

Power Supply situation in Africa



Introduction

Infrastructure development for power supply is a key factor for poverty reduction and contributes significantly to achieving Millennium Development Goals. In Sub-Saharan Africa (SSA) the access rate to electricity is in general very low: 3-40% (excluding South Africa).

The absence of an adequate electrification policy and weak commitment of governments to allocate sufficient means for increasing the access to electricity have been major causes. There is now a clear awareness of the problem and aggressive electrification programs have started e.g. Ethiopia, Kenya and Rwanda.

All efforts in increasing the access of electricity to population are useless without adequate related measures to increase the power production that can satisfy the demand.

The average demand growth for electricity in all regions in SSA is 8% per annum.

Electrification Rates in Africa

| | Electrification Rate |
|------------------------------------|----------------------|
| North Africa <small>(1)</small> | 27 to 99% |
| West Africa | 4 to 40% |
| Central Africa | 3 to 35% |
| East Africa | 5 to 25% |
| Southern Africa | 7 to 70% |

1. Including Mauritania

Source: UPDEA, 2006

Following the UPDEA (Union of Producer, Transporters and Distributors of Electricity in Africa) data of 2006:

- The total **installed capacity** in Africa was about 106.3 GW from which SSA accounts 66.8 GW (63%);
- The total **annual electricity consumption** for Africa was estimated at about 488,315 GWh from which SSA accounts 325,950 GWh (66.7%);
- Total consumption of electricity **per habitant per annum** for Africa 532 kWh/habitant/year;
 - North Africa 952 kWh/habitant/year,
 - West Africa 155 kWh/habitant/year,
 - Central Africa 151 kWh/habitant/year,
 - East Africa 65 kWh/habitant/year,
 - Southern Africa 1767 kWh/habitant/year.
- The total population of the continent was estimated at 917.8 Million, from which SSA accounted 747.3 Million (81%).

Note: Installed Capacity of a Power Plant is measured in MW and 1GW = 1000 MW

Energy consumed in a given period of time is measured in kWh and 1GWh = 10^6 kWh

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Power supply crisis

Eastern Africa

In the Great Lakes Region (Central and East Africa), a number of the countries have faced power shortages, which have caused power supply rationing. In Kenya, Rwanda and Tanzania the deficit has been covered by diesel power plants. Since 2004 25% of Rwanda's energy has been provided by diesel power plants.

The origin of the power supply crisis in those countries is primarily due to the significant decrease of water level in rivers and lakes that are feeding the hydro power plants and to lack of investments in power generation since early 1980s. It is worth mentioning that most of the countries' power supply is provided by hydro

In order to respond to the challenges countries in the region have embarked on aggressive measures in the production as well as in the transmission of energy, interconnecting countries and sharing available capacity. The creation of the Eastern Africa Power Pool in 2005 was one of the major steps undertaken. In this program, Ethiopia with its abundant hydro resources is playing significant role. Ethiopia's planned hydropower projects up to 2015 total additional capacity of about 3,600 MW against the current installed capacity of 810 MW (Ethiopian Electric and Power Corporation, EEPCO, 2007).

Planned major generation projects in the region (>20MW) up to 2015

| | Title of the project | Installed Capacity (MW) | Proposed Commissioning date | Countries involved |
|----|--------------------------------------|-------------------------|-----------------------------|----------------------------|
| 1 | Kabu 16 | 20 | 2012 | Burundi |
| 2 | Rusizi 3 (Share of each Country) | 47.8 (15.9) | 2015 | Burundi, DR Congo & Rwanda |
| 3 | Rusumo Falls (Share of each Country) | 61.5 (15.3) | 2014 | Burundi, Rwanda & Tanzania |
| 4 | Olkaria 3 (Geothermal) | 35 | April 2008 | Kenya |
| 5 | Kiambere Rehabilitation | 20 | April 2008 | Kenya |
| 6 | Kindaruma 3 | 20 | Sept. 2008 | Kenya |
| 7 | Ewaso Ngiro | 220 | - | Kenya |
| 8 | Low Grand Falls | 140 | - | Kenya |
| 10 | Gilgilbe III (1 & 2) | 1800 | 2012 | Ethiopia |
| 11 | Gilgilbe 2 | 420 | 2008 | Ethiopia |
| 12 | Beles | 420 | 2009 | Ethiopia |
| 13 | Takeze | 300 | 2008 | Ethiopia |
| 14 | Halele Warebesa | 422 | 2014 | Ethiopia |
| 15 | Chemoga Yeda I & II | 280 | 2015 | Ethiopia |
| 16 | Bujagari | 200 | 2012 | Uganda |

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Planned Interconnection Projects

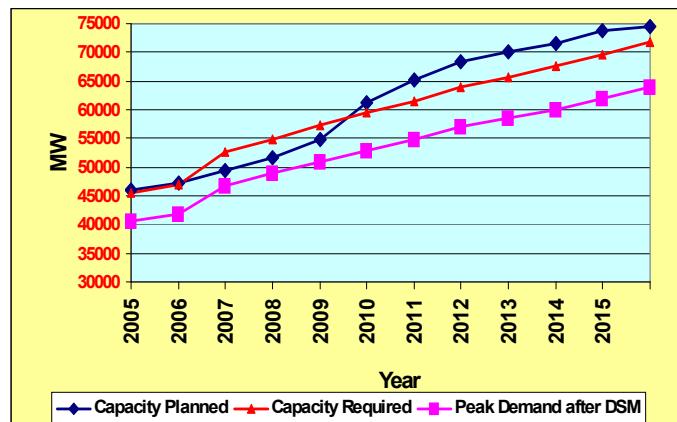
| | Title of the project (Voltage level) | Length of the line (Km) | Voltage Level kV | Countries involved |
|---|---|-------------------------------|---------------------|--------------------------------|
| 1 | Ethiopia-Kenya | 1200 | 400 | Ethiopia & Kenya |
| 2 | Uganda-Kenya | 127 | 220 | Kenya & Uganda |
| 3 | Uganda-Rwanda | 172 | 220 | Uganda & Rwanda |
| 4 | Rwanda – Burundi | 103 | 110 | Rwanda & Burundi |
| 5 | Upgrade of Burundi – Rwanda - DR Congo | 79 | 110 | Burundi – Rwanda - DR Congo |

Southern Africa

The power supply crisis in Southern Africa is deepening. According to the Southern Africa Power Pool (SAPP), the reasons for the current crisis vary:

- Economic growth of more than 5% in most of the SADC countries and with South Africa at almost 6%. Because South Africa is a big economy, 6% translated into 4.6% in electrical demand which was higher than we had previously predicted at 3%.
- No tangible investments in generation capacity in the last twenty years. The last generator in Southern Africa was commissioned in 1982 in the DRC and Zimbabwe. Since then, we have seen no massive investment in generation capacity.
- The 2010 World Cup that would be hosted by South Africa has attracted a lot of companies into building new infrastructure including stadiums, roads, hotels, shopping complex and others. This has added addition stress to the SAPP grid.

Power Supply in all SAPP Members



SAPP Planned Generation Projects 2007-2010

| Country | Generation Capacity MW |
|--------------|---------------------------|
| Angola | 343 |
| Botswana | 400 |
| DRC | 1136 |
| Lesotho | 28 |
| Malawi | 104 |
| Mozambique | 912 |
| Namibia | 800 |
| RSA | 6639 |
| Swaziland | 20 |
| Tanzania | 260 |
| Zambia | 1350 |
| Zimbabwe | 1315 |
| TOTAL | 13307 |

Source: SAPP data, December 2007

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- New mining companies in the DRC and Zambia mining copper opened their mines three years earlier than previously agreed with the power utilities due to high copper prices. Mining activities also increased in South Africa, although the Coega Project which required more than 3,000MW, is now on hold.

To address the situation the SAPP is currently in the process of implementing short-term generation projects that will add an additional 4,000MW to the SAPP grid. Most of these projects are in South Africa and Zambia and should be completed before 2010. So far 1,185MW has been commissioned in the region.

Thereafter, medium to long-term generation projects will be considered. Together these have the potential of adding more than 30,000MW to the grid. The annual average planned new generation capacity is about 3,327 MW.

West Africa¹

The situation in the fifteen Member States of the Economic Community of West African States (ECOWAS) is similar to the rest of the continent. ECOWAS is currently home to about 250 million people; the population is projected to reach 380 million by 2020. At around 130 kWh per habitant per year, electricity consumption per capita in West Africa is among the lowest in the world.

In 2005, the combined consumption of grid supplied energy was about 42,000 GWh and peak power demand reached 6,830 MW. There is considerable auto-generation, probably an additional capacity of 1,000 MW, supplied by small privately owned diesel generators at the peak demand. Taking into account the regional drivers of electricity demand (economic growth, population growth, increased access to electricity and improved satisfaction of suppressed demand), the current projection is for electricity demand in the region to grow at over 7% annually. This will result in a regional peak power demand exceeding 22,000 MW by 2020.



Meanwhile, the estimates for suppressed demand range from 20-30% of what is actually supplied by the grid and auto-generation. **Based on the existing grid based capacity of 10,000 MW and planned retirements, the region needs to increase its generating capacity at least to 27,000 MW by 2023 to meet estimated demand.** Most of the countries in West Africa have small power utilities, only the Ghanaian and Nigerian utilities have installed generating capacity of more than 1,000 MW.

¹ Data from European Commission Capacity Needs Assessment of Power Pools, 2007.
Background paper prepared for ICA Annual Meeting, 13-14 March 2008

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The main energy resources in the region are natural gas (almost all in Nigeria, but also some in Côte d'Ivoire and Mauritania) and hydro. Major hydropower resources exist in Nigeria, Ghana and Guinea and, to a lesser extent, in Sierra Leone, Liberia and Mali. **Other countries in the region rely on (expensive) imported heavy fuel oil or gas oil, or electricity imports from neighbouring countries** (e.g. Togo, Bénin, Burkina Faso, Niger).

Major projects under development include:

- OMVG – 2,000 kilometres of 225 kV transmission lines and associated hydropower projects; the 240 MW Kaléta hydro plant will be the first,
- OMVS – hydropower projects at Férou (62 MW) and Gouina, and expansion of the existing 225 kV transmission system in Senegal.

Revised WAPP Master Plan Projects to 2011²

| Project Demand | *Additional Demand | |
|-------------------|-----------------------|--------|
| | MW | MW |
| 2011 | 12,570 | 6,093 |
| 2015 | 16,638 | 10,161 |
| 2020 | 22,467 | 15,990 |

* Projection based on 2003 Demand

Peak Demand Forecast (2003 -2020) in MW

| Country | 2003 (actual) | 2007 | 2011 | 2015 | 2020 |
|---------------|------------------|--------------|---------------|---------------|---------------|
| Benin & Togo | 191 | 275 | 352 | 448 | 607 |
| Burkina Fasso | 105 | 135 | 178 | 223 | 282 |
| Côte d'Ivoire | 606 | 737 | 930 | 1,175 | 1,572 |
| Ghana | 1,303 | 1,616 | 1,945 | 2,354 | 2,971 |
| Niger | 60 | 103 | 131 | 168 | 230 |
| Nigeria | 3,500 | 5,768 | 7,560 | 9,910 | 13,900 |
| Gambia | 48 | 88 | 132 | 156 | 186 |
| Guinée | 147 | 204 | 397 | 949 | 1,098 |
| Guinée-Bissau | 21 | 28 | 41 | 53 | 61 |
| Liberia | 44 | 58 | 105 | 122 | 122 |
| Mali | 98 | 127 | 170 | 223 | 284 |
| Senegal | 319 | 414 | 572 | 785 | 1,057 |
| Sierra-Leone | 35 | 45 | 57 | 72 | 97 |
| | 6,477 | 9,598 | 12,570 | 16,638 | 22,467 |

The long-term scenario is for the WAPP (West Africa Power Pool) to help meet the region's projected electricity requirement by harnessing additional electricity from:

- An expansion of gas-fired power generation through increased access to Nigeria's enormous proven natural gas reserves (4 trillion cubic meters). The West African Gas Pipeline (WAGP) project will fuel thermal (new and existing oil fired) stations in Ghana, Togo and Benin, and is expected to be operational at the end of 2007.
- The substantial but untapped potential hydro resources of Guinea, some 6,000 MW of which is potentially economic to be developed to generate electricity at a relatively low cost.
- The **private sector** to build a gas based power plant that will be able to export as much as 200 MW to Senegal and Mali along the existing OMVS 225 kV transmission line, effectively reversing the present flow of Manantali power coming to Senegal and Mauritania.

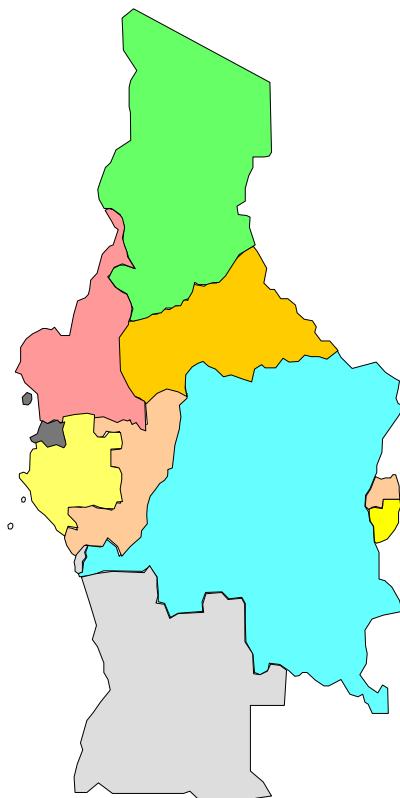
² WAPP, 2007

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- Commercializing the newly developed oil and gas resources off-shore of Mauritania and potentials of Senegal. The oil and gas basins that Mauritania is exploiting extend south to Guinea, both on-shore and off-shore, which promise that soon there could be production of oil and gas in Senegal, Gambia, Guinea Bissau and Guinea. Mauritania is already a major oil exporter, shipping its first load of oil to China in early 2006. It has asked the private sector to build a gas based power plant that will be able to export as much as 200 MW to Senegal and Mali along the existing OMVS 225 kV transmission line, effectively reversing the present flow of Manantali power coming to Senegal and Mauritania.
- The OMVG Project for a new 225 kV transmission loop linking the networks of Guinea, Guinea Bissau, Gambia, OMVS and Senegal (1,711 km, US\$335 million). This project integrates the Sambangalou and Kaleta Hydropower projects as well as the proposed project of Souapiti, Fomi and Fello Sounga in Guinea and Saltinho in Guinea-Bissau. Phase 1 is planned to complete in 2008, together with the Kaleta hydro project. These are hydro projects that have complex financial issues, having been on the drawing board for many years.

Central Africa³



The Economic Community of the Central African States (ECCAS) was created in October 1983 in Libreville (Republic of Gabon) and consists of 11 countries (*Angola, Burundi, Cameroon, Central Africa Republic, Chad, Congo Brazzaville, the Democratic Republic of Congo, Gabon, Equatorial Guinea, Rwanda, Sao Tome and Principe*). The treaty creating the community encourages cooperation in the field of energy and natural resources between Member States. The energy protocol commits Member States to cooperate in the exploitation of hydro, new and renewable energy sources. Following the energy balance of the States, 70–90% of the primary energy consumption is wood. The electrification rate in the ECCAS region is estimated at 13.4% compared to 90% in North Africa. The annual per capita consumption is estimated at 109 kWh.

In April 2003, the Ministers of Energy of the ECCAS Member States signed the Inter-Government Framework Agreement creating the Central Africa Power Pool (CAPP) (excluding Rwanda).

³ Data from European Commission Capacity Needs Assessment of Power Pools, 2007.

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Hydroelectric potential in Central Africa

| Country | Potential (MW) | Energy (GWh) |
|-----------------|----------------|------------------|
| DRC | 100,000 | 774,000 |
| Cameroon | 23,000 | 161,200 |
| Other countries | 21,200 | 147,800 |
| Total | 144,200 | 1,083,000 |

Generation Capacities in Central Africa (2004)

| Countries | Installed capacity (MW) | Distribution in % |
|------------------------------|-------------------------|-------------------|
| Democratic Republic of Congo | 2,502 | 52.2 |
| Cameroon | 902 | 18.8 |
| Angola | 665 | 13.9 |
| Gabon | 414 | 8.6 |
| Others | 311 | 6.5 |

Source: IEA

Governments and companies from the cited countries are considering the options of strengthening power networks with the Inga site in parallel with the rehabilitation of existing power plants for recovering their full capacity. However, the utilization of the Inga Sites hydropower potential relies mainly on building new power plants and interconnection lines designated as 'power highways' originating from the Inga sites for supplying the various African sub-regions, in particular : (i) the DRC-Congo-RCA-Sudan-Egypt interconnection ; (ii) the DRC – Congo – Gabon –Cameroon - Nigeria interconnection; (iii) DRC-Angola-Namibia -RSA.

Major projects under development in CAPP Region include:

- 1. Study on the development of the Inga sites hydropower development and the associated interconnections.**

The specific objective of the study is to examine the feasibility of the development of the Inga sites hydro-electricity potentials in view of supplying with power the various African Sub-Regions.

The study will be financed by ADB and the process of launching the study is going to be initiated in the second semester of 2008.

The DRC has extensive energy resources, including a potential hydropower capacity of approximately 100,000 MW. The Inga Dam alone, on the Congo River, has a potential capacity of 40,000 - 45,000 MW, which could supply all of Southern Africa's electricity needs. Actual production at the Inga Site is currently estimated at no more than 650-750 MW because two-thirds of the turbines are not functioning. The DRC exports hydropower to its neighbours respectively Zambia, Zimbabwe and to South Africa through the SAPP grid via the interconnections between operating members.

The needs of Southern African countries exceed the present level of exchanges which are constrained by the transit capacity of the grid.

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2. Rehabilitation of Inga-1 and 2 and associated transmission lines plus multinational 330 kV Solwezi-Kolwezi line.

2.1 Inga-1 Refurbishment : 110 MW

The project consists in 2 x 55 MW to be commissioned in phases. The project includes also the associated transmission lines.

2.2 Inga-2 Refurbishment: 800 MW

The project is scheduled in phases of 324 MW, 162 MW and 324 MW in year 2007, 2008 and 2011 respectively. It includes the refurbishment of the HVDC (High Voltage Direct Current) Inga - Kolwezi 500 kV line.

3. Study on the Interconnections of CAPP Member States electricity grid

This is part of the master plan for sub-regional interconnection that aims to increase the access to electricity. The study consists in evaluating from technical, economical, financial and environmental point of views, the best scenarios for interconnecting power grids of ECCAS member states. The study will also prepare the feasibility files of the priority interconnection projects.

North Africa

The northern Africa countries do not face energy crisis. According to COMELEC (Comité Maghrébin de l'Electricité) Report 2006, the total installed capacity in COMELEC member countries was 21,773 MW.

COMELEC members are Mauritania, Morocco, Algeria, Tunisia, Libya and Egypt. The energy balance has been positive in 2005 and 2006 and the COMELEC countries have been able to export part of the available power in that period. Therefore in order to sustain the existing energy balance, the COMELEC countries have planned regional project, e.g. Algeria-Morocco-Spain power system interconnection, Tunisia-Italy interconnection.

In 2006, the energy balance in COMELEC countries was:

- Import: 2,855 GWh;
- Export: 692 GWh
- Balance: 2,163 GWh

Thermal generation counts for 90% of the total, hydropower 9%, and the renewable energy 1%.