	250
SIKASS03	MA	MA	OULESS03	MA	MA	6.122	14.89	34.88	250
OULESS03	MA	MA	KODIAL03	MA	MA	1.41	3.437	8.049	250
SIKASS03	MA	MA	4KODE225	MA	MA	3.902	9.509	22.27	250
SIRAKO05	MA	MA	KENIE_05	MA	MA	2.2	5.8	0.9	100
KODIAL03	MA	MA	SELING03	MA	MA	1.52	9.17	13.9	250
SELING03	MA	MA	SIGUIR03	MA	MA	1.52	9.17	13.9	250
BADOUM03	MA	MA	MANANT03	MA	MA	1.65	4.05	9.5	233.8

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
KODIAL05	MA	MA	LAFIA_05	MA	MA	0.58	1.55	0.24	100
KODIAL05	MA	MA	KALABA05	MA	MA	0.36	0.97	0.15	100
MANANT03	MA	MA	TKITA_03	MA	MA	1.99	12.04	18.26	250
TKITA_03	MA	MA	KODIAL03	MA	MA	1.1	6.66	10.1	250
SELING05	MA	MA	SIRAKO05	MA	MA	8.6	20.45	3.64	100
YIBEN_03	SL	SL	KAMAKW03	SL	SL	0.5954	3.664	5.5649	250
KAMAKW03	SL	SL	LINSAN03	SL	SL	1.5679	9.648	14.6542	250
BIKONG03	SL	SL	BUMBUN03	SL	SL	1.4092	8.671	13.1702	250
BUMBUN03	SL	SL	YIBEN_03	SL	SL	0.7542	4.641	7.0489	250
KENEMA03	SL	SL	BIKONG03	SL	SL	0.9427	5.801	8.8111	250
BUMBUN04	SL	SL	FRTOWN04	SL	SL	6.7426	31.1195	7.6502	244
BUMBUN04	SL	SL	FRTOWN04	SL	SL	6.7426	31.1195	7.6502	244
MANO__03	LI	LI	KENEMA03	LI	LI	1.1511	7.084	10.7588	250
YEKEPA03	LI	LI	BUCHAN03	LI	LI	2.1336	13.12	19.9408	250
BUCHAN03	LI	LI	MONROV03	LI	LI	1.0023	6.167	9.3676	250
YEKEPA03	LI	LI	NZEREK03	LI	LI	0.3969	2.442	3.7099	250
MONROV03	LI	LI	MANO__03	LI	LI	1.0023	6.167	9.3676	250
STPAUL03	LI	LI	MONROV03	LI	LI	1.0023	6.167	9.3676	250
BUCHAN03	LI	LI	TIBOTO03	LI	LI	5.5	34	51.6	250
YEKEPA03	LI	LI	2100MAN-	LI	LI	1.5878	9.771	14.8397	250
YEKEPA03	LI	LI	BUCHAN03	LI	LI	2.1336	13.12	19.9408	250
MONROV03	LI	LI	BUCHAN03	LI	LI	1.0023	6.167	9.3676	250
2100MAN-	CI	CI	YEKEPA03	CI	CI	1.5878	9.771	14.8397	250
2010ABOB	CI	CI	1809ELUB	CI	CI	1.69	11.62	10.41	327
2030TAAB	CI	CI	2010ABOB	CI	CI	3.146	14.104	11.896	246
2030TAAB	CI	CI	2010ABOB	CI	CI	1.975	13.566	12.302	327
2010ABOB	CI	CI	2500AZIT	CI	CI	0.194	1.333	1.208	327
2010ABOB	CI	CI	2500AZIT	CI	CI	0.194	1.333	1.208	327
2011ABOB	CI	CI	2160BIAN	CI	CI	1.056	2.593	0.059	72
2011ABOB	CI	CI	2160BIAN	CI	CI	1.0556	2.593	0.059	72
2150PLAT	CI	CI	2240TREI	CI	CI	0.235	0.563	1.102	75
2150PLAT	CI	CI	2240TREI	CI	CI	0.235	0.563	1.102	75
2240TREI	CI	CI	2021VRID	CI	CI	0.75	3.37	0.07	100
2021VRID	CI	CI	2220BIAS	CI	CI	1.404	3.94	0.093	72
2021VRID	CI	CI	2220BIAS	CI	CI	1.422	3.99	0.093	72
2220BIAS	CI	CI	2210RIVI	CI	CI	2.3222	5.7037	0.1262	72
2220BIAS	CI	CI	2210RIVI	CI	CI	2.3222	5.704	0.13	72
2360KORH	CI	CI	2061FERK	CI	CI	10.197	25.044	0.572	72
2370BUND	CI	CI	2360KORH	CI	CI	18.4	51.622	1.225	75
2380ODIE	CI	CI	2370BUND	CI	CI	21.884	61.398	1.457	75
2380ODIE	CI	CI	2111LABO	CI	CI	21.724	60.949	1.446	75
2111LABO	CI	CI	2390SEGU	CI	CI	14.578	40.899	0.97	75
2060FERK	CI	CI	2050BOUA	CI	CI	2.716	18.658	16.719	327
2101MAN-	CI	CI	2400DANA	CI	CI	13.653	38.305	0.909	75
2340BOUA	CI	CI	2350MARA	CI	CI	14.578	40.899	0.97	75
2100MAN-	CI	CI	2090BUYO	CI	CI	2.244	15.418	13.981	327
2090BUYO	CI	CI	2070SOUB	CI	CI	0.955	6.56	5.948	327
2091BUYO	CI	CI	2410DALO	CI	CI	19.9111	58.0741	1.2852	75
2410DALO	CI	CI	2041KOSS	CI	CI	19.662	55.163	1.309	75
2320GAGN	CI	CI	2041KOSS	CI	CI	21.333	59.852	1.42	72
2340BOUA	CI	CI	2300SERE	CI	CI	23.467	65.83701	1.562	75
2340BOUA	CI	CI	2051BOUA	CI	CI	4.693	13.167	0.312	75
2051BOUA	CI	CI	2041KOSS	CI	CI	24.341	59.785	1.364	72
2330ZUEN	CI	CI	2041KOSS	CI	CI	16.48	46.236	1.097	75
2050BOUA	CI	CI	2040KOSS	CI	CI	1.276	8.77	7.953	327
2041KOSS	CI	CI	2250YAMO	CI	CI	9.476	26.584	0.631	72
2250YAMO	CI	CI	2260DIMB	CI	CI	11.982	33.617	0.798	72
2260DIMB	CI	CI	2270ATAK	CI	CI	18.471	51.822	1.229	75
2270ATAK	CI	CI	2280ABEN	CI	CI	7.11	19.951	0.473	75
2290AGNE	CI	CI	2280ABEN	CI	CI	9.422	26.435	0.627	75
2040KOSS	CI	CI	2030TAAB	CI	CI	2.295	10.287	8.677	246
2320GAGN	CI	CI	2310DIVO	CI	CI	14.4	40.4	0.958	75
2031TAAB	CI	CI	2260DIMB	CI	CI	12.836	36.011	0.854	75
2070SOUB	CI	CI	2030TAAB	CI	CI	2.277	15.641	14.183	327
2500AZIT	CI	CI	2020VRID	CI	CI	0.142	0.974	0.883	330
2081PEDR	CI	CI	20FAYE90	CI	CI	6.756	18.953	0.45	75

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
2031TAAB	CI	CI	2120AGBO	CI	CI	21.156	59.353	1.408	75
2011ABOB	CI	CI	2140BONG	CI	CI	12.2444	30.0741	0.6656	75
2140BONG	CI	CI	2170AYAM	CI	CI	13.87	34.067	0.777	72
2170AYAM	CI	CI	2180AYAM	CI	CI	0.8444	2.074	0.047	72
2180AYAM	CI	CI	2190ABRO	CI	CI	12.456	30.593	0.698	72
2011ABOB	CI	CI	2150PLAT	CI	CI	0.9720001	4.3556	0.0962	75
2150PLAT	CI	CI	2160BIAN	CI	CI	0.148	0.356	0.696	75
2160BIAN	CI	CI	2210RIVI	CI	CI	2.174	5.341	0.122	72
2200BASS	CI	CI	2190ABRO	CI	CI	5.278	12.963	0.296	72
2210RIVI	CI	CI	2200BASS	CI	CI	6.038	14.83	0.338	72
200SIR90	CI	CI	2021VRID	CI	CI	1.24	3.63	0.08	75
2111LABO	CI	CI	2101MAN-	CI	CI	11.0341	78.8148	1.7358	132
2071SUBR	CI	CI	2081PEDR	CI	CI	8.493299	60.6667	1.3361	132
2209RIVI	CI	CI	2020VRID	CI	CI	0.228	1.564	1.418	327
2240TREI	CI	CI	2021VRID	CI	CI	0.75	3.37	0.07	100
2100MAN-	CI	CI	2110LABO	CI	CI	1.765	12.13	10.999	246
2070SOUB	CI	CI	2080S-PE	CI	CI	1.359	9.337	8.467	327
2000HIRE	CI	CI	2031TAAB	CI	CI	3.91	11.4	0.25	75
2310DIVO	CI	CI	2000HIRE	CI	CI	7.44	21.72	0.48	75
2010ABOB	CI	CI	2229YOPO	CI	CI	0.151	1.037	0.941	327
2229YOPO	CI	CI	2500AZIT	CI	CI	0.044	0.303	0.275	327
2011ABOB	CI	CI	2130DABO	CI	CI	10.3111	30.0741	0.6656	75
2120AGBO	CI	CI	2231YOPO	CI	CI	9.78	27.43	0.65	75
2231YOPO	CI	CI	2011ABOB	CI	CI	2.31	6.48	0.154	75
2230YOPO	CI	CI	2021VRID	CI	CI	3.314	8.141	0.186	72
2011ABOB	CI	CI	2230YOPO	CI	CI	2.913	7.156	0.163	72
2060FERK	CI	CI	4KODE225	CI	CI	2.576	17.7	16.05	327
2110LABO	CI	CI	2371BUND	CI	CI	2.716	18.658	16.719	327
2371BUND	CI	CI	2060FERK	CI	CI	1.975	13.566	12.302	327
2340BOUA	CI	CI	2290AGNE	CI	CI	55	150	3.6	72
2500AZIT	CI	CI	2209RIVI	CI	CI	0.37	2.53	2.3	327
2030TAAB	CI	CI	2070SOUB	CI	CI	2.277	15.641	14.183	327
2229YOPO	CI	CI	2010ABOB	CI	CI	0.151	1.037	0.941	327
2500AZIT	CI	CI	2229YOPO	CI	CI	0.044	0.303	0.275	327
2040KOSS	CI	CI	2030TAAB	CI	CI	2.295	10.287	8.677	246
2030TAAB	CI	CI	2010ABOB	CI	CI	3.146	14.104	11.896	246
2021VRID	CI	CI	2230YOPO	CI	CI	3.314	8.141	0.186	72
TIBOTO03	CI	CI	2080S-PE	CI	CI	1.4	8.5	13	250
2021VRID	CI	CI	2220BIAS	CI	CI	1.422	3.99	0.093	72
2011ABOB	CI	CI	2230YOPO	CI	CI	2.913	7.156	0.163	72
2140BONG	CI	CI	2011ABOB	CI	CI	12.2444	30.0741	0.6656	75
4BOB1_33	BU	BU	4BOB2_33	BU	BU	7.438	12.121	0.0068	17
4BOB1_33	BU	BU	4BOB2_33	BU	BU	7.438	12.121	0.0068	17
4KODEN33	BU	BU	4BOB2_33	BU	BU	8.356	13.59	0.0068	17
4KODEN33	BU	BU	4BOB2_33	BU	BU	8.448	13.774	0.0068	17
4KODEN33	BU	BU	4BOB2_33	BU	BU	8.448	13.774	0.0068	17
4KOUA_33	BU	BU	4BOB1_33	BU	BU	15.611	25.528	0.0137	17
4KOUA_33	BU	BU	4KODEN33	BU	BU	24.702	40.312	0.0205	17
4BAGR132	BU	BU	4ZANO132	BU	BU	3.03	7.438	0.766	110
4KOMP132	BU	BU	4ZANO132	BU	BU	13.258	32.541	3.3647	110
4ZANO132	BU	BU	4PTDO132	BU	BU	13.545	33.242	3.4468	110
4_PA_225	BU	BU	4KODE225	BU	BU	1.701	10.509	9.4583	327
4_PA_225	BU	BU	4ZAGT225	BU	BU	2.588	15.995	14.4656	327
4KOMSI33	BU	BU	4OUAG333	BU	BU	14.417	23.508	0.012	17
4KOSSO33	BU	BU	4OUAG133	BU	BU	14.784	24.242	0.012	17
4KOSSO33	BU	BU	4OUAG233	BU	BU	23.875	39.027	0.0205	17
4OUAG333	BU	BU	4PTDOI33	BU	BU	10.285	16.804	0.0085	17
4OUAG133	BU	BU	4OUAG233	BU	BU	11.111	18.182	0.0085	17
4PTDOI33	BU	BU	4OUAG233	BU	BU	28.375	46.373	0.0239	17
4PTDOI33	BU	BU	4KOSSO33	BU	BU	26.354	42.975	0.0222	17
4PTDOI33	BU	BU	4ZAGTO33	BU	BU	56.107	117.264	0.0068	17
4ZAGTO33	BU	BU	4KOMSI33	BU	BU	30.854	50.413	0.0256	17
4OUAG190	BU	BU	4OUAG290	BU	BU	0.272	0.728	1.3862	75
4OUAG190	BU	BU	4_PC_090	BU	BU	0.21	0.568	1.0809	75
4OUAG190	BU	BU	4_PC_090	BU	BU	0.21	0.568	1.0809	75
4_PC_090	BU	BU	4KOSSO90	BU	BU	0.741	2.173	0.0509	72

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
4_PC_090	BU	BU	4KOSSO90	BU	BU	0.741	2.173	0.0509	72
4ZAGTO90	BU	BU	4OUAG290	BU	BU	2.667	7.802	0.18	72
OUAGAE03	BU	BU	4ZAGT225	BU	BU	0.254	1.468	1.418	327
OUAGAE08	BU	BU	4KOSSO90	BU	BU	2.644	7.735	0.178	72
OUAGAE08	BU	BU	4KOSSO90	BU	BU	2.644	7.735	0.178	72
PATDOI08	BU	BU	OUAGAE08	BU	BU	2.644	7.735	0.178	72
4ZAGTO33	BU	BU	4PTDOI33	BU	BU	56.107	117.264	0.0068	17
4ZAGTO33	BU	BU	4KOMSI33	BU	BU	30.854	50.413	0.0256	17
4KOMSI33	BU	BU	4OUAG333	BU	BU	14.417	23.508	0.012	17
4PTDOI33	BU	BU	4OUAG333	BU	BU	10.285	16.804	0.0085	17
1010AKOS	GH	GH	1050ACHI	GH	GH	2.93	14.2	3.54	213.08
1010AKOS	GH	GH	1020VOLT	GH	GH	2.12	10.29	2.563	213.08
1010AKOS	GH	GH	1020VOLT	GH	GH	2.12	10.29	2.563	213.08
1010AKOS	GH	GH	1020VOLT	GH	GH	2.12	10.29	2.563	213.08
1010AKOS	GH	GH	1140NKAW	GH	GH	3.226	13.587	6.157	364.3
1139K2BS	GH	GH	1140NKAW	GH	GH	2.476	10.427	4.725	364
1139K2BS	GH	GH	1130KUMA	GH	GH	0.398	1.675	0.759	364
1010AKOS	GH	GH	1150TAFO	GH	GH	2.72	9.74	2.205	169.9
1010AKOS	GH	GH	1150TAFO	GH	GH	1.57	6.84	3.09	364
1010AKOS	GH	GH	1170KPON	GH	GH	0.51	2.45	0.61	213.08
1010AKOS	GH	GH	1170KPON	GH	GH	0.51	2.45	0.61	213.08
1010AKOS	GH	GH	1190KPON	GH	GH	0.77	3.81	0.915	213.08
1010AKOS	GH	GH	1220ASIE	GH	GH	3.94	8.89	1.935	128.12
1010AKOS	GH	GH	1392 AFT	GH	GH	8.837	20.254	4.4135	128.12
1020VOLT	GH	GH	1040TEMA	GH	GH	0.085	0.357	0.162	364
1020VOLT	GH	GH	1040TEMA	GH	GH	0.085	0.357	0.162	364
1020VOLT	GH	GH	1170KPON	GH	GH	1.62	7.84	1.9525	213.08
1020VOLT	GH	GH	1170KPON	GH	GH	1.62	7.84	1.9525	213.08
1020VOLT	GH	GH	1190KPON	GH	GH	1.14	8.429999	1.945	272.96
1050ACHI	GH	GH	1370MALL	GH	GH	0.398	1.675	0.759	364
1370MALL	GH	GH	1060WINN	GH	GH	1.912	6.713	1.578	169.9
1050ACHI	GH	GH	1370MALL	GH	GH	0.398	1.675	0.759	364
1060WINN	GH	GH	1320ABOA	GH	GH	5.34	20.61	4.865	150
1070C-CO	GH	GH	1320ABOA	GH	GH	2.361	9.081	2.135	150
1070C-CO	GH	GH	1370MALL	GH	GH	4.74	18.27	4.305	150
1080TAKO	GH	GH	1090TARK	GH	GH	2.29	8.2	1.855	169.9
1080TAKO	GH	GH	1320ABOA	GH	GH	0.611	2.35	0.552	169.9
1080TAKO	GH	GH	1320ABOA	GH	GH	0.611	2.35	0.552	169.9
1080TAKO	GH	GH	1360ESSI	GH	GH	3.74	11.15	2.555	182
1095NEWT	GH	GH	1100PRES	GH	GH	0.94	3.46	0.84	169.9
1090TARK	GH	GH	1095NEWT	GH	GH	0.37	1.29	0.305	169.9
1100PRES	GH	GH	1120OBUA	GH	GH	2.94	12.84	5.815	364
1100PRES	GH	GH	1300BOGO	GH	GH	0.347	1.462	0.663	364
1090TARK	GH	GH	1320ABOA	GH	GH	1.763	7.424	3.364	364
1090TARK	GH	GH	1100PRES	GH	GH	0.437	1.842	0.835	364
1110DUNK	GH	GH	1210N-OB	GH	GH	1.11	3.97	0.895	169.9
1110DUNK	GH	GH	1300BOGO	GH	GH	2.94	10.51	2.375	150
1120OBUA	GH	GH	1210N-OB	GH	GH	0.32	1.13	0.255	170
1130KUMA	GH	GH	1180KONO	GH	GH	2.29	8.2	1.855	169.9
1130KUMA	GH	GH	1138T262	GH	GH	0.27	1.12	0.505	364
1130KUMA	GH	GH	1260TECH	GH	GH	2.94	12.84	5.815	364
1140NKAW	GH	GH	1150TAFO	GH	GH	2.65	9.47	2.14	169.9
1140NKAW	GH	GH	1180KONO	GH	GH	2.36	8.46	1.91	169.9
1150TAFO	GH	GH	1160AKWA	GH	GH	2.43	8.71	1.97	169.9
1160AKWA	GH	GH	1210N-OB	GH	GH	3.6	16.73	4.13	243.72
1280TAMA	GH	GH	1290BOLG	GH	GH	5.15	23.99	5.945	243.7
1280TAMA	GH	GH	1350YEND	GH	GH	5.3	15.81	3.621	182
1300BOGO	GH	GH	1309WEXF	GH	GH	2.382	8.121	1.8265	182
1390DCEM	GH	GH	1392 AFT	GH	GH	0.1	0.21	0.05	180
1392 AFT	GH	GH	3010LOME	GH	GH	0.273	0.626	0.1365	128.12
1260TECH	GH	GH	1270SUNY	GH	GH	1.8	8.36	2.06	244
1260TECH	GH	GH	1900TESI	GH	GH	2.36	9.95	4.465	364
1270SUNY	GH	GH	1413KENY	GH	GH	1.06	4.466	2.0235	364
1120OBUA	GH	GH	1138T261	GH	GH	1.92	6.87	1.55	169.9
1138T261	GH	GH	1413KENY	GH	GH	1.84	11.53	2.67	244
1138T262	GH	GH	1413KENY	GH	GH	1.84	11.53	2.67	244

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
1130KUMA	GH	GH	1210N-OB	GH	GH	1.6	6.73	3.55	364
1221ASIE	GH	GH	1310SOGA	GH	GH	14.08	27.32	0.205	57
1221ASIE	GH	GH	1230HO	GH	GH	19.85	38.59	0.29	57
1230HO	GH	GH	1240KPEV	GH	GH	9.93	19.3	0.145	57
1240KPEV	GH	GH	1250KPAN	GH	GH	16.06	31.22	0.235	57
1290BOLG	GH	GH	1480ZEB	GH	GH	1.855	5.533	1.258	182
1480ZEB	GH	GH	BAWKU_04	GH	GH	4.3	12.6	2.84	39
ABOA_330	GH	GH	1029VOLT	GH	GH	0.905	5.67	23.18	1000
1500BUI	GH	GH	1901TES2	GH	GH	0.477	2.01	0.911	364
1500BUI	GH	GH	1900TESI	GH	GH	0.477	2.01	0.911	364
1413KENY	GH	GH	1500BUI	GH	GH	4.48	18.867	8.55	364
1500BUI	GH	GH	1590KIN	GH	GH	1.802	7.592	3.44	364
1380SAWL	GH	GH	1901TES2	GH	GH	6.8	20.31	4.68	182.2
1590KIN	GH	GH	1610BUIP	GH	GH	2.253	9.489	4.3	364
1610BUIP	GH	GH	1280TAMA	GH	GH	2.598	10.941	4.958	364
1590KIN	GH	GH	1260TECH	GH	GH	1.723	7.257	3.289	364
1020VOLT	GH	GH	15533BSP	GH	GH	0.21	1.174	0.276	213.08
15533BSP	GH	GH	1050ACHI	GH	GH	0.6	2.848	0.67	213.08
1020VOLT	GH	GH	15533BSP	GH	GH	0.21	1.174	0.276	213.08
15533BSP	GH	GH	1050ACHI	GH	GH	0.6	2.848	0.67	213.08
15533BSP	GH	GH	1050ACHI	GH	GH	0.6	2.848	0.67	213.08
15533BSP	GH	GH	1020VOLT	GH	GH	0.21	1.174	0.276	213.08
1270SUNY	GH	GH	1278MIM	GH	GH	3.18	9.486	2.173	182
KSI330	GH	GH	PRES330	GH	GH	0.728	4.566	18.648	1000
1029VOLT	GH	GH	30101LOM	GH	GH	0.631	3.959	16.169	1000
1140NKAW	GH	GH	1580N_AB	GH	GH	2.65	7.905	1.811	182.2
1140NKAW	GH	GH	1580N_AB	GH	GH	2.65	7.905	1.811	182.2
1109PRES	GH	GH	1809ELUB	GH	GH	0.85	5.94	5.325	327
1600OPB-	GH	GH	1750BONY	GH	GH	1.087	4.577	2.074	364
1750BONY	GH	GH	1800ELUB	GH	GH	1.06	4.466	2.024	364
1360ESSI	GH	GH	1750BONY	GH	GH	1.378	5.805	2.631	364
1600OPB-	GH	GH	1750BONY	GH	GH	1.087	4.577	2.074	364
1200ASAW	GH	GH	1990AYAN	GH	GH	2.535	5.6	1.218	142.05
1990AYAN	GH	GH	1110DUNK	GH	GH	2.535	5.6	1.218	142.05
1290BOLG	GH	GH	1620TUMU	GH	GH	7.367	21.976	5.033	182.2
1620TUMU	GH	GH	1630HAN	GH	GH	3.18	9.486	2.173	182.2
1340WA	GH	GH	1630HAN	GH	GH	3.71	11.067	2.535	182
1340WA	GH	GH	1380SAWL	GH	GH	5.035	15.02	3.44	182
1590KIN	GH	GH	1850ATEB	GH	GH	2.386	10.048	4.553	364
12951BOL	GH	GH	4ZAGT225	GH	GH	2.298	15.802	14.156	327
1220ASIE	GH	GH	1252KPAN	GH	GH	2.25	9.5	4.3	364
1255KADJ	GH	GH	1250KPAN	GH	GH	6.061	25.528	0.39	156
1413KENY	GH	GH	1200ASAW	GH	GH	1.855	7.815	3.541	364
1100PRES	GH	GH	1300BOGO	GH	GH	0.347	1.462	0.663	364
1210JUAB	GH	GH	1200ASAW	GH	GH	1.69	7.145	3.238	364
1210JUAB	GH	GH	1278MIM	GH	GH	1.99	9.08	2.134	364
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1700ASOG	GH	GH	1021SME2	GH	GH	0.0385	0.4758	0.215	600
1021SME2	GH	GH	1700ASOG	GH	GH	0.0385	0.4758	0.215	600
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1020VOLT	GH	GH	1021SME2	GH	GH	0.15	0.75	0.18	213.08
1021SME2	GH	GH	1032SMEL	GH	GH	0.016	0.076	0.019	213.08
1021SME2	GH	GH	1033SMEL	GH	GH	0.016	0.076	0.019	213.08
1021SME2	GH	GH	1034SMEL	GH	GH	0.016	0.076	0.019	213.08
1021SME2	GH	GH	1035SMEL	GH	GH	0.016	0.076	0.019	213.08
1021SME2	GH	GH	1036SMEL	GH	GH	0.016	0.076	0.019	213.08
1021SME2	GH	GH	1031SMEL	GH	GH	0.016	0.076	0.019	213.08
1021SME2	GH	GH	1470TT1P	GH	GH	0.133	0.558	0.253	364
KSI330	GH	GH	1591KIN3	GH	GH	0.757	4.75	19.403	1000
1591KIN3	GH	GH	BOLGA330	GH	GH	1.21	7.57	30.94	1000
1392 AFT	GH	GH	1390DCEM	GH	GH	0.1	0.21	0.05	180
1300BOGO	GH	GH	1309WEXF	GH	GH	2.382	8.121	1.8265	182

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
1220ASIE	GH	GH	3010LOME	GH	GH	5.33	12.03	5.24	128
1758BON3	GH	GH	PRES330	GH	GH	0.383	2.402	9.809	1000
1470TT1P	GH	GH	1021SME2	GH	GH	0.133	0.558	0.253	364
12951BOL	GH	GH	4KODE225	GH	GH	9.4	22.9	53.7	250
PRES330	GH	GH	RIVIER02	GH	GH	0.9	4.64	42.1	1000
PRES330	GH	GH	1758BON3	GH	GH	0.383	2.402	9.809	1000
1060WINN	GH	GH	1870CAPE	GH	GH	3.297	11.579	2.722	150
1320ABOA	GH	GH	1870CAPE	GH	GH	2.584	9.076	2.134	150
1070C-CO	GH	GH	1870CAPE	GH	GH	0.053	0.223	0.1	364
CAPE330	GH	GH	ABOA_330	GH	GH	0.244	1.53	6.25	1000
1270SUNY	GH	GH	1850BERE	GH	GH	1.193	5.024	2.2777	364
1850BERE	GH	GH	1270SUNY	GH	GH	1.193	5.024	2.2777	364
1758BON3	GH	GH	ABOA_330	GH	GH	0.576	3.62	14.78	1000
1029VOLT	GH	GH	1700ASO2	GH	GH	0.021	0.132	0.539	1000
1029VOLT	GH	GH	1700ASO2	GH	GH	0.021	0.132	0.539	1000
1700ASO2	GH	GH	30101LOM	GH	GH	0.631	3.959	16.169	1000
1010AKOS	GH	GH	1020VOLT	GH	GH	2.12	10.29	2.563	213.08
1020VOLT	GH	GH	15533BSP	GH	GH	0.21	1.174	0.276	213.08
15533BSP	GH	GH	1050ACHI	GH	GH	0.6	2.848	0.67	213.08
PRES330	GH	GH	1115DUNK	GH	GH	0.33	2.06	8.4	1000
1115DUNK	GH	GH	KSI330	GH	GH	0.4	2.5	10.24	1000
1290BOLG	GH	GH	1480ZEB	GH	GH	1.855	5.533	1.258	182
1590KIN	GH	GH	1850ATEB	GH	GH	2.386	10.048	4.553	364
1280TAMA	GH	GH	1350YEND	GH	GH	5.3	15.81	3.621	182
1560A4BS	GH	GH	ABOA_330	GH	GH	0.778	4.882	19.942	1000
1560A4BS	GH	GH	1029VOLT	GH	GH	0.126	0.792	3.234	1000
1561A4BS	GH	GH	1370MALL	GH	GH	0.14	0.54	6.9	364
1561A4BS	GH	GH	1050ACHI	GH	GH	0.14	0.54	6.9	350
SAKETE02	TB	BN	IKEJAW02	TB	BN	0.25427	2.158035	13.49217	760
SAKETE02	TB	BN	OMOTOS02	TB	BN	0.43416	3.338832	24.90763	760
SAKETE02	TB	BN	OMOTOS02	TB	BN	0.43416	3.338832	24.90763	760
3010LOME	TB	TO	3020MOME	TB	TO	4.05	10.53	1.995	105
3010LOME	TB	TO	3020MOME	TB	TO	4.05	10.53	1.995	105
3020MOME	TB	TO	MA_GLE04	TB	TO	8.110001	17.92	3.99	105
3010LOME	TB	TO	3LOME161	TB	TO	0.8	2.79	0.545	105
3060NANG	TB	TO	3BOHI161	TB	TO	4.32	13.27	2.85	120
3060NANG	TB	TO	3020MOME	TB	TO	5.95	18.26	3.925	120
3010LOME	TB	TO	3LOME161	TB	TO	0.8	2.79	0.545	105
3020MOME	TB	TO	AVA___04	TB	TO	4.05	10.53	2	105
3040SAKA	TB	BN	3030COTO	TB	BN	2.75	8.45	1.98	105
3040SAKA	TB	BN	3030COTO	TB	BN	2.75	8.45	1.98	105
3040SAKA	TB	BN	3050ONIG	TB	BN	2.31	7.09	1.66	120
3060NANG	TB	TO	3ATAK161	TB	TO	1.94	6.24	1.35	120
3KARA161	TB	TO	3DJOU161	TB	TO	3.6	9.4	1.338	120
3ATAK161	TB	TO	3KARA161	TB	TO	12.65	37.76	8.7	120
MA_GLE04	TB	BN	AVA___04	TB	BN	1.94	6.24	1.35	105
3BOHI161	TB	BN	3050ONIG	TB	BN	4.29	13.22	2.83	120
DAPAON04	TB	TO	BAWKU_04	TB	TO	3.4	10.3	2.4	182
3DJOU161	TB	BN	PARAKO04	TB	BN	6.67	20.31	9.6	120
3KARA161	TB	TO	MANGO_04	TB	TO	6.98	21.24	10.04	120
MANGO_04	TB	TO	DAPAON04	TB	TO	3.82	11.63	5.49	120
MA_GLE04	TB	BN	3030COTO	TB	BN	0.56	1.71	0.81	120
MA_GLE04	TB	BN	3030COTO	TB	BN	0.56	1.71	0.81	120
MA_GLE04	TB	BN	3030COTO	TB	BN	0.56	1.71	0.81	120
MA_GLE04	TB	BN	3030COTO	TB	BN	0.56	1.71	0.81	120
PARAKO04	TB	BN	3050ONIG	TB	BN	15.28	46.52	21.98	120
3040SAKA	TB	BN	MA_GLE04	TB	BN	2.31	7.09	1.66	120
3040SAKA	TB	BN	MA_GLE04	TB	BN	2.31	7.09	1.66	120
3040SAKA	TB	BN	TANZOU04	TB	BN	1.43	4.34	2.05	120
3040SAKA	TB	BN	TANZOU04	TB	BN	1.43	4.34	2.05	120
PARAKO04	TB	BN	BEMBER04	TB	BN	4.9	15.1	3.5	120
BEMBER04	TB	BN	KANDI_04	TB	BN	4.2	12.8	3	120
GUENE_04	TB	BN	KANDI_04	TB	BN	4.2	12.8	3	120
GUENE_04	TB	BN	MALANV04	TB	BN	1.5	4.5	1.1	120
3DJOU161	TB	BN	NATITI04	TB	BN	4.2	12.8	3	120
30101LOM	TB	TO	SAKETE02	TB	TO	2.6	12.8	142.2	760

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
ADJARA04	TB	TO	AVA___04	TB	TO	2.31	7.09	1.66	120
3060NANG	TB	TO	ADJARA04	TB	TO	4.29	13.22	2.83	120
3050ONIG	TB	BN	3040SAKA	TB	BN	2.31	7.09	1.66	120
ADJARA04	TB	TO	AVA___04	TB	TO	2.31	7.09	1.66	120
GAZAOU06	NR	CE	KATSIN06	NR	CE	8.55372	17.06612	1.73689	91.5
MARADI06	NR	CE	GAZAOU06	NR	CE	10.6	21.1	2.1	91.5
GAZAOU06	NR	CE	ZINDER06	NR	CE	14.2	28.4	2.9	91.5
DOSSO_06	NR	FL	NIAM2C06	NR	FL	12.557	31.3636	3.369	95.34
NIAM2C06	NR	FL	NIAM2_06	NR	FL	0	-47	0	96
DOSSO_06	NR	FL	FRONT_06	NR	FL	7.42	18.5331	1.991	95.34
FRONT_06	NR	FL	BIRNIN06	NR	FL	5.1369	12.8306	1.378	95.34
DOSSO02	NR	FL	NIAMRD02	NR	FL	0.501372	4.25528	26.60427	777
ZABORI02	NR	FL	MALANV02	NR	FL	0.272174	2.31	14.44232	777
NIAMRD02	NR	FL	OUAGAE02	NR	FL	1.679598	14.25519	89.12431	777
DOSSO02	NR	FL	ZABORI02	NR	FL	0.186224	1.580532	9.881586	777
DOSSO02	NR	FL	SALKAD02	NR	FL	1.07437	9.118457	57.00915	777
SALKAD06	NR	FL	MARADI06	NR	FL	30.44121	76.03297	8.167273	95.34
NIAM2_06	NR	FL	NIAMRD06	NR	FL	0.475644	1.188015	0.127614	95.34
NIAM2_06	NR	FL	NIAMRD06	NR	FL	0.475644	1.188015	0.127614	95.34
KANDAD06	NR	FL	NIAM2_06	NR	FL	7.42	18.5331	1.991	95.34
KANDAD06	NR	FL	NIAM2_06	NR	FL	7.42	18.5331	1.991	95.34
AJA___02	NI	LA	EGBIN_02	NI	LA	0.05065	0.38953	2.90589	777
AJA___02	NI	LA	EGBIN_02	NI	LA	0.05065	0.38953	2.90589	777
EGBIN_02	NI	LA	IKEJAW02	NI	LA	0.22432	1.72507	12.86893	777
EGBIN_02	NI	LA	IKEJAW02	NI	LA	0.25326	1.94766	14.52944	777
JEBBAP02	NI	SH	JEBBA_02	NI	SH	0.02894	0.22259	1.66051	777
JEBBAP02	NI	SH	JEBBA_02	NI	SH	0.02894	0.22259	1.66051	777
KATAMP02	NI	SH	SHIROR02	NI	SH	0.5427	4.17355	31.13451	777
KATAMP02	NI	SH	SHIROR02	NI	SH	0.5427	4.17355	31.13451	777
BENINC02	NI	BE	DELTA_02	NI	BE	0.38713	2.97713	22.20928	777
BENINC02	NI	BE	SAPELE02	NI	BE	0.1809	1.39118	10.37817	777
BENINC02	NI	BE	SAPELE02	NI	BE	0.1809	1.39118	10.37817	777
BENINC02	NI	BE	SAPELE02	NI	BE	0.1809	1.39118	10.37817	777
BENINC02	NI	BE	EGBIN_02	NI	BE	0.95877	7.37328	55.0043	777
OMOTOS02	NI	BE	IKEJAW02	NI	BE	0.573003	4.863177	30.40488	760
KWALE_02	NI	EN	ONITSH02	NI	EN	0.28944	2.2259	16.60507	777
KWALE_02	NI	EN	ONITSH02	NI	EN	0.28944	2.2259	16.60507	777
AFAM__02	NI	EN	ALAOJI02	NI	EN	0.09045	0.69559	5.18909	777
AFAM__02	NI	EN	ALAOJI02	NI	EN	0.09045	0.69559	5.18909	777
AKANGB02	NI	LA	IKEJAW02	NI	LA	0.06446	0.54711	3.42055	777
AKANGB02	NI	LA	IKEJAW02	NI	LA	0.06446	0.54711	3.42055	777
IKEJAW02	NI	LA	OSHOGB02	NI	LA	0.8416	7.14279	44.65717	777
BIRNIN02	NI	SH	KAINJI02	NI	SH	1.12158	8.625316	64.34472	777
JEBBA_02	NI	SH	KAINJI02	NI	SH	0.29008	2.46198	15.39247	777
JEBBA_02	NI	SH	KAINJI02	NI	SH	0.29008	2.46198	15.39247	777
JEBBA_02	NI	SH	ZUNGER02	NI	SH	0.6	4	30	777
JEBBA_02	NI	SH	ZUNGER02	NI	SH	0.6	4	30	777
JEBBA_02	NI	SH	OSHOGB02	NI	SH	0.56226	4.77199	29.83479	777
JEBBA_02	NI	SH	OSHOGB02	NI	SH	0.56226	4.77199	29.83479	777
KADUNA02	NI	KD	KANO__02	NI	KD	0.82369	6.99082	43.70702	777
KADUNA02	NI	KD	SHIROR02	NI	KD	0.34022	2.88751	18.0529	777
KADUNA02	NI	KD	SHIROR02	NI	KD	0.34022	2.88751	18.0529	777
GOMBE_02	NI	BA	JOS___02	NI	BA	0.94904	8.05464	50.35808	777
GOMBE_02	NI	BA	YOLA__02	NI	BA	0.82369	6.99082	43.70702	777
JOS___02	NI	BA	KADUNA02	NI	BA	0.70551	5.98779	37.43601	777
AJAOKU02	NI	BE	BENINN02	NI	BE	0.69835	5.927	37.05595	777
AJAOKU02	NI	BE	BENINN02	NI	BE	0.69835	5.927	37.05595	777
ALADJA02	NI	BE	DELTA_02	NI	BE	0.1146	0.97264	6.08098	777
ALADJA02	NI	BE	SAPELE02	NI	BE	0.22562	1.91488	11.97192	777
BENINC02	NI	BE	ONITSH02	NI	BE	0.49063	4.1641	26.03418	777
BENINC02	NI	BE	ONITSH02	NI	BE	0.49063	4.1641	26.03418	777
BENINC02	NI	BE	OSHOGB02	NI	BE	0.8989	7.62911	47.69766	777
NEWHAV02	NI	EN	ONITSH02	NI	EN	0.3438	2.91791	18.24293	777
ALAOJI02	NI	EN	IKOTEK02	NI	EN	0.137484	1.0573	7.887409	777
ALAOJI02	NI	EN	ONITSH02	NI	EN	0.49421	4.19449	26.22421	777
AIYEDE02	NI	LA	OSHOGB02	NI	LA	0.42617	3.61699	22.61363	777

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
KANKIA06	NI	KD	KATSIN06	NI	KD	8.18412	16.3287	1.66184	91.5
KANKIA06	NI	KD	KANO__06	NI	KD	13.42853	26.7922	2.72676	91.5
IKEJAW02	NI	LA	BENINC02	NI	LA	1.01304	7.79063	58.11775	777
GOMBE_02	NI	BA	YOLA__02	NI	BA	0.82369	6.99082	43.70702	777
MAMBIL01	NI	BA	MAKURD01	NI	BA	0.234697	3.244979	751.2357	2598
ERUNKA01	NI	LA	OSHOGB01	NI	LA	0.038028	0.525782	121.7223	2598
OSHOGB01	NI	LA	BENINN01	NI	LA	0.096414	1.333044	308.6091	2598
BENINN01	NI	BE	EGBEMA01	NI	BE	0.09603	1.327733	307.3796	2598
BENINN01	NI	BE	AJAOKU01	NI	BE	0.074903	1.035632	239.7561	2598
AJAOKU01	NI	BE	MAKURD01	NI	BE	0.117156	1.619834	375.0031	2598
AJAOKU01	NI	BE	ABUJA_01	NI	BE	0.079897	1.104674	255.7398	2598
JALING01	NI	BA	MAMBIL01	NI	BA	0.234697	3.244979	751.2357	2598
JALING01	NI	BA	GOMBE_01	NI	BA	0.134058	1.853515	429.1019	2598
ABUJA_01	NI	SH	KADUNA01	NI	SH	0.092189	1.274623	295.0844	2598
KADUNA01	NI	KD	KANO__01	NI	KD	0.088347	1.221514	282.7892	2598
IKEJAW02	NI	LA	ERUNKA02	NI	LA	0.114601	0.972635	6.080976	760
ERUNKA02	NI	LA	EGBIN_02	NI	LA	0.107438	0.911846	5.700915	760
JEBBA_02	NI	SH	GANMO_02	NI	SH	0.250689	2.12764	13.30214	760
GANMO_02	NI	LA	OSHOGB02	NI	LA	0.31157	2.644353	16.53265	760
PAPALA02	NI	LA	AIYEDE02	NI	LA	0.214876	1.823691	11.40183	760
PAPALA02	NI	LA	IKEJAW02	NI	LA	0.10854	0.834708	6.226908	760
ALAGBO02	NI	LA	AJA___02	NI	LA	0.094068	0.723416	5.396648	760
ALAGBO02	NI	LA	AJA___02	NI	LA	0.094068	0.723416	5.396648	760
GWAGWA02	NI	SH	LOKOJA02	NI	SH	0.50652	3.895317	29.05888	760
LOKOJA02	NI	SH	AJAOKU02	NI	SH	0.137484	1.0573	7.887409	760
GWAGWA02	NI	SH	LOKOJA02	NI	SH	0.50652	3.895317	29.05888	760
LOKOJA02	NI	SH	AJAOKU02	NI	SH	0.137484	1.0573	7.887409	760
GWAGWA02	NI	SH	KATAMP02	NI	SH	0.10854	0.834711	6.226902	760
KATAMP02	NI	SH	GWAGWA02	NI	SH	0.10854	0.834711	6.226902	760
GWAGWA02	NI	SH	SHIROR02	NI	SH	0.412452	3.171901	23.66223	760
SHIROR02	NI	SH	GWAGWA02	NI	SH	0.412452	3.171901	23.66223	760
OMOTOS02	NI	BE	BENINC02	NI	BE	0.429752	3.647383	22.80366	760
BENINN02	NI	BE	AJAOKU02	NI	BE	0.69835	5.927	37.05595	777
BENINN02	NI	BE	BENINC02	NI	BE	0.071625	0.607897	3.80061	760
BENINN02	NI	BE	BENINC02	NI	BE	0.071625	0.607897	3.80061	760
BENINN02	NI	BE	BENINC02	NI	BE	0.071625	0.607897	3.80061	760
ONITSH02	NI	EN	OWERRI02	NI	EN	0.495666	3.811846	28.43619	760
ONITSH02	NI	EN	OWERRI02	NI	EN	0.495666	3.811846	28.43619	760
OWERRI02	NI	EN	ALAOJI02	NI	EN	0.21708	1.669421	12.4538	760
OWERRI02	NI	EN	ALAOJI02	NI	EN	0.21708	1.669421	12.4538	760
OWERRI02	NI	EN	EGBEMA02	NI	EN	0.10854	0.834711	6.226902	760
OWERRI02	NI	EN	EGBEMA02	NI	EN	0.10854	0.834711	6.226902	760
EGBEMA02	NI	EN	OMOKU_02	NI	EN	0.10854	0.834711	6.226902	760
EGBEMA02	NI	EN	OMOKU_02	NI	EN	0.10854	0.834711	6.226902	760
NEWHAV02	NI	EN	NEWHAS02	NI	EN	0.01809	0.139118	1.037817	760
NEWHAV02	NI	EN	NEWHAS02	NI	EN	0.01809	0.139118	1.037817	760
NEWHAS02	NI	EN	ALIADE02	NI	EN	0.5427	4.173554	31.13451	760
ALIADE02	NI	EN	NEWHAS02	NI	EN	0.5427	4.173554	31.13451	760
MAKURD06	NI	EN	ALIADE02	NI	EN	0.1809	1.391185	10.37817	760
MAKURD06	NI	EN	ALIADE02	NI	EN	0.1809	1.391185	10.37817	760
NEWHAS02	NI	EN	IKOTEK02	NI	EN	0.517374	3.978788	29.68157	760
NEWHAS02	NI	EN	IKOTEK02	NI	EN	0.517374	3.978788	29.68157	760
IKOTEK02	NI	EN	AFAM__02	NI	EN	0.32562	2.504132	18.68071	760
IKOTEK02	NI	EN	AFAM__02	NI	EN	0.32562	2.504132	18.68071	760
IKOTEK02	NI	EN	IKOTAB02	NI	EN	0.27135	2.086777	15.56726	760
IKOTEK02	NI	EN	IKOTAB02	NI	EN	0.27135	2.086777	15.56726	760
PORTHA02	NI	EN	AFAM__02	NI	EN	0.16281	1.252066	9.340353	760
PORTHA02	NI	EN	AFAM__02	NI	EN	0.16281	1.252066	9.340353	760
GOMBE_02	NI	BA	DAMATU02	NI	BA	0.483471	4.103306	25.65412	760
DAMATU02	NI	BA	MAIDUG02	NI	BA	0.501377	4.25528	26.60427	760
YOLA__02	NI	BA	JALING02	NI	BA	0.472727	4.012121	25.08403	760
AJAOKU02	NI	BE	GEREGU02	NI	BE	0.01809	0.139118	1.037817	760
AJAOKU02	NI	BE	GEREGU02	NI	BE	0.01809	0.139118	1.037817	760
BENINN02	NI	BE	EYAEN_02	NI	BE	0.01809	0.139118	1.037817	760
BENINN02	NI	BE	EYAEN_02	NI	BE	0.01809	0.139118	1.037817	760
OWERRI02	NI	EN	AHOADA02	NI	EN	0.824518	2.627732	11.65823	126

Node 1 Name	Country Name	Zone Name	Node 2 Name	Country Name	Zone Name	Resistance %pu	Reactance %pu	Half susceptance %pu	Power rating MVA
OWERRI02	NI	EN	AHOADA02	NI	EN	0.824518	2.627732	11.65823	126
AHOADA02	NI	EN	YENAGO02	NI	EN	0.519559	1.655831	7.346285	126
AHOADA02	NI	EN	YENAGO02	NI	EN	0.519559	1.655831	7.346285	126
YENAGO02	NI	EN	GBARAN02	NI	EN	0.056474	0.179982	0.798509	126
YENAGO02	NI	EN	GBARAN02	NI	EN	0.056474	0.179982	0.798509	126
MAKURD06	NI	EN	JOS___02	NI	EN	0.83214	6.399449	47.73958	760
JOS___02	NI	BA	MAKURD06	NI	BA	0.83214	6.399449	47.73958	760
BIRNIN02	NI	SH	SOKOTO02	NI	SH	0.47034	3.61708	26.98324	760
BIRNIN02	NI	SH	SOKOTO02	NI	SH	1.11019	9.42241	58.90946	777
KADUNA02	NI	KD	JOS___02	NI	KD	0.70551	5.98779	37.43601	777
KANO__02	NI	KD	KATSIN02	NI	KD	0.65124	5.008264	37.36141	760
KANO__02	NI	KD	KATSIN02	NI	KD	0.65124	5.008264	37.36141	760
KANO__02	NI	KD	KADUNA02	NI	KD	0.83214	6.399428	47.73963	777
BIRNIN02	NI	SH	KAINJI02	NI	SH	1.12158	8.625316	64.34472	777
JOS___02	NI	BA	GOMBE_02	NI	BA	0.955152	7.34543	54.79679	777
GOMBE_02	NI	BA	DAMATU02	NI	BA	0.483471	4.103306	25.65412	760
DAMATU02	NI	BA	MAIDUG02	NI	BA	0.50652	3.895304	29.0589	760
JALING02	NI	BA	YOLA__02	NI	BA	0.472727	4.012121	25.08403	760
BIRNIN02	NI	SH	ZABORI02	NI	SH	0.339143	2.878393	17.99589	777
ALAOJI02	NI	EN	IKOTEK02	NI	EN	0.137484	1.0573	7.887409	777
IKOTEK02	NI	EN	CALABA02	NI	EN	0.260496	2.003306	14.94457	777
IKOTEK02	NI	EN	CALABA02	NI	EN	0.260496	2.003306	14.94457	777
BENINN02	NI	BE	OSHOGB02	NI	BE	0.835758	6.427252	47.94719	777
OSHOGB02	NI	LA	BENINN02	NI	LA	0.835758	6.427252	47.94719	777
BENINC02	NI	BE	ONITSH02	NI	BE	0.49566	3.811833	28.43621	777
BENINC02	NI	BE	ONITSH02	NI	BE	0.49566	3.811833	28.43621	777
OMOTOS02	NI	BE	EPE___02	NI	BE	0.30753	2.365006	17.64291	760
OMOTOS02	NI	BE	EPE___02	NI	BE	0.30753	2.365006	17.64291	760
EPE___02	NI	LA	AJA___02	NI	LA	0.1809	1.39118	10.37818	760
EPE___02	NI	LA	AJA___02	NI	LA	0.1809	1.39118	10.37818	760
OMOTOS02	NI	BE	ERUNKA02	NI	BE	0.477576	3.672715	27.3984	760
OMOTOS02	NI	BE	ERUNKA02	NI	BE	0.477576	3.672715	27.3984	760
ONITSH02	NI	EN	NNEWI_02	NI	EN	0.14472	1.112944	8.302544	760
ONITSH02	NI	EN	NNEWI_02	NI	EN	0.14472	1.112944	8.302544	760
NNEWI_02	NI	EN	OWERRI02	NI	EN	0.12663	0.973826	7.264726	760
NNEWI_02	NI	EN	OWERRI02	NI	EN	0.12663	0.973826	7.264726	760
DELTA_02	NI	BE	PORTHA02	NI	BE	0.625914	4.813483	35.9085	126
DELTA_02	NI	BE	PORTHA02	NI	BE	0.625914	4.813483	35.9085	126
IKEJAW02	NI	LA	PAPALA02	NI	LA	0.10854	0.834708	6.226908	760
SOKOTO02	NI	SH	GUSAU_02	NI	SH	0.66933	5.147366	38.39927	760
SOKOTO02	NI	SH	GUSAU_02	NI	SH	0.66933	5.147366	38.39927	760
GUSAU_02	NI	KD	ZARIA_02	NI	KD	0.68742	5.286484	39.43708	760
GUSAU_02	NI	KD	ZARIA_02	NI	KD	0.68742	5.286484	39.43708	760
ZARIA_02	NI	KD	KADUNA02	NI	KD	0.27135	2.08677	15.56727	760
ZARIA_02	NI	KD	KADUNA02	NI	KD	0.27135	2.08677	15.56727	760
KADUNA02	NI	KD	KANO__02	NI	KD	0.83214	6.399428	47.73963	777
JOS___02	NI	BA	GOMBE_02	NI	BA	0.955152	7.34543	54.79679	777
DAMATU02	NI	BA	MAIDUG02	NI	BA	0.50652	3.895304	29.0589	760
ZUNGER02	NI	SH	SHIROR02	NI	SH	0.27383	3.41635	16.36744	777
ZUNGER02	NI	SH	SHIROR02	NI	SH	0.27383	3.41635	16.36744	777
MAMBIL01	NI	BA	MAKURD01	NI	BA	0.234697	3.244979	751.2357	2598
MAMBIL01	NI	BA	JALING01	NI	BA	0.234697	3.244979	751.2357	2598
IKEJAW02	NI	LA	AKANGB02	NI	LA	0.06446	0.54711	3.42055	777

8.5. Couplings

Node 1	Node 2	Node 1	Node 2	Node 1	Node 2	Node 1	Node 2
NIAM22_D	NIAM21_D	1052ACH	1053ACH	1121AOBU	1121BOBU	1072C-CO	1071BCCO
DIFFA_02	MAIDUG02	1053ACH	1054ACH	1121BOBU	1121COBU	1092ATAR	1092BTAR
KAHO2_03	KAOLAC03	1054ACH	1055ACH	1162AKWA	1161AKWA	1181AKON	1181BKON
KAHO1_03	KAOLAC03	1152TAFO	1151TAF0	1273SUNY	1272SUNY	1211ANOB	1211BNOB
CAPEBI08	GTIIPP08	1041T-LV	1042T-LV	1371MALL	1372MALL	1211BNOB	1211CNOB
MAURIT03	DAGANA03	1061BWIN	1061AWIN	15543BLV	15553BLV	1281ATAM	1282ATAM
1132KUMA	1131KUMA	1281ATAM	1281BTAM	11391K2L	11392K2L	1412KENY	1414KENY
1132KUMA	1133KUM1	1081TAKO	1082TAKO	1998AYAN	1995AYAN		
1133KUM1	1133KUM2	1122AOBU	1122BOBU	1201ASAW	1202ASAW		
1051ACH	1052ACH	1122BOBU	1122COBU	1070C-CO	1070CCO3		

8.6. Transformers

Node 1	Node 2	V 1	V 2	SN	Zcc		Node 1	Node 2	V 1	V 2	SN	Zcc
Name	Name	kV	kV	MVA	%pu		Name	Name	kV	kV	MVA	%pu
IKOTAB06	IBOMGT01	132	11.5	45	11.2		KAINJI02	KAING05	330	16	145	12.4
IKOTAB06	IBOMGT02	132	11.5	45	11.2		KAINJI02	KAING06	330	16	145	12.4
IKOTAB06	IBOMGT03	132	15	142	11.2		KAINJI02	KAING07	330	16	92	12
AFAM__02	AFAMGT13	330	10.5	110	8.0		KAINJI02	KAING08	330	16	92	12
AFAM__02	AFAMGT14	330	10.5	110	8.0		KAINJI02	KAING09	330	16	92	12
AFAM__02	AFAMGT15	330	11.5	110	8.0		KAINJI02	KAING10	330	16	92	10.8
AFAM__02	AFAMGT16	330	11.5	110	8.0		KAINJI02	KAING11	330	16	115	11.7
AFAM__02	AFAMGT17	330	11.5	110	8.0		KAINJI02	KAING12	330	16	115	11.7
AFAM__02	AFAMGT18	330	11.5	110	8.0		SHIROR02	SHIRGH1	330	15.65	200	12.85
AFAM__02	AFAMGT19	330	15.75	165	13.0		SHIROR02	SHIRGH2	330	15.65	200	12.85
AFAM__02	AFAMGT20	330	15.75	165	13.0		SHIROR02	SHIRGH3	330	15.65	200	12.85
AFAM__02	AFAM6GT1	330	15	163	13.0		SHIROR02	SHIRGH4	330	15.65	200	12.85
AFAM__02	AFAM6GT2	330	15	163	13.0		KWALE_02	KWALCC1	330	15.75	200	12.85
AFAM__02	AFAM6GT3	330	15	163	13.0		KWALE_02	KWALCC2	330	15.75	200	12.85
AFAM__02	AFAM6GT4	330	15	163	13.0		KWALE_02	KWALCC3	330	15.75	200	12.85
AFAM__02	AFAM6GT5	330	15	163	13.0		BIRNIN02	BIRNT1	330	1	109	12.15
DELTA_06	DELTAG03	132	11.5	81	10.0		BIRNIN06	BIRNT1	132	1	90	-0.1118
DELTA_06	DELTAG04	132	11.5	81	10.0		DELTA_02	DELTT1	330	1	150	12
DELTA_06	DELTAG05	132	11.5	81	10.0		DELTA_06	DELTT1	132	1	150	-1.99745
DELTA_06	DELTAG06	132	11.5	81	10.0		EGBIN_02	EGBINT1	330	1	150	12
DELTA_06	DELTAG07	132	11.5	81	10.0		EGBIN_06	EGBINT1	132	1	150	-1.99745
DELTA_06	DELTAG08	132	11.5	81	10.0		EGBIN_02	EGBINT2	330	1	150	12
DELTA_06	DELTAG09	132	11.5	81	10.0		EGBIN_06	EGBINT2	132	1	150	-1.99745
DELTA_06	DELTAG10	132	11.5	81	10.0		SAPELE02	SAPELST6	330	15.75	400	14.4998
DELTA_06	DELTAG11	132	11.5	81	10.0		SAPELE02	SAPELST5	330	15.75	400	14.4998
DELTA_06	DELTAG12	132	11.5	81	10.0		SAPELE02	SAPELST4	330	15.75	400	14.4998
DELTA_06	DELTAG13	132	11.5	81	10.0		SAPELE02	SAPELST3	330	15.75	400	14.4998
DELTA_06	DELTAG14	132	11.5	81	10.0		SAPELE02	SAPELST2	330	15.75	400	14.4998
DELTA_02	DELTAG15	330	11.5	120	7.8		SAPELE02	SAPELST1	330	15.75	400	14.4998
DELTA_02	DELTAG16	330	11.5	120	7.8		KANO__02	KANOT1A	330	1	450	12
DELTA_02	DELTAG17	330	11.5	120	7.8		KANO__02	KANOT1A	330	1	450	12
DELTA_02	DELTAG18	330	11.5	120	7.8		KANO__06	KANOT1A	132	1	450	-1.99745
DELTA_02	DELTAG19	330	11.5	120	7.8		KANO__06	KANOT1A	132	1	450	-1.99745
DELTA_02	DELTAG20	330	11.5	120	7.8		KANO__01	KANO__02	760	330	1000	10
EGBIN_02	EGBINST1	330	16	270	10.2		KADUNA01	KADUNA02	760	330	1000	10
EGBIN_02	EGBINST2	330	16	270	10.2		AJAOKU01	AJAOKU02	760	330	1000	10
EGBIN_02	EGBINST3	330	16	270	10.2		BENINN01	BENINN02	760	330	1000	10
EGBIN_02	EGBINST4	330	16	270	10.2		OSHOGB01	OSHOGB02	760	330	1000	10
EGBIN_02	EGBINST5	330	16	270	10.2		GOMBE_01	GOMBE_02	760	330	1000	10
EGBIN_02	EGBINST6	330	16	270	10.2		ERUNKA01	ERUNKA02	760	330	1000	10
EGBIN_06	EGBINGT1	132	10.5	38.6	10.0		EGBEMA01	EGBEMA02	760	330	1000	10
EGBIN_06	EGBINGT2	132	10.5	38.6	10.0		MAKURD01	MAKURD06	760	330	1000	10
EGBIN_06	EGBINGT3	132	10.5	38.6	10.0		JALING01	JALING02	760	330	1000	10
EGBIN_06	EGBINGT4	132	10.5	39.5	10.0		CALABA02	CALABGT1	330	15	142	13
EGBIN_06	EGBINGT5	132	10.5	39.5	10.0		CALABA02	CALABGT2	330	15	142	13
EGBIN_06	EGBINGT6	132	10.5	39.5	10.0		CALABA02	CALABGT3	330	15	142	13
EGBIN_06	EGBINGT7	132	10.5	40.5	10.0		CALABA02	CALABGT4	330	15	142	13
EGBIN_06	EGBINGT8	132	10.5	40.5	10.0		CALABA02	CALABGT5	330	15	142	13
EGBIN_06	EGBINGT9	132	10.5	40.5	10.0		EGBEMA02	EGBEMGT1	330	15	142	13
JEBBAP02	JEBBGH1	330	16	119	10.4		EGBEMA02	EGBEMGT2	330	15	142	13
JEBBAP02	JEBBGH2	330	16	119	10.4		EGBEMA02	EGBEMGT3	330	15	142	13
JEBBAP02	JEBBGH3	330	16	119	10.4		OMOTOS02	OMOTGT12	330	10.5	105	14.4
JEBBAP02	JEBBGH4	330	16	119	10.4		OMOTOS02	OMOTGT34	330	10.5	105	14.4
JEBBAP02	JEBBGH5	330	16	119	10.4		OMOTOS02	OMOTGT56	330	10.5	105	14.4
JEBBAP02	JEBBGH6	330	16	119	10.4		OMOTOS02	OMOTGT78	330	10.5	105	14.4

Node 1 Name	Node 2 Name	V 1 kV	V 2 kV	SN MVA	Zcc %pu
OMOTOS02	OMOT2GT1	330	15	157	13
OMOTOS02	OMOT2GT2	330	15	157	13
OMOTOS02	OMOT2GT3	330	15	157	13
OMOTOS02	OMOT2GT4	330	15	157	13
PAPALA02	PAPA2GT1	330	15	157	13
PAPALA02	PAPAGT12	330	10.5	105	14.4
PAPALA02	PAPAGT34	330	10.5	105	14.4
PAPALA02	PAPAGT56	330	10.5	105	14.4
PAPALA02	PAPAGT78	330	10.5	105	14.4
PAPALA02	PAPA2GT2	330	15	157	13
PAPALA02	PAPA2GT3	330	15	157	13
PAPALA02	PAPA2GT4	330	15	157	13
ALAOJI02	ALAOJGT1	330	15	157	13
ALAOJI02	ALAOJGT2	330	15	157	13
ALAOJI02	ALAOJGT3	330	15	157	13
ALAOJI02	ALAOJGT4	330	15	157	13
ALAOJI02	ALAOCCG1	330	17	356	13
ALAOJI02	ALAOCCG2	330	17	356	13
GEREGU02	GEREGGT1	330	15.75	168	16.07
GEREGU02	GEREGGT2	330	15.75	168	16.07
GEREGU02	GEREGGT3	330	15.75	168	16.07
GEREGU02	GEREGGT4	330	15.75	168	16.07
GEREGU02	GEREGGT5	330	15.75	168	16.07
GEREGU02	GEREGGT6	330	15.75	168	16.07
EYAEN_02	EYAENGT3	330	15	142	13
EYAEN_02	EYAENGT4	330	15	142	13
EYAEN_02	EYAENGT1	330	15	142	13
EYAEN_02	EYAENGT2	330	15	142	13
GBARAN06	GBARAGT1	132	15	142	13
GBARAN06	GBARAGT2	132	15	142	13
ABUJA_01	KATAMP02	760	330	1000	10
SAPELE02	SAPELGT4	330	15	142	13
SAPELE02	SAPELGT2	330	15	142	13
SAPELE02	SAPELGT3	330	15	142	13
SAPELE02	SAPELGT1	330	15	142	13
IKOTAB02	IKOTAGT1	330	15	142	13
IKOTAB02	IKOTAGT2	330	15	142	13
IKOTAB02	IKOTAGT3	330	15	142	13
IKOTAB02	IKOTABT1	330	1	150	12
IKOTAB02	IKOTABT1	330	1	150	12
IKOTAB06	IKOTABT1	132	1	150	-1.99745
IKOTAB06	IKOTABT1	132	1	150	-1.99745
IKOTAB06	ALSCOGT1	132	15	142	13
IKOTAB06	ALSCOGT2	132	15	142	13
IKOTAB06	ALSCOGT3	132	15	142	13
IKOTAB06	ALSCOGT4	132	15	142	13
IKOTAB06	ALSCOGT5	132	15	142	13
IKOTAB06	ALSCOGT6	132	15	142	13
OMOKU_02	OMOKU_T1	330	1	150	12
OMOKU_06	OMOKU_T1	132	1	150	-1.99745
OMOKU_02	OMOKUGT2	330	15	142	13
OMOKU_02	OMOKUGT1	330	15	142	13
OMOKU_06	OMOKURG1	132	11.5	62.5	11.2
KATSIN02	KATSINT1	330	1	450	12
KATSINT1	KATSIN06	1	132	450	-1.99745
OMOKU_06	OMOKURG2	132	11.5	62.5	11.2
GBARAN02	GBARANT1	330	1	150	12
GBARAN06	GBARANT1	132	1	150	-1.99745
IKOTAB02	IKOTABT2	330	1	150	12
IKOTAB06	IKOTABT2	132	1	150	-1.99745
NIAM2_06	NIAM22_D	132	20	20	9.8533
NIAM2_06	NIAM22_D	132	20	20	9.8533
NIAM2_06	NIAM21_D	132	20	20	9.8533
NIAM2C06	NIAM2C_D	132	20	30	14
NIAMRD02	NIAMRD06	330	132	150	12.15
NIAMRD02	NIAMRD06	330	132	150	12.15
SALKAD02	SALKAD06	330	132	150	12.15
SALKAD02	SALKAD_G	330	10.5	75	12
BUCHAN_D	BUCHANG1	33	10.5	21.88	10
BUCHAN_D	BUCHANG2	33	10.5	21.88	10
BUMBUN03	BUMBUN04	225	161	70	10
KAMAKW03	KAMAKW_D	225	33	40	10
YIBEN_03	YIBEN__D	225	33	40	10
BIKONG03	BIKONG_D	225	33	40	10
KENEMA03	KENEMA_D	225	33	40	10
YEKEPA03	YEKEPA_D	225	33	40	10
NZEREK03	NZEREK_D	225	33	40	10
MANO__03	MANO___D	225	33	40	10
MONROV03	MONROV09	225	66	70	10
BUCHAN03	BUCHAN_D	225	33	40	10
MATOTO_D	MATOTO07	60	110	25	5.6

Node 1 Name	Node 2 Name	V 1 kV	V 2 kV	SN MVA	Zcc %pu
MATOTO_D	MATOTO07	60	110	25	5.6
MATOTO_D	MATOTO07	60	110	25	5.6
MATOTO_D	MATOTO07	60	110	25	5.6
TOMBO__D	MATOTO_D	20	60	50	11.9
TOMBO__D	MATOTO_D	20	60	50	11.9
TOMBO__D	TB3G1	20	6.3	16	10.5
TB3G2	TOMBO__D	6.3	20	16	10.5
TOMBO__D	TB3G3	20	6.3	16	10.5
TB3G4	TOMBO__D	6.3	20	16	10.5
TB5G3	TOMBO__D	11	20	13.75	10
MANEAH_D	MANEAHG1	60	11	52.5	10
MANEAH_D	MANEAHG2	60	11	52.5	10
MANEAH_D	MANEAHG3	60	11	52.5	10
TB5G1	TOMBO__D	11	20	13.75	10
TOMBO__D	TB5G2	20	11	13.75	10
GRCHUT_D	GRCHUT07	60	110	12.5	10.4
DONKEA07	DONKEA_D	110	15	15	10
LINSAN03	LINSAN07	225	110	75	10
LINSAN03	LINSAN07	225	110	75	10
GARAFI07	GARAFIG1	110	5.65	31.5	9.98
GARAFI07	GARAFIG2	110	5.65	31.5	9.98
DONKEAG2	DONKEA07	6.3	110	8.5	10
BANEAHG1	BANEAH_D	3.15	15	2.78	6
DONKEAG1	DONKEA07	6.3	110	8.5	10
BANEAHG2	BANEAH_D	3.15	15	2.78	6
GRCHUTG3	GRCHUT_D	5.5	60	11	8
GRCHUT_D	GRCHUTG4	60	5.5	11	8
GRCHUTG2	GRCHUT_D	3.3	60	6.3	6.5
GARAFI07	GARAFIG3	110	5.65	31.5	9.98
GRCHUTG1	GRCHUT_D	3.3	60	6.3	6.5
BUMBUN04	BUMBU1G1	161	13.8	31.25	10
BUMBUN04	BUMBU1G2	161	13.8	31.25	10
BUMBUN04	BUMBUN2G	161	13.8	50	10
MONROV09	MONROV_D	66	33	20	10
MONROV09	MONROV_D	66	33	20	10
MONROV09	MTCOFFG1	66	10.5	20.62	10
MONROV09	MTCOFFG2	66	10.5	20.62	10
MONROV09	MTCOFFG3	66	10.5	20.62	10
MONROV09	MTCOFFG4	66	10.5	20.62	10
TOBENE08	TOBENE03	90	225	75	7.49
TOBENE08	TOBENE03	90	225	75	7.49
KAHO2_03	KAHONE2G	225	15	50	13.25
KAHO1_03	KAHONE1G	225	15	50	13.25
BELAIR11	BELAIR08	15	90	50	14.93
BELAIR11	BELAIR08	15	90	50	14.93
BELAIR1G	BELAIR08	11	90	37	13.6
CAPEBI9G	CAPEBI08	6.6	90	33	4.09
CAPEBI8G	CAPEBI08	6.6	90	36	4.61
CAPEBI7G	CAPEBI08	6.6	90	35	4.55
CAPEBI6G	CAPEBI08	6.6	90	26.48	2.86
CAPEBI5G	CAPEBI08	6.6	90	26.48	2.86
CAPEBI4G	CAPEBI08	6.6	90	30	3.33
CAPEBI1G	CAPEBI08	11	90	40	4.8
CAPEBI3G	CAPEBI08	6.6	90	27	2.89
CAPEBI2G	CAPEBI08	6.6	90	30	3.3
KOUNOU11	KOUNOU08	15	90	40	4.78
KOUNOU11	KOUNOU08	15	90	40	4.78
GTI___1G	GTIIPP08	11	90	76	9.88
MATAM_08	MATAM_03	90	225	20	2.04
MATAM_08	MATAM_03	90	225	20	2.04
SAKAL_10	SAKAL_03	30	225	20	2.05
SAKAL_10	SAKAL_03	30	225	20	2.05
SAKAL_10	SAKAL_03	30	225	20	2.05
MANANT5G	MANANT03	11	225	47	5.88
MANANT4G	MANANT03	11	225	47	5.88
MANANT3G	MANANT03	11	225	47	5.88
MANANT2G	MANANT03	11	225	47	5.88
MANANT1G	MANANT03	11	225	47	5.88
BRIKAM1G	BRIKAM03	30	225	50	10
BALI1_11	BALING05	15	150	80	11.2
BALI1_11	BALING05	15	150	54	11.2
BALING1G	BALI2_11	6.6	15	3	6
BALING2G	BALI2_11	6.6	15	3	6
BALING3G	BALI2_11	6.6	15	3	6
BALING4G	BALI2_11	6.6	15	3	6
KODIAL03	KODIAL05	225	150	75	12
SELING1G	SELING05	8.66	150	54	11.2
SOPAM_1G	SIRAKO05	8.66	150	78	11.2
SOTU1_1G	BALING10	2	30	14.5	7.72
BALI2_11	BALING10	15	30	24	10
BALI1_11	BALING10	15	30	15	7.1

Node 1	Node 2	V 1	V 2	SN	Zcc	Node 1	Node 2	V 1	V 2	SN	Zcc
Name	Name	kV	kV	MVA	%pu	Name	Name	kV	kV	MVA	%pu
BALI1_11	BALING10	15	30	15	7.1	1130KUMA	1131KUMA	161	34.5	66	11.2
BALI1_11	BALING10	15	30	15	7.1	1150TAFO	1151TAF0	161	34.5	33	11.21
DARSATAC	BALING10	11	30	30	12	1150TAFO	1152TAFO	161	34.5	33	11.21
DARSAL1G	LAFIA_05	5.5	150	5.3	11.2	1170KPON	1171KPON	161	34.5	33	10.9
DARSAL5G	LAFIA_05	5.5	150	7	11.2	1170KPON	1171KPON	161	34.5	33	10.9
DARSAL6G	LAFIA_05	5.5	150	7	11.2	1190KPON	1195KPON	161	11.5	5	9.15
DARSAL7G	LAFIA_05	5.5	150	8	11.2	1200ASAW	1201ASAW	161	34.5	66	11.3
DARSAL8G	LAFIA_05	0.4	150	4.8	11.2	1200ASAW	1202ASAW	161	34.5	66	11.3
NIONO_1G	SEGOU_05	2	150	3.3	10	1230HO	1231HO-1	69	11.5	7	11.8
BOUGO_1G	SELING05	2	150	3.3	10	1240KPEV	1241KPEV	69	34.5	13	8.36
KODIAL03	KODIAL05	225	150	75	12	1250KPAN	1251KPAN	69	34.5	20	11.28
SEGOU_03	SEGOU_05	225	150	25	12	1300BOGO	1301BOGO	161	34.5	33	10.56
SEGOU_03	SEGOU_05	225	150	25	12	1300BOGO	1301BOGO	161	34.5	33	10.56
KENIE_1G	KENIE_05	8.66	150	18	11.2	1300BOGO	1301BOGO	161	34.5	33	10.56
KENIE_2G	KENIE_05	8.66	150	18	11.2	1310SOGA	1311SOGA	69	34.5	15	8.21
KENIE_3G	KENIE_05	8.66	150	18	11.2	1360ESSI	1361ESSI	161	34.5	33	10.13
FELOU_1G	KAYES_03	11	225	25	12	1360ESSI	1361ESSI	161	34.5	33	10.13
FELOU_2G	KAYES_03	11	225	25	12	1370MALL	1371MALL	161	34.5	66	11.3
KOUTIA1G	KOUTIA03	8.66	225	6	12	1370MALL	1371MALL	161	34.5	66	11.3
SOSUMA1G	SEGOU_05	2	150	3.8	10	1390DCEM	1391DCEM	161	34.5	25	8.49
VICABO1G	SIRAKO05	8.66	150	38	11.2	1390DCEM	1391DCEM	161	34.5	33	10.9
ALBATR1G	KAYES_03	11	225	75	12	1010AKOS	1017AKOS	161	11.5	13.3	11
CAPEB10G	CAPEBI08	6.6	90	62.5	10	1320ABOA	1327ABOA	161	34.5	13.3	9.97
SENDOU1G	SENDOU03	6.6	225	157	10	1090TARK	1092ATAR	161	34.5	33	11.22
KOUNOU08	KOUNOU03	90	225	75	7.49	1320ABOA	ABOA_330	161	330	200	9
TAMBAC03	TAMBAC11	225	15	37.5	10	1320ABOA	ABOA_330	161	330	200	9
DAGANA03	DAGANA11	225	15	40	10	1501G1	1500BUI	14.4	161	160	13
CAPEBI08	CAPEB11G	90	15	157	10	1502G2	1500BUI	14.4	161	160	13
KOUTIA2G	KOUTIA03	8.66	225	36	12	1503G3	1500BUI	14.4	161	160	13
FELOU_3G	KAYES_03	11	225	25	12	1100PRES	PRES330	161	330	200	9
SIKASSO1	SIKASS03	8.66	225	12	12	1100PRES	PRES330	161	330	200	9
1010AKOS	1011AKOS	161	14.4	200	13.35	1139K2BS	KSI330	161	330	200	9
1010AKOS	1012AKOS	161	14.4	200	13.35	1139K2BS	KSI330	161	330	200	9
1010AKOS	1013AKOS	161	14.4	200	13.35	3010LOME	30101LOM	161	330	200	9
1010AKOS	1014AKOS	161	14.4	200	13.35	3010LOME	30101LOM	161	330	200	9
1010AKOS	1015AKOS	161	14.4	200	13.35	1060WINN	1061BWIN	161	34.5	33	11.2
1010AKOS	1016AKOS	161	14.4	200	13.35	1060WINN	1061AWIN	161	34.5	33	11.2
1031SMEL	10311VAL	161	13.8	85	12.9	1280TAMA	1281ATAM	161	34.5	66	11.3
1031SMEL	10317VAL	161	13.8	18	10.1	1280TAMA	1281BTAM	161	34.5	66	11.3
1032SMEL	10312VAL	161	13.8	102	12.9	1380SAWL	1381SAWL	161	34.5	13.3	11.3
1032SMEL	10318VAL	161	13.8	18	12.9	1580N_AB	1581N-AB	161	11	53	11.8
1033SMEL	10313VAL	161	13.8	102	12.9	1580N_AB	1581N-AB	161	11	53	11.8
1034SMEL	10314VAL	161	13.8	102	12.9	1140NKAW	1143NKAW	161	34.5	33	11.22
1035SMEL	10315VAL	161	13.8	85	12.9	1110DUNK	1111DUNK	161	34.5	13.3	11.31
1036SMEL	10316VAL	161	13.8	85	12.9	15533BSP	15543BLV	161	34.5	145	11.3
1190KPON	1191KPON	161	13.8	51	10.6	15533BSP	15553BLV	161	34.5	145	11.3
1190KPON	1192KPON	161	13.8	51	10.6	15533BSP	15543BLV	161	34.5	145	11.3
1190KPON	1193KPON	161	13.8	51	10.6	1370MALL	1372MALL	161	34.5	66	11.3
1190KPON	1194KPON	161	13.8	51	10.6	1370MALL	1372MALL	161	34.5	66	11.3
1320ABOA	1321ABOA	161	13.8	155	12.6	1590KIN	1591KIN	161	34.5	13.3	11.31
1320ABOA	1322ABOA	161	13.8	155	12.6	1139K2BS	11391K2L	161	34.5	66	11.3
1320ABOA	1323ABOA	161	13.8	155	12.6	1139K2BS	11392K2L	161	34.5	66	11.3
1320ABOA	1324ABOA	161	13.8	155	12.6	1750BONY	17501BON	161	34.5	13.3	11.31
1320ABOA	1325ABOA	161	13.8	155	12.6	1340WA	1341WA	161	34.5	13.3	11.3
1413KENY	1412KENY	161	11	53	11.8	1630HAN	1631HAN	161	34.5	13.3	11.3
1413KENY	1412KENY	161	11	53	11.8	1620TUMU	1621TUMU	161	34.5	13.3	11.3
1600OPB-	1601OPB-	161	13.8	145	11.919	1850ATEB	1852ATEB	161	34.5	13.3	11.31
1600OPB-	1602OPB-	161	13.8	145	11.919	1990AYAN	1998AYAN	161	11.5	53	11.8
1809ELUB	1800ELUB	225	161	200	9.72	1990AYAN	1995AYAN	161	11.5	53	11.8
1809ELUB	1800ELUB	225	161	200	9.72	1500BUI	1511BUIL	161	34.5	13.3	11.31
1470TT1P	1471TT1P	161	13.8	141	6.9	1278MIM	1279MIM	161	34.5	33	11.2
1470TT1P	1472TT1P	161	13.8	141	6.9	1278MIM	1279MIM	161	34.5	33	11.2
1309WEXF	13091WEX	161	34.5	33	11.2	1610BUIP	1611BUIP	161	34.5	33	11.22
1095NEWT	10951NTA	161	11.5	33	10.6	1610BUIP	1611BUIP	161	34.5	33	11.22
1095NEWT	10951NTA	161	11.5	33	10.6	1130KUMA	1133KUM1	161	34.5	66	11.2
1480ZEB	1481Z-LV	161	34.5	33	11.3	1130KUMA	1133KUM2	161	34.5	66	11.2
1040TEMA	1041T-LV	161	34.5	66	11.39	1130KUMA	1132KUMA	161	34.5	66	11.2
1040TEMA	1041T-LV	161	34.5	66	11.39	1700ASOG	1701ASO5	161	13.8	55	11.3
1040TEMA	1041T-LV	161	34.5	66	11.39	1700ASOG	1701ASO1	161	13.8	55	11.3
1040TEMA	1041T-LV	161	34.5	66	11.39	1700ASOG	1701ASO2	161	13.8	55	11.3
1040TEMA	1042T-LV	161	34.5	66	11.3	1700ASOG	1701ASO3	161	13.8	55	11.3
1050ACHI	1051ACH	161	34.5	66	11.3	1700ASOG	1701ASO4	161	13.8	55	11.3
1050ACHI	1052ACH	161	34.5	66	11.3	1700ASOG	1701ASO6	161	13.8	55	11.3
1050ACHI	1053ACH	161	34.5	66	11.3	ABOA_330	ABOA3CC1	330	13.8	175	11
1050ACHI	1054ACH	161	34.5	66	11.3	1020VOLT	1029VOLT	161	330	200	9
1050ACHI	1055ACH	161	34.5	66	11.3	1020VOLT	1029VOLT	161	330	200	9
1080TAKO	1081TAKO	161	34.5	66	11.3	1750BONY	1757G	161	13.8	155	12.6
1080TAKO	1082TAKO	161	34.5	66	11.3	1750BONY	1758G	161	13.8	155	12.6
1090TARK	1092BTAR	161	34.5	33	11.22	1350YEND	1351YEND	161	34.5	13.3	11.3
1100PRES	1102APRE	161	13.2	26.7	7.1	1070C-CO	1071BCCO	161	34.5	66	11.3
1130KUMA	1131KUMA	161	34.5	66	11.2	1095NEWT	10951NTA	161	11.5	33	10.6

Node 1 Name	Node 2 Name	V 1 kV	V 2 kV	SN MVA	Zcc %pu
1090TARK	1092BTAR	161	34.5	66	11.3
1260TECH	1261TECH	161	34.5	33	11.22
1252KPAN	1250KPAN	161	69	90	11.3
1470TT1P	1473TT1P	161	13.8	141	6.9
1750BONY	1758BON3	161	330	200	9
1750BONY	1758BON3	161	330	200	9
1210JUAB	1211JUAB	161	34.5	33	11.2
1210JUAB	1211JUAB	161	34.5	33	11.2
1021SME2	1022SM2L	161	34.5	145	11.3
1021SME2	1022SM2L	161	34.5	145	11.3
1180KONO	1181AKON	161	34.5	33	11.22
1180KONO	1181BKON	161	34.5	33	11.22
1210N-OB	1211DNOB	161	34.5	33	11.21
1210N-OB	1211DNOB	161	34.5	33	11.21
1590KIN	1591KIN3	161	330	200	9
1290BOLG	BOLGA330	161	330	200	9
1140NKAW	1143NKAW	161	34.5	33	11.22
1260TECH	1261TECH	161	34.5	33	11.22
1309WEXF	13091WEX	161	34.5	33	11.2
1250KPAN	1251KPAN	69	34.5	20	11.28
2010ABOB	2011ABOB	225	90	70	10.15
2010ABOB	2011ABOB	225	90	70	10.245
2010ABOB	2011ABOB	225	90	70	10.245
2010ABOB	2011ABOB	225	90	70	10.245
2172AYAM	2170AYAM	5.5	90	15	11.5
2181AYAM	2180AYAM	5.5	90	19	9.7
2060FERK	2061FERK	225	90	65	10.17
2100MAN-	2101MAN-	225	90	70	10.16
2070SOUB	2071SUBR	225	90	70	10.13
2090BUYO	2091BUYO	225	90	70	10.1
2093BUYO	2090BUYO	10.5	225	61	10.96
2094BUYO	2090BUYO	10.5	225	61	10.95
2040KOSS	2041KOSS	225	90	65	10.25
2043KOSS	2040KOSS	17	225	72	13.3
2042KOSS	2040KOSS	17	225	72	13.3
2044KOSS	2041KOSS	17	90	72	14.05
2030TAAB	2031TAAB	225	90	70	10.3
2030TAAB	2031TAAB	225	90	70	10.3
2032TAAB	2030TAAB	13.8	225	82.5	12.47
2033TAAB	2030TAAB	13.8	225	82.5	12.53
2034TAAB	2030TAAB	13.8	225	82.5	12.53
2209RIVI	2210RIVI	225	90	70	10.4
2020VRID	2021VRID	225	90	70	10.3
2020VRID	2021VRID	225	90	70	10.3
2020VRID	2021VRID	225	90	70	10.3
2024VRID	2021VRID	11	90	51	11
2025VRID	2021VRID	11	90	51	11
2026VRID	2021VRID	11	90	51	11
2023VGT-	2020VRID	11	225	61	11.53
2022VGT-	2020VRID	11	225	61	11.53
2501AZI	2500AZIT	15.75	225	190	12.5
2502AZI	2500AZIT	15.75	225	190	12.5
2110LABO	2111LABO	225	90	50	10.22
2080S-PE	2081PEDR	225	90	65	10.16
2080S-PE	2081PEDR	225	90	70	10.16
2092BUYO	2091BUYO	10.5	90	82.5	11.53
2171AYAM	2170AYAM	5.5	90	15	11.5
2182AYAM	2180AYAM	5.5	90	19	9.7
20NGTAG8	2021VRID	15	90	151	11
2027VRID	2020VRID	15	225	151	12
2229YOPO	2231YOPO	225	90	100	10.15
2229YOPO	2231YOPO	225	90	100	10.15
3061NANG	3060NANG	10.3	161	35.5	13
3062NANG	3060NANG	10.3	161	35.5	13
3NGLOG12	3LOME161	11	161	32	10.5
4KODE225	4KODEN33	225	33	40	17.5
4KODE225	4KODEN33	225	33	40	17.5
4ZAGT225	4ZAGTO90	225	90	70	16.5
4ZAGT225	4ZAGTO90	225	90	70	16.5
4KOSSO90	4KOSSO33	90	33	40	11.2
4KOSSO90	4KOSSO15	90	15	40	11.4
4OUAG190	4OUAG115	90	15	40	11.4
4OUAG290	4OUAG215	90	15	40	11.4
4BOB2_33	4BOB2_15	33	15	10	7
4BOB2_33	4BOB2_15	33	15	10	7
4BOB1_33	4BOB1_15	33	15	10	6.68
4BOB1_33	4BOB1_15	33	15	10	6.68
4OUAG233	4OUAG215	33	15	15	10
4OUAG233	4OUAG215	33	15	15	10
4OUAG133	4OUAG115	33	15	15	10
4OUAG133	4OUAG115	33	15	15	10

Node 1 Name	Node 2 Name	V 1 kV	V 2 kV	SN MVA	Zcc %pu
4OUAG133	4OUAG115	33	15	15	10
4PTDO132	4PTDOI33	132	33	10	10
4PTDO132	4PTDOI33	132	33	10	10
4PTDO132	4PTDOI33	132	33	10	10
4KOSSO33	4KOSSO15	33	15	15	10
4KOSSO33	4KOSSO15	33	15	15	10
4BAGR132	4BAGRE_6	132	6.6	10	10
4BAGR132	4BAGRE_6	132	6.6	10	10
4KOMP132	4KOMPI_6	132	6.6	10	10
4KOMP132	4KOMPI_6	132	6.6	10	10
4BOB1_15	4BOB11_5	15	5.5	2	6
4BOB1_15	4BOB12_5	15	5.5	2	6.5
4BOB1_15	4BOB13_5	15	5.5	2	6.5
4BOB1_15	4BOB14_5	15	5.5	2	6
4BOB2_15	4BOB21_5	15	5.5	4.75	7
4BOB2_15	4BOB22_5	15	5.5	4.75	7.06
4BOB2_33	4BOB23_5	33	5.5	5	6.88
4BOB2_33	4BOB24_5	33	5.5	5	7.87
4BOB2_33	4BOB25_5	33	5.5	5	6.88
4KOSSO33	4KOS1_11	33	11	5	7.15
4KOSSO33	4KOS2_11	33	11	8	9.89
4KOSSO33	4KOS3_11	33	11	8	9.89
4KOSSO33	4KOS4_11	33	11	10	8.58
4KOSSO33	4KOS5_11	33	11	10	8.58
4KOSSO33	4KOS6_11	33	11	23	10.68
4OUAG215	4OUA21_5	15	5.5	6.6	8
4OUAG215	4OUA22_5	15	5.5	6.6	8
4OUAG215	4OUA23_5	15	5.5	6.6	8
4OUAG215	4OUA24_5	15	5.5	10.65	8
4OUAG215	4OUA25_5	15	5.5	10.65	8
4OUAG115	4OUA11_6	15	6.3	4	7.43
4OUAG115	4OUA12_6	15	6.3	4	7.43
4OUAG115	4OUA13_6	15	5.5	5	7.92
1040TEMA	1040TGEN	161	11	75	10
12951BOL	1290BOLG	225	161	200	11.3
20NTAG82	2021VRID	15	90	151	11
20NTAG83	2021VRID	15	90	151	11
2371BUND	2370BUND	225	90	50	10.22
3NEWIPP	3LOME161	11	161	32	10.5
KOMSILG5	4ZAGTO33	11	33	22.5	10.68
2NEWCC-1	2209RIVI	15.75	225	190	12.5
2NEWCC-2	2209RIVI	15.75	225	190	12.5
2209RIVI	2210RIVI	225	90	70	10.4
KOMSILG6	4ZAGTO33	11	33	22.5	10.68
KOMSILG4	4ZAGTO33	11	33	15.62	10.68
2050BOUA	2340BOUA	225	90	70	10.18
2050BOUA	2340BOUA	225	90	70	10.18
2040KOSS	2041KOSS	225	90	65	10.25
3010LOME	CONTOU1G	161	15	63	11.6
3010LOME	CONTOU1G	161	15	63	11.6
3010LOME	CONTOU1G	161	15	20	8
3030COTO	AKPAKP1G	161	15	37.5	8
NATITI04	NATITI1G	161	15	15	8
3030COTO	PORTON1G	161	15	15	10
PARAKO04	PARAKO1G	161	15	32	10
3010LOME	LOME__1G	161	15	20	10
3KARA161	KARA__1G	161	15	25	10
MA_GLE04	CAI___1G	161	15	12.5	10
MA_GLE04	CAI___2G	161	15	12.5	10
MA_GLE04	CAI___3G	161	15	12.5	10
MA_GLE04	CAI___4G	161	15	12.5	10
MA_GLE04	CAI___5G	161	15	12.5	10
MA_GLE04	CAI___6G	161	15	12.5	10
MA_GLE04	CAI___7G	161	15	12.5	10
MA_GLE04	CAI___8G	161	15	12.5	10
3030COTO	IPPSOL1G	161	15	25	10
3030COTO	IPPTHE1G	161	15	125	10
KANDI_04	SOLBEN1G	161	15	6.25	10
MANGO_04	SOLTOG1G	161	15	6.25	10
KANDI_04	ADFSOL1G	161	15	6.25	10
MA_GLE04	MA_GLE1G	161	15	190	10
MA_GLE04	MA_GLE2G	161	15	190	10
MA_GLE04	MA_GLE3G	161	15	190	10
3040SAKA	SAKETE02	161	330	200	12
3040SAKA	SAKETE02	161	330	200	12
2209RIVI	RIVIER02	225	330	200	9
2209RIVI	RIVIER02	225	330	200	9
2209RIVI	2210RIVI	225	90	70	10.4
2020VRID	2021VRID	225	90	70	10.3
BISSAU03	BISSAU1G	225	30	20	8
MALANV02	MALANV04	330	161	90	8

Node 1 Name	Node 2 Name	V 1 kV	V 2 kV	SN MVA	Zcc %pu
OUAGAE02	OUAGAE03	330	225	150	8
OUAGAE02	OUAGAE03	330	225	150	8
OUAGAE03	OUAGAE08	225	90	100	8
OUAGAE03	OUAGAE08	225	90	100	8
4PTDO132	PATDOI08	132	90	75	10
SAMBAG03	SAMBANG1	225	13.2	40	10
SAMBAG03	SAMBANG2	225	13.2	37.5	10
SAMBAG03	SAMBANG3	225	13.2	37.5	10
SAMBAG03	SAMBANG4	225	13.2	37.5	10
KALETA03	KALETAG1	225	10.3	90	10
KALETA03	KALETAG2	225	10.3	90	10
KALETA03	KALETAG3	225	10.3	90	10
SELING03	SELING05	225	150	150	10
FOMI__03	FOMI__G1	225	10.3	37.5	10
FOMI__03	FOMI__G2	225	10.3	37.5	10
FOMI__03	FOMI__G3	225	10.3	37.5	10
BRIKAM1G	BRIKAM03	30	225	50	10
TAMBAC03	TAMBAC12	225	15	10	10
1320ABOA	1326ABOA	161	13.8	155	12.6
1700ASOG	SASO2CC1	161	13.8	225	11.3
1700ASOG	SASO2CC2	161	13.8	225	11.3
KOMSILG1	4ZAGTO33	11	33	22.5	10.68
KOMSILG2	4ZAGTO33	11	33	23	10.68
KOMSILG3	4ZAGTO33	11	33	15.62	10.68
BOB2_2G1	4BOB2_33	11	33	13	6.88
BOB2_2G2	4BOB2_33	11	33	13	6.88
SMALLHYD	4BOB2_33	0.4	33	4	6.88
NIAM2_06	GOUDELG1	132	20	7.5	9.8533
NIAM2_06	GOUDELG2	132	20	7.5	9.8533
NIAM2_06	GOUDELG3	132	20	7.5	9.8533
NIAM2_06	GOUDELG4	132	20	7.5	9.8533
ALAOJI02	ICSPOWG1	330	15	125	10
ALAOJI02	ICSPOWG2	330	15	125	10
ALAOJI02	ICSPOWG3	330	15	125	10
ALAOJI02	ICSPOWG4	330	15	125	10
ALAOJI02	ICSPOWG5	330	15	125	10
ALAOJI02	ICSPOWG6	330	15	125	10
IKOTAB02	BONMOBG1	330	15	162.5	13
IKOTAB02	BONMOBG2	330	15	162.5	13
IKOTAB02	BONMOBG3	330	15	162.5	13
EGBIN_02	CHEVROG1	330	16	312.5	10.22
EGBIN_02	CHEVROG2	330	16	312.5	10.22
EGBIN_02	CHEVROG3	330	16	312.5	10.22
ALAOJI02	TOTALFG4	330	15	156.25	10
ALAOJI02	TOTALFG3	330	15	156.25	10
ALAOJI02	TOTALFG2	330	15	156.25	10
ALAOJI02	TOTALFG1	330	15	156.25	10
ERUNKA02	WESTCOG1	330	15	156.25	10
ERUNKA02	WESTCOG2	330	15	156.25	10
ERUNKA02	WESTCOG3	330	15	156.25	10
ERUNKA02	WESTCOG4	330	15	156.25	10
IKOTAB02	IBOMP2G1	330	15	156.25	10
IKOTAB02	IBOMP2G2	330	15	156.25	10
IKOTAB02	IBOMP2G3	330	15	156.25	10
IKOTAB02	IBOMP2G4	330	15	156.25	10
IKEJAW02	FARMELEG	330	15	187.5	10
2028VRID	2020VRID	15	225	151	12
2029VRID	2020VRID	15	225	151	12
BALI1_11	BALING10	15	30	15	7.1
MATOTO_D	MATOTO07	60	110	25	5.6
BISSAU03	BISSAU1G	225	30	20	8
GBARAN02	GBARANT2	330	1	150	12
GBARAN06	GBARANT2	132	1	150	-1.99745
MAMBIL02	MAMBIG01	330	15	550	13
MAMBIL01	MAMBIL02	760	330	1000	10
MAMBIL01	MAMBIL02	760	330	1000	10
MAMBIL01	MAMBIL02	760	330	1000	10
MAMBIL02	MAMBIG02	330	15	550	13
MAMBIL02	MAMBIG03	330	15	550	13
MAMBIL02	MAMBIG04	330	15	550	13
MAMBIL02	MAMBIG05	330	15	550	13
MAMBIL02	MAMBIG06	330	15	550	13
MAMBIL02	MAMBIG07	330	15	550	13
MAMBIL02	MAMBIG08	330	15	550	13
ZUNGER02	ZUNGERG1	330	15.65	220	12.85
ZUNGER02	ZUNGERG2	330	15.65	220	12.85
ZUNGER02	ZUNGERG3	330	15.65	220	12.85
ZUNGER02	ZUNGERG4	330	15.65	220	12.85
SALKAD02	SALKADG2	330	10.5	85	12
SALKAD02	SALKADG3	330	10.5	85	12
MAMBIL01	MAMBIL02	760	330	1000	10
1200ASAW	1202ASAW	161	34.5	66	11.3
1230HO	1231HO-1	69	11.5	7	11.8
1310SOGA	1311SOGA	69	34.5	20	8.21
1380SAWL	1381SAWL	161	34.5	13.3	11.3
1139K2BS	11392K2L	161	34.5	66	11.3
1309WEXF	13091WEX	161	34.5	33	11.2
1870CAPE	1871CAPL	161	34.5	66	11.3
1870CAPE	1871CAPL	161	34.5	66	11.3
1870CAPE	CAPE330	161	330	200	9
1850BERE	1851BERL	161	34.5	33	11.22
1850BERE	1851BERL	161	34.5	33	11.22
1480ZEB	1481Z-LV	161	34.5	33	11.3
1350YEND	1351YEND	161	34.5	13.3	11.3
1340WA	1341WA	161	34.5	13.3	11.3
1590KIN	1591KIN	161	34.5	13.3	11.31
1620TUMU	1621TUMU	161	34.5	13.3	11.3
1630HAN	1631HAN	161	34.5	13.3	11.3
1500BUI	1511BUIL	161	34.5	13.3	11.31
1750BONY	17501BON	161	34.5	13.3	11.31
1850ATEB	1852ATEB	161	34.5	13.3	11.31
1010AKOS	1017AKOS	161	11.5	13.3	11
1240KPEV	1241KPEV	69	34.5	13	8.36
1110DUNK	1111DUNK	161	34.5	13.3	11.31
1561A4BS	1560A4BS	161	330	500	9
1561A4BS	1560A4BS	161	330	500	9
1561A4BS	1562A4BS	161	34.5	145	11.3
1561A4BS	1562A4BS	161	34.5	145	11.3
1110DUNK	1115DUNK	161	330	200	9
NIAM2_06	DYODYONG	132	20	33	9.8533
3050ONIG	KETOU__G	161	10.3	200	13
SOUBREG1	2070SOUB	10.5	225	120	11.53
SOUBREG2	2070SOUB	10.5	225	120	11.53
SOUBREG3	2070SOUB	10.5	225	120	11.53
BOUTOUBG	2070SOUB	10.5	225	190	11.53
GOUINA1G	KAYES_03	11	225	59	12
GOUINA2G	KAYES_03	11	225	59	12
GOUINA3G	KAYES_03	11	225	59	12
ADJARAG1	ADJARA04	10.3	161	54	13
ADJARAG2	ADJARA04	10.3	161	54	13
ADJARAG3	ADJARA04	10.3	161	54	13
KANDAD06	KANDADG1	132	20	40	9.8533
KANDAD06	KANDADG2	132	20	40	9.8533
KANDAD06	KANDADG3	132	20	40	9.8533
KANDAD06	KANDADG4	132	20	40	9.8533
CAPE330	HEMANGG	330	13.8	115	11
12951BOL	PWALUGUG	225	13.8	60	11
1350YEND	JUALE__G	161	13.8	110	11
LABE__03	DIGAN__G	225	10.3	117	10
AMARYA03	AMARYAG1	225	10.3	90	10
AMARYA03	AMARYAG2	225	10.3	90	10
AMARYA03	AMARYAG3	225	10.3	90	10
AMARYA03	AMARYAG4	225	10.3	90	10
LINSAN03	KASSAB_G	225	10.3	169	10
BIKONG03	BENKONGG	225	10.3	107	10
YIBEN_03	BUMBUN3G	225	10.3	115	10
BUMBUN03	BUMBU45G	225	10.3	120	10
MANO__03	MANORIG1	225	10.3	115	10
MANO__03	MANORIG2	225	10.3	115	10
STPAUL03	SPAULG11	225	10.3	50	10
STPAUL03	SPAULG21	225	10.3	75	10
STPAUL03	SPAULG12	225	10.3	50	10
STPAUL03	SPAULG22	225	10.3	75	10
MARKALAG	SEGOU_05	2	150	13	10
BADOUMG1	BADOUM03	11	225	47	5.88
BADOUMG2	BADOUM03	11	225	47	5.88
GRIBOPOG	2070SOUB	10.5	225	140	11.53
ABOCOMG1	2140BONG	5.5	90	38	9.7
ABOCOMG2	2140BONG	5.5	90	38	9.7
ABOCOMG3	2140BONG	5.5	90	38	9.7
TIBOTOG1	TIBOTO03	10.5	225	94	11.53
TIBOTOG2	TIBOTO03	10.5	225	94	11.53
TIBOTOG3	TIBOTO03	10.5	225	94	11.53
SENDOU2G	SENDOU03	6.6	225	157	10
SENDOU3G	SENDOU03	6.6	225	157	10
KODIAL03	KODIAL05	225	150	75	12
KOUNOU08	KOUNOU03	90	225	75	7.49
KOUNOU08	KOUNOU03	90	225	75	7.49
KOUNOU08	KOUNOU03	90	225	75	7.49
LINSAN03	LAFOU__G	225	10.3	117	10
MATOTO03	MATOTO07	225	110	75	10
MATOTO03	MATOTO07	225	110	75	10

Node 1	Node 2	V 1	V 2	SN	Zcc		Node 1	Node 2	V 1	V 2	SN	Zcc
Name	Name	kV	kV	MVA	%pu		Name	Name	kV	kV	MVA	%pu
NZEREK03	GOZOGUEG	225	10.3	60	10		BEYLA_03	NZEBELAG	225	10.3	60	10
LABE__03	BONKONDG	225	10.3	190	10		MALI__03	KOURAVEG	225	10.3	169	10
NZEREK03	FRANKO_G	225	10.3	45	10		MALI__03	KOUYA__G	225	10.3	107	10
BOKE__03	POUDADLG	225	10.3	113	10		LABE__03	FETORE_G	225	10.3	155	10
BISSAU03	BISSAU1G	225	30	20	8		LABE__03	GRKINKOG	225	10.3	365	10
1040TEMA	1041T-LV	161	34.5	66	11.39		3010LOME	CCTOGOG1	161	15	190	10
1050ACHI	1051ACH	161	34.5	66	11.3		3010LOME	CCTOGOG2	161	15	190	10
IKOTABT3	IKOTAB06	1	132	150	-1.99745		3010LOME	CCTOGOG3	161	15	190	10
IKOTAB02	IKOTABT3	330	1	150	12		1040TEMA	1041T-LV	161	34.5	66	11.39
MONROV09	MONROV_D	66	33	20	10		1700ASOG	SASOCC3	161	13.8	225	11.3
MATOTO_D	MATOTO07	60	110	25	5.6		1021SME2	BTPP__G1	161	13.8	320	11.3
TOMBO__D	MATOTO_D	20	60	50	11.9		1021SME2	CEMPOWEG	161	13.8	320	11.3
KOUNOU08	KOUNOU03	90	225	75	7.49		BENINN02	ETHIOPG3	330	17	356	13
LINSAN03	BALASSAG	225	10.3	225	10		BENINN02	ETHIOPG4	330	17	356	13
KOUKOU03	KOUKOUTG	225	10.3	351	10		BENINN02	ETHIOPG2	330	17	356	13
BOUREY03	BOUREYAG	225	10.3	225	10		BENINN02	ETHIOPG1	330	17	356	13
KOROUS03	DIAREGUG	225	10.3	90	10							

9. APPENDIX: STABILITY STUDY: DYNAMIC PSA MODEL FOR YEAR 2015: GENERATION DATA

9.1. Generators

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X"d pu	Xq pu	X'q pu	X"q pu	T'do s	T"do s	T'qo s	T"qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
KAHONG71	KAHONE2G	SE	17.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KAHONG72	KAHONE2G	SE	17.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KAHONG73	KAHONE1G	SE	17.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KAHONG74	KAHONE1G	SE	17.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
B_AIRG61	BELAIR11	SE	18.0	15.0	16.0	16.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
B_AIRG62	BELAIR11	SE	18.0	15.0	16.0	16.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
B_AIRG63	BELAIR11	SE	18.0	15.0	16.0	16.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
B_AIRG64	BELAIR11	SE	18.0	15.0	16.0	16.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
B_AIRT4A	BELAIR1G	SE	33.0	11.0	32.0	32.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAPDB11A	CAPEBI4G	SE	26.0	6.6	21.0	21.0	0.005	0.140	1.710	0.314	0.238	0.005	1.100	----	4.11	0.09	----	0.15	1.50	AC1IEEE+	1	DIESEL	2
CAPDB13A	CAPEBI5G	SE	24.0	6.6	19.0	19.0	0.005	0.140	1.480	0.380	0.280	0.005	0.960	----	5.30	0.03	----	0.04	2.00	AC1IEEE+	1	DIESEL	2
CAPDB14A	CAPEBI6G	SE	24.0	6.6	19.0	19.0	0.005	0.140	1.480	0.380	0.280	0.005	0.960	----	5.30	0.03	----	0.04	2.00	AC1IEEE+	1	DIESEL	2
CAPDB144	CAPEBI1G	SE	19.0	11.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
CAPDB145	CAPEBI1G	SE	19.0	11.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
CAPDB19A	CAPEBI3G	SE	25.0	6.6	20.0	20.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAPDB1G3	CAPEBI2G	SE	30.0	6.6	24.0	24.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAPDB17A	CAPEBI9G	SE	34.0	6.6	28.0	28.0	0.004	0.110	2.050	0.180	0.120	0.004	2.050	----	4.00	0.05	----	0.05	4.70	AC1IEEE+	1	GOVCLAS	1
CAPDB15A	CAPEBI8G	SE	38.0	6.6	30.0	30.0	0.004	0.110	1.800	0.180	0.120	0.004	1.800	----	4.30	0.05	----	0.05	4.30	AC1IEEE+	1	GOVCLAS	1
CAPDB18A	CAPEBI7G	SE	38.0	6.6	30.0	30.0	0.004	0.110	1.800	0.180	0.120	0.004	1.800	----	4.30	0.05	----	0.05	4.30	AC1IEEE+	1	GOVCLAS	1
KOUN_1G1	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G2	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G3	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G4	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G5	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G6	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G7	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G8	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUN_1G9	KOUNOU11	SE	9.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
GTI_111A	GTI___1G	SE	44.0	11.0	35.0	35.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GAST	2
GTI_113A	GTI___1G	SE	21.0	11.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	PMCONST	1
TOBIN_1G	CAPEB10G	SE	50.0	6.6	40.0	40.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
BELAIR1G	BELAIR11	SE	19.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
BELAIR2G	BELAIR11	SE	19.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
BELAIR3G	BELAIR11	SE	88.0	15.0	70.0	70.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
SENDOU1G	SENDOU1G	SE	156.0	6.7	125.0	125.0	0.000	0.221	1.905	0.319	0.276	0.000	1.715	0.319	5.00	0.05	1.00	0.05	6.00	AC1IEEE+	1	GOVCLAS	1
KOUDI_1G	TAMBAC11	SE	19.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
KOUDI_2G	TAMBAC11	SE	19.0	15.0	15.0	15.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2

Machine	Node	Country	SN	VN	PN turb	PN alt	Rs	Xs	Xd	X'd	X''d	Xq	X'q	X''q	T'do	T''do	T'qo	T''qo	H	AVR	DATA	GOVERNOR	DATA
Name	Name	Name	MVA	kV	MW	MW	pu	pu	pu	pu	pu	pu	pu	pu	s	s	s	s	MW.s/MVA		SET		SET
ZIGUINCG	ZIGUIN03	SE	13.0	225.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
TAMBDIG1	TAMBAC12	SE	10.0	15.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
ROSSBE1G	DAGANA11	SE	19.0	15.0	15.0	15.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
ROSSBE2G	DAGANA11	SE	19.0	15.0	15.0	15.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
GAMB_EQG	BRIKAM1G	GA	130.0	30.0	104.0	104.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	2
GBISSEQG	BISSAU1G	GB	36.0	30.0	29.0	29.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
TOMBO3G1	TB3G1	GU	14.0	6.3	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
TOMBO3G2	TB3G2	GU	14.0	6.3	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
TOMBO3G3	TB3G3	GU	14.0	6.3	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
TOMBO3G4	TB3G4	GU	14.0	6.3	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
TOMBO5G1	TB5G1	GU	14.0	11.0	11.0	11.0	0.005	0.140	2.130	0.380	0.249	0.005	1.110	----	6.10	0.03	----	0.11	2.00	AC1IEEE+	1	DIESEL	3
TOMBO5G2	TB5G2	GU	14.0	11.0	11.0	11.0	0.005	0.140	2.130	0.380	0.249	0.005	1.110	----	6.10	0.03	----	0.11	2.00	AC1IEEE+	1	DIESEL	3
TOMBO5G3	TB5G3	GU	14.0	11.0	11.0	11.0	0.005	0.140	2.130	0.380	0.249	0.005	1.110	----	6.10	0.03	----	0.11	2.00	AC1IEEE+	1	DIESEL	3
MANEAHG1	MANEAHG1	GU	52.0	11.0	42.0	42.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
MANEAHG2	MANEAHG2	GU	52.0	11.0	42.0	42.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
MANEAHG3	MANEAHG3	GU	52.0	11.0	42.0	42.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
GARAFIG1	GARAFIG1	GU	32.0	5.7	25.0	25.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	4
GARAFIG2	GARAFIG2	GU	32.0	5.7	25.0	25.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	4
GARAFIG3	GARAFIG3	GU	32.0	5.7	25.0	25.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	4
GRCHUTG1	GRCHUTG1	GU	6.0	3.3	5.0	5.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
GRCHUTG2	GRCHUTG2	GU	6.0	3.3	5.0	5.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
GRCHUTG3	GRCHUTG3	GU	11.0	5.5	9.0	9.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
GRCHUTG4	GRCHUTG4	GU	11.0	5.5	9.0	9.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
SAMBANG1	SAMBANG1	GU	40.0	13.2	32.0	32.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
SAMBANG2	SAMBANG2	GU	40.0	13.2	32.0	32.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
SAMBANG3	SAMBANG3	GU	40.0	13.2	32.0	32.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
SAMBANG4	SAMBANG4	GU	40.0	13.2	32.0	32.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
FOMI__G1	FOMI__G1	GU	38.0	10.3	30.0	30.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
FOMI__G2	FOMI__G2	GU	38.0	10.3	30.0	30.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
FOMI__G3	FOMI__G3	GU	38.0	10.3	30.0	30.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	5
DONKEAG1	DONKEAG1	GU	8.0	6.3	8.0	8.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	5
DONKEAG2	DONKEAG2	GU	8.0	6.3	8.0	8.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	5
KALETAG1	KALETAG1	GU	94.0	10.3	80.0	80.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	5
KALETAG2	KALETAG2	GU	94.0	10.3	80.0	80.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	5
KALETAG3	KALETAG3	GU	94.0	10.3	80.0	80.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	5
MANAN11A	MANANT5G	MA	47.0	11.0	40.0	40.0	0.011	0.167	1.000	0.300	0.250	0.011	0.650	----	6.70	0.05	----	0.05	2.80	AC1IEEE+	1	HYGOV	5
MANAN12A	MANANT4G	MA	47.0	11.0	40.0	40.0	0.011	0.167	1.000	0.300	0.250	0.011	0.650	----	6.70	0.05	----	0.05	2.80	AC1IEEE+	1	HYGOV	5
MANAN13A	MANANT3G	MA	47.0	11.0	40.0	40.0	0.011	0.167	1.000	0.300	0.250	0.011	0.650	----	6.70	0.05	----	0.05	2.80	AC1IEEE+	1	HYGOV	5
MANAN14A	MANANT2G	MA	47.0	11.0	40.0	40.0	0.011	0.167	1.000	0.300	0.250	0.011	0.650	----	6.70	0.05	----	0.05	2.80	AC1IEEE+	1	HYGOV	5
MANAN15A	MANANT1G	MA	47.0	11.0	40.0	40.0	0.011	0.167	1.000	0.300	0.250	0.011	0.650	----	6.70	0.05	----	0.05	2.80	AC1IEEE+	1	HYGOV	5
SELING1	SELING1G	MA	14.0	8.7	12.0	12.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	AC1IEEE+	1	HYGOV	5
SELING2	SELING1G	MA	14.0	8.7	12.0	12.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	AC1IEEE+	1	HYGOV	5
SELING3	SELING1G	MA	14.0	8.7	12.0	12.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	AC1IEEE+	1	HYGOV	5

Machine	Node	Country	SN	VN	PN turb	PN alt	Rs	Xs	Xd	X'd	X''d	Xq	X'q	X''q	T'do	T''do	T'qo	T''qo	H	AVR	DATA	GOVERNOR	DATA
Name	Name	Name	MVA	kV	MW	MW	pu	pu	pu	pu	pu	pu	pu	pu	s	s	s	s	MW.s/MVA		SET		SET
SELING4	SELING1G	MA	14.0	8.7	12.0	12.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	AC1IEEE+	1	HYGOV	5
FELOU_1G	FELOU_1G	MA	25.0	11.0	20.0	20.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	AC1IEEE+	1	PIDGOV	6
FELOU_2G	FELOU_2G	MA	25.0	11.0	20.0	20.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	AC1IEEE+	1	PIDGOV	6
FELOU_3G	FELOU_3G	MA	25.0	11.0	20.0	20.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	AC1IEEE+	1	PIDGOV	6
KENIE_1G	KENIE_1G	MA	18.0	8.7	14.0	14.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	AC1IEEE+	1	PIDGOV	7
KENIE_2G	KENIE_2G	MA	18.0	8.7	14.0	14.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	AC1IEEE+	1	PIDGOV	7
KENIE_3G	KENIE_3G	MA	18.0	8.7	14.0	14.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	AC1IEEE+	1	PIDGOV	7
BALIN_G1	BALI1_11	MA	8.0	15.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALIN_G2	BALI1_11	MA	8.0	15.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALIN_G3	BALI1_11	MA	8.0	15.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALIN_G4	BALI1_11	MA	6.0	15.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
DARSAL1G	DARSAL1G	MA	5.0	5.5	4.0	4.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
DARASLA5	DARSAL5G	MA	7.0	5.5	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
DARASLA6	DARSAL6G	MA	7.0	5.5	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
DARASLA7	DARSAL7G	MA	8.0	5.5	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
DARSAL8G	DARSAL8G	MA	5.0	0.4	4.0	4.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
SOPAM_01	SOPAM_1G	MA	14.0	8.7	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
SOPAM_02	SOPAM_1G	MA	14.0	8.7	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
SOPAM_03	SOPAM_1G	MA	14.0	8.7	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
SOPAM_04	SOPAM_1G	MA	14.0	8.7	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
SOPAM_05	SOPAM_1G	MA	14.0	8.7	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALBIDG1	BALI1_11	MA	12.0	15.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALBIDG2	BALI1_11	MA	12.0	15.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALBIDG3	BALI1_11	MA	12.0	15.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALBIDG4	BALI1_11	MA	12.0	15.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALBIDG5	BALI1_11	MA	12.0	15.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BALBIDG6	BALI1_11	MA	12.0	15.0	10.0	10.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
ALBATR1G	ALBATR1G	MA	75.0	11.0	66.0	66.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
DARSATAC	DARSATAC	MA	27.0	11.0	25.0	25.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
VICABO1G	VICABO1G	MA	38.0	8.7	30.0	30.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
BUMBU1G1	BUMBU1G1	SL	32.0	13.8	25.0	25.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
BUMBU1G2	BUMBU1G2	SL	32.0	13.8	25.0	25.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
BUMBUN2G	BUMBUN2G	SL	50.0	13.8	40.0	40.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
GOMA_HG1	KENEMA_D	SL	8.0	33.0	6.0	6.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
GOMA_HG2	KENEMA_D	SL	8.0	33.0	6.0	6.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
BO_DI_3G	KENEMA_D	SL	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
KINGT1G1	FRTOWN04	SL	9.0	161.0	7.0	7.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
KINGT1G2	FRTOWN04	SL	8.0	161.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
KINGT2G1	FRTOWN04	SL	6.0	161.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
KINGT2G2	FRTOWN04	SL	6.0	161.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
BLACKHG1	FRTOWN04	SL	9.0	161.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
BLACKHG2	FRTOWN04	SL	9.0	161.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
BLACKHG3	FRTOWN04	SL	9.0	161.0	8.0	8.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
MTCOFFG1	MTCOFFG1	LI	21.0	10.5	16.0	16.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
MTCOFFG2	MTCOFFG2	LI	21.0	10.5	16.0	16.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
MTCOFFG3	MTCOFFG3	LI	21.0	10.5	16.0	16.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
MTCOFFG4	MTCOFFG4	LI	21.0	10.5	16.0	16.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
BUCHANG1	BUCHANG1	LI	22.0	10.5	18.0	18.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
BUCHANG2	BUCHANG2	LI	22.0	10.5	18.0	18.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
BUSHRD1G	MONROV_D	LI	28.0	33.0	23.0	23.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G1	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G2	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G3	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G4	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G5	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G6	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G7	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
BUSHR2G8	MONROV_D	LI	6.0	33.0	5.0	5.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
2171AYAM	2171AYAM	CI	13.0	5.5	10.0	10.0	0.005	0.180	1.210	0.330	0.220	0.005	0.700	----	5.00	0.03	----	0.05	2.84	UNITROLA	1	MIPREG	1
2172AYAM	2172AYAM	CI	13.0	5.5	10.0	10.0	0.005	0.180	1.210	0.330	0.220	0.005	0.700	----	5.00	0.03	----	0.05	2.84	UNITROLA	1	MIPREG	1
2181AYAM	2181AYAM	CI	19.0	5.5	15.0	15.0	0.005	0.180	1.120	0.345	0.225	0.005	0.700	----	5.00	0.03	----	0.05	2.84	UNITROLA	2	MIPREG	2
2182AYAM	2182AYAM	CI	19.0	5.5	15.0	15.0	0.005	0.180	1.120	0.345	0.225	0.005	0.700	----	5.00	0.03	----	0.05	2.84	UNITROLA	2	MIPREG	2
2092BUYO	2092BUYO	CI	61.0	10.5	55.0	55.0	0.005	0.120	1.010	0.290	0.205	0.005	0.690	----	3.30	0.06	----	0.12	3.29	EXST1	1	MIPREG	3
2093BUYO	2093BUYO	CI	61.0	10.5	55.0	55.0	0.005	0.120	1.010	0.290	0.205	0.005	0.690	----	3.30	0.06	----	0.12	3.29	EXST1	1	MIPREG	3
2094BUYO	2094BUYO	CI	61.0	10.5	55.0	55.0	0.005	0.120	1.010	0.290	0.205	0.005	0.690	----	3.30	0.06	----	0.12	3.29	EXST1	1	MIPREG	3
2042KOSS	2042KOSS	CI	62.0	17.0	35.0	58.5	0.011	0.180	0.900	0.321	0.231	0.011	0.640	----	5.00	0.03	----	0.05	3.94	UNITROLP	1	MIPREG	4
2043KOSS	2043KOSS	CI	62.0	17.0	35.0	58.5	0.011	0.180	0.900	0.321	0.231	0.011	0.640	----	5.00	0.03	----	0.05	3.94	UNITROLP	1	MIPREG	5
2044KOSS	2044KOSS	CI	62.0	17.0	35.0	58.5	0.011	0.180	0.900	0.321	0.231	0.011	0.640	----	5.00	0.03	----	0.05	3.94	UNITROLP	1	MIPREG	6
2032TAAB	2032TAAB	CI	78.0	13.8	65.0	70.2	0.003	0.180	0.900	0.330	0.255	0.003	0.650	----	5.00	0.04	----	0.05	4.41	UNITROLP	2	MIPREG	7
2033TAAB	2033TAAB	CI	78.0	13.8	65.0	70.2	0.003	0.180	0.900	0.330	0.255	0.003	0.650	----	5.00	0.04	----	0.05	4.41	UNITROLP	2	MIPREG	7
2034TAAB	2034TAAB	CI	78.0	13.8	65.0	70.2	0.003	0.180	0.900	0.330	0.255	0.003	0.650	----	5.00	0.04	----	0.05	4.41	UNITROLP	2	MIPREG	7
2022VGT1	2022VGT-	CI	26.0	11.0	24.0	24.0	0.003	0.180	2.580	0.273	0.199	0.003	2.500	----	3.60	0.04	----	0.04	2.00	AVR3	1	TURGAZ+	1
2022VGT2	2022VGT-	CI	26.0	11.0	24.0	24.0	0.003	0.180	2.580	0.273	0.199	0.003	2.500	----	3.60	0.04	----	0.04	2.00	AVR3	1	TURGAZ+	1
2023VGT1	2023VGT-	CI	26.0	11.0	24.0	24.0	0.003	0.180	2.580	0.273	0.199	0.003	2.500	----	3.60	0.04	----	0.04	2.00	AVR3	1	TURGAZ+	1
2023VGT2	2023VGT-	CI	26.0	11.0	24.0	24.0	0.003	0.180	2.580	0.273	0.199	0.003	2.500	----	3.60	0.04	----	0.04	2.00	AVR3	1	TURGAZ+	1
2024VRID	2024VRID	CI	43.0	11.0	33.0	33.0	0.003	0.124	2.290	0.209	0.199	0.003	2.072	----	6.40	0.04	----	0.03	2.20	AVR3	1	TURGAZ+	1
2025VRID	2025VRID	CI	43.0	11.0	33.0	33.0	0.003	0.124	2.290	0.209	0.199	0.003	2.072	----	6.40	0.04	----	0.03	2.20	AVR3	1	TURGAZ+	1
2026VRID	2026VRID	CI	43.0	11.0	33.0	33.0	0.003	0.124	2.290	0.209	0.199	0.003	2.072	----	6.40	0.04	----	0.03	2.20	AVR3	1	TURGAZ+	1
2027VRID	2027VRID	CI	139.0	15.0	111.0	111.0	0.002	0.131	1.670	0.240	0.166	0.002	1.603	----	6.64	0.05	----	0.08	2.27	AVR3	1	TURGAZ+	1
2028VRID	2028VRID	CI	139.0	15.0	111.0	111.0	0.002	0.131	1.670	0.240	0.166	0.002	1.603	----	6.64	0.05	----	0.08	2.27	AVR3	1	TURGAZ+	1
2029VRID	2029VRID	CI	139.0	15.0	111.0	111.0	0.002	0.131	1.670	0.240	0.166	0.002	1.603	----	6.64	0.05	----	0.08	2.27	AVR3	1	PMCONST	1
2501AZI	2501AZI	CI	210.0	15.8	148.0	148.0	0.013	0.170	2.530	0.250	0.190	0.013	2.360	----	10.76	0.02	----	0.03	2.30	UNITROLP	3	GT13E2	1
2502AZI	2502AZI	CI	210.0	15.8	148.0	148.0	0.013	0.170	2.530	0.250	0.190	0.013	2.360	----	10.76	0.02	----	0.03	2.30	UNITROLP	3	GT13E2	1
20NGTAG8	20NGTAG8	CI	139.0	15.0	111.0	111.0	0.002	0.131	1.670	0.240	0.166	0.002	1.603	----	6.64	0.05	----	0.08	2.27	AVR3	1	TURGAZ+	4
20NTAG82	20NTAG82	CI	139.0	15.0	111.0	111.0	0.002	0.131	1.670	0.240	0.166	0.002	1.603	----	6.64	0.05	----	0.08	2.27	AVR3	1	TURGAZ+	4
20NTAG83	20NTAG83	CI	139.0	15.0	111.0	111.0	0.002	0.131	1.670	0.240	0.166	0.002	1.603	----	6.64	0.05	----	0.08	2.27	AVR3	1	PMCONST	1

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
2NEWCC-1	2NEWCC-1	CI	210.0	15.8	148.0	148.0	0.013	0.170	2.530	0.250	0.190	0.013	2.360	----	10.76	0.02	----	0.03	2.30	AVR3	1	TURGAZ+	3
2NEWCC-2	2NEWCC-2	CI	210.0	15.8	148.0	148.0	0.013	0.170	2.530	0.250	0.190	0.013	2.360	----	10.76	0.02	----	0.03	2.30	AVR3	1	TURGAZ+	3
FAYE_H_G	20FAYE90	CI	6.0	90.0	5.0	5.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
4KOS1_11	4KOS1_11	BU	5.0	11.0	4.0	4.0	0.010	0.120	1.350	0.209	0.135	0.010	0.670	----	3.25	0.05	----	0.06	5.08	IEEET1	2	TGOV1	1
4KOS2_11	4KOS2_11	BU	8.0	11.0	6.0	6.0	0.010	0.120	1.700	0.260	0.181	0.010	0.850	----	2.95	0.05	----	0.06	5.08	IEEET1	2	TGOV1	1
4KOS3_11	4KOS3_11	BU	8.0	11.0	6.0	6.0	0.010	0.120	1.700	0.260	0.181	0.010	0.850	----	2.95	0.05	----	0.06	5.08	IEEET1	2	TGOV1	1
4KOS4_11	4KOS4_11	BU	10.0	11.0	8.0	8.0	0.004	0.100	1.992	0.274	0.175	0.004	0.961	----	6.52	0.02	----	0.13	5.08	IEEET1	2	TGOV1	2
4KOS5_11	4KOS5_11	BU	10.0	11.0	8.0	8.0	0.004	0.100	1.992	0.274	0.175	0.004	0.961	----	6.52	0.02	----	0.13	5.08	IEEET1	2	TGOV1	2
4KOS6_11	4KOS6_11	BU	23.0	11.0	18.0	18.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
4KOS1_15	4KOSSO15	BU	8.0	15.0	6.0	6.0	0.010	0.120	1.284	0.220	0.150	0.010	0.681	----	3.10	0.02	----	0.06	5.08	IEEET1	2	TGOV1	4
4KOS2_15	4KOSSO15	BU	8.0	15.0	6.0	6.0	0.010	0.120	1.284	0.220	0.150	0.010	0.681	----	3.10	0.02	----	0.06	5.08	IEEET1	2	TGOV1	4
4OUA11_6	4OUA11_6	BU	3.0	6.3	3.0	3.0	0.010	0.120	2.250	0.300	0.130	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	5
4OUA12_6	4OUA12_6	BU	3.0	6.3	3.0	3.0	0.010	0.120	2.250	0.300	0.130	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	5
4OUA13_6	4OUA13_6	BU	4.0	5.5	4.0	4.0	0.010	0.120	2.250	0.300	0.130	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	5
4OU1_215	4OUAG215	BU	4.0	15.0	3.0	3.0	0.010	0.120	2.250	0.350	0.150	0.010	0.600	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	6
4OU2_215	4OUAG215	BU	4.0	15.0	3.0	3.0	0.010	0.120	2.250	0.350	0.150	0.010	0.600	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	6
4OU3_215	4OUAG215	BU	4.0	15.0	3.0	3.0	0.010	0.120	2.250	0.350	0.150	0.010	0.600	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	6
4OUA21_5	4OUA21_5	BU	7.0	5.5	5.0	5.0	0.010	0.120	1.800	0.380	0.250	0.010	1.070	----	5.62	0.05	----	0.06	5.08	IEEET1	2	TGOV1	7
4OUA22_5	4OUA22_5	BU	7.0	5.5	5.0	5.0	0.010	0.120	1.800	0.380	0.250	0.010	1.070	----	5.62	0.05	----	0.06	5.08	IEEET1	2	TGOV1	7
4OUA23_5	4OUA23_5	BU	7.0	5.5	5.0	5.0	0.010	0.120	1.800	0.380	0.250	0.010	1.070	----	5.62	0.05	----	0.06	5.08	IEEET1	2	TGOV1	7
4OUA24_5	4OUA24_5	BU	10.0	5.5	9.0	9.0	0.010	0.120	2.250	0.375	0.283	0.010	0.550	----	5.00	0.03	----	0.06	5.08	IEEET1	2	TGOV1	8
4OUA25_5	4OUA25_5	BU	10.0	5.5	9.0	9.0	0.010	0.120	2.250	0.375	0.283	0.010	0.550	----	5.00	0.03	----	0.06	5.08	IEEET1	2	TGOV1	8
4BOB11_5	4BOB11_5	BU	1.0	5.5	1.0	1.0	0.010	0.120	1.300	0.200	0.150	0.010	0.670	----	5.00	0.05	----	0.06	5.08	IEEET1	2	TGOV1	9
4BOB12_5	4BOB12_5	BU	2.0	5.5	2.0	2.0	0.010	0.120	1.230	0.200	0.150	0.010	0.670	----	5.00	0.05	----	0.06	5.08	IEEET1	2	TGOV1	9
4BOB13_5	4BOB13_5	BU	2.0	5.5	2.0	2.0	0.010	0.120	1.230	0.200	0.150	0.010	0.670	----	5.00	0.05	----	0.06	5.08	IEEET1	2	TGOV1	9
4BOB14_5	4BOB14_5	BU	2.0	5.5	2.0	2.0	0.010	0.120	1.230	0.200	0.150	0.010	0.670	----	5.00	0.05	----	0.06	5.08	IEEET1	2	TGOV1	9
4BOB21_5	4BOB21_5	BU	5.0	5.5	4.0	4.0	0.010	0.120	1.371	0.220	0.140	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	10
4BOB22_5	4BOB22_5	BU	5.0	5.5	4.0	4.0	0.010	0.120	1.371	0.220	0.140	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	10
4BOB23_5	4BOB23_5	BU	5.0	5.5	4.0	4.0	0.010	0.120	1.371	0.220	0.140	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	11
4BOB24_5	4BOB24_5	BU	5.0	5.5	4.0	4.0	0.010	0.120	1.371	0.220	0.140	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	11
4BOB25_5	4BOB25_5	BU	5.0	5.5	4.0	4.0	0.010	0.120	1.371	0.220	0.140	0.010	0.680	----	3.20	0.05	----	0.06	5.08	IEEET1	2	TGOV1	11
KOMSILG1	KOMSILG1	BU	22.0	11.0	18.0	18.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
KOMSILG2	KOMSILG2	BU	16.0	11.0	12.0	12.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
KOMSILG3	KOMSILG3	BU	16.0	11.0	12.0	12.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
KOMSILG4	KOMSILG4	BU	16.0	11.0	12.0	12.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
KOMSILG5	KOMSILG5	BU	22.0	11.0	18.0	18.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
KOMSILG6	KOMSILG6	BU	22.0	11.0	18.0	18.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
BOB2_2G1	BOB2_2G1	BU	12.0	11.0	10.0	10.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
BOB2_2G2	BOB2_2G2	BU	12.0	11.0	10.0	10.0	0.003	0.100	1.596	0.266	0.156	0.003	0.794	----	7.61	0.03	----	0.14	5.08	IEEET1	2	TGOV1	3
4BAGRE16	4BAGRE_6	BU	9.0	6.6	8.0	8.0	0.010	0.100	1.090	0.286	0.206	0.010	0.630	----	2.90	0.06	----	0.06	2.83	IEEET1	1	HYGOV	1
4BAGRE26	4BAGRE_6	BU	9.0	6.6	8.0	8.0	0.010	0.100	1.090	0.286	0.206	0.010	0.636	----	2.90	0.06	----	0.06	2.83	IEEET1	1	HYGOV	1
4KOMPI16	4KOMPI_6	BU	8.0	6.6	7.0	7.0	0.010	0.200	1.000	0.350	0.220	0.010	0.660	----	2.30	0.03	----	0.07	3.28	IEEET1	1	HYGOV	3
4KOMPI26	4KOMPI_6	BU	8.0	6.6	7.0	7.0	0.010	0.200	1.000	0.350	0.220	0.010	0.660	----	2.30	0.03	----	0.07	3.28	IEEET1	1	HYGOV	3

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
MANASEMA	OUAGAE08	BU	25.0	90.0	20.0	20.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
AKOSOMG1	1011AKOS	GH	180.0	14.4	150.0	170.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
AKOSOMG2	1012AKOS	GH	180.0	14.4	150.0	170.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
AKOSOMG3	1013AKOS	GH	180.0	14.4	150.0	170.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
AKOSOMG4	1014AKOS	GH	180.0	14.4	150.0	170.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
AKOSOMG5	1015AKOS	GH	180.0	14.4	150.0	170.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
AKOSOMG6	1016AKOS	GH	180.0	14.4	150.0	170.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	4
BUI___G1	1501G1	GH	148.0	14.4	133.0	133.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	3
BUI___G2	1502G2	GH	148.0	14.4	133.0	133.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	3
BUI___G3	1503G3	GH	148.0	14.4	133.0	133.0	0.006	0.145	1.260	0.310	0.210	0.006	0.760	----	6.64	0.05	----	0.10	2.97	EXPIC1	1	PIDGOV	3
KPONGHG1	1191KPON	GH	44.0	13.8	35.0	40.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
KPONGHG2	1192KPON	GH	44.0	13.8	35.0	40.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
KPONGHG3	1193KPON	GH	44.0	13.8	35.0	40.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
KPONGHG4	1194KPON	GH	44.0	13.8	35.0	40.0	0.048	0.180	0.882	0.320	0.270	0.048	0.600	----	4.50	0.05	----	0.05	2.80	EXST1	1	PIDGOV	2
ABOAT1G1	1321ABOA	GH	138.0	13.8	110.0	110.0	0.005	0.178	2.426	0.327	0.214	0.005	2.344	0.412	7.64	0.02	0.60	0.04	7.78	ST4B	1	GAST	1
ABOAT1G2	1322ABOA	GH	138.0	13.8	110.0	110.0	0.005	0.178	2.426	0.327	0.214	0.005	2.344	0.412	7.64	0.02	0.60	0.04	7.78	ST4B	1	GAST	1
ABOAT1ST	1323ABOA	GH	138.0	13.8	110.0	110.0	0.005	0.183	2.488	0.335	0.220	0.005	2.403	0.419	7.64	0.02	0.60	0.04	4.84	ST4B	1	PMCONST	1
ABOAT2G1	1324ABOA	GH	138.0	13.8	110.0	110.0	0.005	0.178	2.426	0.327	0.214	0.005	2.344	0.412	7.64	0.02	0.60	0.04	7.78	ST4B	1	GAST	1
ABOAT2G2	1325ABOA	GH	138.0	13.8	110.0	110.0	0.005	0.178	2.426	0.327	0.214	0.005	2.344	0.412	7.64	0.02	0.60	0.04	7.78	ST4B	1	GAST	1
ABOAT2ST	1326ABOA	GH	138.0	13.8	110.0	110.0	0.005	0.183	2.488	0.335	0.220	0.005	2.403	0.419	7.64	0.02	0.60	0.04	4.84	ST4B	1	PMCONST	1
TEMAT1G1	1471TT1P	GH	138.0	13.8	110.0	110.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2
TEMAT1G2	1472TT1P	GH	138.0	13.8	110.0	110.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2
TEMAT1ST	1473TT1P	GH	138.0	13.8	110.0	110.0	0.005	0.183	2.488	0.335	0.220	0.005	2.403	0.419	7.64	0.02	0.60	0.04	4.84	ST4B	1	PMCONST	1
DOMIT1G1	1758G	GH	138.0	13.8	110.0	110.0	0.005	0.178	2.426	0.327	0.214	0.005	2.344	0.412	7.64	0.02	0.60	0.04	7.78	ST4B	1	GAST	8
DOMIT1G2	1757G	GH	138.0	13.8	110.0	110.0	0.005	0.178	2.426	0.327	0.214	0.005	2.344	0.412	7.64	0.02	0.60	0.04	7.78	ST4B	1	GAST	8
BARGE_G1	1601OPB-	GH	78.0	13.8	62.0	62.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2
BARGE_G2	1602OPB-	GH	78.0	13.8	62.0	62.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2
TEMAT2G3	1040TGEN	GH	10.0	11.0	8.0	8.0	0.004	0.079	2.041	0.256	0.171	0.004	1.048	----	5.21	0.07	----	0.22	3.00	ST4B	1	GAST	4
TEMAT2G4	1040TGEN	GH	10.0	11.0	8.0	8.0	0.004	0.079	2.041	0.256	0.171	0.004	1.048	----	5.21	0.07	----	0.22	3.00	ST4B	1	GAST	4
TEMAT2G5	1040TGEN	GH	10.0	11.0	8.0	8.0	0.004	0.079	2.041	0.256	0.171	0.004	1.048	----	5.21	0.07	----	0.22	3.00	ST4B	1	GAST	4
TEMAT2G1	1040TGEN	GH	16.0	11.0	13.0	13.0	0.006	0.124	2.318	0.348	0.244	0.006	1.186	----	5.58	0.05	----	0.14	3.00	ST4B	1	GAST	3
TEMAT2G2	1040TGEN	GH	16.0	11.0	13.0	13.0	0.006	0.124	2.318	0.348	0.244	0.006	1.186	----	5.58	0.05	----	0.14	3.00	ST4B	1	GAST	3
TEMAMRP1	1040TEMA	GH	56.0	161.0	45.0	45.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	3.00	ST4B	1	GAST	1
TEMAMRP2	1040TEMA	GH	25.0	161.0	20.0	20.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	3.00	ST4B	1	GAST	1
TEMAMRP3	1040TEMA	GH	19.0	161.0	15.0	15.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	3.00	ST4B	1	GAST	1
SUNASOG1	1701ASO1	GH	44.0	13.8	35.0	35.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	5.00	EXST1	1	GAST	5
SUNASOG2	1701ASO2	GH	44.0	13.8	35.0	35.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	5.00	EXST1	1	GAST	5
SUNASOG3	1701ASO3	GH	44.0	13.8	35.0	35.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	5.00	EXST1	1	PMCONST	1
SUNASOG4	1701ASO4	GH	44.0	13.8	35.0	35.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	5.00	EXST1	1	GAST	5
SUNASOG5	1701ASO5	GH	44.0	13.8	35.0	35.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	5.00	EXST1	1	GAST	5
SUNASOG6	1701ASO6	GH	44.0	13.8	35.0	35.0	0.002	0.100	2.510	0.308	0.217	0.002	2.300	0.370	8.20	0.05	1.00	0.05	5.00	EXST1	1	PMCONST	1
ABOA3CC1	ABOA3CC1	GH	175.0	13.8	140.0	140.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2
SASO2CC1	SASO2CC1	GH	225.0	13.8	180.0	180.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
SASO2CC2	SASO2CC2	GH	225.0	13.8	180.0	180.0	0.003	0.130	1.980	0.251	0.145	0.003	1.810	0.359	1.31	0.04	0.64	0.04	5.00	ST4B	1	GAST	2
3061NANG	3061NANG	TB	36.0	10.3	33.0	33.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	2
3062NANG	3062NANG	TB	36.0	10.3	33.0	33.0	0.011	0.167	0.994	0.268	0.185	0.011	0.767	----	8.00	0.04	----	0.04	2.80	EXST1	2	HYGOV	2
3NGLOG12	3NGLOG12	TB	25.0	11.0	20.0	20.0	0.006	0.100	0.994	0.294	0.210	0.006	0.700	0.400	8.00	0.05	0.71	0.04	3.00	IEEET2	1	GAST	6
3NEWIPP	3NEWIPP	TB	25.0	11.0	20.0	20.0	0.006	0.100	0.994	0.294	0.210	0.006	0.700	0.400	8.00	0.05	0.71	0.04	3.00	IEEET2	1	GAST	6
CONTOU1G	CONTOU1G	TB	21.0	15.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CONTOU2G	CONTOU1G	TB	21.0	15.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CONTOU3G	CONTOU1G	TB	21.0	15.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CONTOU4G	CONTOU1G	TB	21.0	15.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CONTOU5G	CONTOU1G	TB	21.0	15.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CONTOU6G	CONTOU1G	TB	21.0	15.0	17.0	17.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
AKPAKP1G	AKPAKP1G	TB	38.0	15.0	30.0	30.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
NATITI1G	NATITI1G	TB	15.0	15.0	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
PORTON1G	PORTON1G	TB	15.0	15.0	12.0	12.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
PARAKO1G	PARAKO1G	TB	32.0	15.0	25.0	25.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
LOME__1G	LOME__1G	TB	20.0	15.0	16.0	16.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
CEETKARA	KARA__1G	TB	20.0	15.0	16.0	16.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
SOKODE1G	KARA__1G	TB	5.0	15.0	4.0	4.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	3
CAI___1G	CAI___1G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___2G	CAI___2G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___3G	CAI___3G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___4G	CAI___4G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___5G	CAI___5G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___6G	CAI___6G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___7G	CAI___7G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
CAI___8G	CAI___8G	TB	12.0	15.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
IPPTHE1G	IPPTHE1G	TB	125.0	15.0	100.0	100.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
MA_GLE1G	MA_GLE1G	TB	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	GAST	2
MA_GLE2G	MA_GLE2G	TB	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	GAST	2
MA_GLE3G	MA_GLE3G	TB	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	PMCONST	1
GOUDELG1	GOUDELG1	NR	8.0	20.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
GOUDELG2	GOUDELG2	NR	8.0	20.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
GOUDELG3	GOUDELG3	NR	8.0	20.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
GOUDELG4	GOUDELG4	NR	8.0	20.0	6.0	6.0	0.005	0.140	2.000	0.300	0.200	0.005	1.900	0.275	6.20	0.03	0.50	0.03	2.00	AC1IEEE+	1	DIESEL	1
TAG1_NY2	NIAM21_D	NR	12.0	20.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
TAG2_NY2	NIAM21_D	NR	12.0	20.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
TAG3_NY2	NIAM21_D	NR	12.0	20.0	10.0	10.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
SALKADAG	SALKAD_G	NR	75.0	10.5	60.0	60.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
ZINDCC1G	ZINDER06	NR	75.0	132.0	60.0	60.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	CCGOV	1
SONIC1_G	SONIC1_D	NR	20.0	20.0	16.0	16.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
SONIC2_G	SONIC2_D	NR	20.0	20.0	16.0	16.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
SONIC3_G	SONIC3_D	NR	20.0	20.0	16.0	16.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
SONIC4_G	SONIC4_D	NR	20.0	20.0	16.0	16.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
NIGERSOL	NIAM2_06	NR	75.0	132.0	50.0	50.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	GOVCLAS	1
AFAMGT13	AFAMGT13	NI	110.0	10.5	88.0	88.0	0.000	0.088	2.170	0.210	0.154	0.000	1.953	0.210	5.00	0.05	1.00	0.05	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT14	AFAMGT14	NI	110.0	10.5	88.0	88.0	0.000	0.088	2.170	0.210	0.154	0.000	1.953	0.210	5.00	0.05	1.00	0.05	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT15	AFAMGT15	NI	110.0	11.5	88.0	88.0	0.000	0.081	2.370	0.210	0.137	0.000	1.953	0.210	5.00	0.05	1.00	0.05	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT16	AFAMGT16	NI	110.0	11.5	88.0	88.0	0.000	0.081	2.370	0.210	0.137	0.000	1.953	0.210	5.00	0.05	1.00	0.05	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT17	AFAMGT17	NI	110.0	11.5	88.0	88.0	0.000	0.081	2.370	0.210	0.137	0.000	1.953	0.210	5.00	0.05	1.00	0.05	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT18	AFAMGT18	NI	110.0	11.5	88.0	88.0	0.000	0.081	2.370	0.210	0.137	0.000	1.953	0.210	5.00	0.05	1.00	0.05	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT19	AFAMGT19	NI	163.0	15.8	138.0	138.0	0.000	0.175	2.750	0.275	0.200	0.000	2.230	0.210	5.00	0.06	1.00	0.49	6.00	ST1IEEE	1	TURGAZ+	3
AFAMGT20	AFAMGT20	NI	163.0	15.8	138.0	138.0	0.000	0.175	2.750	0.275	0.200	0.000	2.230	0.210	5.00	0.06	1.00	0.49	6.00	ST1IEEE	1	TURGAZ+	3
DELTAG03	DELTAG03	NI	30.0	11.5	24.0	24.0	0.000	0.100	1.800	0.210	0.150	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG04	DELTAG04	NI	30.0	11.5	24.0	24.0	0.000	0.100	1.800	0.210	0.150	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG05	DELTAG05	NI	30.0	11.5	24.0	24.0	0.000	0.100	1.800	0.210	0.150	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG06	DELTAG06	NI	30.0	11.5	24.0	24.0	0.000	0.100	1.800	0.210	0.150	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG07	DELTAG07	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG08	DELTAG08	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG09	DELTAG09	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG10	DELTAG10	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG11	DELTAG11	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG12	DELTAG12	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG13	DELTAG13	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG14	DELTAG14	NI	30.0	11.5	24.0	24.0	0.000	0.105	1.440	0.168	0.129	0.000	1.370	----	5.46	0.04	----	0.49	6.45	AC1IEEE+	1	TURGAZ+	3
DELTAG15	DELTAG15	NI	134.0	11.5	114.0	114.0	0.004	0.181	1.905	0.319	0.226	0.004	1.835	0.542	3.71	0.03	0.35	0.08	9.60	AC1IEEE+	1	TURGAZ+	3
DELTAG16	DELTAG16	NI	134.0	11.5	114.0	114.0	0.004	0.181	1.905	0.319	0.226	0.004	1.835	0.542	3.71	0.03	0.35	0.08	9.60	AC1IEEE+	1	TURGAZ+	3
DELTAG17	DELTAG17	NI	134.0	11.5	114.0	114.0	0.004	0.181	1.905	0.319	0.226	0.004	1.835	0.542	3.71	0.03	0.35	0.08	9.60	AC1IEEE+	1	TURGAZ+	3
DELTAG18	DELTAG18	NI	134.0	11.5	114.0	114.0	0.004	0.181	1.905	0.319	0.226	0.004	1.835	0.542	3.71	0.03	0.35	0.08	9.60	AC1IEEE+	1	TURGAZ+	3
DELTAG19	DELTAG19	NI	134.0	11.5	114.0	114.0	0.004	0.181	1.905	0.319	0.226	0.004	1.835	0.542	3.71	0.03	0.35	0.08	9.60	AC1IEEE+	1	TURGAZ+	3
DELTAG20	DELTAG20	NI	134.0	11.5	114.0	114.0	0.004	0.181	1.905	0.319	0.226	0.004	1.835	0.542	3.71	0.03	0.35	0.08	9.60	AC1IEEE+	1	TURGAZ+	3
EGBINST1	EGBINST1	NI	246.0	16.0	221.0	221.0	0.004	0.200	2.000	0.310	0.280	0.004	2.000	0.500	7.10	0.06	1.00	0.11	6.50	ST1IEEE	1	GOVCLAS	1
EGBINST2	EGBINST2	NI	246.0	16.0	221.0	221.0	0.004	0.200	2.000	0.310	0.280	0.004	2.000	0.500	7.10	0.06	1.00	0.11	6.50	ST1IEEE	1	GOVCLAS	1
EGBINST3	EGBINST3	NI	246.0	16.0	221.0	221.0	0.004	0.200	2.000	0.310	0.280	0.004	2.000	0.500	7.10	0.06	1.00	0.11	6.50	ST1IEEE	1	GOVCLAS	1
EGBINST4	EGBINST4	NI	246.0	16.0	221.0	221.0	0.004	0.200	2.000	0.310	0.280	0.004	2.000	0.500	7.10	0.06	1.00	0.11	6.50	ST1IEEE	1	GOVCLAS	1
EGBINST5	EGBINST5	NI	246.0	16.0	221.0	221.0	0.004	0.200	2.000	0.310	0.280	0.004	2.000	0.500	7.10	0.06	1.00	0.11	6.50	ST1IEEE	1	GOVCLAS	1
EGBINST6	EGBINST6	NI	246.0	16.0	221.0	221.0	0.004	0.200	2.000	0.310	0.280	0.004	2.000	0.500	7.10	0.06	1.00	0.11	6.50	ST1IEEE	1	GOVCLAS	1
EGBINGT1	EGBINGT1	NI	39.0	10.5	31.0	31.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT2	EGBINGT2	NI	39.0	10.5	31.0	31.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT3	EGBINGT3	NI	39.0	10.5	31.0	31.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT4	EGBINGT4	NI	40.0	10.5	32.0	32.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT5	EGBINGT5	NI	40.0	10.5	32.0	32.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT6	EGBINGT6	NI	40.0	10.5	32.0	32.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT7	EGBINGT7	NI	40.0	10.5	36.0	36.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT8	EGBINGT8	NI	40.0	10.5	36.0	36.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
EGBINGT9	EGBINGT9	NI	40.0	10.5	36.0	36.0	0.004	0.175	2.750	0.275	0.200	0.004	2.200	0.420	9.50	0.06	1.50	0.49	3.10	ST1IEEE	1	TURGAZ+	3
JEBBGH1	JEBBGH1	NI	119.0	16.0	101.0	101.0	0.004	0.230	0.650	0.480	0.240	0.004	0.440	----	5.20	0.05	----	0.10	3.25	AC1IEEE+	1	GOVHYDR	3

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
JEBBGH2	JEBBGH2	NI	119.0	16.0	101.0	101.0	0.004	0.230	0.650	0.480	0.240	0.004	0.440	----	5.20	0.05	----	0.10	3.25	AC1IEEE+	1	GOVHYDR	3
JEBBGH3	JEBBGH3	NI	119.0	16.0	101.0	101.0	0.004	0.230	0.650	0.480	0.240	0.004	0.440	----	5.20	0.05	----	0.10	3.25	AC1IEEE+	1	GOVHYDR	3
JEBBGH4	JEBBGH4	NI	119.0	16.0	101.0	101.0	0.004	0.230	0.650	0.480	0.240	0.004	0.440	----	5.20	0.05	----	0.10	3.25	AC1IEEE+	1	GOVHYDR	3
JEBBGH5	JEBBGH5	NI	119.0	16.0	101.0	101.0	0.004	0.230	0.650	0.480	0.240	0.004	0.440	----	5.20	0.05	----	0.10	3.25	AC1IEEE+	1	GOVHYDR	3
JEBBGH6	JEBBGH6	NI	119.0	16.0	101.0	101.0	0.004	0.230	0.650	0.480	0.240	0.004	0.440	----	5.20	0.05	----	0.10	3.25	AC1IEEE+	1	GOVHYDR	3
KAING05	KAING05	NI	126.0	16.0	120.0	120.0	0.004	0.150	0.850	0.300	0.240	0.004	0.550	----	5.60	0.02	----	0.08	3.25	AC1IEEE+	1	GOVHYDR	1
KAING06	KAING06	NI	126.0	16.0	120.0	120.0	0.004	0.150	0.850	0.300	0.240	0.004	0.550	----	5.60	0.02	----	0.08	3.25	AC1IEEE+	1	GOVHYDR	1
KAING07	KAING07	NI	85.0	16.0	81.0	81.0	0.004	0.100	0.760	0.248	0.200	0.004	0.430	----	6.06	0.04	----	0.13	3.23	AC1IEEE+	1	GOVHYDR	2
KAING08	KAING08	NI	85.0	16.0	81.0	81.0	0.004	0.100	0.760	0.248	0.200	0.004	0.430	----	6.06	0.04	----	0.13	3.23	AC1IEEE+	1	GOVHYDR	2
KAING09	KAING09	NI	85.0	16.0	81.0	81.0	0.004	0.100	0.760	0.248	0.200	0.004	0.430	----	6.06	0.04	----	0.13	3.23	AC1IEEE+	1	GOVHYDR	2
KAING10	KAING10	NI	85.0	16.0	81.0	81.0	0.004	0.100	0.760	0.248	0.200	0.004	0.430	----	6.06	0.04	----	0.13	3.23	AC1IEEE+	1	GOVHYDR	2
KAING11	KAING11	NI	115.0	16.0	109.0	109.0	0.004	0.130	0.780	0.260	0.220	0.004	0.440	----	6.50	0.02	----	0.07	3.45	AC1IEEE+	1	GOVHYDR	2
KAING12	KAING12	NI	115.0	16.0	109.0	109.0	0.004	0.130	0.780	0.260	0.220	0.004	0.440	----	6.50	0.02	----	0.07	3.45	AC1IEEE+	1	GOVHYDR	2
SHIRGH1	SHIRGH1	NI	176.0	15.6	150.0	150.0	0.004	0.150	0.800	0.300	0.200	0.004	0.490	----	5.57	0.02	----	0.08	3.24	AC1IEEE+	1	GOVHYDR	4
SHIRGH2	SHIRGH2	NI	176.0	15.6	150.0	150.0	0.004	0.150	0.800	0.300	0.200	0.004	0.490	----	5.57	0.02	----	0.08	3.24	AC1IEEE+	1	GOVHYDR	4
SHIRGH3	SHIRGH3	NI	176.0	15.6	150.0	150.0	0.004	0.150	0.800	0.300	0.200	0.004	0.490	----	5.57	0.02	----	0.08	3.24	AC1IEEE+	1	GOVHYDR	4
SHIRGH4	SHIRGH4	NI	176.0	15.6	150.0	150.0	0.004	0.150	0.800	0.300	0.200	0.004	0.490	----	5.57	0.02	----	0.08	3.24	AC1IEEE+	1	GOVHYDR	4
KWALCC1	KWALCC1	NI	210.0	15.8	178.0	178.0	0.003	0.170	2.530	0.250	0.190	0.003	2.360	0.400	10.12	0.05	0.93	0.03	3.10	AC1IEEE+	1	GAST	2
KWALCC2	KWALCC2	NI	210.0	15.8	178.0	178.0	0.003	0.170	2.530	0.250	0.190	0.003	2.360	0.400	10.12	0.05	0.93	0.03	3.10	AC1IEEE+	1	GAST	2
KWALCC3	KWALCC3	NI	210.0	15.8	178.0	178.0	0.003	0.170	2.530	0.250	0.190	0.003	2.360	0.400	10.12	0.05	0.93	0.03	3.10	AC1IEEE+	1	PMCONST	1
SAPELST1	SAPELST1	NI	134.0	15.8	121.0	121.0	0.004	0.130	2.400	0.215	0.160	0.004	2.160	----	8.61	0.05	----	0.10	1.18	AC1IEEE+	1	GOVCLAS	1
SAPELST2	SAPELST2	NI	134.0	15.8	121.0	121.0	0.004	0.130	2.400	0.215	0.160	0.004	2.160	----	8.61	0.05	----	0.10	1.18	AC1IEEE+	1	GOVCLAS	1
SAPELST3	SAPELST3	NI	134.0	15.8	121.0	121.0	0.004	0.130	2.400	0.215	0.160	0.004	2.160	----	8.61	0.05	----	0.10	1.18	AC1IEEE+	1	GOVCLAS	1
SAPELST4	SAPELST4	NI	134.0	15.8	121.0	121.0	0.004	0.130	2.400	0.215	0.160	0.004	2.160	----	8.61	0.05	----	0.10	1.18	AC1IEEE+	1	GOVCLAS	1
SAPELST5	SAPELST5	NI	134.0	15.8	121.0	121.0	0.004	0.130	2.400	0.215	0.160	0.004	2.160	----	8.61	0.05	----	0.10	1.18	AC1IEEE+	1	GOVCLAS	1
SAPELST6	SAPELST6	NI	134.0	15.8	121.0	121.0	0.004	0.130	2.400	0.215	0.160	0.004	2.160	----	8.61	0.05	----	0.10	1.18	AC1IEEE+	1	GOVCLAS	1
AFAM6GT1	AFAM6GT1	NI	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
AFAM6GT2	AFAM6GT2	NI	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
AFAM6GT3	AFAM6GT3	NI	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
AFAM6GT4	AFAM6GT4	NI	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
AFAM6GT5	AFAM6GT5	NI	188.0	15.0	150.0	150.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT1	PAPAGT12	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT2	PAPAGT12	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT3	PAPAGT34	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT4	PAPAGT34	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT5	PAPAGT56	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT6	PAPAGT56	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT7	PAPAGT78	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA1GT8	PAPAGT78	NI	48.0	10.5	38.0	38.0	0.004	0.010	2.000	0.220	0.148	0.004	2.000	----	10.00	0.02	----	0.01	4.00	ST1IEEE	1	TURGAZ+	3
PAPA2GT1	PAPA2GT1	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
PAPA2GT2	PAPA2GT2	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
PAPA2GT3	PAPA2GT3	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
PAPA2GT4	PAPA2GT4	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
OMOT1GT1	OMOTGT12	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT2	OMOTGT12	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT3	OMOTGT34	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT4	OMOTGT34	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT5	OMOTGT56	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT6	OMOTGT56	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT7	OMOTGT78	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT1GT8	OMOTGT78	NI	48.0	10.5	38.0	38.0	0.004	0.140	2.380	0.231	0.170	0.004	2.380	0.231	10.20	0.05	1.50	0.05	4.00	AC1IEEE+	1	TURGAZ+	3
OMOT2GT1	OMOT2GT1	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
OMOT2GT2	OMOT2GT2	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
OMOT2GT3	OMOT2GT3	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
OMOT2GT4	OMOT2GT4	NI	158.0	15.0	126.0	126.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	4.00	ST1IEEE	1	TURGAZ+	3
GEREGGT1	GEREGGT1	NI	174.0	15.8	148.0	148.0	0.000	0.106	1.918	0.184	0.121	0.000	1.918	0.330	10.00	0.05	2.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GEREGGT2	GEREGGT2	NI	174.0	15.8	148.0	148.0	0.000	0.106	1.918	0.184	0.121	0.000	1.918	0.330	10.00	0.05	2.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GEREGGT3	GEREGGT3	NI	174.0	15.8	148.0	148.0	0.000	0.106	1.918	0.184	0.121	0.000	1.918	0.330	10.00	0.05	2.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GEREGGT4	GEREGGT4	NI	174.0	15.8	148.0	148.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GEREGGT5	GEREGGT5	NI	174.0	15.8	148.0	148.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GEREGGT6	GEREGGT6	NI	174.0	15.8	148.0	148.0	0.000	0.106	2.170	0.210	0.133	0.000	1.953	0.210	5.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALAOJGT1	ALAOJGT1	NI	141.0	15.0	120.0	120.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALAOJGT2	ALAOJGT2	NI	141.0	15.0	120.0	120.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALAOJGT3	ALAOJGT3	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALAOJGT4	ALAOJGT4	NI	158.0	15.0	126.0	126.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CALABGT1	CALABGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CALABGT2	CALABGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CALABGT3	CALABGT3	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CALABGT4	CALABGT4	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CALABGT5	CALABGT5	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EGBEMGT1	EGBEMGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EGBEMGT2	EGBEMGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EGBEMGT3	EGBEMGT3	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EYAENGT1	EYAENGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EYAENGT2	EYAENGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EYAENGT3	EYAENGT3	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
EYAENGT4	EYAENGT4	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GBARAGT1	GBARAGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
GBARAGT2	GBARAGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IKOTAGT1	IKOTAGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IKOTAGT2	IKOTAGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IKOTAGT3	IKOTAGT3	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
SAPELGT1	SAPELGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
SAPELGT2	SAPELGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
SAPELGT3	SAPELGT3	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
SAPELGT4	SAPELGT4	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3

Machine Name	Node Name	Country Name	SN MVA	VN kV	PN turb MW	PN alt MW	Rs pu	Xs pu	Xd pu	X'd pu	X''d pu	Xq pu	X'q pu	X''q pu	T'do s	T''do s	T'qo s	T''qo s	H MW.s/MVA	AVR	DATA SET	GOVERNOR	DATA SET
OMOKUGT1	OMOKUGT1	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
OMOKUGT2	OMOKUGT2	NI	141.0	15.0	113.0	113.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
OMOKURG1	OMOKURG1	NI	62.0	11.5	50.0	50.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
OMOKURG2	OMOKURG2	NI	62.0	11.5	50.0	50.0	0.004	0.180	2.300	0.300	0.220	0.004	2.200	0.250	8.00	0.02	0.50	0.01	2.00	AC1IEEE+	1	TURGAZ+	3
ALSCOGT1	ALSCOGT1	NI	112.0	15.0	90.0	90.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALSCOGT2	ALSCOGT2	NI	112.0	15.0	90.0	90.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALSCOGT3	ALSCOGT3	NI	112.0	15.0	90.0	90.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALSCOGT4	ALSCOGT4	NI	112.0	15.0	90.0	90.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALSCOGT5	ALSCOGT5	NI	112.0	15.0	90.0	90.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALSCOGT6	ALSCOGT6	NI	112.0	15.0	90.0	90.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IBOMGT01	IBOMGT01	NI	48.0	11.5	38.0	38.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	2.00	AC1IEEE+	1	TURGAZ+	3
IBOMGT02	IBOMGT02	NI	48.0	11.5	38.0	38.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	2.00	AC1IEEE+	1	TURGAZ+	3
IBOMGT03	IBOMGT03	NI	140.0	15.0	112.0	112.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ICSPOWG1	ICSPOWG1	NI	125.0	15.0	100.0	100.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ICSPOWG2	ICSPOWG2	NI	125.0	15.0	100.0	100.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ICSPOWG3	ICSPOWG3	NI	125.0	15.0	100.0	100.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ICSPOWG4	ICSPOWG4	NI	125.0	15.0	100.0	100.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ICSPOWG5	ICSPOWG5	NI	125.0	15.0	100.0	100.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ICSPOWG6	ICSPOWG6	NI	125.0	15.0	100.0	100.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
BONMOBG1	BONMOBG1	NI	162.0	15.0	130.0	130.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
BONMOBG2	BONMOBG2	NI	162.0	15.0	130.0	130.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
BONMOBG3	BONMOBG3	NI	162.0	15.0	130.0	130.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CHEVROG1	CHEVROG1	NI	312.0	16.0	250.0	250.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CHEVROG2	CHEVROG2	NI	312.0	16.0	250.0	250.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
CHEVROG3	CHEVROG3	NI	312.0	16.0	250.0	250.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
TOTALFG1	TOTALFG4	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
TOTALFG2	TOTALFG3	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
TOTALFG3	TOTALFG2	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
TOTALFG4	TOTALFG1	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
WESTCOG1	WESTCOG4	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
WESTCOG2	WESTCOG3	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
WESTCOG3	WESTCOG2	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
WESTCOG4	WESTCOG1	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IBOMP2G1	IBOMP2G1	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IBOMP2G2	IBOMP2G2	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IBOMP2G3	IBOMP2G3	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
IBOMP2G4	IBOMP2G4	NI	156.0	15.0	125.0	125.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
FARMELEG	FARMELEG	NI	188.0	15.0	150.0	150.0	0.000	0.119	1.820	0.231	0.164	0.000	1.660	0.330	8.00	0.05	1.00	0.05	1.37	AC1IEEE+	1	TURGAZ+	3
ALAOCCG1	ALAOCCG1	NI	335.0	17.0	285.0	285.0	0.004	0.180	1.870	0.262	0.230	0.004	1.870	0.450	7.10	0.06	1.00	0.11	3.09	AC1IEEE+	1	CCGOV	1
ALAOCCG2	ALAOCCG2	NI	335.0	17.0	285.0	285.0	0.004	0.180	1.870	0.262	0.230	0.004	1.870	0.450	7.10	0.06	1.00	0.11	3.09	AC1IEEE+	1	CCGOV	1

9.2. Converters

Machine Name	Node Name	SN MVA	VN kV	Filtering s	Resistance	Reactance	Control	Data Set
WIND__1G	CAPEB11G	156	15	0.01	0	0.8	WINDFEQ	1
NIGEREOL	NIAM2_06	36	15	0.01	0	0.8	WINDFEQ	1

9.3. SVC

SVC Name	Connection Node Name	Country Name	Voltage level kV	Minimum reactive power Mvar (reactor behavior)	Maximum reactive power Mvar (capacitor behavior)
KENYASVC	1414KENY	GH	11	-40	40
TAMALSVC	1282ATAM	GH	34.5	-40	40
MONROSVC	MONROV03	LI	225	-65	0
BUMBUSVC	BUMBUN03	SL	225	-32	2
LINSASVC	LINSAN03	GU	225	-15	15

In static studies, SVC are modeled as loads. Dynamically, they behave according to their transfer function in the macroblock INTERSVC.

One of Europe's major engineering consultancies, Tractebel Engineering is part of GDF SUEZ, an industrial group with the financial strength to address the challenges of the future. With approximately 3,900 people in 20 countries, we offer life-cycle engineering solutions for power, nuclear, gas, industry and infrastructure clients. Services include a full range of engineering assignments: Architect Engineer, Owner's Engineer and Consulting Engineer. Our customers are private and public companies, as well as national and international institutions.

TRACTEBEL ENGINEERING S.A.
Avenue Ariane 7
1200 Brussels - BELGIUM
www.tractebel-engineering-gdfsuez.com

Yves BOUFFIOULX
tel. +32 2 773 83 79
fax +32 2 773 88 90
yves.bouffioulx@gdfsuez.com