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Sub-Saharan Africa Power Sector

and Opportunities for Manufacturing Suppliers

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bcf	Billion cubic feet
COMELEC	Comite Maghrebin De L'Electricite
CSP	Concentrating solar power
Discos	Distribution companies (Nigeria)
EAPP	Eastern Africa Power Pool
EDM	Electricidade de Moçambique
EPC	Engineering, procurement and construction
EWURA	Energy and Water Utilities Regulatory Authority (Tanzania)
GWh	Gigawatt-hour
IPP	Independent Power Producer
HCB	Hidroeléctrica de Cahora Bassa (Mozambique)
HVDC	High-voltage direct current
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electricity Transmission Company
kV	Kilovolts
MW	Megawatt
MOTRACO	Mozambique Transmission Company
MVA	Megavolt Ampere
NERSA	National Energy Regulator of South Africa
NIPP	National Integrated Power Project (Nigeria)
PEAC	Central African Power Pool
PHCN	Power Holding Company of Nigeria
PTFP	Presidential Task Force on Power (Nigeria)
REIPPP	Renewable Energy Independent Power Producer Procurement (South Africa)
SAPP	Southern Africa Power Pool
tcf	Trillion cubic feet
TANESCO	Tanzania Electricity Supply Company
TCN	Transmission Company of Nigeria
US	United States
USc	US cents
USD	US dollar
WAPP	West Africa Power Pool

1. Introduction

Electricity is an essential commodity for which most households are willing to spend a large part of their cash income, if necessary. People need electricity to light their house at night and use electrical appliances for pleasure and convenience. Thanks to an improved political situation and discoveries of natural resources, sub-Saharan Africa has been experiencing a remarkable economic growth. Overall income levels and total wealth of the population - although by no means evenly distributed - has been rising, making electricity a more affordable commodity than before. Despite this, less than one third of the households in the region have access to electricity. The total installed generation capacity of sub-Saharan Africa is far below that of the UK alone, yet the region's population is over 14 times larger than the UK's. It is estimated that the rolling blackouts scheduled by electricity utility companies across the continent cost on average 2.1 per cent of the continent's GDP.[1]

In recent years, governments in sub-Saharan African countries have been making a modest investment in both network generation capacity expansion and rural electrification. However, they have faced problems that have prevented a drastic improvement. First, the overall business environment in most of those countries is not good enough to expect a large flow of private-sector investment in the power sector. Secondly, in a similar vein, the power sector is not structured or sufficiently developed so as to facilitate private investment. For example, the sector is often dominated by vertically-integrated state utilities with no or little competition in the generation or supply sub-sectors, and electricity tariff rates are often insufficient to cover the supply cost. Tariff rates can be high, but this is attributable to inefficient operation of the state utilities. The state utilities lack sufficient institutional capacity as a business entity.

Furthermore, there is an issue of insufficient technical capability of the state utilities, which is evidenced by high transmission and distribution losses. The fact that villages tend to be sparsely distributed over a vast land also prevents an efficient supply of electricity. A tremendous amount of capital investment will be required not only for generation capacity, but also for the development of the transmission network. To meet the requirement, private sector involvement is essential.

To improve the power supply, many sub-Saharan African nations are hoping to harness newly-found natural resources for the generation of electricity. Gas reserves are being discovered in many parts of the region. However, again because of lack of investment in gas transmission systems, gas is still a small fraction of the power generation mix in the region. Most of thermal power plants burn expensive imported petroleum products. Increasingly, attention is being placed on the potential of renewable energy based electricity.

[1] The World Bank, Fact Sheet: The World Bank and Energy in Africa. <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,,contentMDK:21935594~pagePK:146736~piPK:146830~theSitePK:258644,00.html>.

Some people may blame the lack of progress on unrealistic and overambitious master development plans for the power sector. Those plans, however, simply reflect the magnitude of investment required to alleviate the existing and future demand and supply gap. For example, there are hundreds of industrial estates awaiting grid-connection in the region. As the overall business environment gradually improves and the power sector gradually changes, the situation is getting better. However, because of continuously increasing power demand by all the sectors of the economy, there remains much to be done in the sector.

1.1 Opportunities for international manufacturers

For international suppliers, the sub-Saharan Africa power sector presents a wealth of opportunities. The installed capacity growth has been stagnant for 20 years but a number of power station projects are planned for completion over the next decade and electricity demand is forecast to increase rapidly in the region, for example, by 13 per cent annually in Kenya. From the country analyses chapters in this report, it is evident that long-term planning in the region is beginning to take place, which has led to a rise in foreign direct investment. Private sector companies are gaining an increasing foothold in the African markets as legislation is passed which allows private participation in their power sector. Power infrastructure projects are being undertaken at an increased rate as state-owned electricity utilities and private companies simultaneously work on projects to compensate for the shortfall in installed capacity. International suppliers are needed, not only to construct new generation capacity, but also to maintain and refurbish outdated power plants and upgrade transmission system to carry more power.

New generation capacity projects almost always require parallel transmission lines projects, which further increase the available opportunities to supply equipment and services. Transmission lines, transformers and substations are required to efficiently evacuate the generated electricity to the load centres. Some African countries have even begun to create designated entities to fast-track the development of the national grid. Electricity theft is common in Africa and, as a result, to improve collection efficacy, many distribution companies are calling upon international suppliers to provide metering system equipment.

Many international suppliers have entered into Africa by undertaking engineering, procurement and construction (EPC) contracts for international oil companies to facilitate upstream oil and gas operations. For countries such as Nigeria and Mozambique who are trying to capitalise on their natural resources, there is a role for international suppliers in ensuring the building of necessary infrastructure including power plants. Industry, telecommunication and transportation sectors are growing in Africa, which both supports and is supported by the power sector.

The power sector is following the oil and gas industry in so far as local content laws are starting to be enacted. The laws require a certain level of local participation in power infrastructure projects and international suppliers will increasingly be required to invest in the local people and communities in order to be eligible to bid for projects.

1.2 Objectives and structure of report

The institutional landscape and investment climate in each country varies and this report endeavours to give insightful information on the current power sector situation in the selected countries. The analysis will provide international suppliers with the means to begin weighing the potential gains against the potential risks of operating in certain parts of sub-Saharan Africa. Another objective of the report is to describe the activities of international suppliers and identify future areas of opportunity in the power sector within the countries studied.

Following the introduction, this report provides a Regional Overview and country analyses for five countries: South Africa, Nigeria, Kenya, Mozambique and Tanzania. Among the five countries, South Africa, Nigeria and Mozambique are in the top five producers of electricity in sub-Saharan Africa. Nigeria has a well-established oil and gas industry, both Mozambique and Tanzania have made recent major gas discoveries, whilst Kenya has discovered oil and South Africa has shale gas resources. The natural resources possessed by the countries in question provide an impetus for the growth of their power supply.

The Regional Overview focuses upon power pools and major future power infrastructure developments across the whole of sub-Saharan Africa. Each regional analysis chapter discusses the power sector organisations, policies, generation, demand, transmission, distribution, rural electrification, tariff rates and the activities of international suppliers. The conclusion for each country analysis involves a survey of the most problematic aspects of the power sector within the country and future opportunities for manufacturing suppliers are identified.

The conclusion of the report produces a visual display of the perceived opportunities and risks within the countries studied for international suppliers. The conclusion also includes commentary summarising our findings for each country.

2. Regional Overview

2.1 Regional transmission network interconnection

There are five regional power pools across Africa. They are: Comite Maghrebin De L'Electricite (COMELEC), Southern Africa Power Pool (SAPP), Eastern Africa Power Pool (EAPP), Western Africa Power Pool (WAPP) and Central African Power Pool (PEAC). The SAPP was the first international power pool established outside of Europe and North America in 1995.[2] Table 2.1 displays the countries and electrical utilities or Independent Power Producers (IPPs) belonging to each power pool, and Figure 2.1 exhibits a map of the power pool member countries. A country can be a member of more than one power pool, such as Tanzania and Democratic Republic of the Congo.

Table 2.1: Power pool members

Country	Participating utility
Comite Maghrebin De L'Electricite (Algeria, established in 1999)	
Algeria	Sonelgaz
Libya	General Electricity Company of Libya (GECOL)
Mauritania	Société Mauritanienne d'Electricité (SOMELEC)
Morocco	Office National de l'Electricité du Maroc (ONE)
Tunisia	Société Tunisienne de l'Electricité et du Gaz (STEG)
Southern Africa Power Pool (South Africa, established in 1995)	
Angola	Empresa Nacional de Electricidade (ENE)*
Botswana	Botswana Power Corporation
Democratic Republic of the Congo	Société Nationale d'Electricité (SNEL)
Lesotho	Lesotho Electricity Corporation (LEC)
Mozambique	Electricidade de Moçambique (EDM)
Malawi	Electricity Supply Corporation of Malawi (ESCOM)*
Namibia	Nam Power
South Africa	Eskom
Swailand	Swaziland Electricity Company (SEC)
Tanzania	Tanzania Electricity Supply Company (TANESCO)*
Zambia	ZESCO Limited
	Copperbelt Energy Cooperation (CEC)
	Lunsemfwa Hydro Power Company (LHPC)
Zimbabwe	Zimbabwe Electricity Supply Authority (ZESA)
East Africa Power Pool (Ethiopia, established in 2005)	
Burundi	Régie de Production des Eaux et de l'Electricité (REGIDESO)

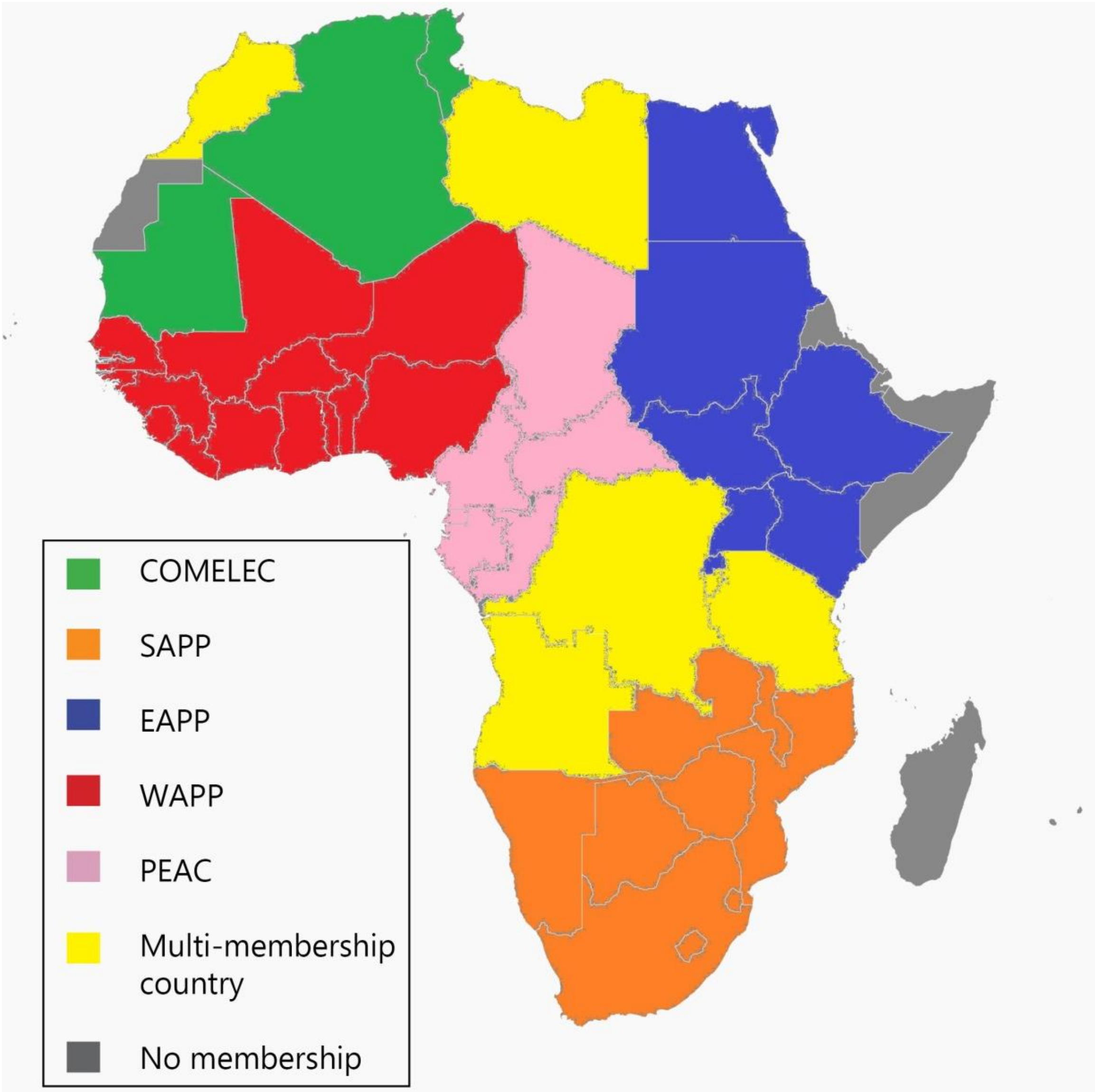
[2] Private Sector, "Promoting regional power trade – The Southern Africa Power Pool," June 2008. <http://siteresources.worldbank.org/EXTFINANCIALSECTOR/Resources/282884-1303327122200/145olear.pdf>.

Democratic Republic of the Congo	Société Nationale d'Electricité (SNEL)
Democratic Republic of the Congo /Rwanda /Burundi	Société International d'Electricité des Pays des Grands Lacs (SINELAC)
Egypt	Egyptian Electricity Holding Company (EEHC)
Ethiopia	Ethiopian Electric Power Corporation (EEPCO)
Kenya	Kenya Electricity Generation Company (KenGen)
	Kenya Electricity Transmission Company (KETRACO)
	Kenya Power and Lighting Company (KPLC)
Libya	General Electricity Company of Libya (GECOL)
Rwanda	Electricity Water and Sanitation Agency (EWSA)
Sudan	National Electricity Corporation (NEC)
Tanzania	Tanzania Electric Supply Company Ltd. (TANESCO)
Uganda	Uganda Electricity Transmission Compnay Limited (UETCL)
West Africa Power Pool (Benin, established in 1999)	
Benin	Société Béninoise d'Energie Electrique (SBEE)
Benin/Togo	Communauté Electrique du Bénin (CEB)
Côte D'Ivoire	Compagnie Ivoirienne d'Electricité (CIE)
	Société des énergies de Côte d'Ivoire (CI-ENERGIES)
Burkina Faso	Société Nationale d'électricité du Burkina Faso (SONABEL)
Ghana	Volta River Authority (VRA)
	GTS Engineering Services
	CENIT Energy
	CENPOWER
	Electric Company of Ghana (ECG)
	Ghana Grid Company Limited (GRIDCO)
	GTG Energy (GTG)
Gambia	National Water and Electricity Company Ltd (NAWEC)
Guinea	Electricité De Guinée (EDG)
Guinea Bissau	Empressa Publica de Electridad e Agua de Guine Bissau (EAGB)
Liberia	Liberia Electricity Corporation (LEC)
Mali	Énergie du Mali (EDM-SA)
	Société de Gestion de l'Energie de Manantali (SOGEM)
Morocco	L'Office National de l'Électricité (ONE)*
Niger	Société Nigérienne d'Electricité (NIGELEC)
Nigeria	Power Holding Company of Nigeria (PHCN)
Senegal	Société National d'Éléctricité du Sénégal (SENELEC)
Sierra Leone	National Power Authority of Sierra Leone (NPA)
Togo	Compagnie Énergie Électrique Togo (CEET)
	CountourGlobal
Central Africa Power Pool (Congo (Republic of the), established in 2003)	
Angola	Empresa Nacional de Electricidade (ENE EP)
	Empresa de Distribuição de Energia Eléctrica (EDEL)
Burundi	Régie de Production et Distribution d'Eau et d'Electricité

	(REGIDESO)
Cameroon	Société Nationale d'Electricité (AES SONEL)
Central African Republic	Energie Centrafricaine (ENERCA)
Chad	Société Nationale d'Electricité Tchad (SNET)
Congo	Société Nationale d'Electricité (SNE)
Democratic Republic of Congo	Société Nationale d'Electricité (SNEL)
Equatorial Guinea	Sociedad de Electricidad de Guinea Ecuatorial (SEGESA)
Gabon	Société d'énergie et d'eau du Gabon (SEEG)
Sao Tome	Empresa de Água e Electricidade (EMAE)

Source: Power Pool websites.

Figure 2.1: African power pools



Base map from www.freevectormaps.com

Each power pool promotes the trade of electricity between countries to increase the level of reliability and stability of electricity supply for the interconnected countries. In the future it is expected that electricity will be traded, not only within, but also between different power pools. Table 2.2 displays the installed generation capacity and percentage of electricity generated through hydropower and thermal power for each of the regional power pools. PEAC and WAPP have the lowest installed capacity per capita and a relatively high percentage of hydropower.

Table 2.2: Regional installed generation capacity

Region	COMELEC	SAPP	EAPP	WAPP	PEAC	Total
Installed capacity (MW)	30,298	54,923	36,436	9,912	6,073	137,651
Population (millions)	88.2	259	385.6	250	132	1,114
Installed capacity per capita (kW per thousand)	343	212	94	40	46	124
Thermal power (MW)	27,958	43,446	26,598	6,465	850	106,533
Thermal power (per cent)	92	79	73	70	14	77
Hydropower (MW)	2,064	9,546	8,744	3,447	5,222	25,639
Hydropower (per cent)	7	17	24	30	86	19

Note: CAPP statistics are from 2009, WAPP and COMELEC statistics are from 2010, EAPP statistics are from 2012 and SAPP statistics are from 2013. The total figure has been taken from US EIA estimates from 2011 as certain countries belong to more than one power pool region.
Source: “Regional Power Status in African Power Pools,” The Infrastructure Consortium for Africa. <http://www.icafrica.org/fileadmin/documents/Knowledge/Energy/ICA_RegionalPowerPools_Report.pdf>; power pool annual reports and population statistics from regional statistic services.

The majority of generation capacity is found in northern and southern Africa. South Africa possesses over 80 per cent of SAPP’s installed capacity and has an installed capacity of approximately 41,000 MW, nearly 30 per cent of Africa’s total installed capacity. Excluding South Africa, the EIA estimated that sub-Saharan Africa’s installed capacity was 36,600 MW in 2011, which is equivalent to the installed capacity of Sweden alone.[3] South Africa, Morocco, Algeria, Libya and Egypt account for 75 per cent of Africa’s generation capacity.[4] The installed capacity mix of those countries is dominated by thermal power.

[3] US Energy Information Administration, International Energy Statistics, 2014. <http://www.eia.gov/ cfapps/ipdbproject/iedindex3.cfm>.
[4] Wat, S., “Hydro in Africa: Navigating a Continent of Untapped Potential,” Hydro World, 22 October 2013. <http://www.hydroworld.com/articles/print/volume-21/issue-6/articles/african-hydropower/hydro-in-africa-navigating-a-continent.html>.

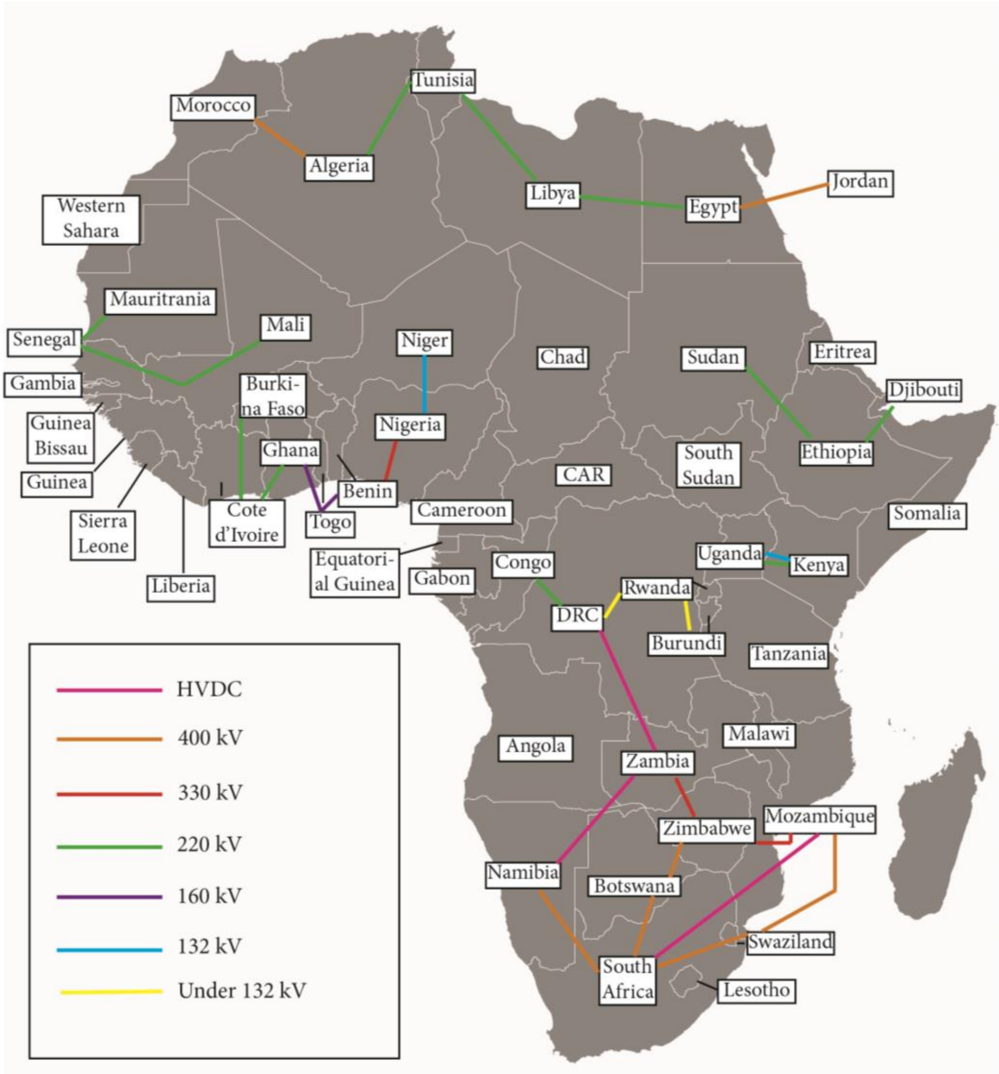
Thermal power accounts for over 75 per cent of the continent's generation capacity. Several sub-Saharan African nations rely upon expensive emergency power from back-up diesel generators to compensate for the shortfall in electricity supply. For example, 50 per cent of Uganda's electricity is supplied by Aggreko's back-up generators.[5]

EAPP, which does include Egypt, has over four times the population of COMELEC yet has only a marginally larger installed capacity. Central Africa has favourable conditions for the development of hydropower with 13 countries in sub-Saharan Africa using hydropower to produce more than 60 per cent of their electricity.[6] The share of installed capacity occupied by hydropower in EAPP and WAPP is expected to grow rapidly as the majority of major power development investments are for hydropower projects, such as Ethiopia's 1,870 MW Gilgel Gibe III.

Existing transmission lines interconnecting African countries are displayed in Figure 2.2. The map shows that South Africa is the figurehead for regional trade, having the largest installed capacity in Africa and a high demand for electricity. The South African electrical utility Eskom imported 12,778 GWh and exported 15,731 GWh in 2013/14.[7]

[5] "The dark continent," The Economist, 16 August 2007. <http://www.economist.com/node/9660077>.
[6] Ibid.
[7] Eskom, "Integrated Report," 2014. <http://integratedreport.eskom.co.za/pdf/full-integrated.pdf>.

Figure 2.2: Existing international transmission lines



Base map from freevectormaps.com.
Note: the length of the lines in the map does not represent the distance of the transmission line.

There are various major planned regional interconnector projects in sub-Saharan Africa, which are listed in Table 2.3. Some of the key advantages of the power pools are that operating costs for utilities are reduced and shortfalls in electricity supply can be compensated for by importing excess electricity generated in a nearby country, hence improving the security and reliability of the electricity supply.

The Inga hydropower development in the Democratic Republic of the Congo, which will be the largest hydropower station in the world, is a notable generation project with the potential to produce approximately 44,000 MW of power (see Section 2.3). The proposed project has had a significant impact upon the planning for future regional interconnection with potential transmission lines leading away in all directions from Inga. Once the Inga power plant becomes operational, it is likely that the Democratic Republic of the Congo's coast will feature as a major transmission hub for Central Africa. The planned interconnector transmission lines are often associated with planned power station projects.

Table 2.3: Planned interconnector projects in sub-Saharan Africa

Project name	Countries involved	Expected completion	Details
West Africa			
Gouina	Mali, Senegal	2017–2019	As part of a 140 MW hydropower plant, which will be built at Gouina in Mali, a 280 km 225 kV line to Tamabacounda in Senegal will be constructed. The project is estimated to cost USD 394 million. Feasibility studies are underway.
OMVS hydropower and interconnection	Guinea, Mali	2017–2021	Four hydropower plants will be built in Guinea and Mali. The electricity generated will be shared between the two countries and is part of the master plan of the Organisation pour la Mise en Valeur de fleuve Senegal (OMVS). Feasibility studies are underway. The project will cost USD 1.4 billion.
Interconnection	Ghana, Mali, Burkina Faso	2015	A 742 km 225 kV transmission line will connect the three countries together. The project includes four substations. The project has been approved and will cost USD 230 million.
OMVG	Senegal, Gambia, Guinea Bissau, Guinea	2015–2017	A 1,677 km 225 kV transmission loop will interconnect four countries and includes 15 substations. The project also includes a 128 MW hydropower plant in Sambangalou in Senegal. The project has been approved and will cost USD 1.009 billion. Additional generation projects are under consideration which will connect up to the transmission loop.
CLSG	Côte D'Ivoire, Liberia, Sierra Leone and Guinea	2015	A 1,060 km double circuit 225 kV transmission line has been approved. The installation of the second circuit is dependent upon whether hydroelectric power is developed in the area. It will cost USD 430 million.
Zungeru and Median Backbone	Nigeria, Benin, Togo, Ghana	2017–2021	A 700 MW hydropower plant will be built in Nigeria. As part of this project, a 713 km 330 kV transmission line will be built across the northerly part of the four countries.

Tiboto and Buchana-San Pedro interconnection	Liberia, Côte D'Ivoire	2019–2021	A 225 MW hydropower plant will be constructed at the border of Liberia and Côte D'Ivoire. A 400 km 225 kV transmission line will allow the electricity to be shared between the countries. Two substations will be built, whilst an existing substation will also be utilised. The project is in the identification stage and will cost USD 678 million. The construction of the transmission line faces difficulties due to the adversely wet climate in this region.
Fomi-Linsan-Nzerkore-Bamako	Guinea, Mali	2017–2019	A 90 MW hydropower plant will be built in Fomi. A 225 kV transmission line will be built in three parts and will cost USD 550 million.
Fomi-Boundiali	Guinea, Côte D'Ivoire	2017–2021	A 380 km 225 kV transmission line will be built between Guinea and Côte D'Ivoire, using substations from other planned transmission projects in the region. Transmission lines, including lines in Burkina Faso, will also be reinforced as part of this project.
Coastal Backbone	Nigeria, Benin, Togo, Ghana, Côte D'Ivoire	2017	A 330 kV line goes through Nigeria, Benin, Togo and Ghana at present. The transmission line will be extended from Ghana to Côte D'Ivoire for USD 57 million.
North-South axis	Ghana	2017–2019	A 640 km 330 kV transmission line will run from the south of Ghana to the north which will increase the amount of electricity transmitted to Burkina Faso. Three 161 kV stations will be upgraded to 330 kV stations. The project will cost USD 240 million and the feasibility studies have been completed.
North core	Nigeria, Benin, Niger, Burkina Faso	2017–2019	Over 800 km of 330 kV transmission lines will be built to connect the four countries. Two existing substations will be extended whilst two new substations will be constructed. Feasibility studies have been completed and the project will cost USD 540 million.
Wind farm	Senegal, Gambia	2017–2021	A 200 MW wind farm is under consideration and the project is in the site identification stage. The project will cost an estimated USD 318 million.

Mambilla and 760 kV network	Nigeria, Benin	2019–2021	A 2,600 MW hydropower plant will be built in Nigeria. A 760 kV transmission line will transport the electricity around Nigeria and to Benin. All existing infrastructure will have to be adapted to serve the new voltage. The cost is estimated to be USD 6 billion.
East Africa			
Tanzania-Kenya interconnection	Tanzania, Kenya	2015	A 260 km 400 kV transmission line is under construction from Tanzania to Kenya.
Rusumo	Rwanda, Burundi, Tanzania	2015	Three separate transmission lines are under construction from Rusumo falls on the Tanzania-Rwanda border. All the lines will be 220 kV.
Ethiopia-Kenya interconnection	Ethiopia, Kenya	2016–2019	A 1,120 km 500 kV transmission line is to be constructed. The project will be carried out in two phases with the completion of the final phase expected by 2019.
Ethiopia-Sudan interconnection	Ethiopia, Sudan	2016	A 570 km four circuit 500 kV transmission line will connect Ethiopia and Sudan. Feasibility studies have been completed.
Egypt-Sudan interconnection	Egypt, Sudan	2016	Feasibility studies have been completed for a 1,665 km 600 kV interconnector.
Rwegura-Kigoma	Burundi, Rwanda	2016	A feasibility study for a 110 kV line was undertaken. However, another study has been undertaken exploring the possibility of a 220 kV transmission line. The EU gave the East African Community USD 20 million for the 220 kV line in 2013.
Southern Africa			
ZIZABONA	Zimbabwe, Zambia, Botswana, Namibia	2016	A 408 km 400 kV transmission line, initially operated at 330 kV, will connect the four countries. The project will include five substations and will cost a total of USD 223 million.
Zambia-Tanzania-Kenya interconnector	Zambia, Tanzania, Kenya	N/A	The project has been under consideration since the late 1980s, with 1,600 km of 330 kV transmission lines planned. TANESCO has secured funding for phase I of the project. The Iringa-Shinyanga 400 kV transmission line within Tanzania and the transmission line in Zambia are under construction with plans to connect them soon and be

			operating by 2016. The project will cost an estimated USD 659 million.
Mozambique-Malawi interconnector	Mozambique, Malawi	2015	A Memorandum of Agreement was signed between the two countries. The feasibility studies are outdated so will have to be repeated once funding has been approved. The project costs an estimated USD 81 million.
Karavia-Luano	Democratic Republic of the Congo, Zambia	2014	Construction work on the 220 kV line has begun in the Democratic Republic of the Congo, whilst the Zambian utility has been pushed to reinitiate the tender process due to an increase in cost by the contractor.
Namibia-Angola interconnector	Namibia, Angola	2016	The terms of reference for the feasibility studies were sent to both nations. Angola is funding the project and has engaged consultants to begin the technical feasibility studies.
Central Africa			
Memve-ele-Bata-Ntoum	Cameroon, Gabon, Equatorial Guinea	N/A	360 km of 400 kV transmission lines are in the planning stage at a forecasted cost of USD 440 million.
Maroua-N'Djamena	Cameroon, Chad	N/A	A USD 3 million 20 month study on the project began in January 2014 for 950 km of transmission lines.
Central African Republic DRC interconnection	Central Africa Republic, Democratic Republic of the Congo	2017	A new 100 km 132 kV transmission line from Bangui to Libenge will be constructed, along with rehabilitation of the associated power plants and infrastructure. The project will cost USD 93 million.
Inga-Cabinda-Pointe Noire	Congo (Republic of the), Angola, Democratic Republic of the Congo	N/A	The project was agreed upon in 2006 and financing for the project is in place. The project will cost USD 98 million. As of 2011, detailed studies were underway and in 2013 a meeting over the difficulty mobilizing funds was held.
Northern Highway	Democratic Republic of the Congo, Congo (Republic of the), Central Africa Republic, Sudan, Egypt	N/A	Feasibility studies for the 5,351 km transmission line to Cairo from Inga were undertaken in 1997. The delays in the approval of the Inga project have meant that no progress on the transmission line has been made.

Western Highway	Democratic Republic of the Congo, Congo (Republic of the), Gabon, Equatorial Guinea, Cameroon, Central Africa, Chad, Nigeria	N/A	An intergovernmental agreement for the project was signed in 2008. The transmission line relies upon the Grand Inga project going ahead. A feasibility study was undertaken for the project connecting PEAC and WAPP. The project will cost an estimated USD 2 billion.
Southern Highway (Western corridor)	Democratic Republic of the Congo, Angola, Ethiopia, Gabon, Namibia, South Africa	N/A	The 3,800 km transmission line would run from the Democratic Republic of the Congo to South Africa. The project would feed the SAPP with electricity from Inga hydropower station. South Africa signed an agreement to receive electricity exports from Inga in return for investing in the construction of the dam. The project will take seven years to complete from the commencement of construction. A feasibility study was completed in 2012. A regional transmission entity would need to be established for the execution of the project. The estimated cost is USD 10.5 billion.
Southern Highway (Eastern corridor)	Democratic Republic of the Congo, Zambia, Zimbabwe, Botswana, South Africa	N/A	The transmission line was proposed as part of the Inga project development plan as an additional transmission line to South Africa which will run through different countries. Feasibility studies were completed in 1997. The Western corridor looks likely to be built first and the Eastern corridor will be constructed if the demand for electricity exists.
Chollet	Congo (Republic of the), Cameroon	N/A	A study is to take place for the construction of a hydropower plant in Chollet at the border of Congo and Cameroon and the associated transmission lines. China has lent Cameroon the funding to realise the project.

Source: WAPP, Power Grid. <http://www.ecowapp.org/?page_id=12>; EAPP, Regional Power System Master Plan and Grid Code Study, May 2011. <http://www.eappool.org/eng/pub/masterplan/Final%20Master%20Plan%20Report%20Vol%20I.pdf>; SAPP, Annual Report 2013. <http://www.sapp.co.zw/docs/22867%20Annual%20Report%20New.pdf>; PEAC, Projets Intégrateurs Prioritaires. <http://www.peac-ac.org/index.php?option=com_content&view=article&id=94&Itemid=66>; Panzu, V., The Grand Inga Power Plant Project, SAPP. <http://www.sapp.co.zw/documents/The%20Grand%20Inga%20Project.pdf>.

2.2 Sub-Saharan Africa power sector investment initiatives

The following section outlines details on four large donor initiatives supporting the growth of the sub-Saharan power sector.

2.2.1 Power Africa

In June 2013, the US President Barack Obama announced that USAID would begin the Power Africa programme, which has the aim of doubling the level of access to electricity in the sub-Saharan region. Power Africa has targeted the creation of 10,000 MW of additional generation capacity and facilitating electrical connections for 20 million households and commercial establishments. Six countries will be focused upon, namely Ethiopia, Ghana, Kenya, Liberia, Nigeria and Tanzania.

In order to achieve the level of funding required, USAID has formed partnerships with large private companies, including international suppliers such as GE, and offers policy support to African governments to create an enabling environment for investment in energy infrastructure projects. The strategy of the scheme is to pool together the resources and capabilities of US government agencies, African governments and the private sector in order to improve the sub-Saharan Africa electricity sector. For the first phase from 2013 to 2018, the US has pledged USD 7 billion of financial support including loans. The large private company partners have pledged to double that figure for financing power sector projects.

In June 2014, "Beyond the Grid" began as a sub-initiative of Power Africa. The scheme focuses wholly upon rural, off-grid electrification. A total of 27 partners will invest over USD 1 billion.[8]

There is a lack of clarity om USAID's stance concerning the 40,000 MW hydropower Inga project in the Democratic Republic of the Congo. The USAID administrator suggested that USAID might participate in the construction of the Inga dam. However, a US law passed in 2014 requires the US to vote against multilateral funding for any large-scale hydropower projects, which will make it harder for institutions, such as the World Bank who pledged their support for Inga in 2009, and the African Development Bank, to finance large hydropower projects.[9]

2.2.2 Sustainable Energy for All (SE4ALL)

SE4ALL is an initiative set up by the UN Secretary General in 2011. The aim of the initiative is threefold: first, to ensure universal access to energy; second, to double the global rate of energy efficiency improvement; and third, to double the share of renewable energy in the global energy mix. Africa is one of the three focus areas of the initiative and 43 African countries are receiving support from SE4ALL. USD 50 million has been contributed by investors in the promotion of these goals.

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[8] USAID, Power Africa, 13 May 2014. <http://www.usaid.gov/powerafrica>.
[9] Morris, S., "Obama Administration: 'Power Africa!' Congress: 'But Forget about Hydro.'" Centre for Global Development, 15 January 2014. <http://www.cgdev.org/blog/obama-administration-power-africa-congress-forget-about-hydro>.

The scheme is supported by the Sustainable Energy Fund for Africa (SEFA) established by the African Development Bank and facilitated by a USD 56 million investment by the Danish Government. SEFA provides finance for small to medium sized sustainable energy projects.[10]

2.2.3 Africa Renewable Energy Fund (AREF)

The fund was established in March 2014 and is allocated solely to sub-Saharan Africa. There is USD 100 million of committed investment for small to medium sized renewable energy IPP projects (5 MW to 50 MW with a financial commitment of USD 10 to 30 million) across sub-Saharan Africa. The fund is based in Nairobi, Kenya, and it is hoped that USD 200 million will be invested in grid-connected renewable energy electricity projects by March 2015.[11]

2.2.4 Climate Investment Fund (CIF)

The fund consists of four programmes: the Clean Technology Fund (CTF), the Forest Investment Program (FIP), the Pilot Program for Climate Resistance (PPCR) and Scaling Up Renewable Energy in Low Income Countries Program (SREP). CTF funds renewable energy, sustainable transport and energy efficiency projects for middle income countries, which include Nigeria and South Africa, and SREP funds renewable energy projects for low income countries, which include Ethiopia, Kenya, Liberia, Mali and Tanzania. About one third of the overall USD 8 billion fund has thus far been allocated to Africa.

2.3 Independent power producers (IPPs)

In Africa, projects are undertaken increasingly by IPPs, which can be completely privately-owned companies or joint ventures between a state-owned company and a private sector company. IPPs tend to sell the generated electricity to the country's electricity utility through power purchase agreements. There are approximately 50 IPPs operating in Africa with an estimated installed capacity of 12,000 MW.[12] However, of these IPP projects in sub-Saharan Africa, only 23 were grid-connected projects over 40 MW.[13] The majority of projects on the continent are smaller-scale IPP developments.

There are great opportunities for IPPs to enter into the sub-Saharan African power markets at present through renewable energy generation developments. As sub-Saharan electricity utility companies tend to prioritise large-scale non-renewable power station projects, there is a high

[10] Sustainable Energy for All. <http://www.se4all.org/>.
[11] "African Renewable Energy Fund (AREF) launced with $100m committed capital and anchor investments from AfDB and SEFA," African Development Bank Group, 13 March 2014. <http://www.afdb.org/en/news-and-events/article/african-renewable-energy-fund-aref-launched-with-100m-committed-capital-and-anchor-investments-from-afdb-and-sefa-12901/>.
[12] Eberhard, A., Meeting Africa's Power Challenges, University of Cape Town. <http://www.gsb.uct.ac.za/files/AUWAfricasPowerChallenges.pdf>.
[13] Wat, S., "Hydro in Africa: Navigating a Continent of Untapped Potential," Hydro World, 22 October 2013. <http://www.hydroworld.com/articles/print/volume-21/issue-6/articles/african-hydropower/hydro-in-africa-navigating-a-continent.html>; ICA, "When the Power Comes," November 2011. <http://www.icafrica.org/fileadmin/documents/Knowledge/Energy/ICA_WHEN%20THE%20POWER%20COMES_report.pdf>.

level of opportunity for private companies to invest in smaller-scale renewable power station projects. Sub-Saharan Africa has an abundance of natural resources for generating power from renewable energy as show in Sections 2.4, 2.5 and 2.7, and the weaker transmission infrastructure is better suited to small-scale projects. Most sub-Saharan African countries are following South Africa by developing financial incentives through feed-in tariff systems to encourage private companies to invest in renewable energy power projects (see Section 3.2.2). Because of the high level of opportunity and the increasing policy support for IPP renewable projects, the total investment in renewable energy including large hydropower on the whole continent is expected to rise from USD 3.6 billion in 2012 to USD 57 billion in 2020.[14] In the case of South Africa, since IPPs have established a foothold in the power sector through renewable energy projects, further opportunities have arisen for IPPs to expand their operations to non-renewable generation projects.

Nigeria's power reform (see Section 4.1) was an extreme case of unbundling and privatisation of different parts of the electricity sector by selling assets to IPPs. For all sub-Saharan African countries, one of the key factors for the development of their power sector is to find the best institutional, legislative and fiscal framework to encourage private investors to enter into their electricity sector and provide the much-needed capital. Through the involvement of IPPs, sub-Saharan African countries hope that the technical efficiency of the electricity infrastructure and network will improve.[15]

2.4 Hydropower

Africa is using only between 5 and 10 per cent of its hydropower potential. A study by the International Journal on Hydropower and Dams in 2010 showed that Africa is the continent with the greatest undeveloped hydropower technical potential with only 8 per cent of the technical potential exploited to date.[16] In early 2014, Africa produced 3 per cent of global hydroelectricity yet it holds 12 per cent of the global hydropower potential.[17] Figure 2.3 shows that Democratic Republic of the Congo has by far the largest hydropower potential followed by Ethiopia. The overall installed hydropower capacity in Africa amounted to 27 GW in late 2012.[18]

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[14] Wat, S., "Hydro in Africa: Navigating a Continent of Untapped Potential," Hydro World, 22 October 2013. <http://www.hydroworld.com/articles/print/volume-21/issue-6/articles/african-hydropower/hydro-in-africa-navigating-a-continent.html>.

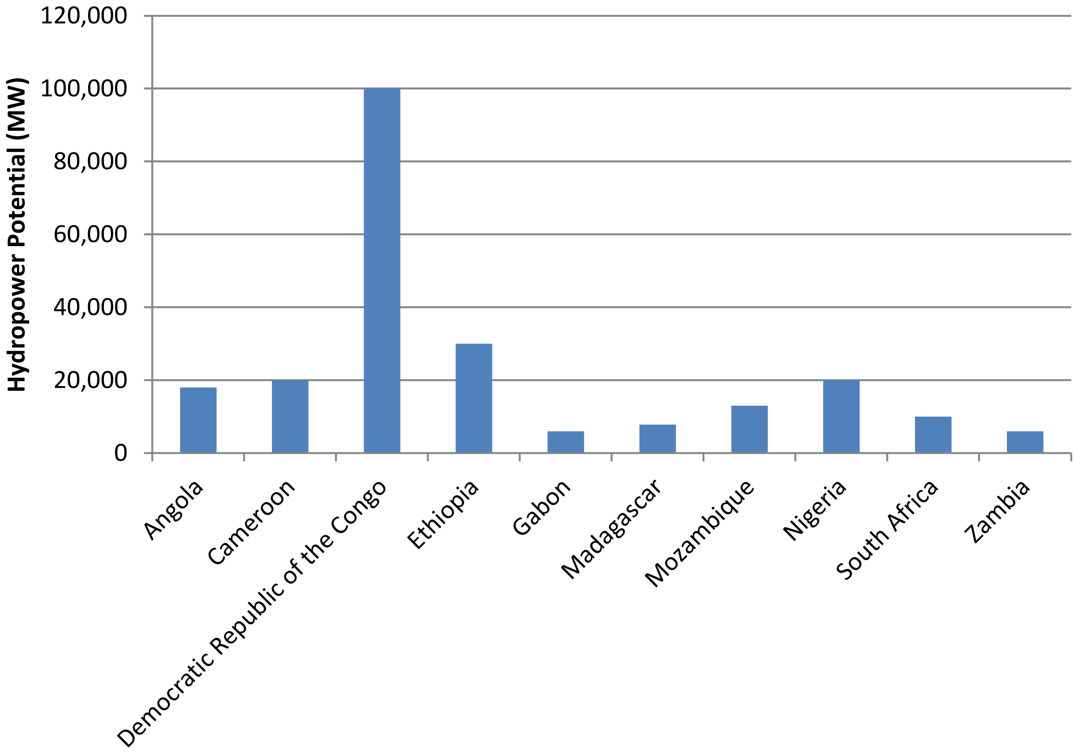
[15] UN Industrial Development Organisation, "The reform of the power sector in Africa," 2007. <http://www.unido.org/fileadmin/media/documents/pdf/EEU_Training_Package/Module4.pdf>.

[16] Wat, S., "Hydro in Africa: Navigating a Continent of Untapped Potential," Hydro World, 22 October 2013. <http://www.hydroworld.com/articles/print/volume-21/issue-6/articles/african-hydropower/hydro-in-africa-navigating-a-continent.html>; IEA, "Technology Roadmap Hydropower," 2012. <http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapHydropower.pdf>.

[17] Wat, S., "Hydro in Africa: Navigating a Continent of Untapped Potential," Hydro World, 22 October 2013. <http://www.hydroworld.com/articles/print/volume-22/issue-1/regional-profile/africa-s-hydropower-future.html>.

[18] International Hydropower Association, 2013 IHA Hydropower Report. <http://www.hydropower.org/report/>.

Figure 2.3: Hydropower potential in sub-Saharan African countries



Note: the figure is not exhaustive, other countries have hydropower potential, such as Uganda, but data is unavailable. Source: Sirix, Hydropower. <http://sirix.eu/hydropower/>.

The International Hydropower Association has identified that the regional interconnection led by the power pools is a "stepping stone" for the development of large-scale hydropower projects in sub-Saharan Africa. Frost & Sullivan estimates that by 2020, hydropower plants will account for 50 per cent of new power stations in West Africa (excluding Nigeria) and 74 per cent in East Africa.[20] Many of the hydropower projects are funded and executed by Chinese banks and companies, such as China Exim Bank and Sinohydro, and the African Development Bank was engaged in five ongoing large-scale hydropower projects at the beginning of 2014.[21]

African leaders decided upon a set of priority energy infrastructure projects to be completed by 2020 at a Programme for Infrastructure Development for Africa (PIDA) meeting in 2012. Nine hydropower plants, which are Great Millennium Renaissance Dam, Mphamda Nkuwa, Inga III, Ruzizi III, Rusumo Falls, Kaleta, Batoka, Sambagalou and Fomi, were identified as priority projects and have an installed capacity of 50 GW among them.[22]

[20] Duma, M., "Hydropower: Africa's Solution to the electricity crisis," Frost and Sullivan, 2 June 2009. <https://www.frost.com/sublib/display-market-insight.do?id=169253081>.
[21] Wat, S., "Hydro in Africa: Navigating a Continent of Untapped Potential," Hydro World, 22 October 2013. <http://www.hydroworld.com/articles/print/volume-22/issue-1/regional-profile/africa-s-hydropower-future.html>.
[22] "Africa's Energy Priorities in the Programme for Infrastructure Development in Africa and the MDB Infrastructure Action Plan," AU Commission and NEPAD Agency, 25 April 2012. <http://www.africapartnershipforum.org/50126848.pdf>.

Democratic Republic of the Congo is estimated to have 100,000 MW of hydropower potential, including the 40,000 MW Grand Inga hydropower plants, which will follow the 4,300 MW Inga III project. The Grand Inga power station would have twice the installed capacity of the world's current largest hydropower generator, the Three Gorges Dam on the Yangtze River in China. Six power stations are planned in phases, each adding over 6,000 MW of installed capacity. The power stations will cost USD 80 billion in total to construct with a further USD 10 billion expected for transmission lines evacuating power from Inga. Given the central location of the Democratic Republic of the Congo on the continent, three long distance transmission lines are under consideration to Nigeria, Egypt and South Africa and a transmission line to South Africa and another to the Democratic Republic of the Congo capital Kinshasha are already under construction.[23] South Africa has agreed to purchase 2,500 MW of power from Inga III in return for investing in the construction of Inga III. However, the future of the Grand Inga project is uncertain. Major existing and planned hydropower stations (100 MW and above) are listed in Table 2.4.

Table 2.4: Major existing and planned hydropower stations in sub-Saharan Africa

Country	Name	Installed capacity (MW)	Year of operation
Botswana	Dikgatlhong	3,600*	2012
Cameroon	Edea	264	1953
	Song Loulou	398	1988
	Memve'ele	200	2016
Congo (Republic of the)	Imboulou	120	2012
Côte D'Ivoire	Kossou	176	1973
	Taabo	210	1979
	Buyo	165	1980
Democratic Republic of the Congo	Inga I	351	1972
	Inga II	1,424	1982
	Inga III	4,300	2020
	Zongo II	257	2015
	Ruzizi III (borders Rwanda)	145	2020
	Grand Inga	40,000	N/A
Equatorial Guinea	Djibloho	120	2012
Ethiopia	Finchaa	134	1973
	Melka Wakena	150	1989
	Gilgel Gibe I	184	2004
	Gilgel Gibe II	420	2009
	Gilgel Gibe III	1,870	2014
	Gilgel Gibe IV	1472	N/A
	Gilgel Gibe V	660	N/A

[23] Jullien, M., "Can DR Congo's Inga dam project power Africa?" BBC, 15 November 2013. <http://www.bbc.co.uk/news/world-africa-24856000>.

	Tekeze	100	2007
	Beles	460	2010
	Halele Worabesa	440	2015
	Chemoga Yeda	278	2015
	Genale Dawa III	254	2015
	Grand Renaissance	6,000	2018
	Akosombo	1,020	1965
	Kpong	160	1982
Gabon	Grand Poubara	400	2013
Ghana	Bui	400	2012
Guinea	Boke	130	2016
	Kaleta	240	2016
	Fomi	102	N/A
Kenya	Kiambere	168	1988
	Turkwel	104	1991
	Gitaru	225	1999
Malawi	Nkhula B	120	1992
	Kapichira	128	2000
Mali	Manantali	200	2002
Mozambique	Cahora Bassa	2,075	1974
	Boroma	200	2017
	Cahora Bassa North Bank	1,245	2018
	Lupata	600	2018
	Mphanda Nkuwa	1,500	2018
Niger	Kandadji	130	2017
Nigeria	Kainji	800	1968
	Jebba	540	1985
	Shiroro	600	1990
	Zamfara	100	2012
	Mabilla	2,600	N/A
Senegal	Sambagalou	128	2017
South Africa	Gariep	360	1971/76
	Vanderkloof	240	1977
	Drakensberg	1,000	1981
	Palmiet	400	1988
	Ingula	1,332	2015
Tanzania	Kidatu	204	1976
	Kihansi	180	2000
Uganda	Nalubaale	180	1954
	Kiira	200	2000
	Bujagali	250	2012
	Isimba	183	2018
	Karuma	600	2018
	Ayago	600	2023
Zambia	Victoria Falls	108	1968
	Kafue Gorge	990	1973

	Kariba North Bank	720	1975
	Kariba North Bank Extension	390	2013
	Itezhi-Tezhi	120	2015
	Lower Kafue Gorge	750	2017
	Batoka	800	2018
Zimbabwe	Kariba South	750	1960
	Batoka	800	2018

Note: * 3,600 MW includes power generated through water supplied to Mmambula energy project.
Source: Sirix, Chinese Hydropower Projects in Africa. <http://media.sirix.eu/2012/03/Chinese-hydro-developments-in-Africa.jpg>; "Hydropower developments in Africa," ESI-Africa, 19 April 2013. <http://www.esi-africa.com/hydropower-developments-in-africa/>; Wikipedia, List of power stations in Africa. <http://en.wikipedia.org/wiki/List_of_power_stations_in_Africa; National electricity utility websites.

2.5 Gas pipelines, infrastructure and production

2.5.1 Gas reserves and production

Proven gas reserves are the quantity of gas resources estimated with a high level of confidence to be recoverable with existing equipment and under current operating conditions. Africa's total proven natural gas reserves were 606 trillion cubic feet (tcf) in 2014.[24] Nigeria has the largest proven reserves in sub-Saharan Africa with 180.7 tcf. Proven natural gas reserves rose from 4.5 tcf to 100 tcf in Mozambique in 2014. Tanzania has also made significant gas discoveries, which are yet to be classified as proven reserves but are estimated to be in the region of 40 tcf.[25] The discovery of gas in these countries has influenced the power sector enormously as energy policy is redirected and investments have been made in gas-fired power stations.

In 2011, sub-Saharan Africa accounted for 2.7 per cent of the total world gas production.[26] According to the African Development Bank, natural gas production in Africa is forecasted to have reached 10 tcf by 2030, more than double the current level of production.[27] The natural gas proven reserves and production for all sub-Saharan African countries with known gas resources is shown in Table 2.5.

[24] US Energy Information Administration, International Energy Statistics, 2014. <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm>.
[25] United Republic of Tanzania, United Republic of Tanzania Ministry of Energy and Minerals, Natural Gas Policy of Tanzania, May 2013. <http://kefalomay.files.wordpress.com/2013/05/draft-the-natural-gas-policy-of-tanzania-2013.pdf>.
[26] US Energy Information Administration, International Energy Statistics, 2014. <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm>.
[27] African Development Bank and the African Union, "Oil and Gas in Africa", 2009. <http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Oil%20and%20Gas%20in%20Africa. pdf>.

Table 2.5: Natural gas reserves and production in sub-Saharan Africa

Region	Country	Gas	
		Production 2012 (billion cubic feet)	**Proven Reserves 2014 (trillion cubic feet)**
West Africa	Benin	0	0.04
	Côte D'Ivoire	57.16	1
	Ghana	0	0.8
	Mauritania	0	1
	Nigeria	1,190.48	180.7
	Senegal	0.72	0
	Sub-total	*1,248.46*	*183.54*
Central Africa	Angola	26.84	9.7
	Cameroon	5.83	4.77
	Congo (Republic of the)	40.97	3.2
	Democratic Republic of the Congo	0.32	0.04
	Equatorial Guinea	242.97	1.3
	Gabon	3.18	1
	Sub-total	*320.11*	*20.01*
Eastern Africa	Ethiopia	0	0.88
	Mozambique	153.80	100
	Somalia	0	0.2
	Tanzania	32.80	0.23
	Uganda	0	0.5
	Sub-total	*32.80*	*1.81*
Southern Africa	Namibia	0	2.2
	Rwanda	0	2
	South Africa	41.91	0.53 (2012)

	Sub-total	*195.71*	*104.73*
Total sub-Saharan Africa		**1,797.08**	**310.09**

Source: US Energy Information Administration, International Energy Statistics, 2014. <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm>.

2.5.2 Domestic consumption

The gas pipeline infrastructure in sub-Saharan Africa is very limited. The development of pipelines is crucial for the future development of gas-fired power production in sub-Saharan Africa. In Nigeria, several gas-fired power stations have been constructed but did not have their gas supply in place at the time of the commissioning of the power stations. In January 2014, the shortage of gas, combined with power station faults and a backlog of maintenance work led to 2,993 MW of power remaining under-utilized.[28] Furthermore, gas pipelines enable countries without gas reserves to import gas and construct gas-fired power stations, instead of relying on expensive imports of oil and diesel. For example, Ghana does not produce gas (although it has proven gas reserves) but imports gas from Nigeria via the West African Gas Pipeline to fuel gas-fired power plants. Table 2.6 details major existing and planned natural gas pipelines.

Table 2.6: Major existing and planned gas pipelines in sub-Saharan Africa

Country(ies)	Status	Description
Nigeria, Benin, Togo, Ghana	Operational since 2011	West African Gas Pipeline (WAGP) transports gas from the Escravos region in Nigeria to Benin, Togo and Ghana. It was the first regional gas transmission system in sub-Saharan Africa. The pipeline was damaged by a ship's anchor in 2012 but repairs were completed by July 2013.
Nigeria, Niger, Algeria	Under review	A Memorandum of Understanding has been signed by Nigeria, Niger and Algeria for the Trans-Saharan Gas Pipeline joint venture. The pipeline would transport gas from Nigeria to Algeria with the aim of also exporting to the EU. A feasibility study was completed in 2006, but progress on the project has been slow. Security issues in all three countries have contributed to uncertainty for potential developers as the pipeline would be an ideal target for terrorist groups operating in the region. The project's future remains uncertain.
Nigeria, Cameroon, Equatorial Guinea	Under review	A third LNG train's construction at Equatorial Guinea's Punta Europa site depends upon whether gas import pipelines can be built from Nigeria and Cameroon. The project would cost USD 3 billion.

[28] Oketola, D., "Nigeria loses 2,994MW to gas shortage, faults," Punch, 28 January 2014. <http://www.punchng.com/business/business-economy/power-nigeria-loses-2994mw-to-gas-shortage-faults/>.

Mozambique, South Africa	Operational	Sasol owns a gas pipeline over 800 km long, running from the Temane/Pande field in Mozambique to Secunda in South Africa. The pipeline was built in an agreement between the two national governments to link Mozambique natural gas production with South Africa's high demand. Both countries have an option to acquire a combined 50 per cent ownership.
Tanzania, Kenya	Feasibility study conducted	The Mtwara pipeline is intended to transport gas from Dar es Salaam in Tanzania to Tanga and Mombasa in Kenya according to the East African Community. It is unknown whether construction will go ahead.
South Sudan, Kenya	Planned	The Lamu (Lapsset corridor) pipeline that Toyota Tsusho intends to construct will connect South Sudan to the Kenyan port of Lamu.
Mozambique	Planned	A Memorandum of Understanding between Gigajoule International Ltd and Empresa Nacional de Hidrocarbonetos, Mozambique's national oil company, was signed in early 2013 to do a joint study and, if deemed feasible, construct a gas pipeline from Cabo Delgado to Maputo. The study should be ready by mid-2014.
Nigeria	Under construction	Shell Petroleum Development has contracted the Otumara-Saghara-Escravos Pipeline in Nigeria. The 41 km pipeline will collect processed associated gas from Western Niger Delta and send it through the Escravos Lagos system for use within the domestic market.
Ghana	Under construction	Ghana National Petroleum Corporation (GNPC) proposed the Natural Gas Transportation and Processing Project in order to transport and process gas from the Jubilee Field. Ghana's pipeline from the Jubilee field to Takoradi has been delayed until mid-2014. This is a subsea pipeline. Ghana Gas is also constructing a 75 km natural gas pipeline in western Ghana.
South Africa	Operational	The gas pipeline was converted from a line previously used for liquids. It runs from Secunda to Durban via Empangeni.
Tanzania	Under construction	China and Tanzania have signed a USD 1 billion loan agreement to build a gas pipeline in East Africa from Dar es Salaam, the capital, to Mtwara in the south of the country.

Source: see footnotes[29]

[29] West Africa Gas Pipeline Authority, WAGPCO, 2013. <http://41.204.59.211:81/>; Bala-Gbogbo, E., "West African Gas Pipeline Co. Resumes Deliveries After Repairs," Bloomberg, 18 July 2013. <http://www.bloomberg.com/news/2013-07-18/west-african-gas-pipeline-co-resumes-deliveries-after-repairs.html>; "Trans-Saharan gas pipeline to reach Europe in 2015," Business Intelligence, 22 February 2009. <http://www.bi-me.com/main.php?id=31951&t=1&c=33&cg=4&mset=>; Oredein, O., "Nigeria to review Trans-Saharan gas pipeline plan," Hydrocarbon Processing, 5 September 2013. <http://www.hydrocarbonprocessing.com/Article/3203147/Nigeria-to-review-Trans-Saharan-gas-pipeline-plan.html?ArticleId=3203147>; NNPC, "Trans-Sahara gas pipeline project viable – GMD," 2013. <http://www.nnpcgroup.com/PublicRelations/NNPCinthenews/tabid/92/articleType/ArticleView/articleId/172/TRA

In 2012, sub-Saharan Africa produced 1,797 bcf of natural gas; yet the region consumed only 700 bcf, (see Figure 2.4) Algeria alone consumes double the amount of gas. Only South Africa and Ghana consume more gas than they produce. Although much of the gas is exported in the form of Liquefied Natural Gas and is as yet underused in sub-Saharan African countries, we will see more and more gas-fired power stations in the coming years. For example, in Mozambique, three gas-fired power plants will be built in Ressano Garcia. Upon completion, it is expected to reduce the country's dependence on electricity imports from South Africa's power market, particularly during peak hour supply, which is prohibitively priced. In addition, Japan is to provide the country with a loan of JPY 17.27 billion to build a new combined-cycle gas-fired power plant in Maputo. The agreement for the scheme was signed during the visit of Japanese Prime Minister Shinzo Abe to Mozambique in January 2014. Table 2.7 lists the major existing and planned gas-fired power stations in sub-Saharan Africa.

Table 2.7: Major existing and planned gas-fired power stations in sub-Saharan Africa

Country	Name of plant	Type	Capacity (MW)	Status
Angola	Futila	Combined Cycle Gas-turbine	70	In operation.
	Luanda	Open Cycle Gas-turbine	148	In operation.
	Luanda (floating stabiliser)	Open Cycle Gas-turbine	96	In operation.
Congo (Republic of the)	Côte Matève	Combined Cycle Gas-turbine	300	In operation.

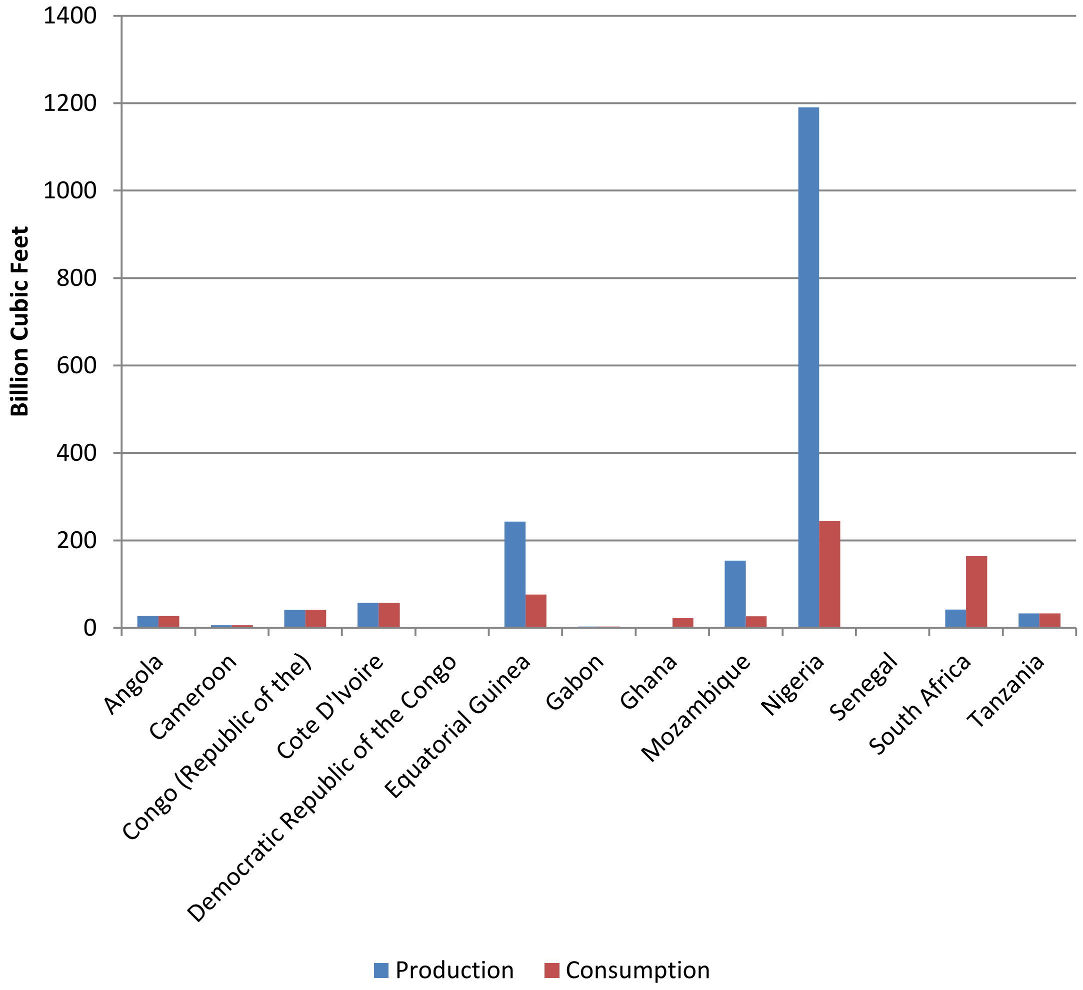
NS-SAHARA-GAS-PIPELINE-PROJECT-viable--GMD.aspx>; Hydrocarbons Technology. Equatorial Guinea LNG Project, Bioko Island, Punta Europa, Equatorial Guinea. <http://www.hydrocarbons-technology.com/projects/bioko-lng/>. "Fenosa, E.ON To Build Second LNG Train in Gulf of Guinea." Downstream Today. 22 February 2008. <http://www.downstreamtoday.com/news/article.aspx?a_id=8873>; Endeavour, "Pande Gas Pipeline, Mozambique," 2013. <http://endeavor-energy.com/case_studies/pande-gas-pipeline-mozambique/>; Madamombe, I., "Pipeline benefits Mozambique, South Africa," October 2007. < http://www.un.org/africarenewal/magazine/october-2007/pipeline-benefits-mozambique-south-africa>; "Feasibility study for natural gas pipeline, Tanzania and Kenya," COWI, 16 February 2014. <http://www.cowi-africa.com/menu/projects/Water-and-environment/Pages/Feasibilitystudyfornaturalgaspipeline,TanzaniaandKenya.aspx>; Nkwame, M., "Tanzania: Mtwara Gas Pipeline to Connect EAC ," AllAfrica, 24 January 2013. <http://allafrica.com/stories/201301240061.html>; Rehn, C., "Toyota to construct South Sudan-Kenya oil pipeline," Energy Global, 3 June 2013. <http://www.energyglobal.com/news/pipelines/articles/Toyota_to_construct_South_Sudan_to_Kenya_oil_pipeline-350.aspx#.UoS3zPmpW30>; "Gas to flow from Northern Mozambique," Pipelines International, June 2013. <http://pipelinesinternational.com/news/gas_to_flow_from_northern_mozambique/081716/>; Tubb, R., "2012 Worldwide Pipeline Construction Report," Pipeline International, January 2012. <http://pipelineandgasjournal.com/2012-worldwide-pipeline-construction-report?page=show>; Priestly-Eaton, H., "Ghana's West African natural gas pipeline delayed to 2014," Energy Global, 20 September 2013. <http://www.energyglobal.com/news/pipelines/articles/Ghanas_natural_gas_pipeline_delayed_to_2014.aspx#.UoS2R_mpW30>; "Gas pipeline construction on schedule – TPDC," IPP Media, 9 February 2014. <http://www.ippmedia.com/frontend/?l=64607>; Transnet, Transnet Pipelines. <http://www.transnet.net/Divisions/PipeLines.aspx>.

Côte D'Ivoire	Centrale CIPREL	Open Cycle Gas-turbine	210	In operation.
	Azito	Combined Cycle Gas-turbine	288 (to be increased to 427)	In operation. (Increased capacity due to be in operation by early 2015).
Equatorial Guinea	Punta Europa	Gas – unknown type	28	In operation.
Ghana	Takoradi 2	Combined Cycle Gas-turbine	220 (to be increased to 340)	In operation. (Increased capacity due to be in operation in late 2014).
Kenya	Dongo Kundu	Combined Cycle Gas-turbine	800	36 companies expressed interests in bidding for the development.
Mozambique	Ressano Garcia	Gas-turbine	175	Operation expected to begin in 2014.
	Maputo	Combined Cycle Gas-turbine	100	Construction due to be complete in 2018.
Nigeria	Geregu II	Open-Cycle Gas turbine	434	In operation.
	Egbin	Gas-fired steam turbine	1320	Partially operational at 994 MW.
	Ughelli	Simple cycle gas turbine	900	Partially operational at 360 MW.
	Sapele I	Gas-fired steam turbine and Simple cycle gas turbine	1020	Partially operational at 200 MW.
South Africa	Sasolburg	Gas engine	140	In operation.
Tanzania	Mtwara	Gas – unknown type	400	Construction expected to begin in 2014.
	Ubungo II	Open-Cycle Gas turbine	100	In operation.

Source: see footnote[30] Note: the list is not exhaustive.

[30] Industcards, “CCGT Plants in Africa - other countries,” 28 September 2013. <http://www.industcards.com/cc-africa.htm>; Global Energy Observatory, “Luanda OCGT Power Plant,” <http://globalenergyobservatory.org/geoid/42580>; Isolux Corsan, “Electrical power plant on floating stabilisers (Luanda) – Angola,” <http://www.isoluxcorsan.com/en/project/electrical-power-plant-on-floating-stabilisers-luanda.html#descripcion>; Global Energy Observatory, “CIPREL OCGT Power Plant.” <http://globalenergyobservatory.org/geoid/42574>; “Globeq’s new power plant in Côte d’Ivoire to commence operations in 2015,” African Review of Business and Technology, 22 November 2013. <http://www.africanreview.com/energy-a-power/power-generation/globeq-s-new-power-plant-in-cote-d-ivoire-to-commence-operations-in-2015>; “Electrical Power in Equatorial Guinea – Overview,” MBendi, 28 March 2014.

Figure 2.4: Production and consumption of natural gas in sub-Saharan African countries



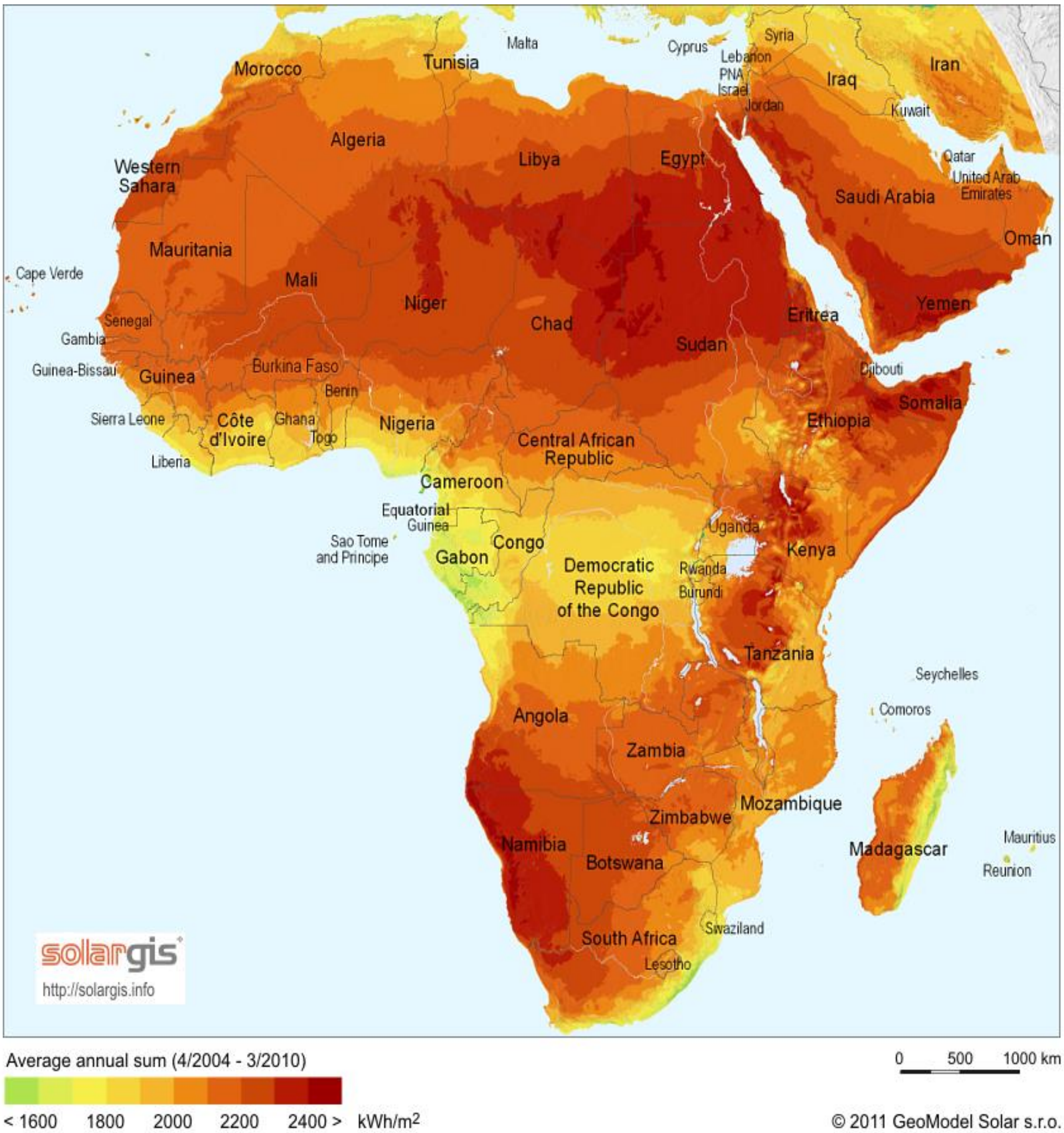
Source: US Energy Information Administration, International Energy Statistics, 2014. <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm>.

<http://www.mbendi.com/indy/powr/af/eq/p0005.htm>; Munda, C., "Ketraco seeks experts for gas and coal power lines,"24 Tanzania, 26 November 2013. <http://www.24tanzania.com/ketraco-seeks-experts-for-gas-and-coal-power-lines/>; Wahito, M., "62 firms interested in Kenya coal, LNG plants," Business & Tech, 25 October 2013. <http://www.capitalfm.co.ke/business/2013/10/62-firms-interested-in-kenya-coal-lng-plants/>; "Finland's Wärtsilä to operate power plant in Mozambique," Club of Mozambique, 01 May 2013. <http://www.clubofmozambique.com/solutions1/sectionnews.php?secao=mining&id=28478&tipo=one>; "Mozambique: Gas-Fired Power Station Inaugurated," AllAfrica, 30 November 2012. <http://allafrica.com/stories/201212010005.html>; "Mozambique: Japan to Finance New Maputo Power Station," AllAfrica, 14 January 2014. <ttp://allafrica.com/stories/201401140941.html>; Amafule, E., "Jonathan inaugurates 434MW Geregu power plant." Punch. 4 October 2013. <http://www.punchng.com/business/business-economy/jonathan-inaugurates-434mw-geregu-power-plant/>; "Geregu Generation Company Limited," NIPP Transaction. <http://www.nipptransactions.com/ndphc-generating-companies/geregu-ii-power-station/>; Egbin Power Plc, <http://www.egbinpower.com/>; Transcorp Ughelli Power, "Transcorp, GE partner to improve power generation in Nigeria," 30 January 2014. < http://www.ughellipower.com/press-release >; Ogunlesi, T., "Nigeria's dysfunctional state power plants set to go private," Financial Times, 7 May 2013. <http://www.ft.com/cms/s/0/1b93eb52-b326-11e2-95b3-00144feabdc0.html?siteedition=uk#axzz2xjET7t63>; "South Africa's first gas-fired power plant fully operational," Sasol, Press Release, 10 July 2013. <http://www.sasol.co.za/media-centre/media-releases/south-africa-s-first-gas-fired-power-plant-fully-operational>.

2.6 Solar power

The solar power potential of Africa is shown in Figure 2.5. The map is of global horizontal irradiation, which is the most important measure for assessing solar energy potential. It should be noted that the Central Africa region with the least potential for solar power is where the highest potential for hydropower on the continent lies (see Section 2.4).

Figure 2.5: Solar power potential in Africa



Map from SolarGIS © 2014 GeoModel Solar

Africa's largest solar power plant is under construction in Ghana and is due to become operational in 2015. The USD 400 million solar PV plant will generate 155 MW of power. The construction of the plant followed the introduction of a feed-in tariff system for electricity generated from renewable energy in 2011.[33]

It is problematic that the initial target market for solar panels is primarily seen to be small rural communities located away from the power grid when they lack the finances to pay for solar PV systems; hence the industry cannot grow rapidly. There are two possible solutions through which the solar power industry could become widespread in sub-Saharan Africa, especially for rural electrification purposes.

First, the urban middle-class market currently has no great demand for solar PV systems, they use electricity supplied by utilities from the grid and back-up diesel generators. Yet the urban middle-class can afford solar PV systems, they can influence market trends as they are the main consumers of electricity, and ultimately can encourage the development of the solar PV industry in sub-Saharan African countries. If the marketing strategy of solar PV in sub-Saharan Africa changes, then the use of solar PV for rural electrification purposes could become more widespread as the solar PV industry will already have found an entry point into the sub-Saharan African market.[34]

However, a different path of growth for the solar PV industry is demonstrated by the example of Bangladesh. In a decade, Bangladeshi households with solar PV systems increased from 7,000 to 1.4 million in low-income rural households. Factors which contributed towards the large increase were: expensive petroleum products; cheap solar PV panels; the telecommunications industry driving up the demand for electricity; slow-paced grid-connections; policy support, such as lifting the import duty on solar panels; a well-managed implementing agency and a well-designed micro-credit financing scheme.[35] Many of these factors apply to sub-Saharan African countries; however, there are challenges. India, China and Japan who supplied solar panels for Bangladesh are not in such close proximity to the region, there are varying levels of policy support for off-grid electrification in sub-Saharan Africa, and financial and power sector companies often have records of corruption or mismanagement of funds. Furthermore, the failure of micro-credit schemes in South Africa casts doubts on a similar development of the solar PV industry across sub-Saharan Africa.[36]

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[33] Vaughan, A., "Africa's largest solar power plant to be built in Ghana," The Guardian, 4 December 2012. <http://www.theguardian.com/environment/2012/dec/04/africa-largest-solar-power-plant-ghana>.

[34] Hankins, M., "Why Africa is Missing the Solar Power Boat," Renewable Energy World, 3 April 2013. <http://www.renewableenergyworld.com/rea/news/article/2013/04/why-africa-is-missing-the-solar-electricity-boat?page=all>.

[35] Islamic Development Bank, Solar power is turning on the lights in Bangladesh, March 2012. <http://www.isdb.org/irj/go/km/docs/documents/IDBDevelopments/Attachments/Projects/4_IDB-SuccessStory4_Bangladesh_Solar_power_is_turning_on_the_lights.pdf>; The World Bank, Electricity from Solar Panels Transforms Lives in Rural Bangladesh, 13 June 2012. <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTENERGY2/0,,contentMDK:23214147~pagePK:210058~piPK:210062~theSitePK:4114200,00.html>.

[36] Bateman, M., "Microcredit has been a disaster for the poorest in South Africa," Guardian Professional, 19 November 2013. <http://www.theguardian.com/global-development-professionals-network/2013/nov/19/microcredit-south-africa-loans-disaster>.

2.7 Biomass

Biomass accounted for 81.2 per cent of energy consumption in sub-Saharan Africa excluding South Africa in 2009. However, biomass is not widely used as a source for electricity generation and is used privately, mostly for cooking and heating.

Oil-based generation is very common across Africa and expensive.[37] Biomass is beginning to be seen as an alternative or mitigation through co-firing to expensive diesel powered generation. Especially in the face of increased oil prices, biomass allows African countries to reduce their dependence upon expensive oil-based generation and their carbon emissions. In 2012, according to IRENA, hydropower, geothermal and biomass generation cost approximately USc 5-7 per kWh in Africa.[38] In comparison, the African Development Bank estimates that emergency electricity produced using fossil fuels costs USc 20-30 per kWh on average.[39] The average annual yield for biomass is estimated to be 2,500 tons per hectare and production is reportedly cost-competitive when a barrel of crude oil costs over USD 100.[40] Furthermore, sub-Saharan Africa is seen as a good location for the development of biomass because both the price of land and population density is low.

Another factor which is pushing companies to invest in biomass in Africa is the European Union Renewable Energy Directive 2009 target for 10 per cent of energy consumption within the transport sector to be sourced from renewable sources by 2020. Europe would be the key export market for African biomass. Controversy was raised concerning the effect of the policy on food security in Africa. The most recent amendment has limited the permitted contribution of food-based biomass to 6 per cent towards the 10 per cent renewable target.[41] With more foreign investment in the production of biomass and a cap on the export potential to Europe, the growth of biomass-based power stations could follow in Africa. Details about important biomass-based power station developments are given in Table 2.8.

Table 2.8: Major existing and planned biomass-based power stations in sub-Saharan Africa

Company (nationality)	Country(ies)	Details

[37] Herro, A., "Biofuels in Africa May Help Achieve Global Goals, Experts Say," Worldwatch Institute. <http://www.worldwatch.org/node/5284>.
[38] IRENA, Renewable Power Generation Costs in 2012, 2013. <http://costing.irena.org/media/2769/Overview_Renewable-Power-Generation-Costs-in-2012.pdf>.
[39] Ncube, M., "The High Cost of Electricity Generation in Africa," 18 Feburary 2013. <http://www.afdb.org/en/blogs/afdb-championing-inclusive-growth-across-africa/post/the-high-cost-of-electricity-generation-in-africa-11496/>.
[40] Knaup, H., "Green Gold Rush: Africa Becoming a Biofuel Battleground," Spiegel. <http://www.spiegel.de/international/world/green-gold-rush-africa-becoming-a-biofuel-battleground-a-576548.html>.
[41] Biofuel Policy Watch, "EU Parliament Adopts Revisions to Proposed Amendment to the Renewable Energy Directive," 19 September 2013. <http://biofuelpolicywatch.wordpress.com/2013/09/19/eu-parliament-adopts-revisions-to-proposed-amendment-to-the-renewable-energy-directive/>.

Tower Power (UK)	Kenya	Construction of the first commercial biomass-based power plant in Kenya began in February 2012. Fed by Mathenge, the power plant will produce 11.5 MW and will cost USD 21 million. Another biomass-based power plant is planned for Kinango which will cost USD 24 million. A power purchase agreement is under negotiation with Kenya Power.
NamPower (Namibia), STEAG Energy Services (Germany) and Transworld Cargo (Namibia)	Namibia	A detailed study on Namibian biomass processing for energy production was completed in 2013. There is a high level of bush encroachment in Namibia and debushing programmes could result in the growth of biomass production. Initial pilot plants of 5 MW and hybrid biomass and solar heat power plants were recommended as priority utilization options for biomass.
SERREC (US)	Senegal	SERREC plans to build a 30 MW biofuel power plant in Saint Louis/Matam, Senegal. The project will require USD 70 million and SERREC is looking for additional sponsors. SERREC’s long-term plan is to construct 15 biomass-based power plants of 10 MW to 35 MW in West Africa.
Various	South Africa	The process for a bidding round for 800 MW of cogeneration power plants which will be fuelled by biomass, industrial waste and combined heat and power sources began in April 2014.
Building Energy (Italy)	South Africa	As part of the third bidding round of the Renewable Energy Independent Power Producer Procurement Program (REIPPP) in South Africa, a 17.5 MW biomass-based power plant which will produce 132 GWh annually was selected. Building Energy, an Italian company, proposed the project. The project involves the combustion of sugar cane tops, and will cost USD 100 million. It is expected to be commissioned in 2016.
Eskom (South Africa)	South Africa	Eskom, the South African utility, is considering burning biomass alongside coal at existing coal-fired power plants. Combusting biofuels has the potential to reduce coal consumption by 10 per cent. South Africa is unable to source all of the biomass itself, so would have to import biomass from other Southern African countries. It is hoped that the Arnot power plant can be a pilot for co-firing, however, co-firing does not feature in South African energy policy as of yet.
Hans Merensky (South Africa) and Finsa (Spain)	South Africa	An integrated plywood production plant and biomass power plant fed by wood residues at Kokstad is under construction. The project will cost USD 154 million. The plant was expected to be operational in 2008. The current status of the plant is unknown.

Sugar companies (South Africa)	South Africa	The sugar industry proposed that USD 2.1 billion should be spent on 15 cane-fueled power plants. Collectively, the 15 plants could produce up to 712 MW. The future of these plants is dependent on a power purchase agreement being settled with Eskom.
Bio2Watt (South Africa)	South Africa	Bosch Projects has contracted Barloworld Power to supply equipment for a 4 MW biogas power plant in Bronkhorspruit. The electricity produced will be used at an automotive plant. Cattle manure and mixed organic waste will feed the power plant.
Clenergen (US)	South Africa, Zambia and Ghana	Crop plantations will be established in Mozambique, Tanzania, Madagascar for Indian and Southern African biomass-based power plants. Clenergen entered into a Strategic Alliance with South African Energy Technologies for the construction of gasification biofuel power plants in South Africa and the Copper Mining Belt in Zambia. In Ghana, Clenergen is undertaking detailed feasibility studies for the cultivation of bamboo to be combusted in biomass power plants in Northern Ghana. They have already leased land in Ghana for the cultivation of biomass.
TPC sugar factory (Tanzania)	Tanzania	The TPC sugar factory produces approximately one third of Tanzania's sugar output. The 17.5 MW power station consists of a high-pressure boiler and steam turbine fuelled by bagasse, a by-product of sugar production. 3 MW is sold to TANESCO, the Tanzania electricity utility.

Source: see footnote.[42]

If waste biomass is not available through the year, a large area of land is required for the production of crops to fuel biomass power stations. Concerns have been raised about the undeveloped legal framework for land ownership in many African countries and the ensuing social problems, such as displacement of indigenous people and competing land uses, in

[42] "Kenya's first commercial biomass power plant," ESI Africa, 17 January 2012. <http://www.esi-africa.com/kenya-s-first-commercial-biomass-power-plant/>; Greacen, C., IFC Investment Climate Infrastructure Workshop on Small Power Producers, 30 April 2013. <http://palangthai.files.wordpress.com/2013/04/30apr2013-tz-sppexperience-greacen.pptx>; Melville, T., "South Africa invests in biomass energy," Energy Digital, 5 January 2014. <http://www.energydigital.com/renewable_energy/south-africa-invests-in-biomass-energy>. <http://www.businessweek.com/news/2013-07-25/south-africa-sugar-industry-proposes-2-dot-1-billion-power-projects>; Creamer, T., "Eskom mulls big biomass co-firing plan in bid to lower coal emissions," Komatiland forests, 14 December 2012. <http://www.komatilandforests.co.za/index.php?option=com_content&view=article&id=109:eskom-mulls-big-biomass-co-firing-plan-in-bid-to-lower-coal-emissions&catid=1:news&Itemid=2>; "60MW biomass power plant for Kokstad, South Africa," IOL news, 26 September 2006. <http://www.iol.co.za/news/south-africa/r1-2bn-hi-tech-plant-for-kokstad-1.295146#.U6voYZRdWig>; Clenergen. <http://www.clenergen.com/renewable-energy>. Clenergen, Republic of Ghana. <http://www.clenergen.com/ghana/projects/republic-of-ghana>; Drottboom, M., "Clenergen to lease land in Ghana for Biomass Power Plant," Bulk Solids Handling, 9 November 2010. <http://www.bulk-solids-handling.com/management/projects_contracts/articles/291470/>; NamPower, "Study on Nambian Biomass Processing for Energy Production," 15 October 2013. <http://www.nampower.com.na/pages/docs/projects/renewable-energy/Namibia%20Biomass%20Processing_Study%202013%20_Final.pdf>; VC4A, 30 MW Biomass Power Plant – Senegal. <https://vc4africa.biz/ventures/30-mw-biomass-power-plant-senegal/>.

biomass projects. In response, several sub-Saharan African countries, such as Ethiopia and Mozambique, have begun to develop biomass policy. Other concerns about the development of biomass in sub-Saharan Africa which have been voiced are food security, the use of water for irrigation, low developmental benefit, financial viability and the environmental impact.

2.8 Nuclear power

The Koeberg nuclear power station in South Africa is the sole commercial nuclear power plant on the continent. It has an installed capacity of 1,800 MW with two 900 MW pressurised water reactors and delivers 5 per cent of South Africa's electricity supply. The power plant was built in the West Cape because it was too inefficient and expensive to transport coal or transmit electricity to the region from the eastern side of the country. In 2013, Westinghouse, a subsidiary of Toshiba, signed a Memorandum of Understanding with Sebata Group to prepare for the construction of an AP1000 reactor for South Africa. In June 2014, President Zuma announced after his reelection that the procurement of nuclear power would go ahead.[43]

In terms of resources, Botswana, Central African Republic, Gabon, Guinea, Malawi, Mali, Mauritania, Namibia, Niger, Nigeria, Tanzania, Zambia and Zimbabwe have uranium deposits; and South Africa, Mozambique and Egypt have thorium deposits.[44] There is strong interest to construct nuclear power stations from South Africa, Kenya and Nigeria; Uganda, Senegal and Niger have also expressed an interest in developing nuclear expertise.[45] Kenya, Ghana and Democratic Republic of the Congo have tested research-orientated reactors.

South Africa was researching the Pebble Bed Modular Reactor (PBMR). It was the first new small modular reactor (SMR, under 300 MW) to go beyond the design stage. SMRs are more suitable than large reactors (in the region of 1 GW) for sub-Saharan African countries' low voltage transmission infrastructure and they can be added in phases. Furthermore, the level of upfront capital investment required is much lower. In 2010, funding for PBMR in South Africa was terminated before PBMR was able to be commercialised, which was a significant setback for the development of nuclear power in Africa. As a result, several SMR models are expected to be operational by the mid-2020s.[46]

A long wait for nuclear power stations in Africa is likely for a further reason besides the wait for the appropriate technology. In order to build a nuclear power stations in a country, a nuclear programme must be established. A nuclear programme involves extensive planning,

[43] Paton, C., "SA needs nuclear power, says Zuma," Business Day Live, 18 June 2014. <http://www.bdlive.co.za/national/2014/06/18/sa-needs-nuclear-power-says-zuma>.

[44] World Nuclear Association, Uranium in Africa, July 2014. <http://www.world-nuclear.org/info/Country-Profiles/Others/Uranium-in-Africa/>; International Thorium Energy Organisation, World Thorium Resources, 23 January 2014. <http://www.itheo.org/articles/world-thorium-resources>.

[45] "Can Africa Go Nuclear? Energy Demand Battle With Safety Concerns Across The Continent," International Business Times, 24 July 2013. <http://www.ibtimes.com/can-africa-go-nuclear-energy-demands-battle-safety-concerns-across-continent-1359279>.

[46] Rodman, L. and Hartman, K., "New nuclear power plant designs: the not so small role of small modular reactors," National Conference of State Legislatures," 27 June 2014. <http://www.ncsl.org/research/energy/nuclear.aspx>.

legislation, safeguards, human resources, waste management and the establishment of a nuclear regulatory body. The International Atomic Energy Agency (IAEA) provides a programme to develop infrastructure for the introduction of new nuclear power in the country.[47] In most cases, the process takes 15 years before commissioning the first plant. In exceptional cases, the timeframe can be shorter; for example, Qatar is hoping to streamline the process to eight years through high levels of investment but the majority of sub-Saharan African nations lack the capital to streamline the process.

[47] International Atomic Energy Agency, "Developing Infrastructure for New Nuclear Power Programmes," September 2011. <http://www.iaea.org/Publications/Booklets/NuclearPower/npinfrastruture0911.pdf>.

3. South Africa

3.1 Electricity sector structure and organisations

3.1.1 Generation, transmission, distribution and supply companies

Wholly state-owned Eskom dominates the electricity sector in South Africa. The company is vertically-integrated, covering the generation, transmission, distribution and supply of electricity in South Africa. Eskom exerts a near monopoly upon generation and transmission - it generated over 95 per cent of the electricity consumed in South Africa in 2013 and controls almost all of the country's transmission assets.[48] It also sells electricity to local municipalities, which redistribute the electricity to businesses and households within their area. Eskom's head office is in Johannesburg. A small office is located overseas in London for quality control of equipment manufactured overseas.

Eskom is the 11th largest generator of power in the world. It sold 216,561 GWh of electricity in 2012/13, supplying electricity to more than 4.8 million residential customers, about 40 per cent of whom are in rural areas.[50] Close to 3 per cent of South Africa's GDP can be attributed directly to Eskom as a result of its operational and capital expenditure.[51]

Power generation by Independent Power Producers (IPPs) in South Africa was non-existent in 2010, but reached 3,671 GWh by March 2014, many of which have entered South Africa through the Renewable Energy Independent Power Producer Procurement (REIPPP) programme.[52] The Government has resisted privatizing Eskom. However, privatization of a section of the power system was proposed in the Independent System Market Operator (ISMO) bill which mandates the formation of a separate entity who determines the allocation and price of electricity to the transmission grid.[53] Arguments have emerged over parliament's apparent abandonment of the bill, but the bill is due to be readdressed in the second half of 2014 after the May 2014 elections.[54] Private sector investment could help to reduce the

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[48] Global Transmission Report, South Africa: Installed Capacity, Generation and Imports, 1 August 2013. <http://www.globaltransmission.info/archive.php?id=16762>.

[50] Eskom, Coal in South Africa, January 2014. <http://www.eskom.co.za/AboutElectricity/FactsFigures/Documents/CO0007CoalSARev12.pdf>; Eskom, "Integrated Report," 2013. <http://integratedreport.eskom.co.za/integrated_report_2013/pdf/full.pdf>.

[51] Eskom, The Eskom Factor 2011. <http://www.eskom.co.za/OurCompany/SustainableDevelopment/Documents/EskomFactor.pdf>.

[52] Eskom, Supplementary and Divisional Report, Transmission, March 2014. <http://integratedreport.eskom.co.za/supplementary/lin-transmission.php>.

[53] "No power, no economy – the future of Eskom, and the privatisation of electricity in SA," BizNews, 25 April 2014. <http://www.biznews.com/interviews/2014/04/lee-swan/>.

[54] Blaine, S., "Parliament will 'revisit energy bill' after elections, says minister," Business Day Live, 11 April 2014. <http://www.bdlive.co.za/business/energy/2014/04/11/parliament-will-revisit-energy-bill-after-elections-says-minister>.

funding burden on the government, the borrowing requirements of Eskom and help to diversify generation technologies, particularly the technology for off-grid projects.[55]

3.1.2 Ministry and regulatory agencies

The Department of Energy (DoE), formerly the Department of Minerals and Energy, was formed in 2009 and is responsible for the energy policy in South Africa. In 2011/12, DoE was estimated to have a budget of RSA 6,090 million (USD 573 million) and the budget was forecast to decrease to RSA 4,300 million (USD 404 million) in 2013/14.[56]

National Energy Regulator of South Africa (NERSA) is the principal regulatory agency for the power sector in South Africa. Established in 2004, its mandate covers electricity and petroleum and gas pipelines. NERSA approves of new tariff schedules proposed by the electricity retail companies.

The National Nuclear Regulator was established in 1999 to protect people, property and the environment against nuclear damage and provide expertise in order to regulate South Africa's nuclear industry.[57]

3.1.3 Other organisations

Industry associations and other organisations relevant to the South Africa power sector are included in Table 3.1.

Table 3.1: Other relevant power sector organisations in South Africa

Organisation name	Description
South Africa National Energy Development Institute (SANEDI)	State-owned successor to South African National Energy Research Institute (SANERI) and National Energy Efficiency agency. Directs, monitors and conducts applied energy research. Develops, deploys and undertakes measures to promote the uptake of green energy and energy efficiency.
Sasol	An international integrated energy and chemical company. Inaugurated South Africa's first gas-fired power plant which uses gas imported from Mozambique. Sasol is indicative of a growing interest on behalf of mining and manufacturing companies to be vertically integrated and to supply their own energy. The long-term plan for such companies is to supply surplus energy generated to the national grid.

[55] Eskom, Guide to Independent Power Producer (IPP) processes. <http://www.eskom.co.za/Whatweredoing/InfoSiteForIPPs/Pages/Guide_To_Independent_Power_Producer_IPP_Processes.aspx>.
[56] Republic of South Africa, National Treasury, "Estimates of National Expenditure 2011," 23 February 2011. <http://www.treasury.gov.za/documents/national%20budget/2011/enebooklets/Vote%2029%20Energy.pdf>.
[57] National Nuclear Regulator, History. <http://www.nnr.co.za/history/>.

Nuclear Energy Corporation of South Africa (NESCA)	State-owned company responsible for undertaking and promoting research and development in the field of nuclear energy and radiation sciences.
Central Energy Fund Group (CEF)	A South African company with operations across sub-Saharan Africa. Provides energy solutions and manages the operation of the South African Government's oil and gas assets.
The Petroleum, Oil and Gas Corporation of South Africa (PetroSA)	The national oil and gas company of South Africa.
Energy Intensive User Group (EIUG)	A non-profit association whose members are energy intensive consumers. The aim of EIUG is to be recognised as leading thinkers on energy-related concerns.
Sustainable Energy Society of Southern Africa (SESSA)	Dedicated to the use of renewable energy and energy efficiency in Southern Africa.
South Africa Wind Energy Association (SAWEA)	An association representing the wind industry in South Africa.
Southern African Biogas Industry Association (SABIA)	An association representing the biogas industry in South Africa.
Southern Africa Solar Thermal and Electricity Association (SASTELA)	An association representing the Concentrating Solar Power (CSP) industry in South Africa.
South Africa Photovoltaic Industry Association (SAVPIA)	An association representing the solar PV industry.

Source: organisations' websites.

3.2 Energy and electricity policy

3.2.1 Key policies

White Paper 1998

Before 1998, South Africa's energy policy had been focused upon self-reliance and the security of the energy supply. The White Paper changed South Africa's focus to ensuring access to electricity for the sect of the population who was without electricity in 1998, largely because of apartheid divisions. The liberalization of the energy market was also proposed. The electricity sector objectives are summarized as follows: [59]

1) increased access to affordable energy services

2) improved governance of the energy sector to achieve greater integration in energy policy development and energy services delivery

3) stimulating economic development by encouraging competition within the energy markets and cost-reflective tariff rates

[59] Republic of South Africa, White Paper on the Energy Policy of the Republic of South Africa, December 1998. <http://www.energy.gov.za/files/esources/petroleum/wp_energy_policy_1998.pdf>.

4) management of energy-related environmental impacts by reducing harmful energy-related emissions from household energy consumption and power plant electricity generation

5) energy supply security through diversification of supply sources and increased regional trade

Integrated Energy Plan (IEP) 2003, 2005

The main points of the 2003 IEP were: energy supply would remain reliant on coal for the next two decades; attempts at diversifying the energy supply would be made; investigations into nuclear options would continue; exploration of domestic oil and gas deposits would take place; and load factors on electricity generation plants would be maximized. The 2005 document considers diversification of energy sources and low carbon alternative planning scenarios.

National Energy Regulation Act 2004, 2011

The Act established the single regulatory body NERSA. The amendment in 2011 restructured the body and established an energy appeal board.

Electricity Regulation Act 2006, 2007, 2011

The Act established a national regulatory framework for the electricity supply industry. NERSA was made the custodian and enforcer of the framework. The 2011 amendment aimed to provide a regulatory framework to promote IPP participation.

National Energy Act 2008

The Act ensures energy resources are available in sustainable quantities at affordable prices to support economic growth and poverty alleviation. Provisions were made for the development of the Integrated Energy Plan and the formation of SANEDI.

Electric Pricing Policy 2008

The Policy provides the guidelines for tariff schedules. The Policy suggested tariff rates promote economic efficiency whilst allowing for subsidies and support mechanisms for low income energy users. Guidelines for tariff schedules in each area of the power sector supply chain are covered. [61]

Independent Systems and Market Operator (ISMO) Bill (draft)

The Bill was drafted in May 2011 but since then seems to have been erased from the parliamentary schedule. It will be reconsidered after the elections on 7th May 2014. Under the bill, an ISMO would be created who is independent of generators and distributors of energy, and would procure electricity produced to sell to customers. However, it was determined that unless the ISMO owned the transmission network, the interests of Eskom and the ISMO would

[61] Republic of South Africa, Department of Minerals and Energy, Electricity Pricing Policy of the South African Electricity Supply Industry, 19 December 2008. <http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Documents/18671_not13981.pdf>.

conflict.[62] The Bill is important for managing the relationship between Eskom and the increased number of IPPs operating in South Africa.

Medium Term Risk Mitigation Plan (MTRM) for Electricity in South Africa 2010 to 2016

The Plan was created because of the anticipated shortfall of electricity supply until 2016. The Integrated Resource Plan is a long-term plan, hence short-term supply shortages were out of its scope (see Section 3.2.2 below). Risks to the electricity supply, mitigations and solutions were identified.

3.2.2 Renewable energy policy

White Paper 2003

The 2003 White Paper set a renewable energy target of 10,000 GWh to South Africa's final energy consumption by 2013, to be produced mainly from biomass, wind, solar, small-scale hydro and bio-fuels. 10,000 GWh was equivalent to approximately 4 per cent of the projected electricity demand by 2013.[63] The Ministry of Energy reviewed their target for generation by renewable sources to be 30 per cent of the country's total generation by 2025.[64]

Energy Efficiency Strategy 2005, revised 2008

The strategy sets a national target for energy efficiency of 12 per cent by 2015.

Integrated Resource Plan 2010-2030

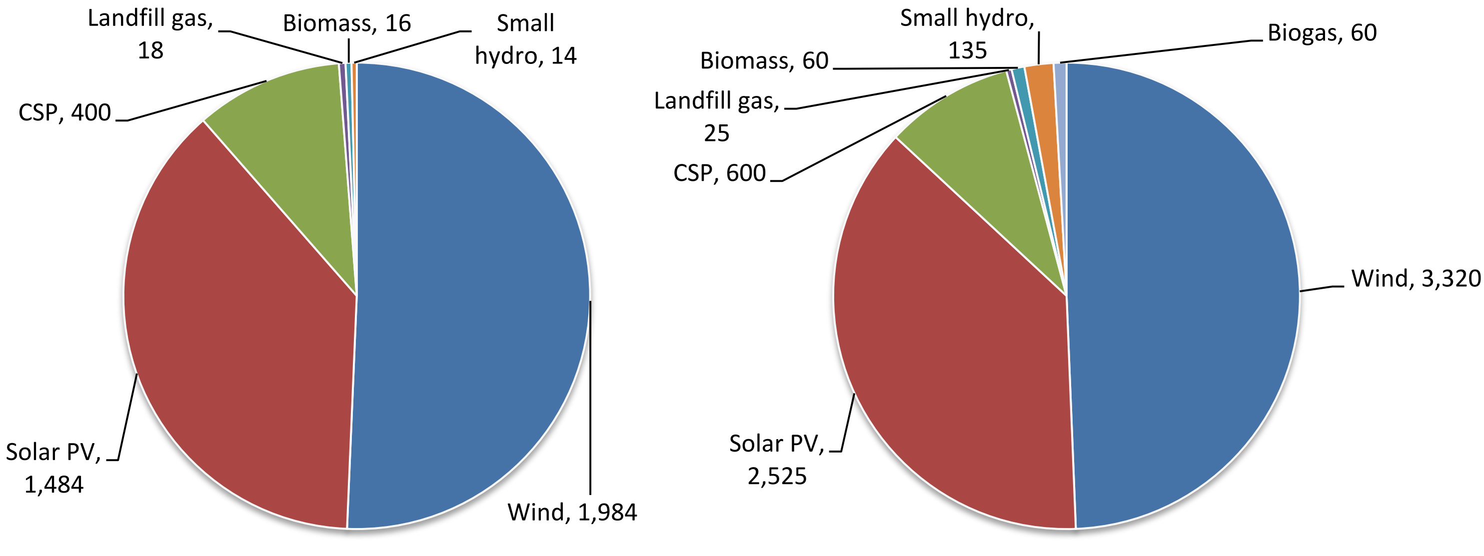
The Electricity Supply Act 2008 requires the Minister of Energy to develop the plan on an annual basis, hence it is a 'living' plan.[65] The plan was introduced to try to spur the development of renewable energy.

The most recent review focused upon the development of shale gas resources making future plans uncertain. Specific targets for renewable energy and energy efficiency are set. The Minister sets targets through the Renewable Energy Independent Power Producer Procurement Programme (REIPPP). The first request for proposals in 2011 was for 3,725 MW of new renewable energy power plants to be commissioned before 2016. In 2012, another request for proposals for an additional 3,200 MW of renewable energy power plants was decided upon with bidding rounds to follow. 64 projects have been agreed upon from 2011 to present in three bidding rounds and two more rounds of bidding at least will take place (the mix of power stations in the first three bidding rounds and planned for all the five bidding

[62] Davie, E., "What has happened to the ISMO bill?" Free Market Foundation, 27 June 2013. <http://www.freemarketfoundation.com/issues/feature-article-what-has-happened-to-the-ismo-bill>.
[63] United Nations Commission on Sustainable Development, "South Africa Country Report," September 2005. <http://www.un.org/esa/agenda21/natlinfo/countr/safrica/energy.pdf>.
[64] Republic of South Africa, Department of Energy, Overview of Renewable Energy Roadmap, 26 September 2013. <http://www.energy.gov.za/files/IEP/jhb_workshop/Overview-of-Renewable-Energy-Roadmap-Public-Workshop-26Sep2013.pdf>.
[65] Republic of South Africa, Department of Energy, Integrated Resource Plan for Electricity (IRP 2010-2030, Update Report 2013, November 2013. <http://www.doe-irp.co.za/content/IRP2010_updatea.pdf>.

rounds are displayed in Figure 3.1). The submission date for the fourth round of bidding is 18th August 2014.

Figure 3.1: Renewable electricity projects in REIPPP's first three bidding rounds and all five bidding rounds (total 3,906 MW and 6,725 MW)



Source: Republic of South Africa, Department of Energy, Renewable Energy IPP Procurement Programme, Bid Window 3 Preferred Bidders' announcement, 4 November 2013. <http://www.energy.gov.za/IPP/List-of-IPP-Preferred-Bidders-Window-three-04Nov2013.pdf>.

Renewable Energy Feed in Tariffs (REFIT) 2009

REFIT promotes and obliges Eskom to purchase power output from qualifying renewable power generators at pre-determined prices (see Table 3.2).

Table 3.2: Feed-in tariff system in South Africa (USc/kWh)

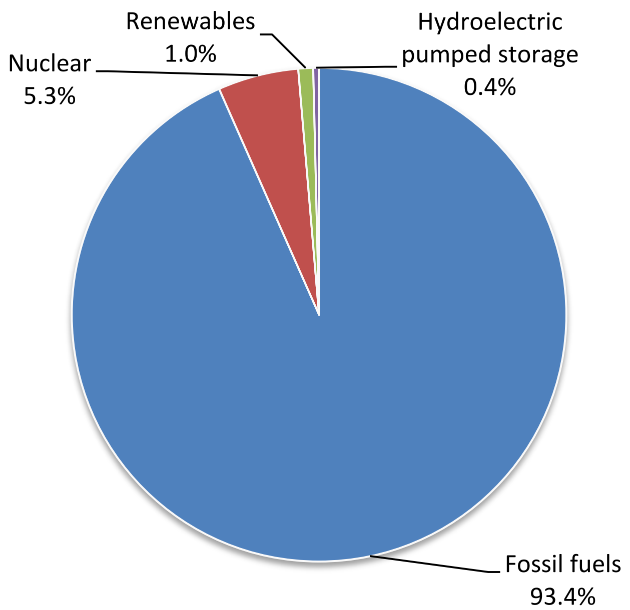
	Technology	Tariff
Phase I	Landfill gas power plant	8.39
	Small hydro power plant (less than 10MW)	8.77
	Wind power plant	11.66
	Concentrating solar power trough plant with 6 hours storage	19.58
Phase II	Concentrating solar power without storage	29.28
	Biomass solid	1.18
	Biogas	11.00
	Large-scale grid connected photovoltaic systems (≥ 1 MW)	36.74
	Concentrating solar power central tower with 6 hours storage	21.54

Source: NERSA, "Review of Renewable Energy Feed-In Tariffs, March 2011.
<http://regulationbodyofknowledge.org/wp-content/uploads/2013/09/NERSA_Review_of_Renewable.pdf>.
Exchange rate, 1 ZAR = 0.0932564 USD, 14 July 2014. <http://www.xe.com/>.

3.3 Power generation

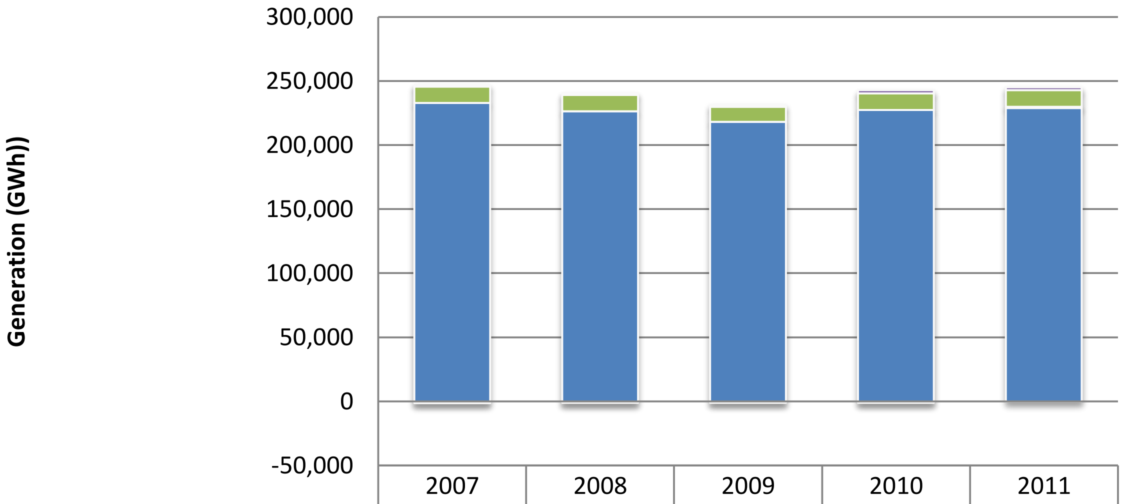
3.3.1 Current generation

Figure 3.2: South Africa electricity generation mix 2011 (total 243,400 GWh)



Source: US Energy Information Administration, International Energy Statistics. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>.

Figure 3.3: South Africa generation mix development 2007–2011



	2007	2008	2009	2010	2011
Renewables	1,244	1,518	1,716	2,427	2370
Nuclear	12,601	12,748	11,574	12,900	12,939
Hydroelectric pumped storage	-1,256	-1,044	-971	-900	926
Fossil fuels	233,054	226,472	218,292	227,508	228,992

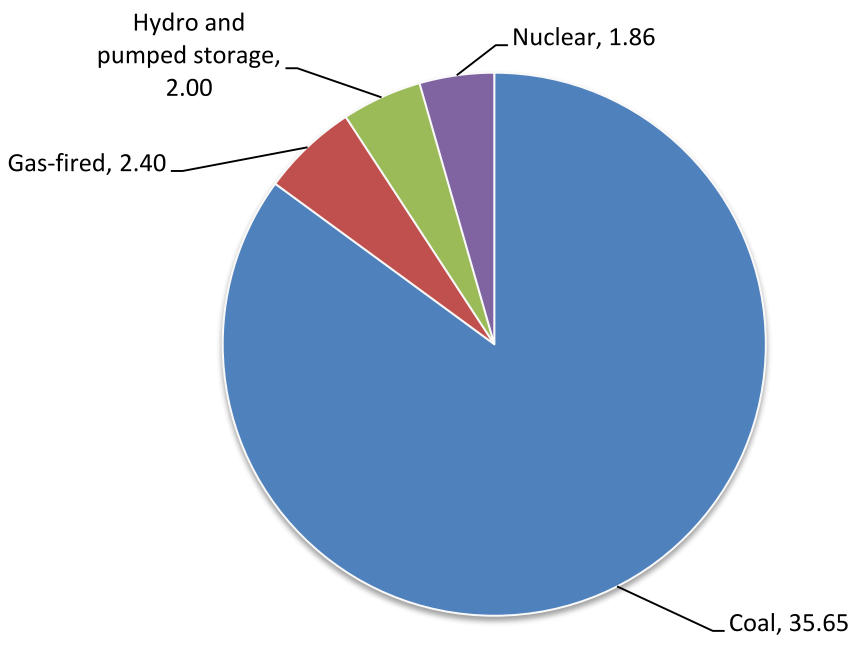
Source: US Energy Information Administration, International Energy Statistics. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>.

The majority of South Africa's power generation is supplied by coal, although several of the coal-fired power plants have been decommissioned since the 1980s. South Africa has one operational nuclear plant, Koeberg. The coal power stations and Koeberg are the base load stations. A small amount of hydropower contributes to the generation mix but this is not expected to increase. Pumped-storage hydropower plants improve grid reliability by allowing electricity produced in low demand periods to be used in high demand periods, although they incur a net generation loss.[66] Gas turbines and hydropower stations with the pumped storage units are used as peak demand stations.

In 2013/2014, Eskom and IPPs generated 234,800 GWh of electricity collectively, an increase of 18,239 GWh compared with 2012/13. An additional 9,245 GWh was imported from nearby African nations.[67]

Eskom's generation segment had 27 power stations in March 2014 with a total installed capacity of 41.99 GW. Figure 3.4 shows Eskom's installed capacity by generation type and Table 3.3 gives further details on South African power stations owned by Eskom and other companies. Kalkbult was the first REIPPP project to be completed and grid-connected. US Energy Information Administration estimated South Africa's overall installed capacity including IPPs to be 45.7 GW in February 2014.

Figure 3.4: Eskom's installed capacity mix 2013 (GW)



Source: Eskom, "Supplementary and Divisional Report," 2013. <http://integratedreport.eskom.co.za/integrated_report_2013/divisional/pdf/full.pdf>.

[66] US Energy Information Administration, Pumped storage provide grid reliability even with net generation loss, 8 July 2013. <http://www.eia.gov/todayinenergy/detail.cfm?id=11991>.
[67] Eskom, "Integrated Report," 2014. <http://integratedreport.eskom.co.za/pdf/full-integrated.pdf>.

Table 3.3: Power stations in South Africa

Name	Power plant type	Owner	Capacity (MW)	Year of operation
Pretoria West*	Coal	Tshwane	180	1952
Kelvin	Coal	Consortium (Aldwych International is the operator)	600	1957
Rooiwal*	Coal	Tshwane	300	1963
Arnot	Coal	Eskom	2,352	1975
Duvha	Coal	Eskom	3,600	1980
Hendrina	Coal	Eskom	2,000	1970
Kendal	Coal	Eskom	4,116	1988
Kriel	Coal	Eskom	3,000	1976
Lethabo	Coal	Eskom	3,708	1985
Majuba	Coal	Eskom	4,110	1996
Matimba	Coal	Eskom	3,990	1986
Matla	Coal	Eskom	3,600	1983
Tutuka	Coal	Eskom	3,654	1985
Camden	Coal	Eskom	1,510	1976 (2010)
Koeberg	Nuclear	Eskom	1,940	1984
Gariep	Hydropower	Eskom	360	1971
Vanderkloof	Hydropower	Eskom	240	1977
Drakensburg	Pumped storage	Eskom	1,000	1981
Palmiet	Pumped storage	Eskom	400	1988
Acacia	Gas-fired	Eskom	171	1976
Port Rex	Gas-fired	Eskom	171	1976
Ankerlig	Gas-fired	Eskom	1,338	2007
Gourikwa	Gas-fired	Eskom	746	2007
Newcastle	Cogeneration	IPSA	18	2008
Sasolburg	Gas-fired	Sasol	140	2012
Kalkbult	Solar PV	Scatec	75	2013
Droogfontein	Solar PV	Globeleq	50	2013
De Aar	Solar PV	Globeleq	50	2013
Jeffreys Bay	Wind	Consortium	138	2014
Hopefield	Wind	Umoya Energy	66	2014
Linde	Solar PV	Scatec	40	2014

Note:* these power plants are not fully operational and are only used when Eskom is load-shedding. Source: Mbanjwa, X., “More power for the city, please Metro Council,” IOL news, 14 December 2007. <http://www.iol.co.za/news/south-africa/more-power-for-the-city-please-metro-council-

1.382652#.U6qO4pRdWig>; Wikipedia, List of Power Stations in South Africa. <http://en.wikipedia.org/wiki/List_of_power_stations_in_South_Africa>; Eskom, Eskom power stations. <http://www.eskom.co.za/Whatweredoing/ElectricityGeneration/PowerStations/Documents/EskomGenerationDivMapREV81.pdf>.

3.3.2 Planned projects and generation targets

Table 3.4 provides a list of major planned generation projects in South Africa with a discussion of the strategy behind the planned generation below the table.

Table 3.4: Planned installed capacity additions in South Africa

Project name	Power plant type	Owner	Capacity (MW)	Expected year of operation
Medupi	Coal	Eskom	4,800	2014
Cookhouse	Wind	Africa Clean Energy Developments	140	2014
Sere	Wind	Eskom	100	2014
Gouda	Wind	Blue Falcon 140	135	2014
Dorper	Wind	Rainmaker Energy	100	2014
Kouga	Wind	Consortium	110	2014
Kusile	Coal	Eskom	4,800	2014–2018
KaXu	CSP	Abengoa	100	2015
Ingula	Pumped Storage	Eskom	1,322	2015
West Coast 1	Wind	Aurora	90.8	2015
Noupoort	Wind	Mainstream Renewable Power	80	2015
Pofadder	CSP	Xina	100	2016
Amakhala Emoyeni	Wind	Cennergi	133.7	2016
Tsitsikamma Community	Wind	Tsitsikamma Community	94.8	2016
Nojoli	Wind	African Clean Energy Developments	87	2016
Longyuan Mulilo De Aar Maanhaarberg	Wind	Longyuan Mulilo consortium	96	2016
Karoshoek	CSP	Ilangethu	100	2017
Upington	CSP	Eskom	100	2017
Khobab	Wind	Mainstream Renewable Power	138	2017
Loeriesfontein 2	Wind	Mainstream Renewable Power	138	2017
Gibson Bay	Wind	Red Cap	110	2017
Loeriesfontein 2	Wind	Mainstream Renewable Power	138	2017

Note: the projects expected for completion in 2014 have not been inaugurated as of June 2014. Source: Republic of South Africa, Department of Energy, Independent Power Producers.

<http://www.energy.gov.za/files/events_overview%20IPP.html>; Eskom, "Integrated Report," 2013.
<http://integratedreport.eskom.co.za/integrated_report_2013/pdf/full.pdf>

The overall strategy is for Eskom to maintain coal power plants and future additional power generation capacity will be constructed by IPPs. Eskom has a few planned power plants but due to the success of REIPPP, the programme will be extended to other forms of electricity generation. As a consequence, IPPs will have an even larger presence in the South African power sector.

In 2014, Eskom rehabilitated two coal-fired power stations mothballed in 1990, Grootvlei and Komati, which added 1,200 MW and 940 MW of installed capacity respectively. Eskom will also operate Medupi, Kusile, Ingula and Upington upon completion (see Table 3.4).

Further generation capacity will be added to the grid through IPPs' renewable energy power projects as part of the DoE's REIPPP initiative, which will lower South Africa's carbon footprint. The major projects over 80 MW agreed upon have been listed in Table 3.4. There are many other smaller-scale renewable electricity projects which have also been agreed upon, a complete list of planned projects can be found in Appendix 9.1. The REIPPP has had three rounds of bidding for projects: round one agreed to 1,416 MW, round two to 1,044 MW and round three to 1,456 MW of installed capacity additions. The total capacity agreed upon thus far is therefore 3,916 MW. A further 2,808 MW is still available for allocation in further bidding rounds, hence the total additional installed capacity resulting from the REIPPP initiative could amount to 6,724 MW.[68] Bid submission for the fourth round is set to take place in August 2014. South Africa's generation mix can be expected to have steady growth in the proportion of wind and solar PV energy contributions as a result of the REIPPP programme.

The success of the REIPPP model has led to further similar procurement programmes for IPPs. The DoE has announced that the procurement process for 800 MW of cogeneration plants (biomass, industrial waste and combined heat and power) and for 2,500 MW of coal-fired power plants would begin in April and May 2014, respectively.[69]

Renewable power plants are planned to increase to 18,200 MW and nuclear power capacity to 9,600 MW by 2030 as laid out in the Integrated Resource Plan.[70] Shale gas resources do not feature prominently in the Integrated Resource Plan but in the 2013 update were under consideration as an alternative to nuclear power. The update of the Integrated Resource Plan recommended delaying the nuclear procurement programme, but in June 2014, President Zuma expressed that South Africa would procure nuclear power stations as soon as possible and in March 2014, it was reported that China's main nuclear companies were lining up a USD

[68] Republic of South Africa, Department of Energy, Renewable Energy IPP Procurement Programme, Bid Window 3 Preferred Bidders' announcement, 4 November 2013. <http://www.energy.gov.za/IPP/List-of-IPP-Preferred-Bidders-Window-three-04Nov2013.pdf>.
[69] "Will South Africa's baseload IPP procurement follow REIPPP model?" ESI-Africa, 6 May 2014. <http://www.esi-africa.com/will-south-africas-baseload-ipp-procurement-follow-reippp-model/>.
[70] US Energy Information Administration, South Africa Country Analysis, 28 February 2014. <http://www.eia.gov/countries/cab.cfm?fips=SF>.

93 billion contract to build six reactors by 2030.[71] In October 2013, draft Technical Regulations for Petroleum Exploration and Exploitation were released.[72] Once the regulations are passed and licenses are awarded, the role of natural gas in South Africa's power sector will be made more definitive.

3.4 Demand and consumption

3.4.1 Electricity consumption

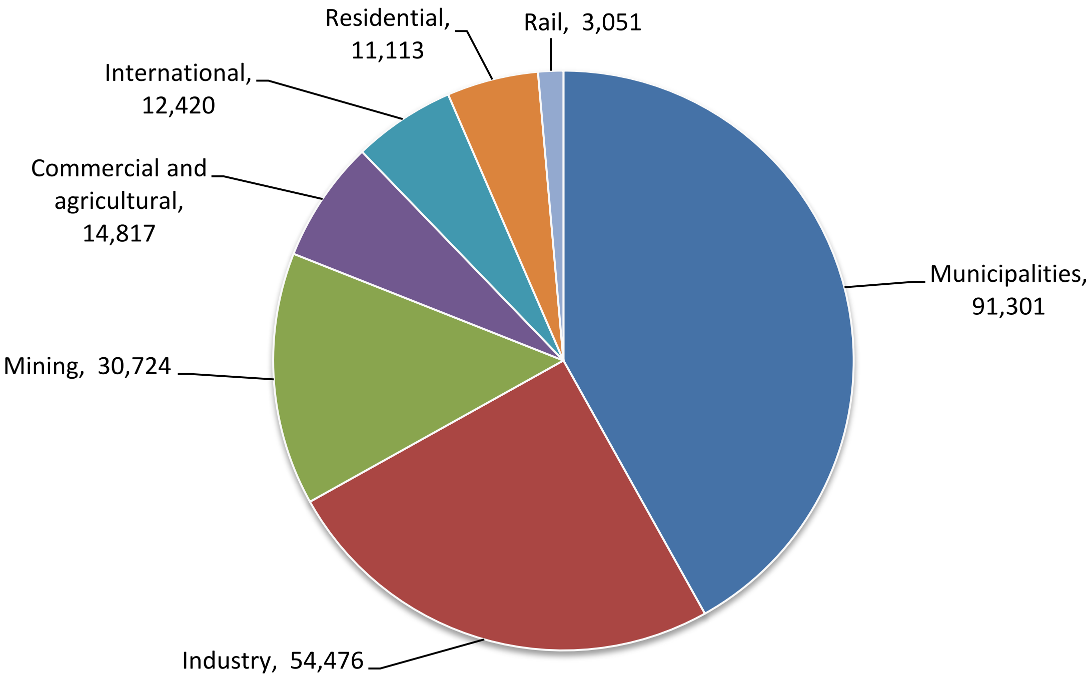
Neither DoE nor NERSA have provided any data on electricity demand per sector since 2006. Nonetheless, the mining and manufacturing industries in South Africa are known to be energy intensive.

Eskom sold 217,903 GWh of electricity in 2013/14 to about 3,000 industrial customers, 1,000 mining customers, 50,000 commercial customers and 84,000 agricultural customers. It also supplied electricity to 5.1 million residential customers. The electricity consumption per sector is shown in Figure 3.5. In the same year, 202,770 GWh of electricity was consumed domestically, with the remainder sold internationally in the Southern Africa Power Pool (SAPP). The peak power demand in 2012/13 was 35.9 GW.[73]

The electricity system is constrained as the reserve margin is very small. Consequently, blackouts have been a frequent occurrence, particularly at the end of the last decade, and Eskom has rolling blackouts scheduled from March onwards in 2014.[74] In November 2013, Eskom requested that the largest industrial customers cut electricity consumption by 10 per cent during peak demand periods.

[71] World Nuclear Association, Nuclear Power in South Africa, May 2014. <http://www.world-nuclear.org/info/country-profiles/countries-o-s/south-africa/>.
[72] Republic of South Africa, Department of Mineral Resources, Proposed Technical Regulations for Petroleum Exploration and Exploitation, October 2013. <http://www.eisourcebook.org/cms/Jan%202014/South%20Africa,%20Petroleum%20Exploration%20&%20Exploitation%20Regulations.pdf>.
[73] South African Power Pool, "Annual Report 2013," 2013. <http://www.sapp.co.zw/docs/22867%20Annual%20Report%20New.pdf>.
[74] Vuuren, A.J., "Eskom Begins Rolling Blackouts in South Africa Amid Power Crunch," Bloomberg, 17 June 2014. <http://www.businessweek.com/news/2014-06-17/eskom-begins-rolling-blackouts-in-south-africa-amid-power-crunch>.

Figure 3.5: Consumers of electricity in South Africa 2011 (total 217,903 GWh)



Source: Eskom, "Integrated Report," 2014. <http://integratedreport.eskom.co.za/pdf/full-integrated.pdf>.

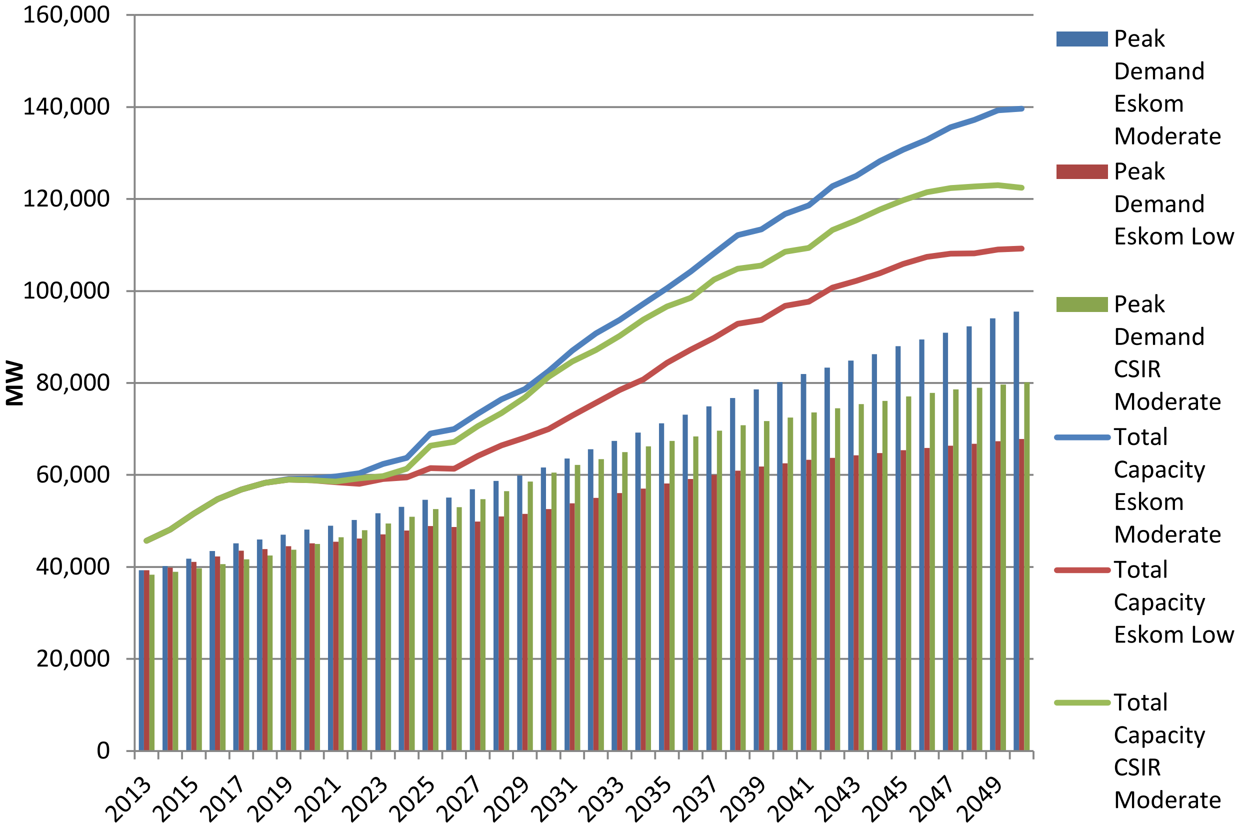
3.4.2 Projected demand

The SAPP forecast predicts that peak demand will be 53.9 GW by 2025, up from 45 GW in 2014.[76] The Integrated Resource Plan model assumed an average annual electricity demand growth of 2.9 per cent up to 2030 on the basis of moderate economic growth and this forecasted growth in demand results in a higher demand than the 53.9 GW predicted by SAPP by 2025.[77]

The Integrated Resource Plan was updated in 2013 due to a reduction in the levels of demand in South Africa over the past few years, which required a revision of the load forecasting. The new moderate growth forecast demand was an average annual growth of 2.3 per cent. Seven different load forecasts were included in the update of the Integrated Resource Plan, two of which were produced by Eskom and five forecasts by the Council for Scientific and Industrial Research (CSIR) with global and domestic economic growth variables. Both Eskom forecasts and the medium growth forecast by CSIR are given in Figure 3.6.

[76] Southern Africa Power Pool, <http://www.sapp.co.zw/docs/22867%20Annual%20Report%20New.pdf>.
[77] Eskom, Integrated Resource Plan 2010 and the MYPD 3 Tariff. <http://integratedreport.eskom.co.za/integrated_report_2013/per-plan.php>.

Figure 3.6: Load forecast in South Africa 2010–2050



Source: Republic of South Africa, Integrated Resource Plan for Electricity (IRP) 2010-2030, Update Report 2013, November 2013. <http://www.doe-irp.co.za/content/IRP2010_updatea.pdf>.

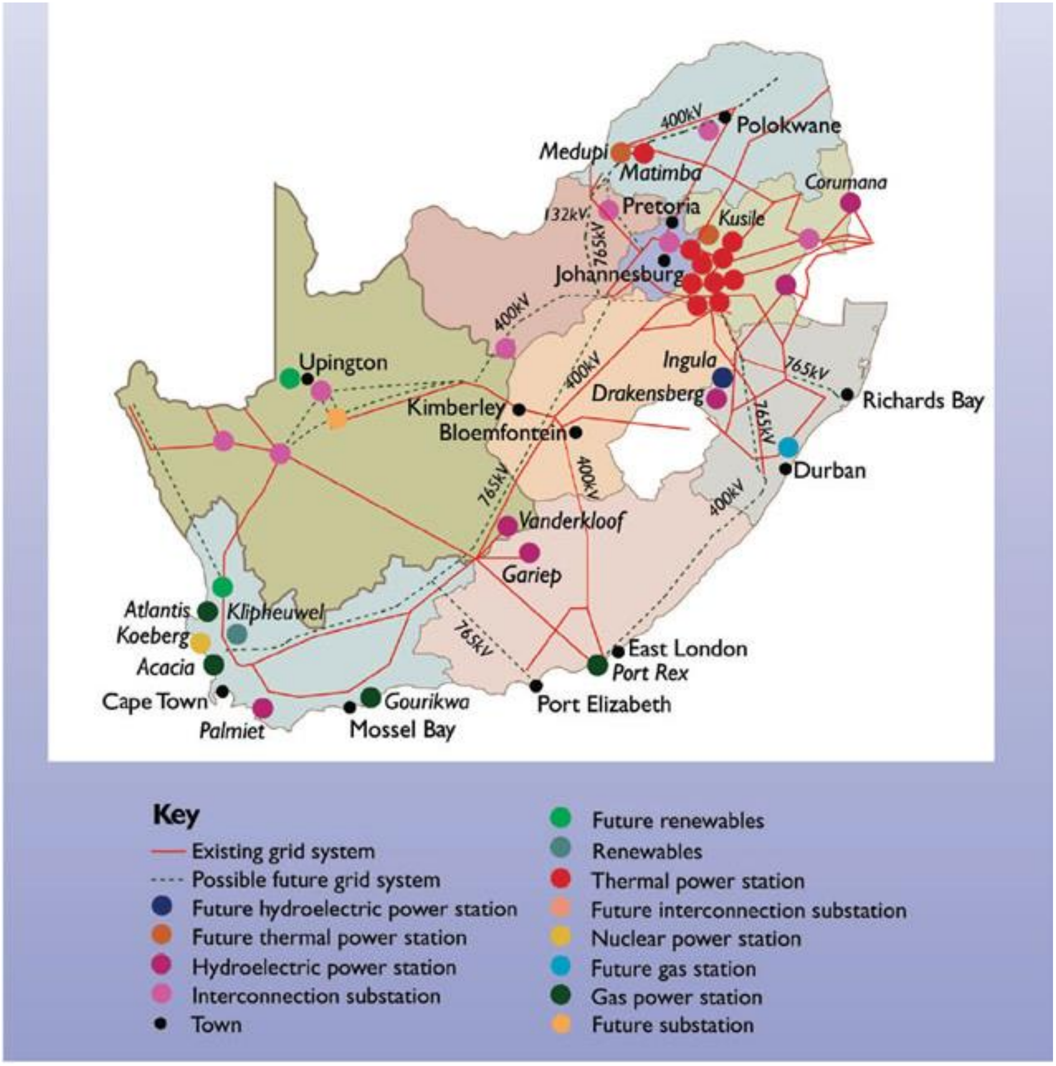
3.5 Transmission and distribution

3.5.1 Situation and problems

In 2014, Eskom operated 29,297 km of transmission lines and 157 substations. Eskom also operated 46,093 km of distribution lines, 276,027 km of reticulation power lines and 7,293 km of underground cables. The cumulative substation capacity was 232,179 MVA. Eskom has a transformer capacity for transmission of 135,840 MVA and distribution of 105,754 MVA. Eskom estimates that they supply electricity to 45 per cent of South African customers, whilst redistributors, including municipalities, resell 55 per cent of electricity.[78] The transmission network including substations and power stations is shown in Figure 3.7.

[78] Eskom, Our Company. <http://www.eskom.co.za/OurCompany/CompanyInformation/Pages/Company_Information_1.aspx>.

Figure 3.7: South African national grid



Source: Eskom, Company Information.
<http://www.eskom.co.za/OurCompany/CompanyInformation/Pages/Company_Information_1.aspx>.

Overall, Eskom performs well globally with regard to energy loss management. The transmission network performs strongly but the distribution network suffers from problems. In 2013/14, Eskom's total energy losses were 9.08 per cent, of which non-technical losses were estimated at 1.78–2.85 per cent. NERSA set a target for 2013 which Eskom fell short of by 0.15 per cent. Distribution losses have stayed roughly the same at 7.13 per cent, whereas transmission losses decreased from 2.80 per cent to 2.34 per cent in 2014. In the same year, conductor theft continued to be a problem. Electricity theft is also on the rise due to economic hardship and unaffordable consumer electricity tariff rates.

3.5.2 Future plans

As part of Eskom's Transmission Ten-Year Development Plan, 12,500 km of new transmission lines are planned for construction by 2022.[79] There are also approximately 60 grid strengthening projects ongoing.[80] A possible 765 kV transmission line has been proposed to run parallel to an existing 400 kV line from West Cape, nearby Koeberg nuclear power station, to Johannesburg (see Figure 3.7).[81]

There are advanced plans for Inga III in Democratic Republic of the Congo to supply 2,500 MW annually to South Africa through a long-distance transmission line which would most likely pass through Angola and Namibia, but could take an alternative route through Democratic Republic of the Congo, Zambia, Zimbabwe and Botswana. A treaty was signed in May 2013 for Inga III, as well as a Memorandum of Understanding in 2011 for the larger, subsequent Great Inga project. Construction is planned to begin in 2016.[82] As part of the treaty, South Africa will provide funding for the construction of Inga III and receive 2,500 MW of power imports.

From 2003 until 2010, South Africa had planned to restructure the distribution industry into six regional distributors. However, the plan was dropped in 2010.[83] The DoE has since taken over responsibility of the rehabilitation and extension of the distribution network. A funding and implementation plan has been proposed by DoE to reduce the electricity distribution infrastructure maintenance backlogs of ZAR 27.4 billion (USD 2.6 billion) to ZAR 15 billion (USD 1.4 billion) by 2015.[84]

3.6 Rural electrification

Rural electrification is especially important in South Africa for addressing the inequalities which still exist from apartheid, as the electrification backlog was largely race-based. One of South Africa's key initiatives for rural electrification was the Integrated National Electrification Programme which began in 2002. It consists of five policy guidelines, as follows:

- Non-Grid Households Electrification Policy Guidelines – implemented due to the grid electrification programme failing to recover operation costs of supplying electricity to rural areas

[79] Eskom, "Transmission Ten-Year Development Plan 2013-2022," September 2012. <http://www.eskom.co.za/Whatweredoing/TransmissionDevelopmentPlan/Documents/TransDevPlanBrochure2013-2022.pdf>.
[80] Eskom, Standard Presentation, December 2013. <http://www.eskom.co.za/OurCompany/Investors/Presentations/Documents/EskomStandardPresentationDec2013.pdf>.
[81] Eskom, Our Company. <http://www.eskom.co.za/OurCompany/CompanyInformation/Pages/Company_Information_1.aspx>.
[82] International Rivers, Grand Inga Dam, DR Congo. <http://www.internationalrivers.org/campaigns/grand-inga-dam-dr-congo>.
[83] Eberhard, A., An Overview of the Restructuring of the South African Electricity Distribution Industry (EDI), South African Local Government Association, 28 May 2013. <http://www.gsb.uct.ac.za/files/SALGAWorkshop.pdf>.
[84] Republic of South Africa, Department of Energy, "Annual Report 2012/2013," 2013. <http://www.energy.gov.za/files/Annual%20Reports/DoE-Annual-Report-2012-13.pdf>.

- Policy Guidelines for the Electrification of Unproclaimed Areas – promotes the electrification of informal settlements, shifting from the previous exclusive focus on the electrification of formal settlements
- Schools and Clinics Electrification Policy Guidelines – policy and strategic guidance to facilitate the electrification of schools and clinics
- Policy Guidelines for the Electrification of Farm Dweller Houses – supports the provision of electricity to farm workers
- Suite of Supply Policy Guidelines for the Integrated National Electrification Programme – provides a uniform set of standardised supply options and connection fees and a uniform approach to electrification tariff pricing[85]

In terms of financial support for low-income customers, Free Basic Electricity Policy 2003 mandated the allocation of an allowance of 50 kWh per month free for poor grid-connected households. Free Basic Alternative Energy Policy 2007 was created to promote the provision of alternative off-grid energy sources to members of the population without access to a grid-connected electricity supply.

In 2009, South Africa achieved 75 per cent electrification with 88 per cent of the urban population and 55 per cent of the rural population having access to electricity.[86] The distribution across the provinces is shown in Table 3.5. Seventy-five per cent of the houses without access to electricity are in the Eskom supply area with the other 25 per cent located in municipal supply areas.[87] According to the World Bank, 84.7 per cent of South Africans had access to electricity in 2011, which makes South Africa one of the African nations with the highest electrification rate despite only one third of the population having access to electricity in 1990.[88] The improvement was mainly achieved by grid extension. An annual subsidy of USD 400 million is made available for grid-connected or off-grid electrification projects, which ensures 200,000 new connections per year.

Table 3.5: Access to electricity by province in South Africa 2009

Province	Total households	Backlog of unconnected households	Electrified households (per cent)
Western Cape	1,333,886	191,366	86
Northern Cape	272,958	50,405	82
North West	914,070	196,605	78

[85] Republic of South Africa, Department of Energy, Policies. <http://www.energy.gov.za/files/policies101.06_frame.html>.
[86] Niez, A. "Comparative Study on Rural Electrification Policies in Emerging Economies," International Energy Agency, March 2010. <https://www.iea.org/publications/freepublications/publication/rural_elect.pdf>.
[87] Republic of South Africa, Department of Energy, Overview of Universal Energy Access Strategy, 31 October 2013. <http://www.energy.gov.za/files/IEP/DurbanWorkshop/Overview-of-Universal-Energy-Access-Strategy.pdf>.
[88] The World Bank, Access to electricity, 2013. <http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS/countries/1W?display=default>; GNESD, South African Electrification Programme, 2012. <http://energy-access.gnesd.org/index.php?option=com_content&view=article&id=141:south-african-electrification-programme&catid=3:projects&Itemid=24>.

Gauteng	3,127,991	740,569	76
Free State	823,972	201,919	75
Mpumalanga	879,082	231,485	74
Limpopo	1,250,716	329,440	74
Kwa Zulu-Natal	818,708	818,708	66
Eastern Cape	1,667,435	669.421	60
Total	12,675,275	3,429,918	75

Source: Republic of South Africa, Department of Energy, Electrification Statistics, 2009. <http://www.energy.gov.za/files/media/explained/statistics_electrification_2009.pdf>.

The New Households Electrification Strategy 2013 proposes changing the target for universal access (defined as 97 per cent) to electricity in South Africa from 2014 to 2025. The reason for the change of date is due to the lengthy processes involved in formalizing informal settlements and the difficulty in making electrification cost-effective for rural settlements. It is hoped that 90 per cent of electrified households will be grid-connected whilst the remaining households will have their energy needs supplied by off-grid sources. Off-grid developments are starting to play a bigger role in household electrification as off-grid solutions start to become more important in South African electrification policy.

The future strategy for tackling the backlog of households needing an electrical connection will be influenced by the New Electrification Roadmap for South Africa and surrounding countries in the SAPP, which Eskom and Duke Energy (US) are working on. The Roadmap aims to ensure the delivery of access to energy to 500 million people, equivalent to 100 million connections by 2025. Research, partnerships, resources, financing and analysis will be gathered until 2015 by which time planning will be completed and implementation will take place over the ensuing ten years.[90]

3.7 Tariffs

Eskom has three main tariff classes: residential, urban and rural customers. Eskom stipulates which areas count as urban and rural. Within these classes multiple tariff categories are available as shown in Table 3.6. In total there are 13 tariff categories.

Table 3.6: Tariff categories in South Africa

Customer type	Tariff category	Details
Urban	Nightsave Urban Large	High load factor urban customers with a notified maximum demand larger than 1 MVA.
	Nightsave Urban Small	High load factor urban customers with a notified maximum demand from 25 kVA up to 1 MVA.
	Megaflex	Time-of-use tariff for urban customers with a

[90] UN Sustainable Development, Electrification Roadmap For South Africa, Africa and Developing Countries. <http://sustainabledevelopment.un.org/index.php?page=view&type=1006&menu=1348&nr=1021>.

		notified maximum demand larger than 1 MVA.
	Miniflex	Time-of-use tariff for urban customers with a notified maximum demand from 25 kVA up to 5 MVA.
	Businessrate	Small businesses, government institutions or similar supplies in urban areas with a notified maximum demand of up to 100 kVA.
	Public Lighting	Tariff for public lighting in areas which Eskom provides a supply for.
Residential	Homepower Standard	Residential customers in urban areas with a notified maximum demand of up to 100 kVA.
	Homepower bulk	Residential bulk supplies, typically sectional title developments and multiple housing units, in urban areas.
	Homelight	A subsidised tariff for low-usage single-phase residential supplies.
Rural	Nightsave Rural	High load factor rural customers with a notified maximum demand from 25 kVA with a supply voltage equal or less than 22 kV or 33 kV in an area designated rural by Eskom.
	Ruraflex	Time-of-use electricity tariff for rural customers with dual and three-phase supplies with a notified maximum demand from 25 kVA with a supply voltage equal or less than 22 kV or 33 kV in an area designated rural by Eskom.
	Landrate	Rural customers with a notified maximum demand up to 100 kVA with a supply voltage equal or less than 500 V.
	Landlight	A subsidised tariff for low-usage single-phase supplies in rural areas limited to 20A.

Source: Eskom, "Tariff & Charges Booklet 2014/15," April 2014. <http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Documents/TariffBrochureV9.pdf>. Exchange rate, 1 ZAR = 0.0966459 USD, 8 May 2014. <http://www.xe.com/>.

For each tariff category that Eskom offers, there is a municipal equivalent, also known as the local authority tariff with marginal price differences. Each tariff category is also further broken down into four categories depending on the transmission zone and voltage. The Nightsave tariff categories offer differentiated rates for high and low demand seasons. The Homepower Standard tariff is shown in Table 3.7. This tariff is the standard residential tariff.

Table 3.7: Standard residential electricity tariff rates in South Africa (USc)

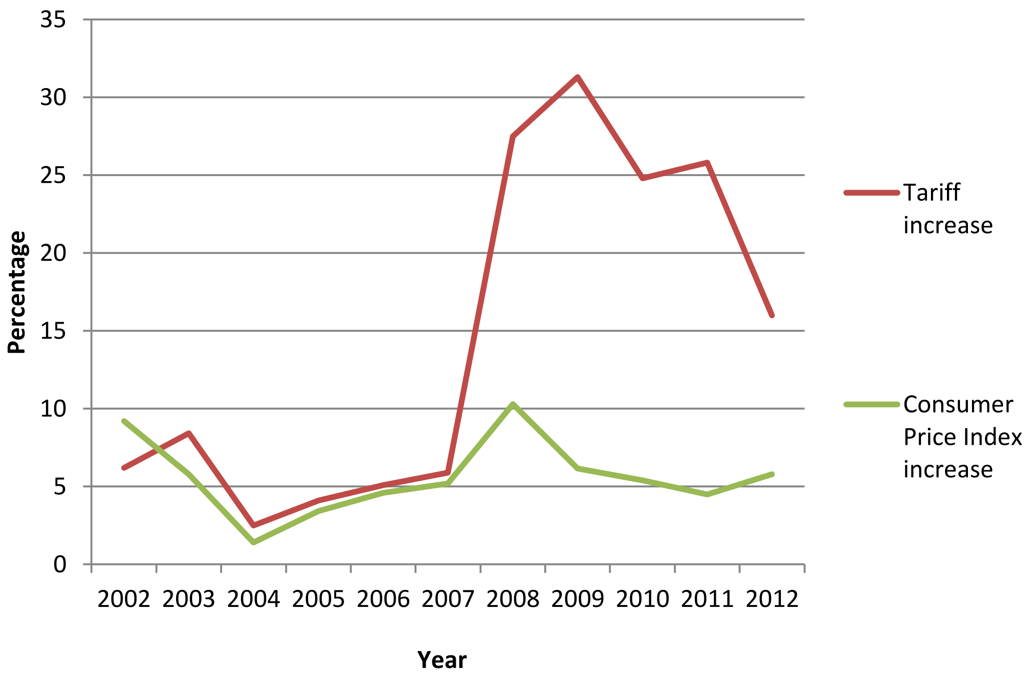
VAT included	Energy Charge (USc/kWh)		Network access charge (USc/day)
	Block 1 (>0-600kWh)	Block 2 (>600 kWh)	

	Non-local	Local	Non-local	Local	Non-local	Local
Homepower 1 Dual-phase 32 kVA Three-phase 25 kVA	9.760	9.767	15.409	15.417	41.815	41.815
Homepower 2 Dual-phase 64 kVA Three-phase 50 kVA	9.760	9.767	15.034	15.044	78.5	78.5
Homepower 3 Dual-phase 100 kVA Three-phase 100 kVA	9.760	9.767	15.034	15.044	1.619	162.0
Homepower 4 Single-phase 16 kVA	9.760	9.767	15.703	15.715	0.255	25.5

Source: Eskom, "Tariff & Charges Booklet 2014/15," April 2014. <http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Documents/TariffBrochureV9.pdf>. Exchange rate, 1 ZAR = 0.0966459 USD, 8 May 2014. <http://www.xe.com/>.

Tariff rates in South Africa have been undergoing significant increases. Increases of over 24 per cent were seen annually between 2008 and 2011, as shown in Figure 3.8. Prior to 2008, the electricity tariff rates were very low and not reflective of the production cost. Because of the financial unsustainability of the tariff rates, Eskom was unable to invest in additional generation capacity in the 1990s and early 2000s.

Figure 3.8: Eskom's electricity tariff rate increases 2002–2012



Source: Eskom, Average price increases. <http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Pages/Average_Price_Increases.aspx>.

NERSA, who decides the tariff schedule, introduced the first Multi Year Price Determination in 2008, which sets a pricing arrangement for several years rather than annually. All municipality tariff rates will be increased by 8.06 per cent annually from 2014-2018. All rates for the non-municipality tariffs (except for Homelight 20A) were increased by exactly 8 per cent. Eskom sent a proposal for an average of 16 per cent annual tariff rate increases in order to meet their needs, which included a 3 per cent increase each year to support the introduction of IPPs in South Africa. NERSA, consequently, permitted the tariff rates to be increased by half of Eskom's proposal. The average price for electricity will rise from 65.51 ZAc/kWh (USc 6.1) in 2013/14 to 89.13 ZAc/kWh (USc 8.3) in 2018.[91]

3.8 International manufacturers

The following section outlines the involvement of international suppliers in major projects in the South African power sector.

ABB

ABB plans to start making central inverters in South Africa to support the rapidly growing local photovoltaic market. A new inverter production line is planned for 2014, which will be located at ABB's existing facilities in Johannesburg.[92]

In 2012, ABB won a USD 225 million contract to develop Witkop and Soutpan solar PV power parks with an installed capacity of 33 MW and 31 MW respectively. ABB was contracted to design, engineer, install, and commission the parks. ABB will supply the inverters, protection equipment, switchgear, dry-type transformers, controllers, and the supervisory control and data acquisition (SCADA) system.[93] The solar PV parks are part of phase 1 of REIPPP programme and construction began in 2013.

ABB received a USD 25 million order to provide electrical and control systems for one of the world's largest solar PV power plants with a single-axis tracking system. The 75 MW Kathu PV power will be located in the Kalahari Desert close to one of the largest open-pit iron ore mines in the world, and will be operational in 2014.[95]

Siemens

In 2012 financial year, Siemens estimated that sales to customers in South Africa amounted to EUR 470 million and new orders from South Africa totalled EUR 504.5 million. The Power

[91] NERSA, "NERSA's decision on Eskom's Revenue Application for the Third Multi-Year Price Determination period 2013/14 to 2017/18," 28 February 2013. <http://www.eskom.co.za/CustomerCare/TariffsAndCharges/Documents/NERSA_decision.pdf>.

[92] "ABB will make solar photovoltaic inverters in South Africa," Electric Light & Power, 28 May 2013. <http://www.elp.com/articles/2013/05/abb-will-make-solar-photovoltaic-inverters-in-south-africa.html>.

[93] Brown, N. "ABB Wins $225 Million Order For Two South African PV Plants," Clean Technica, 8 December 2012. <http://cleantechnica.com/2012/12/08/abb-wins-225-million-order-for-two-south-african-pv-plants/>.

[95] Alexopoulou, M., "ABB to provide system solutions for 75MW South African Kathu PV power plant," PV Tech, 3 May 2013. <http://www.pv-tech.org/news/order_focus_abb_to_provide_system_solutions_for_75mw_south_african_kathu_pv>.

Transmission and Power Distribution Divisions relocated to new facilities in Northriding, Randburg, South Africa in 2010. Table 3.9 details Siemen's extensive activity in the power sector in South Africa.

Table 3.8: Siemens activity in South Africa's power sector

Project	Completion	Scope of supply
Majuba power station	Various	The original contract for building the Majuba plant was awarded to Siemens in 1982. The plant did not start operating until 1996. In 2004, a contract was awarded to modernize the instrumentation and control system.
Kendal power station	1994	Supplied six 686 MW Steam Turbine Generator sets for the Kendal Power Plant.
Mozambique-South Africa transmission	2003	Fixed series capacitor technology was provided to interconnect South Africa and Mozambique. Siemens received a turnkey long-distance power transmission project from The Mozambique Transmission Company (MOTRACO) to provide energy to the Mozal Aluminium Smelter in Maputo. The project included the installation of two fixed series capacitor banks in the MOTRACO transmission network.
Camden power station	2008	In 2003, Siemens were contracted to overhaul the Siemens turbines in the Camden power station, refurbish the control and instrumentation, and replace the fire detection and generator protection, as well as the low-voltage switchgear. The Camden plant was mothballed in 1990 and fifteen years later it was returned to service with six 200 MW units synchronised. In 2008, the remaining two units were back in operation, with the plant adding a total of 1,600 MW to the power grid.
Ankerlig and Gourikwa power stations	2009	Siemens built the Ankerlig Power plant (Cape Town) and Gourikwa Power Plant (Mossel Bay) open-cycle gas turbine power plants. 2,100 MW was added to the national grid for Eskom.
Moses Mabhida stadium	2010	Supplied stadium protection relay feeder points at the Moses Mabhida stadium to help and monitor an efficient power supply. In the run up to the 2010 World Cup in South Africa, Siemens won orders close to EUR 1 billion.
Substations	2010	Siemens received an order for Cape Town's Athlone substation and substation frame agreements were signed with Ethekwini.
Hendrina power station	2010	Lifetime assessment contract for the power plant.
Duhva power station	2012	The order from Eskom for the replacement of the control and instrumentation system of units 1-6 was valued at EUR 36 million.

Jeffreys Bay Wind Farm	2012/2022	Siemens' first wind farm commission involved the erection and ten-year maintenance of 60 wind turbines with a total 138 MW installed capacity. The plant was inaugurated in early 2014.
Drakensburg Mountains pumped-storage	2013	Siemens supplied the complete electro-mechanical equipment, including four pump-turbines, four motor-generators and the complete automation and control system. The plant contributes 1,330 MW to South Africa's installed capacity. Siemens served as a partner for Voith, who built the plant. Siemens also participated in a similar project with Voith for the Ingula pumped-storage facility.
Komati power station	2013	Siemens took charge of a massive instrumentation and control systems project at Eskom's previously mothballed Komati Power Station, which put all nine units back in service.
Kusile power station	2013	Siemens supplied generator transformers and electrical and auxiliary power for the Kusile power station.
Northern Cape solar project	2014	Two solar power projects, which are under development at two separate sites in the Northern Cape, will be designed and constructed by Siemens
Transformers	2014	Eskom extended its frame agreement for the supply of Siemens transformers in sizes up to 765 kV until the end of 2014. The extension increased the value of the original contract signed in 2007 to approximately EUR 230 million. The scope of the order included the design, engineering, manufacturing, testing, supply, delivery, installation and commissioning of a range of power transformers and shunt reactors at various locations.
Medupi power station	2014	In 2013, Alstom, initially contracted for the Medupi power plant by Eskom, repeatedly failed the testing of the control system it had been developing. Eskom then prised the contract from Alstom and gave it to Siemens in 2014.
Sere wind farm	2014/2019	An onshore wind power order on the west coast for the delivery and installation of 46 wind turbines of the type SWT-2.3-108, with an output of 2.3 MW, a rotor diameter of 108 meter on 115 meter towers each. The deal also includes a five-year service agreement.

Source: see footnote.[99]

[99] Siemens, Siemens in South Africa, <http://africa.siemens.com/en/siemens-in-africa/country-profiles/south_africa.htm>; Siemens, South Africa, November 2013. <http://www.siemens.com/about/en/worldwide/south_africa_1154675.htm>; Dyer-Bracher S., "Playing a role in the South African energy mix," Siemen discover, 8 March 2012. <https://www.discoversiemensafrica.com/topics/playing-a-role-in-the-south-african-energy-mix/>; Siemens, Energy Sector Reference Projects. <http://africa.siemens.com/en/siemens-in-africa/reference-projects/energy_sector.htm#toc-1>; "Suntech, Siemens, collaborate on 100 MW of solar projects in South Africa," Electric Light & Power, 12 October 2012. <http://www.elp.com/articles/2012/12/suntech-siemens-collaborate-on-

GE

GE was awarded a ZAR 500 million (USD 47 million) contract for the engineering, design, manufacture and installation of low-voltage switchgear at Eskom's Medupi power station. Delivery started in 2010 and ran until 2011.[100]

Mitsubishi Heavy Industries (MHI) and Hitachi

MHI's business activities in South Africa include participation in the programme to develop and design a pebble bed modular reactor (PBMR) for small-size nuclear power plants which ran from 1993–2010. The company anticipates local business opportunities in power generation systems, including nuclear power.[101]

In 2007, a consortium comprising of Hitachi Power Europe GmbH (now: Mitsubishi Hitachi Power Systems Europe GmbH) and Hitachi Power Africa (now: MHPS Africa) was awarded two contracts from Eskom to design, manufacture, supply, erect and commission six 800 MW utility steam turbine generators for each of the Medupi and Kusile Power Stations in Lephalale, Limpopo Province, and Emalahleni, Mpumalanga Province, respectively. The scope of work included engineering, supply, manufacturing, construction and commissioning of utility steam turbine generators, related components such as regenerative steam air-heaters, coal mills and feeders, soot-blowers, high pressure and low pressure pipework, deashers and fans.

Steam turbine generators were also provided by Hitachi at Majuba, Tutuka, Duvha, Kriel, Hendrina, Grootvlei and Sasol II/III coal-fired power stations. Hitachi provided a DS Burner for Sasol II, Boiler 2.[102]

Hitachi bought the ruling South African party's 25 per cent stake in the South African business Hitachi Power Africa (HPA) as the contract was with Eskom, a state-owned company, hence leading to a conflict of interests.[103] HPA has been transferred to Mitsubishi Hitachi Power Systems Europe.[104]

100-mw-of-solar-projects-in-south-africa.html>; Mantshantsha, S. "Medupi to start producing power soon, says Eskom," Business Day live, 21 February 2014. <http://www.bdlive.co.za/business/energy/2014/02/21/medupi-to-start-producing-power-soon-says-eskom>; "Siemens wins 100 MW wind power order from South Africa," Siemens, 16 May 2013. <http://www.siemens.com/press/en/feature/2013/energy/2013-05-sere-wind.php>.

[100] Boyd, R., "Switchgear contract for Medupi power station," ee publishers, 25 May 2010. <http://www.ee.co.za/article/switchgear-contract-for-medupi-power-station.html>.

[101] "MHI Establishes Offices in Kiev, Ukraine, and Johannesburg, South Africa, To Explore Demand in Economically Expanding Regions Through Effective Information Gathering and Brisk Business Development," Mitsubishi Heavy Industries, 26 May 2009. <http://www.mhi.co.jp/en/news/story/0905261295.html>.

[102] Mitsubishi Hitachi Power Systems Africa, References in South Africa. <http://www.za.mhps.com/en/references-south-africa.html>.

[103] Wild, F., "Hitachi Buys ANC Stake in S. Africa Unit After Criticism," Bloomberg, 28 February 2014. <http://www.bloomberg.com/news/2014-02-27/hitachi-buys-anc-stake-in-s-africa-unit-amid-conflict-criticism.html>.

[104] "Mitsubishi Hitachi Power Systems now in South Africa," infastructurene.ws and service delivery, 17 April 2014. <http://www.infrastructurene.ws/2014/04/17/mitsubishi-hitachi-power-systems-now-in-south-africa/>.

Toshiba

Toshiba's subsidiary Westinghouse Electric Company, which has two offices in South Africa through acquiring IST Nuclear, won a contract from Eskom to continue providing fuel for the Koeberg nuclear power station between 2011 and 2015. The contract was worth USD 30 million.[105]

In 2013, Westinghouse signed a Memorandum of Understanding with South African Company Sebata Group to prepare for the construction of an AP1000 nuclear reactor in South Africa. The companies hope to form a nuclear industry capacity building engineering-led organisation. Prior to the Memorandum of Understanding, Westinghouse signed an agreement with Nuclear Energy Corporation of South Africa (NESCA) to research and co-operate in the development of local fabrication capabilities for nuclear fuel assembly components.[106]

Honeywell

In 2006, Honeywell was awarded a USD 41.4 million contract by Eskom to upgrade the mothballed Grootvlei power plant and supply the distributed control system. Honeywell supplied its Experion Process Knowledge System (PKS), field instrumentation, basic design, engineering, fire detection, training simulation and installation services to the plant. The upgrade included the refurbishment of the automation and control systems for Grootvlei's six units. The upgrade was completed in 2008.[107]

Schneider Electric

Schneider Electric began to supply solar PV equipment for its first solar project in South Africa in 2013. The solar PV plant's installed capacity is 20 MW and Schneider Electric is supplying a PV box, a plug and play power conversion system, a DC combiner box, a step-up transformer and medium-voltage switchgear.[108]

American Superconductor (AMSC)

In 2013, AMSC was selected to connect South Africa's largest wind farm, Cookhouse, to the national grid. A D.VAR system was installed for the South African company Consolidated Power Projects (CONCO). Cookhouse is scheduled for completion in late 2014.

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[105] "Westinghouse gets Koeberg contract," Nuclear Engineering International, 2 December 2009. <http://www.neimagazine.com/news/newswestinghouse-gets-koeberg-contract>.

[106] Pultarova, T., "Westinghouse increasing involvement in South Africa," Engineering and Technology Magazine, 24 October 2013. <http://eandt.theiet.org/news/2013/oct/westinghouse-south-africa.cfm>.

[107] "Honeywell wins $41.4 million contract to upgrade South African power station," Automation.com, 10 August 2006. <http://www.automation.com/automation-news/industry/honeywell-wins-414-million-contract-to-upgrade-south-african-power-station>.

[108] Melenka, J., "Schneider Electric is expanding its Solar PV Business with local solutions in South Africa," Renewable Energy World, 21 June 2013. <http://www.renewableenergyworld.com/rea/companies/schneider-electric/news/article/2013/06/schneider-electric-is-expanding-its-solar-pv-business-with-local-solutions-in-south-africa>.

Smaller renewable energy international manufacturers

- ACS CobrA (Spain), Gransolar (Spain) and Kensani Energy EPC (South Africa) – EPC contract for 75 MW Lesedi solar PV project[110]
- Juwi AG (Germany) – EPC contract for 86 MW solar park in Prieska[111]
- Kentz (US) – USD 45 million EPC contract for 75 MW Kalkbult solar PV project[112]
- Nordex (Germany) – EPC contracts for 100 MW Dorper, 80 MW Kouga, 134 MW Amakhala Emoyei wind farms[113]
- Suzlon (India) – wind turbine manufacturer for 138 MW Cookhouse wind farm[114]
- Tractebel (Belgium) – EPC contract for 100 MW Upington concentrated solar power project[115]

3.9 Risks and opportunities

3.9.1 Issues

Distribution

There are serious structural and financial problems relating to South Africa's electricity distribution industry (EDI). EDI Holdings was a company set up in 2003 to restructure the South African EDI. However, the company was closed in 2011 with the EDI remaining split between Eskom and local municipalities, and there is still no coherent strategy to reform the EDI. There are many poorly run and non-viable municipal distributors. Municipalities have marked-up prices through misreporting and loopholes outside of NERSA's regulatory powers and use the revenue for projects besides the maintenance and upgrading of distribution assets.[116] The corruption of the municipalities forms part of the explanation of the reluctance to restructure the EDI into six provinces. The South African Local Government Association highlights that the distribution system maintenance backlogs are growing and need attention with a national total of ZAR 27 billion (USD 2.6 billion) of maintenance works needed as of 2008.[117]

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[110] SolarReserve, Lesedi PV Project. <http://www.solarreserve.com/what-we-do/pv-development/lesedi/>.
[111] "German firms wins major SA solar contract," SouthAfrica.info, 3 December 2013. <http://www.southafrica.info/business/investing/solar-031213.htm#.U2IaVYFdWig>.
[112] "Kentz awarded US$45M EPC Solar Power Project in South Africa," Kentz, 9 November 2012. <http://www.kentz.com/media-centre/press-releases/kentz-awarded-us$45m-epc-solar-power-project-in-south-africa.aspx>.
[113] Nordex, "Nordex awarded third major contract in South Africa," 14 June 2013 <http://www.nordex-online.com/index.php?id=53&L=2&tx_ttnews%5Btt_news%5D=2404&tx_ttnews%5BbackPid%5D=46&cHash=044540cda8>.
[114] "Suzlon's SA wind project powers ahead," SouthAfrica.info, 8 April 2013. <http://www.southafrica.info/business/investing/suzlon-080313.htm#.U2IgG4FdWig>.
[115] Rajgor, G., "Surge in solar energy news from South Africa – Top 5 solar power project announcements this month (so far)," renewable energy focus, 15 November 2012. <http://www.renewableenergyfocus.com/blog/2012/11/15/surge-in-solar-energy-news-from-south-africa-top-5-solar-power-project-announcements-this-month-so-far/693.aspx>.
[116] Marais, J., "Spotlight on electricity mark-ups," Business Day live, 20 January 2013. <http://www.bdlive.co.za/business/energy/2013/01/20/spotlight-on-electricity-mark-ups>.
[117] Eberhard, A., An Overview of the Restructuring of the South African Electricity Distribution Industry (EDI), South African Local Government Association, 28 May 2013. <http://www.gsb.uct.ac.za/files/SALGAWorkshop.pdf>.

Capacity shortages

South Africa suffers from a shortage of capacity due to the growth in demand and lack of construction. The supply and demand balance is very tight. Overinvestment in power stations was then followed by underinvestment in generation capacity due to the aforementioned hesitancy regarding reforming during which time Eskom built no new power plants.

Power station maintenance

The power stations require a high level of maintenance. There is a backlog of maintenance projects and the delaying of maintenance projects only goes towards amplifying the necessity of the maintenance. Eskom must take their plants offline thereby lowering operating capacity. Eskom must use expensive diesel generation as a replacement, the alternative to which is a shortfall in supply and load shedding.

Rural electrification

Rural access to electricity is related to apartheid and racial tensions. Difficulties exist over whether to provide informal settlements with electricity, as they are often transient and setting up an electrical connection is expensive. South Africa has reached a point where it is no longer cost effective to extend the grid to further rural areas. In addition, the tariff rates are becoming unaffordable to many whilst still failing to be cost-reflective.

Theft

Copper theft and electricity theft is common in South Africa. Eskom's energy losses as a result of electricity theft are approximately ZAR 2 billion annually.[118] A national partnership campaign Operation Khanyisa was set up as an electricity theft reporting mechanism. Enforcement has stepped up from 2010 to 2013. For example, racketeering charges and conviction relating to electricity theft resulted in two people receiving a combined sentence of 111 years. In the same period of time, Eskom has recovered ZAR 234 million (USD 21.9 million).[119]

Private investment

There have been difficulties attracting private investors.[120] Tariff rates were not high enough to gain the necessary returns in the late 1990s and early 2000s. In response, the Government took steps to try to introduce private investors but the uncertainty of the policies and structure of the electricity sector did not attract private investment into South Africa. Eskom's vertical and horizontal market dominance is at variance with international policy developments in the electricity sector and could be an obstacle to future competitive

[118] Operation Khanyisa, Fact Sheet, 11 May 2012. <http://www.kwanalu.co.za/upload/files/OperationKhanyisaFactSheet.pdf>.

[119] Sapa, "Operation Khanysia a success: Eskom," Iol, 23 August 2013. <http://www.iol.co.za/business/news/operation-khanyisa-a-success-eskom-1.1567154#.U8PWYpRdWig>.

[120] Joffe, H., "Challenges for South Africa's Electricity Supply Industry," 1 March 2012. <hsf.org.za/resource-centre/focus/focus-64/HJoffe64.pdf/download>.

developments. Nonetheless, the REIPPP has finally encouraged private investors into South Africa. However, in March 2014, the outgoing Chief Executive of Eskom revealed that Eskom and IPPs were struggling to settle the terms for power purchase agreements because of high price demands on behalf of the IPPs.[121] This is likely to remain an issue until the ISMO bill is passed (see Section 3.2.1). Eskom's structure might also be an impediment to the integration of electricity systems and trade in the SAPP due to the disparity in size of the utilities.

3.9.2 Future opportunities

UK Trade and Investment estimated that South African power infrastructure projects have a projected GBP 28 billion (USD 47.3 billion) spend.[122] Energy supply diversification from coal provides a wealth of opportunities for international manufacturers.[123] South Africa offers the development fund, called the Manufacturing Competitiveness Enhancement Programme, consisting of industrial financing loans and production incentive grants for South African registered entities with existing manufacturing operations. One of the incentive grants is the Green Technology and Resource Efficiency Improvement to support enterprises with green technology upgrades.[124] Opportunities in the power sector identified by UK Trade and Investment and from the discussion above are as follows:

- Design, engineering and supply for a new coal power plant which is under consideration, in addition to services for Medupi and Kusile. 2,500 MW of coal-fired power plants will be licensed in a procurement programme.
- Maintenance and upgrade of the existing coal power plants is required.
- Renewable energy is entering the market. Opportunities are abound due to the REIPPP programme with 64 projects agreed upon from 2011 to present and at least 2 further bidding rounds due to take place. The submission date for the fourth round of bidding is 18th August 2014. Standard Bank recommends that negotiations with suppliers and EPC contractors should take place before a bid is submitted.[125] The majority of bids will be for wind, solar PV and Concentrating Solar Power (CSP) developments. Further opportunities lie in projects connecting these developments to the grid. The local content requirements for each bidding round of the REIPPP have increased (see Table 3.9) and there are question marks surrounding the uncertainty of the requirements for the next round. In addition, a new black identity shareholder requirement was added

[121] Khuzawayo, W., "Eskom cannot afford IPP prices – Dames," IOL news, 10 March 2014. <http://www.iol.co.za/business/news/eskom-cannot-afford-ipp-prices-dames-1.1658563#.U61wMJRdWig>.
[122] UK Trade & Investment, Exporting to South Africa, 26 March 2014. <https://www.gov.uk/government/publications/exporting-to-south-africa/exporting-to-south-africa>.
[123] Steele M., "Another coal-fired power station to fuel South Africa's addiction?" Greenpeace, 24 February 2012. <http://www.greenpeace.org/africa/en/News/Blog/another-coal-fired-power-station-to-fuel-sout/blog/39214/>.
[124] Industrial Development Corporation, MCEP for existing manufacturers. <http://www.idc.co.za/development-funds/manufacturing-competitiveness-enhancement-programme>.
[125] Standard Bank, Funding projects in REIPP – lessons learnt from BD1, September 2012. <http://www.record.org.za/resources/doc_download/58-funding-projects-in-reippp-lessons-learned-a-campbell>.

in the third round of bidding, which stipulates that companies or programmes must have black South Africans as shareholders.[126]

Table 3.9: REIPPP local content requirement thresholds (per cent)

Technology	Bidding round 1		Bidding round 2		Bidding round 3	
Thresholds	**Current**	**Target**	**Current**	**Target**	**Current**	**Target**
Onshore wind	25	45	25	60	40	65
Solar PV	35	50	35	60	45	65
CSP without storage	35	50	35	60	45	65
CSP with storage	35	45	35	60	40	65
Biomass	25	45	25	60	40	65
Biogas	25	45	25	60	40	65
Landfill gas	25	45	25	60	40	65
Small hydro	25	45	25	60	40	65

Source: Standard Bank, Funding projects in REIPP – lessons learnt from BD1, September 2012.
<http://www.record.org.za/resources/doc_download/58-funding-projects-in-reippp-lessons-learned-a-campbell>.

- Opportunities exist in the design, installation and construction for 800 MW of cogeneration power plants in a new procurement programme and related infrastructure required for the mass production of biomass.
- Improvements to the natural gas infrastructure are under consideration with shale gas exploration taking place and natural gas imports from Angola and Mozambique likely. Opportunities exist in facilitating exploration, imports and the construction of natural gas infrastructure.
- Carbon Capture and Storage, to offset the continued use of coal, is also under consideration.[127]
- There is significant pressure to add six new reactors to the Koberg nuclear power plant – a tender announcement is to be expected by the end of 2014. A roadmap for nuclear power is expected soon which will shed light on the opportunities available for suppliers.
- New transmission lines and grid-strengthening projects.
- Maintenance projects for the distribution network.

[126] Cloete, K., “Suppliers seek clarity on future REIPPP local-content requirements,” Polity, 26 September 2013.
<http://www.polity.org.za/article/suppliers-seek-clarity-on-future-reipppp-local-content-requirements-2013-09-26>.
[127] “South Africa: Changing The Energy Mix For A Low Carbon Future,” UK Trade & Investment, December 2013.
<http://opentoexport.com/article/south-africa-changing-the-energy-mix-for-a-low-carbon-future/>.

4. Nigeria

4.1 Electricity sector structure and organisations

4.1.1 Generation, transmission, distribution and supply companies

Power Holdings Company of Nigeria (PHCN), formerly known as the National Electric Power Authority (NEPC) and, pre-1972, the Electricity Corporation of Nigeria (ECN), was the state-owned monopoly of the Nigerian electricity industry up until reforms began in the early 2000s. The reforms took place due to PHCN's poor operational and financial performance. In 2005-2006, PHCN was unbundled into seven generation companies, one transmission company and 11 distribution (and supply) companies. In 2012, PHCN was liquidated. On 30th September 2013, five of the generation companies and 10 of the distribution companies were handed over to private companies for approximately USD 2.5 billion and the outstanding deals for the remaining companies were concluded within half a year.[128] Table 4.1 shows the unbundled companies of PHCN and the proceeding private owners.

In order to accelerate the structural reform of Nigeria's power sector and increase private participation, the Presidential Task Force on Power (PTFP) was formed in June 2010. The Roadmap for Power Sector Reform produced by PTFP outlined that the generation and distribution sectors would be privatized whilst the transmission sector would be managed by a private company under five year contracts.

Table 4.1: PHCN's unbundled successor companies

Sector	Company	Private owner
Generation	Afam	Talveras
	Egbin	NEDC/KEPCO
	Kainji Hydro Electric	Mainstream Energy
	Sapele	CMEC/Eurafric Energy
	Shiroro Hydro Electric	North South
	Ughelli	Transcorp/Woodrock
	Jebba Hydro Electric	Mainstream Energy
Transmission	Transmission Company of Nigeria (TCN)	Manitoba Hydro International (Management contract only)
Distribution	Abuja	Kann Consortium
	Benin	Vigeo
	Eko	West Power and Gas
	Enugu	Interstate
	Ibadan	Integrated Energy
	Ikeja	NEDC/KEPCO

[128] Brock, J., "Nigeria hands state power assets to private buyers," Reuters, 30 September 2013, <http://www.reuters.com/article/2013/09/30/nigeria-power-privatisation-idUSL6N0HQ2AF20130930>; Adam Smith International, "Nigerian power breakthrough provides new hope for millions," The Guardian Professional. <http://www.theguardian.com/global-development-professionals-network/adam-smith-international-partner-zone/nigerian-power-breakthrough-global-development>.

(and supply)	Jos	Aura Energy
	Kaduna	Northwest Power
	Kano	Sahelian
	Port Harcourt	4Power Consortium
	Yola	Integrated Energy

Source: Oluokum, A., "Nigeria completes privatization of power companies," PM News, 23 December 2013. <http://www.pmnewsnigeria.com/2013/12/23/nigeria-completes-privatization-of-power-companies/>; Alohan, J. et al., "Nigeria: FG Limits Role, As Private Owners Take Over Power Sector," All Africa, 2 November 2013. <http://allafrica.com/stories/201311030048.html>; Sotunde, O., "CMEC/EURAFRIC Completes Sapele Power Plant Acquisition," Ventures, 24 February 2014. <http://www.ventures-africa.com/2014/02/cmeceurafric-completes-sapele-power-plant-acquisition/>.

In addition to the generation companies listed in Table 4.1, there are more private sector companies involved in generating electricity in Nigeria. Independent Power Producers (IPPs) were present before the privatisation process and have continued to increase their presence by building new power plants. Furthermore, the ten power plants built under the National Integrated Power Project (NIPP), which was an initiative set up in 2004 to commission the construction of electricity infrastructure, are also up for sale in a second wave of privatisation. The Nigerian Electricity Regulatory Commission (NERC) claims that it has issued up to 70 licenses to IPPs as of June 2014.[131]

Any new power plants are to be financed and built by the private sector. The Federal Government outlined that their limited involvement in the power sector will consist of incentivizing renewable and coal power generation.[132]

One of the main areas of focus for Manitoba Hydro International, the contracted manager of the TCN, is to ensure that the Transmission Service Provider (TSP), the Market Operator (MO) and the System Operator (SO) function separately so that the TSP can eventually be privatised.[133] The TSP is mostly concerned with asset management whilst the MO and SO are service providers.

4.1.2 Ministry and regulatory agencies

The Federal Ministry of Power, which split from the Ministry of Power and Steel in 2007, initiates and formulates policies on the development of Nigeria's power sector and directs other agencies involved in the power sector. NGN 74.3 billion (USD 463 million) was allocated to the Ministry of Power and related government energy organisations, including TCN and the regulatory body, in the 2013 budget.[134]

[131] NERC, Frequently Asked Questions. <http://www.nercng.org/index.php/about-us/frequently-asked-question>.
[132] Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.
[133] Manitoba Hydro International, "MHI Awarded Management Contract by the Transmission Company of Nigeria." <http://www.mhius.ca/news/read,article/45/mhi-awarded-management-contract-by-the-transmission-company-of-nigeria-(tcn)>.
[134] Federal Government of Nigeria, Budget Office, 2013 Budget, Summary, Ministry of Energy. <http://www.budgetoffice.gov.ng/2013-budget_details/24.%20Summary_Power.pdf>.

NERC is the main statutory, independent regulatory agency of the Nigerian electricity industry. NERC issues licenses to market participants and ensures compliance with market rules and operating guidelines.

The Energy Commission of Nigeria (ECN) is mandated to strategically plan and coordinate national power policies. It provides a centre for information relating to both national policy and the performance of the energy sector. ECN provides solutions for the implementation of policy and advises the government on power sector funding.

PTFP and the Presidential Action Committee on Power (PACP) were established in 2010. PTFP was set up to coordinate the activities of various agencies and entities throughout the structural reform and privatization process, as well as planning and executing short-term projects in line with the Roadmap for Power Sector Reform. PACP provides additional oversight.

4.1.3 Other organisations

Industry associations and other organisations relevant to the Nigerian power sector are included in Table 4.2.

Table 4.2: Other relevant power sector organisations in Nigeria

Organisation name	Description
Niger Delta Power Holding Company Limited	Responsible for the implementation of the National Integrated Power Project (NIPP), which involved the construction of ten power plants, through ten wholly-owned subsidiaries.
Nigerian Bulk Electricity Trading Plc	Set up to purchase electricity and ancillary services through power purchase agreements (PPAs) from IPPs and successor generation companies and to resell the electricity to distribution companies.
Operator of the Nigerian Electricity Market	Market operator of the wholesale electricity market. Undertakes the administration of the Nigerian electricity market, approves entry of market participants and supervises and enforces compliance with the market rules.
Nigeria System Operator	Primarily responsible for the planning, dispatch and operation of the transmission system so that supply matches demand whilst adhering to the Grid Code. The Nigeria System Operator exercises control over the grid to maintain an efficient, coordinated and economic supply of electricity and is a semi-autonomous sector under TCN.
Gas Aggregation Company Nigeria Limited	A Strategic Aggregator with the aim of stimulating the growth of the domestic gas market.
National Power Training Institute of Nigeria	Human resources development and workforce capacity building for the power sector.

Nigeria Electricity Liability Management Company Limited	Manages all assets, liabilities and obligations not taken over by successor companies.

Source: KPMG, “A Guide to the Nigerian Power Sector,” December 2013. <http://www.kpmg.com/Africa/en/IssuesAndInsights/Articles-Publications/Documents/Guide%20to%20the%20Nigerian%20Power%20Sector.pdf>.

4.2 Energy and electricity policy

4.2.1 Key policies

The key policies governing the power sector in Nigeria are:

Energy Commission Act 1979, 1988, 1989, 2011

The Act established the Energy Commission of Nigeria (ECN). The 2011 amendment seeks to prioritise the promotion and development of renewable energy sources.

National Electric Power Policy 2001

The Policy was a pre-cursor to the Reform Act in 2005 by setting the framework and objectives for the restructuring of the power sector.

National Energy Policy 2003

The National Energy Policy encourages optimum utilization of the country’s energy resources for sustainable national development with private sector participation. An integrated energy policy was necessary to guide future energy related sub-sector policy developments. A further reason for the policy was that a national energy policy is normally needed and requested by foreign investors.[136]

Electric Power Sector Reform Act 2005

The Act was the start and the foundation of the restructuring process of the power sector in Nigeria as the Act laid out the conditions under which private companies may participate in the generation, transmission and distribution of electricity. A legislative framework was developed in accordance with the National Electric Power Policy 2001. It led to the unbundling of PHCN and the establishment of NERC. It created the conditions for the development of a competitive electricity market and provided the basis for the determination of the tariff system.

Roadmap for the Power Sector Reform 2011, 2013

The Roadmap produced by the Presidential Task Force on Power is a strategy for fast-tracking the implementation of the 2005 Reform Act. The Roadmap seeks to complete the removal of legal, commercial and regulatory obstacles for private investors. It also sets out the plan for

[136] Federal Republic of Nigeria, Energy Commission of Nigeria, National Energy Policy, April 2003. <http://www.wacee.net/getattachment/21cca4e4-ef1b-4c59-8501-98b3e8624b88/National_Energy_Policy_Nigeria.pdf.aspx>.

rehabilitation of Nigeria's power sector. A revision was released in 2013 and further revisions are planned.

4.2.2 Renewable energy policy

Renewable Energy Master Plan 2005

The Master Plan, supported by United Nations Development Programme, is the roadmap for the development of renewable energy, excluding large hydropower projects. The renewable energy targets set are given in Table 4.3. However, these targets were not close to fulfilment according to the figures given in The Roadmap for Power Sector Reform in 2013. The Roadmap for Power Sector Reform proposed renewable energy sources will produce 50 MW by 2015 and 1,050 MW by 2020. In the medium-term, the Roadmap suggests that the Federal Government has plans for renewable energy to contribute to 5 per cent of the generation mix. A draft revision of the Renewable Energy Master Plan was subject of discussion in 2013 but no further details have been released.[137]

Table 4.3: Renewable power targets in Renewable Energy Master Plan (MW)

Renewable	2007	2015	2025
Small hydro	50	600	2,000
Solar PV	5	120	500
Solar thermal	0	1	5
Biomass	0	100	800
Wind	1	20	40
All renewable	56	841	3,345
High growth peak demand	**7,000**	**14,000**	**29,000**
Percentage of renewables in total generation mix	**0.8**	**6**	**11.53**

Source: Federal Republic of Nigeria, Energy Commission of Nigeria, Renewable Energy Master Plan: Final Draft Report, November 2005. <http://www.iceednigeria.org/workspace/uploads/nov.-2005.pdf>.

Renewable Electricity Policy Guidelines 2006

The Renewable Electricity Policy Guidelines were implemented by the Renewable Energy Action Plan in which the Federal Government expressed their intention for power generated using renewable energy, excluding large hydropower, to contribute to a minimum of 735 MW and at least 5 per cent of Nigeria's electricity generating capacity, by 2016. The distribution of the renewable energy sources targeted for 2016 differs from Table 4.3 as follows:[138]

- small hydro – 400 MW
- solar PV – 130 MW

[137] Isaac, N., "Nigeria: Renewable Energy As a Driving Force for Sustainable Devt," AllAfrica, 9 April 2013. <http://allafrica.com/stories/201304090148.html>.
[138] Federal Republic of Nigeria, Federal Ministry of Power and Steel, Renewable Electricity Action Program (REAP), December 2006. <http://www.iceednigeria.org/workspace/uploads/dec.-2006-2.pdf>.

- wind – 100 MW
- biomass – 105 MW

<u>Feed-in tariffs</u>

The feed-in tariff schedule is given as part of the Multi-Year Tariff Order and the figures are for wholesale contract prices for electricity generated by renewable sources (see Table 4.4). No feed-in tariff rates exist for landfill gas or offshore wind projects.

Table 4.4: Feed-in tariff system in Nigeria (USc/kWh)

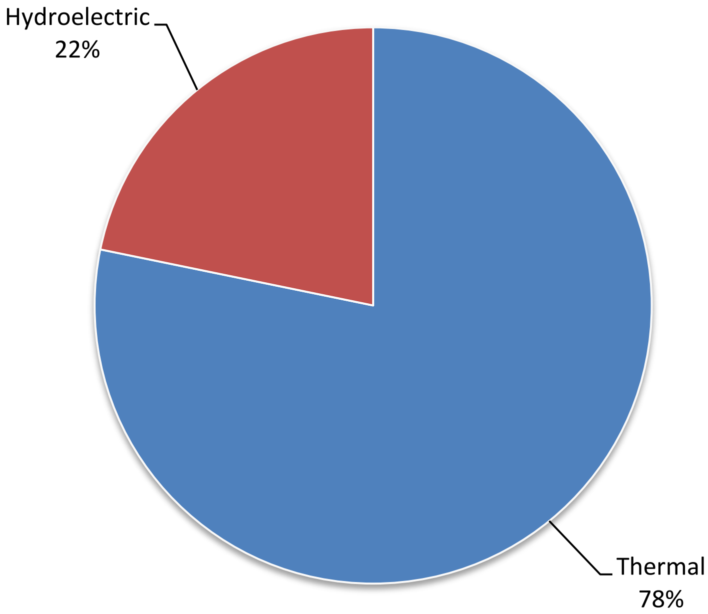
Power Plant	2012	2013	2014	2015	2016
Large hydro	3.01	3.26	3.52	3.80	4.11
Small hydro	14.52	14.44	16.92	18.27	19.72
Land mounted wind	15.12	16.34	17.65	19.07	20.60
Solar	41.85	10.66	48.76	52.63	56.81
Biomass	16.90	18.26	19.72	21.31	23.02

Source: NERC, Multi-Year Tariff Order, 1 June 2012. <http://www.ecowrex.org/system/files/documents/2012_multiyear-tariff-order-generation_nerc.pdf>. Exchange rate, 1 NGN = 0.00616257 USD, 14 July 2014. <http://www.xe.com/>.

4.3 Power generation

4.3.1 Current generation

Figure 4.1: Nigeria electricity generation mix 2011 (total 25,700 GWh)



Source: US Energy Information Administration, International Energy Statistics. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>.

Nigeria's generation mix is not diverse as it consists only of gas-fired and hydropower stations, as shown in Figure 4.1 and Table 4.6. Nigeria has one of the lowest electricity generation per capita rates in the world. The Ministry of Power stated that Nigeria has a per-capita installed capacity of about 40 kW of electricity per one thousand inhabitants compared to 120 kW by Indonesia, 145 kW by India, 190 kW by Morocco, 270 kW by South Africa and 530 kW by Brazil.[139] In 2004, National Integrated Power Project (NIPP) was conceived as a fast-track government funded initiative to stabilize the generation capacity and resulted in the construction of ten medium-sized gas power plants, some of which were not operational by mid-2014.[140]

For many years, available generation capacity has remained constant at approximately 4,000 MW, even though installed capacity is reported to have increased.[141] The 2010 Roadmap for Power Sector Reform identified that in the short-term, the Federal Government was committed to rehabilitating approximately 1,000 MW of generating capacity at existing PHCN power stations and installing an additional 1,266 MW at new NIPP power stations. In December 2012, the expected rehabilitation and the successful commissioning of NIPP's Omotosho and Olorunsogo were delivered. However, there was significant under-performance from the remainder of the NIPP gas-fired power stations. The reasons for the under-performance were delays in construction, insufficient gas supply infrastructure and insufficient transmission infrastructure to evacuate the electricity.

While the 11,680 MW target for 2012 was not achieved, the installed capacity had increased by 2,000 MW to 6,000 MW in total by December 2012. Table 4.5 compares the generation capacity that was expected for December 2013 in the Roadmap for Power Sector Reform with the generation capacity reported by the PTFP in July 2014.

Table 4.5: Installed, available and actual capacity in Nigeria (MW)

Capacity	Projected generation December 2013	Confirmed generation May 2014
Installed Generation	8,664	N/A
Available Generation	6,579	4,030
Actual Generation	4,671	3,558

Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>; Presidential Task Force on Power, 6 May 2014. < http://www.nigeriapowerreform.org/>.

[139] Federal Republic of Nigeria, Ministry of Power, "Investment Opportunities in the Nigerian Power Sector." <http://www.power.gov.ng/download/Publication%20on%20Investment%20opportunities%20in%20the%20Nigerian%20Power%20Sector.pdf>.
[140] NDPHC, National Integrated Power Project. <http://ndphc.net/?page_id=3331>.
[141] Thompson, C., "Privatisation shines a light on a route of the dark age," Financial Times, 5 May 2014. <http://www.ft.com/cms/s/0/fcd5b44a-bb15-11e3-948c-00144feabdc0.html#axzz311NZJvBZ>.

Table 4.6: Power stations in Nigeria

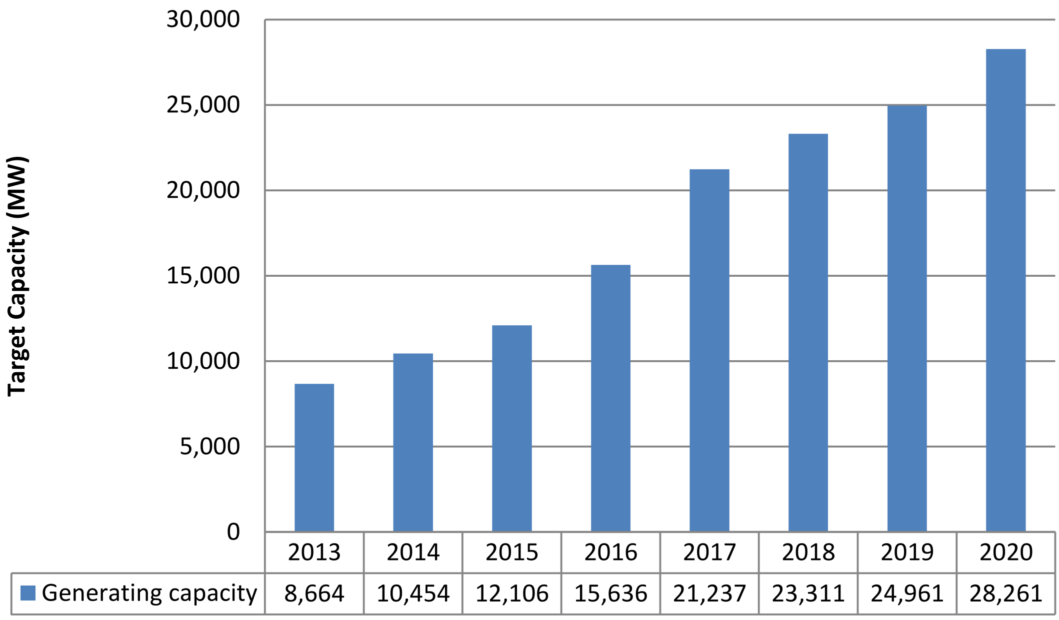
Name	Type	Owner	Capacity (MW)	Year completed
AES Barge	Gas-fired	AES Nigeria Barge	270	2001
Aba	Gas-fired	Geometric Power	140	2013
Afam IV-V	Gas-fired	Afam Power	987 (60)	1982/2002
Afam VI	Gas-fired	Shell Production Development Company	624	2009, 2010
Egbin	Gas-fired	Egbin Power	1320 (994)	1985-1986
Geregu I and II	Gas-fired	Geregu Generation	848	2007, 2013
Ibom	Gas-fired	Ibom Power	190 (60)	2009
Ihovbor	Gas-fired	Benin Generation	450	2014
Okpai	Gas-fired	Agip Oil	480	2005
Olorunsogo	Gas-fired	Sepco III and Pacific Energy	336 (160)	2007
Olorunsogo II	Gas-fired	Olorunsogo Generation	675 (562)	2012
Omoku I	Gas-fired	Rivers	150	2005
Omoku II	Gas-fired	Omoku Generation	252	2013
Omotosho I	Gas-fired	Omotosho Power	336	2005
Omotosho II	Gas-fired	Omotosho Generation	513	2012
Sapele I	Gas-fired	Sapele Power	1020 (200)	1978, 1981
Sapele II	Gas-fired	Ogorode Generation	508	2012
Ughelli	Gas-fired	Ughelli Power	900 (360)	1996, 1975, 1978, 1990
Kainji	Hydropower	Kainji Hydro Electric	760	1968
Shiroro	Hydropower	Shiroro Hydro Electric	600	1990
Jebba	Hydropower	Kainji Hydro Electric	540	1985
Zamfara	Hydropower	Zamfara	100	2011

Note: the figure in brackets under the capacity column is the actual generation capacity for power plants which fall well under their installed capacity. NERC, licensees. <http://www.nercng.org/index.php/industry-operators/licensing-procedures/licencees?start=80>; Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013.

<http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>; Wikipedia, List of power stations in Nigeria. <http://en.wikipedia.org/wiki/List_of_power_stations_in_Nigeria>.

4.3.2 Planned projects and generation targets

Figure 4.2: Targeted annual cumulative installed capacity in Nigeria 2013–2020



Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

An additional 26,561 MW of installed capacity is required to match the power demand forecast in Nigeria Vision 20:2020. An annual growth of 3,000 MW of generation capacity would be required. The latest government publication, the revision of the Roadmap for Power Sector Reform, targets 28,261 MW of generation capacity by 2020, which requires over a 20,000 MW increase from the end of 2013 to the end of 2020 and an improved performance by existing power plants. The targeted generation capacity will largely be achieved by IPPs. Once the NIPP projects are all completed in 2015, the current output of the NIPP plants should rise from 1,000 MW to 4,771 MW. There are a large number of planned projects in Nigeria (including the large-scale Mambilla hydropower project) which are listed in Appendix 9.2.

Table 4.7: Planned installed capacity additions in Nigeria 2020 (MW)

Power plant type	Generation capacity	
	2012	2020
Hydro	1,270	5,690
Gas and oil	4,730	20,000+
Coal	0	1,000
Renewable	0	1,000
All	6,000	28,261

Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

4.4 Demand and consumption

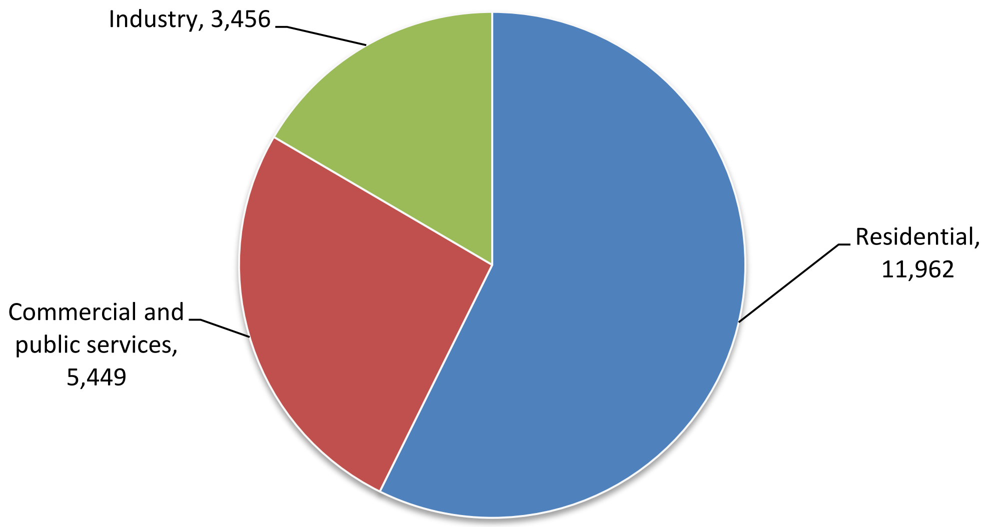
4.4.1 Electricity consumption

The World Bank estimated that Nigerians consumed 149 kWh per capita in 2011, up from 120 kWh per capita in 2009, but still less than half of the amount consumed per capita in Ghana and only a small fraction of that in South Africa. The demand-supply gap is estimated to be at 80 per cent.[142]

The consumption figure is much higher than the generation per capita figure and the gap between the figures could be largely attributable to the widely spread use of personal diesel or petrol generators in Nigeria. The Manufacturing Association of Nigeria estimated that over 60 million Nigerians have their own electricity generator, totalling at 6,000 MW – almost double the available capacity from power plants.[143] Nigerian residents are estimated to spend USD 10 billion annually fuelling private power generators. Residential users pay USD 0.50/kWh on candles and kerosene while self-generation of electricity costs USD 0.31–0.43/kWh. Manufacturing companies pay approximately USD 0.37/kWh on diesel generation. In contrast, electricity from a grid-connected supply costs USD 0.11–0.14/kWh.[144] Consumption in 2010 by different consumer groups is shown in Figure 4.3.

[142] Laurea, "Nigeria Report," 2012. <http://www.laurea.fi/en/connect/results/Documents/Nigeria%20Country%20Report.pdf>.
[143] Federal Republic of Nigeria, Energy Commission of Nigeria, "60m Nigerians now own power generators," <http://www.energy.gov.ng/index.php?option=com_content&view=article&id=74>.
[144] "The light is getting brighter in Nigeria," The Guardian Professional. <http://www.theguardian.com/global-development-professionals-network/adam-smith-international-partner-zone/nigeria-power-electricity-africa>.

Figure 4.3: Consumers of electricity in Nigeria 2010 (total 20,867 GWh)



Source: International Energy Agency, Nigeria: Electricity and Heat for 2010. <http://www.iea.org/statistics/statisticssearch/report/?country=NIGERIA&product=electricityandheat&year=2010>.

Actual power demand is unknown because of the growth of non-metered self-generated electricity for which it is very difficult to collect reliable information. No Federal Government policy includes load forecasting. An NOI poll showed that close to two-thirds of Nigerians received less than five hours of electricity per day with 18 per cent receiving zero hours of electricity at all in the first quarter of 2014. As a result, 79 per cent of Nigerians use alternative sources to augment their supply.[145]

4.4.2 Projected demand

The Vision 20: 2020 document estimates that Nigeria will need between 25,000 MW and 40,000 MW of power generation to accommodate for the 2020 forecasted demand. However, the forecasted demand is based upon the assumption that Nigeria will take a less energy intensive growth path than countries such as China; hence the future level of demand could in fact be much larger. Industry is expected to take up a larger share (than that shown in Figure 4.3) of the country's consumption as the extractive industries and associated manufacturing grow.[146]

The annual electricity demand growth is projected to be 7–13 per cent depending upon economic growth.[147] One of the weaknesses of Nigerian power sector policy is the absence of a

[145] NOI Polls, "6 in 10 Nigerian Households Received Less Than 5 Hours of Power Supply Daily in Q1," 15 April 2014. <http://www.noi-polls.com/index.php?s_id=3&p_id=317&p_pt=1&parent=11#.U2isZ4FdWig>.
[146] National Technical Working Group, "Report of the Energy Sector Nigeria Vision 2020," July 2009. <http://www.npc.gov.ng/vault/NTWG%20Final%20Report/energy%20ntwg%20report.pdf>.
[147] Laurea, "Nigeria Report," 2012. <http://www.laurea.fi/en/connect/results/Documents/Nigeria%20Country%20Report.pdf>.

load forecast. To attain Brazil's GDP per capita of USD 10,000 by 2030, Nigeria would need to generate 135 GW of power for the projected 230 million population. This figure is at least 15 times the current installed capacity. Power plants would need to be built at the rate of 7 GW a year from 2012 onwards, which has been achieved by only the US and China.[148] The widespread use of petrol and diesel generators is therefore likely to continue for some time until grid supply catches up with demand.

The Presidential Task Force on Power has recognized the need for a pilot program on energy efficient lighting to provide the impetus for promoting a national energy efficiency policy. It is projected that the development of a national policy on energy efficient lighting will be concluded before December 2014.

4.5 Transmission and distribution

4.5.1 Situation and problems

As mentioned in Section 4.1, the Transmission Company of Nigeria (TCN) is managed by Canadian Manitoba Hydro International in a three year contract from 2012 to 2015. During this time, TCN will be broken down into the Market Operator (MO), System Operator (SO) and Transmission Service Provider (TSP) so that the latter may become a commercial company. All the Nigerian distribution companies have all been privatized.

The transmission network is the biggest weakness in Nigeria's electricity sector. The national grid and related infrastructure suffers from inadequate, outdated and poorly maintained equipment as a result of poor planning and a lack of funding. As Table 4.8 shows, Nigeria has over 1,000 MW of "stranded" power, which is usable installed capacity surplus to the maximum capacity of the transmission and distribution system, hence cannot be fed into the grid for end users. In 2010, the transmission network covered less than 40 per cent of the country and could only handle under 6,000 MW. There were 12,000 km of transmission lines over 132 kV with a further 1,600 km under construction. Average transmission losses were 8.5 per cent.[149] In the eastern part of the country, four power plants were disrupted from coming online because of a shortfall of transmission lines to evacuate electricity from the power plants in 2012.

The targets of the 2010 Roadmap were to increase the capability of the distribution network by about 20 per cent, reduce aggregate distribution losses by at least 5 per cent by April 2011 and secure a noticeable increase in the average number of hours of electricity supplied to consumers by April 2011. The projected Distribution Companies' (Discos) capacity of 10,077 MVA (8,061 MW) by the end of Q4 2012 could not be achieved. The actual performance, in

[148] Federal Republic of Nigeria, Ministry of Power, "Investment Opportunities in the Nigerian Power Sector." <http://www.power.gov.ng/download/Publication%20on%20Investment%20opportunities%20in%20the%20Nigerian%20Power%20Sector.pdf>.

[149] Labo, H.S., Current Status and Future Outlook of the Transmission Network, PHCN, January 2010. <http://www.nigeriaelectricityprivatisation.com/wp-content/uploads/downloads/2011/02/Transmission_Company_of_Nigeria_Investor_Forum_Presentation.pdf>.

terms of capacity delivered by the Discos, by the end of Q4 2012 was 9,197.5 MVA (7,350 MW). Table 4.9 shows the wheeling capacity break-down for each distribution company.

Table 4.8: Nigerian distribution companies' maximum delivery capacity in 2012 (MW)

Regional Disco	Maximum wheeling capacity by January 2012	Maximum wheeling capacity by December 2012
Abuja	568	633
Benin	529	625
Eko	844	1019
Enugu	668	757
Ibadan	960	1057
Ikeja	935	1058
Jos	397	448
Kaduna	368	415
Kano	397	483
Port Harcourt	550	681
Yola	144	174
Total	6,360	7,350

Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

The NIPP included 118 transmission projects and 296 distribution projects. However, huge shortfalls have followed, with the cumulative transformer capacity reaching 2,880 MVA (2,304 MW) from the target of 6,190 MVA (4,952 MW) in 2013.

Due to a lack of funding, TCN failed to achieve the targets for 2012, which were set in 2010, as shown in Table 4.8. A serious shortfall in relation to 330 kV projects was partly due to the non-compliance of EPC contractors on a large transmission project (see Section 4.8). The distribution companies also fell short, fulfilling only 12 per cent of the improved distribution capacity target set for 2012. Consequently, in 2014, 63 per cent of Nigerians surveyed in a national opinion poll felt that their power supply had either not improved or had got worse.[150]

Table 4.9: Transmission network performance in Nigeria 2012

	330KV Transformation Capacity			132KV Transformation Capacity		
	Targeted	**Achieved**	**Slipped**	**Targeted**	**Achieved**	**Slipped**
MVA	9,833	8,588	1,245	11,232	10,907	325
MW	7,866	6,870	996	8,986	8,726	260

Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

[150] NOI Polls, "6 in 10 Nigerian Households Received Less Than 5 Hours of Power Supply Daily in Q1," 15 April 2014. <http://www.noi-polls.com/index.php?s_id=3&p_id=317&p_pt=1&parent=11#.U2isZ4FdWig>.

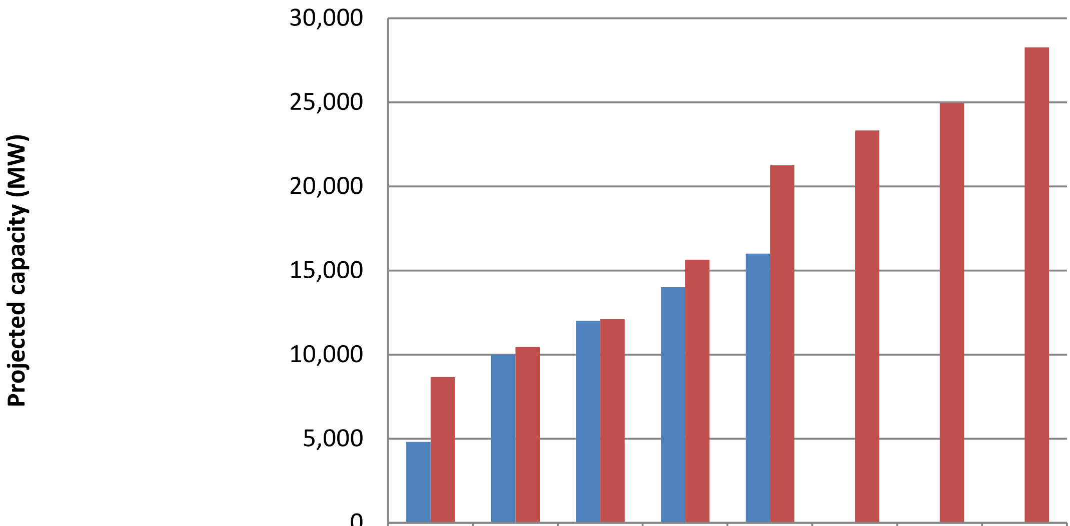
4.5.2 Future plans

The revision of the Roadmap for Power Sector Reform makes it clear that there is no firm projection on the level of future investment required for the improvements to the transmission system. Transmission tariff rates, as they stand, are inadequate to cover the financing costs associated with a large programme of investment in the transmission network. The Federal Government currently funds transmission investment through annual budgets, which introduces significant uncertainty and risk. The required investment will depend upon how the reformed electricity market develops. Funding of 1-1.5 USD billion per year is forecast to be required over the next five years, largely for planning, before a more detailed nationwide transmission system study is conducted.

The 2010 Roadmap set out that the Federal Government plan to build a new Ultra High-Voltage (765 kV) transmission line to evacuate power from the Mabilla hydropower station. The viability and scheduling of the project will be determined within the mid-term planning that is underway at TCN in their Network Expansion Blueprint, although no timeline or publication date for the Blueprint has been announced.

The expected transmission wheeling capacity for the end of 2016 is 11,000 MW, which is 4,000 MW lower than the expected generation capacity (see Figure 4.4).

Figure 4.4: Forecasted transmission capacity against forecasted available capacity in Nigeria 2013 - 2020



	2013	2014	2015	2016	2017	2018	2019	2020
Transmission wheeling capacity	4,800	10,000	12,000	14,000	16,000			
Available generation capacity	8,664	10,454	12,106	15,636	21,237	23,311	24,961	28,261

Source: Federal Republic of Nigeria, PTFP, “Roadmap for Power Sector Reform: Revision I,” August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

In 2011, the distribution network was targeted to: increase the delivery capacity by about 30 per cent, reduce aggregate distribution losses by at least 5 per cent and secure a noticeable increase in the average number of hours of electricity supplied to consumers by the end of 2013. In the medium- to long-term, responsibility for the operational effectiveness of the distribution network will transfer to private sector operators, although the NERC has an important role in setting a cost-reflective tariff. The Bureau of Public Enterprises indicated that an average annual investment of USD 357.7 million would be made collectively by the Discos for the next five years, starting from 2013.[151]

The monthly revenue gap of the Nigerian electricity market was about NGN 1.5 billion (USD 9.2 million) in August 2013, due to low collection efficiency and the non-payment of the Multi-Year Tariff Order subsidies by the Federal Government. The commercial targets for private distribution companies will be in line with their particular vesting contracts. The forecasted distribution system delivery capacity and information on the investment required are exhibited in Table 4.10 and Figure 4.5.

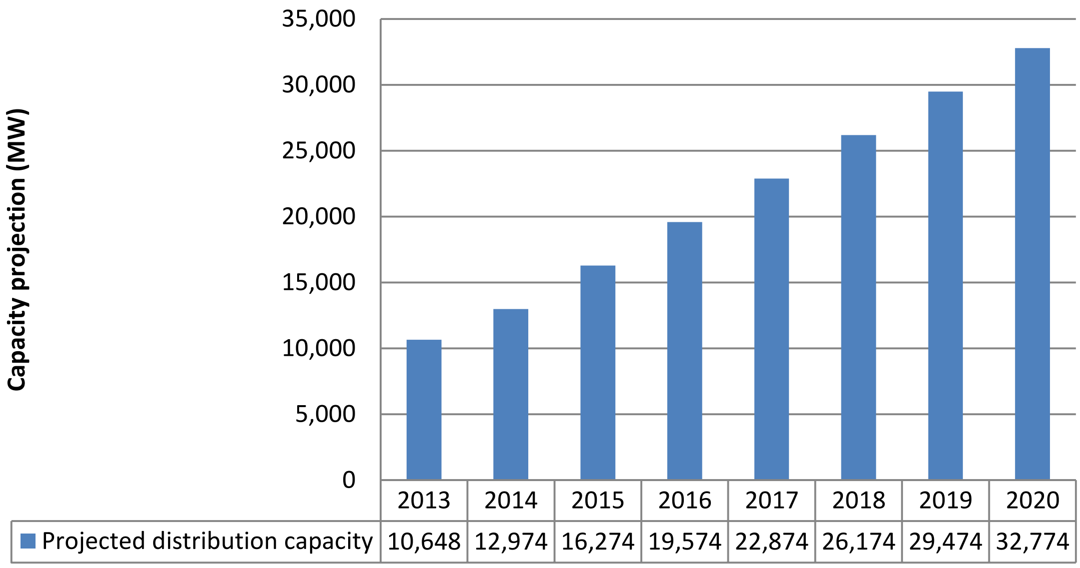
[151] Alike, E., "Nigeria: Power Investors to Commit U.S.$1.8 Billion to Distribution Companies," AllAfrica, 6 November 2013. <http://allafrica.com/stories/201311060169.html>.

Table 4.10: Forecasted distribution capacity additions and investment in Nigeria 2013–2020

Year	Additional capacity (MW)	Funding source	Investment required (USD billion)
2013	3,298	NIPP and MYTO I subsidy-funded projects	315
2014	2,326	NIPP and private investment	222
2015	3,300	Private investment	315
2016	3,300	Private investment	315
2017-2020	13,200	Private investment	1,261

Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>. Exchange rate, 1 NGN = 0.00616257 USD, 14 July 2014. <http://www.xe.com/>.

Figure 4.5: Forecasted distribution capacity in Nigeria 2013–2020



Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

4.6 Rural electrification

The World Bank statistics in 2011 calculated that 48 per cent of the overall population had access to electricity in Nigeria, whilst only 18 per cent of the rural population had access to electricity.[152] Poverty levels have grown concurrently with the population size as shown in Table 4.11. The lack of access to electricity is better understood placed in the wider context of the growing levels of poverty in Nigeria as the population size has increased nearly threefold in 30 years. Access to electricity is more readily available in southern Nigeria, whereas northern states like Kano have close to one million households without access to electricity.

[152] USAID, What Power Africa means for Nigeria, 9 April 2014. <http://www.usaid.gov/powerafrica/partners/african-governments/Nigeria>.

Table 4.11: Population and poverty development in Nigeria

Year	Estimated population (millions)	Population in poverty (millions)	Proportion of poverty (per cent)
1980	65	17.1	27.2
1985	75	34.7	46.3
1992	91.5	39.2	42.7
1996	102.3	67.1	65.6
2004	126.3	68.7	54.4
2010	163	112.47	69.0

Source: Ugwo O. et Al, "Expanding access to pro-poor energy services in Nigeria," International Centre for Energy, Environment and Development, October 2012. <http://www.iceednigeria.org/workspace/uploads/final-pro-poor-energy-access-paper-26-nov.pdf>.

The Rural Electrification Authority (REA) was established under Section 88 of the Electric Power Sector Reform Act 2005. REA has the mandate to implement rural electrification plans for Nigeria under the supervision of the Minister of Power. There are three kinds of rural electrification projects which REA undertakes:

- expansion of the grid to rural areas
- development of isolated and mini-grid systems
- off-grid renewable power generation

REA established and administers the Rural Electrification Fund to support rural electrification programmes through public and private sector participation. Up to 2013, REA had abandoned 1,994 rural electrification projects, many of which were 90 per cent complete. The reason cited for the abandonment was that many projects were inherited from the Ministry of Power and Steel. In their latest round of bidding in 2013, 7,000 companies bid for 360 projects, the majority of which were grid extensions.[153] Table 4.12 shows that REA's allocation of the Ministry of Energy's budget was raised dramatically in 2013 and the increased funding for rural electrification could continue as the Federal Government will not have to invest in basic infrastructure, such as power plants, with the completion of the privatization process.

Table 4.12: MoE's annual budget (USD)

Year	Allocation to REA	Ministry of Energy's total budget	Percentage of the allocation
2013	39,786,890	456,647,114	8.7
2012	3,949,131	444,373,738	0.9
2011	4,231,878	560,935,567	0.8
2010	1,946,218	964,270,152	0.2

Source: Federal Republic of Nigeria, Budget Office, 2013 Budget, Summary, Ministry of Energy. <http://www.budgetoffice.gov.ng/2013-budget_details/24.%20Summary_Power.pdf>. Exchange rate, 1 NGN = 0.00616257 USD, 14 July 2014. <http://www.xe.com/>.

[153] Yusuf A., "7,000 firms bid for 360 rural electrification contracts," Daily Independent, August 2013. <http://dailyindependentnig.com/2013/08/7000-firms-bid-for-360-rural-electrification-contracts/>.

There is significant controversy surrounding REA, relating to corruption, and the organization was close to termination in 2011. President Goodluck Jonathan, however, has expended a significant portion of the Federal Government budget on REA and in early 2014, Managing Director Achugbu was suspended for poor implementation of the budget. Because the private distribution companies are mandated to invest in the expansion of their distribution facilities to reach rural communities, the functions of the REA could be narrowed.[154]

The Government target is to reach 75 per cent electrification by 2020. President Jonathan inaugurated operation 'Light-Up Nigeria' in early 2014. The programme promotes the use of renewable energy sources to generate electricity for rural communities. Under the first phase of the programme, at least three communities in each of the 36 states would be electrified through solar energy.[155] President Jonathan claimed that a Rural Electrification Strategy, which would be the policy outlining the future development of rural electrification in Nigeria, would be ready by the first quarter of 2014 but there is no sign of the Strategy's release as of July 2014.

The European Union agreed in early 2014 to partner with Nigeria in supporting rural electrification.[156] In Table 4.13, donor agencies and the projects they have supported are listed.

Table 4.13: Example donor agency rural electrification projects in Nigeria

Donor agency	Project name and description	Level of funding (USD)
USAID	Power Africa project. For Nigeria, USAID helps through credit enhancement, grants, technical solutions and investment promotion efforts.	N/A
	Energy efficient woodstoves in Lagos and Ebonyi states.	N/A
GIZ/EU	Nigeria's Energy Support Programme.	33 million
	Energising access to Sustainable Energy.	55 million
UNDP	GEF Nigeria energy efficiency project. Data gathering, setting up test centres, raising awareness and pilot projects.	2.8 million
	Access to renewable energy scale up initiative.	5.9 million
UNIDO	30 kW and 75 kW pilot hydro projects in Enugu and Bauchi states.	N/A
GEF	Between 2010 and 2014, USD 5 million has been spent for projects, for example, mini-grids based on renewable energy sources and small scale associated gas utilization.	14.3 million
JICA	Bwari solar powered plant for the treatment of water in 2014.	10 million
	Rural electrification in Cross River and Akwa Ibom states in 2008.	5.6 million

[154] "Nigeria's Rural Electrification Agency – Hobbled By Squabbles," All Africa, 4 February 2014. <http://allafrica.com/stories/201402041194.html?viewall=1>.
[155] "Jonathan inaugurates 'Light-Up Rural Nigeria' project in Abuja," Premium Times, 14 January 2014. <http://www.premiumtimesng.com/news/153317-jonathan-inaugurates-light-rural-nigeria-project-abuja.html>.
[156] Embassy of Nigeria Sweden, "The European Union (EU) to support Nigeria in rural electrification," 21 January 2014. <http://nigerianembassy.nu/eu-to-support-nigeria-in-rural-electrification/>.

	Introduction of clean energy by solar electricity generation system in 2011.	9.6 million

Source: Ugwo O. et Al, "Expanding access to pro-poor energy services in Nigeria," International Centre for Energy, Environment and Development, October 2012. <http://www.iceednigeria.org/workspace/uploads/final-pro-poor-energy-access-paper-26-nov.pdf>; Donor agency websites

4.7 Tariffs

There are five tariff categories in Nigeria and 14 sub-categories in total (see Table 4.14). The tariff rates vary for each Distribution Company (Disco), of which there are 11. A sample of the tariff rates from Eko, Abuja and Yola are shown in Table 4.15. These states were chosen as they vary in distribution wheeling capacity hence have different sized customer bases. As shown in Table 4.9, Eko has the largest capacity, Yola the smallest capacity and Abuja a medium-size capacity.

Table 4.14: Tariff categories in Nigeria

Customer category		Description	Remarks
Residential	R1	Life-Line (50 kWh)	Premises used exclusively as a residence-house, flat or multi-storeyed house.
	R2	Single and 3-phase	
	R3	LV maximum demand	
	R4	HV maximum demand (11/33 KV)	
Commercial	C1	Single and 3-phase	Premises used for any purpose other than exclusively as a residence or a factory for manufacturing goods.
	C2	LV maximum demand	
	C3	HV maximum demand (11/33 KV)	
Industrial	D1	Single and 3-phase	Premises used for manufacturing goods.
	D2	LV maximum demand	
	D3	HV maximum demand (11/33 KV)	
Special	A1	Single and 3-phase	Customers such as farmers, water boards, religious houses, hospitals, government research institutes and educational establishments.
	A2	LV maximum demand	
	A3	HV maximum demand	
Street Lighting	S1	Single and 3-phase	

Source: NERC, New tariff classes under the 2012 Tariff Order. <http://www.nercng.org/index.php/document-library/func-startdown/101/>.

Table 4.15: Electricity tariff rates for Eko, Abuja and Yola 2014 and 2015 (USD)

Disco	**Eko**	**Abuja**	**Yola**	**Eko**	**Abuja**	**Yola**
Category	**2014 Fixed charge (USD/month)**			**2015 Fixed charge (USD/month)**		
R1	0	0	0	0	0	0
R2	6.99	6.13	7.77	10.49	8.60	12.18
R3	297.33	459.83	250.78	327.07	645.71	393.01
R4	934.13	1,187.02	1,567.27	1,027.55	1,666.839	2,456.24
C1	6.99	6.13	7.77	10.49	8.60	12.18

C2	158.43	416.87	227.34	185.30	585.36	356.29
C3	810.04	1,076.12	1,420.85	891.04	1,511.11	2,226.76
D1	8.43	87.26	7.77	10.11	122.53	12.18
D2	803.50	882.33	1,397.97	884.47	1,238.99	2,197.13
D3	810.04	1,076.117	1,420.85	891.04	1,511.11	2,226.762
A1	6.06	6.13	7.77	9.09	8.60	12.18
A2	357.16	376.32	462.98	392.88	528.43	725.59
A3	399.46	474.48	626.48	439.40	666.28	981.82
S1	6.99	5.24	7.77	10.49	7.35	12.18
	2014 Energy charge (USc/kWh)			**2015 Energy charge (USc/kWh)**		
R1	2.49	2.49	2.49	2.49	2.49	2.49
R2	8.00	8.23	7.94	7.99	8.64	8.34
R3	14.73	14.76	14.11	14.73	15.50	14.82
R4	14.73	14.76	14.11	14.73	15.50	14.82
C1	9.84	10.81	11.11	9.84	11.35	11.66
C2	13.70	13.72	13.12	13.70	14.40	13.78
C3	13.70	13.72	13.12	13.70	14.40	13.78
D1	11.05	11.07	10.59	10.90	11.62	11.12
D2	14.35	14.38	13.75	14.35	15.10	14.44
D3	14.35	14.38	13.75	14.35	15.10	14.44
A1	10.58	10.60	10.14	10.58	11.12	10.64
A2	15.08	10.60	10.14	10.58	11.12	10.64
A3	15.08	10.60	10.14	10.58	11.12	10.64
S1	8.12	8.75	7.78	8.12	9.18	8.17

Source: NERC, Retail Tariff for respective DISCOs. <http://www.nercng.org/index.php/document-library/Tariff-Charges--and--Market-Rules/Retail-Tariff-for-respective-DISCOs/>. Exchange rate, 1 NGN = 0.00621426 USD, 8 May 2014. <http://www.xe.com/>.

In 2008, NERC decided to introduce the Multi-Year Tariff Order (MYTO) as the framework for determining the electricity industry tariff pricing structure. The two key principles are cost-reflectivity and affordability. MYTO provides a 15-year tariff path with minor and major reviews every year and every five years, respectively.

The initial tariff schedule MYTO I had gas prices and exchange rates which had changed substantially by 2012, and as a result, prospective foreign investors found the tariff rates to be unattractive. MYTO I also failed to consider the tariff rates for power generation from alternative sources of energy, such as coal, wind and solar, which prospective investors had showed an interest in. Consequently, MYTO II was developed for the period of June 2012–May 2017, far earlier than the major five year review scheduled for 2013, to improve upon the shortcomings of MYTO I.

A Federal Government tariff subsidy was introduced for the first two years of MYTO II to protect rural and poor urban customers from price shocks associated with the new tariff schedule. The subsidy applies per unit of electricity billed to those customers and the Federal Government pays the distribution companies. This subsidy ended in June 2014.

4.8 International manufacturers

This section lists the involvement of manufacturing companies in major projects in the Nigerian power sector.

ABB

ABB pledged to set up a local power equipment manufacturing plant in Nigeria. The development is part of the Federal Government's privatisation objective that will allow both local and international companies to invest in the nation's power sector.[157]

In 2000, ABB won a USD 40 million order to design and build a new high-voltage power transmission corridor, including the installation of fiber optics, to Nigeria's federal capital of Abuja.[158]

ABB won contracts worth USD 44 million from state-owned National Electric Power Authority (NEPA) in 2002, for two transmission and distribution projects to upgrade the country's electrical supply infrastructure.[159]

In a major, two-year project worth USD 34 million, ABB designed and built a 132 km 330 kV transmission line connecting the cities of Benin and Onitsha in southern Nigeria. The contract included a 2.5 km overhead transmission line across the Niger River, and installation of composite fiber optic cable throughout the line to strengthen the country's telecommunications and data communications capabilities.

In a USD 10 million project, ABB worked on the fast-track refurbishment of 92 circuit breakers (330 kV and 132 kV) at seven different transmission and distribution substations throughout Nigeria. In addition to supplying spare parts and a range of high-voltage components, ABB provided technical training for Nigeria's NEPA engineers.

Siemens

Following the Afam V and Geregu I plants, Geregu II was the third gas-turbine power plant to be constructed by Siemens in Nigeria as a turnkey project. The scope of delivery for Geregu II included three SGT5-2000E gas turbines, three SGen5-100A generators, as well as all the electrical systems and the SPPA-T3000 control system. Delivery was completed in 2013.[160]

Siemens signed a memorandum of strategic collaboration and partnership with the Nigerian Federal Government in 2012. The memorandum enables the company to set up a local service

[157] Kalejaye, K., "Power: ABB to set up manufacturing plant in Nigeria," Vanguard, 28 January 2014. <http://www.vanguardngr.com/2014/01/power-abb-set-manufacturing-plant-nigeria-2/>.

[158] "ABB wins US$ 40-million power transmission project in Africa," ABB, 7 November 2000. <http://www.abb.co.uk/cawp/seitp202/c1256c290031524bc125699000486ee1.aspx>.

[159] "ABB wins power contracts worth US$ 44 million in Nigeria," ABB, 18 April 2002. <http://www.abb.co.uk/cawp/seitp202/c1256c290031524bc1256b9f00276566.aspx>.

[160] "More Power for Nigeria's future: Siemens hands over Geregu II gas-turbine power plant to customer on schedule," Siemens, 4 June 2013. <http://www.siemens.com/press/en/feature/2013/energy/2013-06-geregu2.php>.

workshop, develop and train local service staff and construct a 1,600 MW gas turbine power station in Lekki, Lagos.

GE

GE Chairman, Jeffrey Immelt, said that from 2013 the company would invest USD 1 billion in Nigeria in the following five years by building a manufacturing plant in Calabar to support power generation and oil production.[161]

GE has supplied most of the gas turbines in Nigeria. GE supplied four 126 MW GE Frame 9E Gas Turbines and two 285 MW GE Steam Turbines for the Alaoji power station. At the Olorunsogo II power plant four GE Frame 9E Gas Turbines and two GE Steam Turbines were provided. The Calabar, Sapele II and Ihovbor power plants each have four GE Frame 9E Gas Turbines.[162]

In 2010, GE announced that it would provide four gas turbines for the 500 MW Omotosho Phase 2 power plant in Ondo, Nigeria. The scope of supply includes gas turbines, generators, accessories, and technical assistance and training for the EPC contractor for the project, China Machinery & Equipment Company.[163]

GE supplied the majority of the gas turbines in Ughelli power plant. Nigeria's Transnational Corporation (Transcorp) has partnered with GE to expand the capacity of its 360 MW Ughelli plant by 1,000 MW over the next three to five years.[164]

In a consortium with Rockson Engineering Nigeria, GE signed a contract for the construction of the Kaduna dual thermal plant fed by low pour fuel oil and natural gas. The contract was worth USD 230 million. The 215 MW plant is scheduled to be completed by the end of 2014. [165]

GE signed a USD 350 million Memorandum of Understanding in 2014 to light up small communities across the country. Investors will be able to build smaller power plants off the main grid with smaller turbines.[167]

In a partnership with the US African Development Foundation, GE has been involved with projects granting USD 100,000 to proposals for off-grid energy solutions for marginalized African communities. Six winners were chosen, three of which were from Nigeria.[168]

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[161] Mazen, M., "General Electric Plans £1 Billion Investment in Nigerian Power," Bloomberg, 31 January 2013. <http://www.bloomberg.com/news/2013-01-31/general-electric-plans-1-billion-investment-in-nigerian-power.html>.

[162] Industcards, CCGT Plants in Nigeria, 17 March 2014. <http://www.industcards.com/cc-nigeria.htm>.

[163] Bowman, A., "Nigeria wins $1bn General Electric manufacturing investment," 31 January 2013. <http://blogs.ft.com/beyond-brics/2013/01/31/nigeria-wins-1bn-general-electric-manufacturing-investment/#axzz2ni9sQ1J6>.

[164] Odendaal, N., "Transcorp, GE cement deal to expand Nigeria power plant," Engineering News, 31 January 2014. <http://www.engineeringnews.co.za/article/transcorp-ge-cement-deal-to-expand-nigeria-power-plant-2014-01-31>.

[165] Adeoye, Y., "Rockson, GE to construct 215MW power plant in Kaduna," Vanguard, 30 November 2009. <http://www.vanguardngr.com/2009/11/rockson-ge-to-construct-215mw-power-plant-in-kaduna/>.

[167] Nnabugwu, F., "Nigeria, General Electric sign $350m MoU on power plants for small communities," Vanguard, 3 February 2014. <http://www.vanguardngr.com/2014/02/nigeria-general-electric-sign-350m-mou-power-plants-small-communities/>.

Hitachi

From 2011 to 2013, Hitachi rehabilitated Egbin's thermal power boiler and turbine in Lagos for which Hitachi originally supplied six 220 MW turbines. The company was contracted to supply six H25 gas turbine units at the Delta Ughelli power station between 2002 and 2008.[169]

Schneider Electric

In 2012, Schneider Electric signed a NGN 4.2 billion (EUR 20 million) energy management contract with the Rivers State Government. Schneider Electric designed, manufactured and supplied 28 units of 15 MVA 33/11 kV injection substations. A service centre and workshop will be set up as part of the contract. Prior to the contract, Schneider Electric had supplied, installed and commissioned six 132/33 kV substations in Ahoada, Emohua, Degema, Trans-Amadi, Ogu and Kaa for EUR 8 million.[170]

Daewoo Engineering & Construction

In 2012, Daewoo Engineering & Construction signed a Memorandum of Understanding with the Federal Government for the construction of 10,000 MW of power plants, in which Daewoo will provide 20 per cent of the equity for various projects.[171]

Electrobas

In 2012, the Brazilian firm, Electrobas signed a Memorandum of Understanding on the development of power projects in Nigeria.[172]

Alstom

In 2012, Alstom was contracted by the Rivers State Government to deliver a GT13E2 gas turbine to the Port Harcourt power plant. The gas turbine has an output of 182.2 MW. The contract price was approximately USD 54 million.[173]

In 2013, Alstom signed a technical cooperation agreement with Taleveras Group of Companies Limited. The agreement is for supplies and services for the rehabilitation and capacity expansion of the Afam power station.[174]

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[168] African Development Foundation, Round I. <http://www.adf.gov/offgrid/USADFPowerAfricaChallenge-RoundI.htm>.

[169] Hitachi Plant Technologies, HPT's Activity for Thermal Power Plants, July 2006. <http://www.vhpc.com.ve/presentations/eng/3%20Thermal%20Power%20Short%20Version%20-%20July%202006.pdf>.

[170] Bamidele, J., "Schneider Electric signs EUR20 million Energy management contract with Nigerian state," Biztellers, 6 March 2012. <http://biztellers.com/2012/03/schneider-electric-signs-e20-million-energy-management-contract-with-nigerian-state/>.

[171] Opara, S., "FG, Daewoo sign MoU for 10,000MW," Punch, 5 July 2012. <http://www.punchng.com/business/business-economy/electricity-fg-daewoo-sign-mou-for-10000mw/>.

[172] Bello, M.,"FG Signs MoU with Brazil's Electrobas," This Day Live, 22 June 2012. <http://www.thisdaylive.com/articles/fg-signs-mou-with-brazil-s-electrobas/118470/>.

[173] "Nigeria chooses Alstom to equip its Port Harcourt power plant," Alstom, 2 January 2012. <http://www.alstom.com/press-centre/2010/4/Nigeria-chooses-Alstom-to-equip-its-Port-Harcourt-power-plant-20100415/>.

Alstom's global gas turbine equipment and services was acquired by GE in June 2014.[175]

Rolls Royce

Rolls Royce was awarded a USD 82 million contract in September 2005 from Technip for six RB211 industrial gas turbines. They supplied a 31 MW Rolls Royce RB211 GT for a small-scale project in Kolo Creek power station which was installed in early 2008.[176]

CNEEC-Sinohydro

The consortium of China National Electric Engineering Co. and Sinohydro won a USD 1.3 billion engineering, procurement and construction contract for the Zungeru hydropower plant. The 700 MW power station will be the largest in Nigeria at the time of completion. The project was largely funded by Chinese loans.

Group Five

The South African company Group Five was awarded a USD 62 million contract for the design, supply and installation of a 130 MW gas-fired power station in Abia state. The project was scheduled to be completed in late 2008. Group Five also executed the first stage of the 2005 USD 90 million contract for a new power station in Akwa Ibom state.[177]

Paymabargh and Cartlark

Iran's Paymabargh and Nigeria's Cartlark were contracted in 2005 for Lot 4 in Akwa Ibom state which included the 330 KV substation at Ikot-Ekpene, four incoming 330 KV double circuit transmission lines from Alaoji, Afam, Ikot-Abasi and Odukpani power plants and two outgoing 330 KV double circuit transmission lines to Ugwuaji and Enugu state. The contract, initially for two years work, was terminated after six years of non-completion.[178]

4.9 Risks and opportunities

4.9.1 Issues

Transmission

The transmission network is the central problem in Nigeria's comprehensively underperforming electricity sector. The transmission system is constituted of radial lines which are not interconnected, resulting in high levels of power failure. For instance, Baysela state did

[174] Opara, T., "Alstom partners Nigeria in infrastructural development," Vanguard, 19 October 2013. <http://www.vanguardngr.com/2013/10/alstom-partners-nigeria-in-infrastructural-development/>.

[175] Saintvilus, R., "Why General Electric Stock Can Still Shock Investors After Alstom," The Street, 1 July 2014. <http://www.thestreet.com/story/12761553/1/why-general-electric-stock-can-still-shock-investors-after-alstom.html>.

[176] "RB211 for Nigeria's Kolo Creek," Modern Power Systems, 1 December 2006. <http://www.modernpowersystems.com/features/featurerb211-for-nigeria-s-kolo-creek/>.

[177] "Group Five awarded R430 million independent African power generation project," Group Five, 10 December 2007. <http://www.groupfive-online.co.za/news_article.php?articleID=777>.

[178] Okafor, C., "Power: Contractor's Indifference May Cost Nigeria 2605MW," This Day Live, 14 March 2012. <http://www.thisdaylive.com/articles/power-contractor-s-indifference-may-cost-nigeria-2605mw/111421/>.

not have power for three weeks due to the failure of one of the transmission lines.[179] Substations are overloaded and the equipment is outdated. Along with vandalism, the outdated and overloaded network contributes to high transmission losses.

Transmission Company of Nigeria (TCN) is reviewing Manitoba Hydro International's management contract after controversy over the discretionary powers allotted to Manitoba Hydro International.[180] The planned transmission projects have fallen well behind schedule with the targets set in 2010 not even close to fulfilment, and have been mired in contractual disputes (See Section 4.8, Paymabargh and Cartlark).

There are limited funds for development projects - the Roadmap for the Power Sector highlights that the uncertain Federal Government annual determination of funding for transmission is an obstacle to commissioning long-term projects and TCN is unable to raise finances upfront for investments due to a lack of credit-worthiness, even if the transmission charges could cover the costs. TCN's Managing Director announced in early 2014 that TCN needed USD 7.7 billion over the next five years to expand and improve the transmission network. A conclusion for the transmission funding solution was targeted for June 2014 but no details have been released as of July 2014.

Even with the funding, transmission projects face obstacles in the form of a lack of technical expertise, community issues and right of way disputes. The long-term development strategy, known as the Transmission Network Expansion Blueprint, was supposed to be produced in late 2013 but it has yet to be released as of July 2014.

<u>Maintenance</u>

Power stations and infrastructure, which were built in the 1970s during Nigeria's oil industry growth, have not been properly maintained. Successive governments failed to place importance upon maintenance, which has led to a current-day backlog in maintenance required for the whole power system. The Minister of Power, Chinedu Nebo, conceded that the Federal Ministry of Power's 2012 budget failed to account sufficiently for the maintenance of power equipment.

<u>Gas supply</u>

The majority of power plants in Nigeria are gas-fired yet the infrastructure to supply them with the gas they need is inadequate. In January 2014, the shortage of gas, combined with faults and backlog of maintenance works at the power plants led to 2,993 MW of generation capacity remaining under-utilized.[181] The construction of gas infrastructure faces difficulties due to the

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[179] Daly, J., "Not Darkest Africa, but Darkest Nigeria – 120 Million Without Electricity," Oilprice, 24 June 2013. <http://oilprice.com/Energy/Energy-General/Not-Darkest-Africa-but-Darkest-Nigeria-120-Million-Without-Electricity.html>.

[180] Echewofun, S., "Nigeria: FG to Cut Manitoba's Power in N3.9 Billion Deal," All Africa, 8 January 2014. <http://allafrica.com/stories/201401080399.html>.

[181] Oketola, D., "Nigeria loses 2,994MW to gas shortage, faults," Punch, 28 January 2014. <http://www.punchng.com/business/business-economy/power-nigeria-loses-2994mw-to-gas-shortage-faults/>.

insecurity of the Niger Delta region. The required gas transportation infrastructure investment is estimated by the Chairman of Oil Producers Trade Section of Lagos Chamber of Commerce and Industry to be USD 10 billion with a further USD 12 billion for gas-fired power stations and USD 3 billion for associated transmission and distribution lines.[182]

Available or actual generation capacity has not increased, despite the increase in installed capacity. Several of the NIPP gas-fired power plants were built without the guarantee of a gas supply at the time of their completion.

The Nigerian Gas Company (NGC), a subsidiary of Nigerian National Petroleum Corporation (NNPC), allocates gas between the power, industrial and export sectors with no public accounting for the volume of gas allocated. IPPs and the Ministry of Power can't predict the future level of gas supply or determine whether the gas delivered is in line with legal agreements. Payments for the gas by the power sector have been in arrears. Reforms are needed in the arrangements of the gas supply for the power sector. These reforms include increased transparency in gas allocations, ensuring the timely payment for gas used by the power sector and adherence to the contractual legal model for the gas industry rather than unofficial agreements and relationships.[183]

Distribution companies (Discos)

Discos face a difficult challenge in making returns on investments. A high initial capital expenditure is required, which has mostly been acquired through loans. Only three out of 11 Discos had remitted payments to the Market Operator in December 2013, for power received in the month. It puts into question whether the private companies have the financial capability to make the requisite improvements to the distribution system in their region.[184]

Despite the changes to the tariff schedule through the Multi Year Tariff Order, the tariff rates still fail to be cost-reflective and private companies could fail to recover operational costs (see Section 4.7). Customer service is poor as the metering system is insufficient and estimated billing leads to many overcharged customers. NERC has tried to introduce pre-paid meters but the Discos have not taken serious action to improve the metering system. Yet the Discos will struggle to raise the funds to improve customer service as fraudulent customers pose an operational and financial obstacle, with the violations ranging from unlawful connections to the distribution line to bypassing or tampering with the electricity meter.[185] There is currently no policy or initiatives countering electricity theft.

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[182] Oketola, D., "Funding, infrastructure, gas supply problems plague power sector," Punch, 29 December 2013. <http://www.punchng.com/business/energy/funding-infrastructure-gas-supply-problems-plague-power-sector-2/>.

[183] Uddin, M., "Powering Nigeria's future from gas," The Guardian Professional. <http://www.theguardian.com/global-development-professionals-network/adam-smith-international-partner-zone/powering-nigeria-future-from-gas>.

[184] Nnodim, O., "Power distribution firms owe govt – NERC," 26 February 2014. <http://www.punchng.com/business/business-economy/power-distribution-firms-owe-govt-nerc/>.

[185] Joseph, O., "Issues and challenges in the Privatized Power Sector in Nigeria," Journal of Sustainable Development Studies Vol. 6, No.1, 2014. <http://infinitypress.info/index.php/jsds/article/view/704/324>; NERC, Tariff Design and

Expectations

The policy and targets set by the Federal Government are unrealistic in places, especially with regard to short-term improvements. The revision of the Roadmap for Power Sector Reform is full of unachieved targets, often not even close to being achieved. It was hoped that post-privatization, an immediate improvement to the power supply would occur. However, the power supply became worse once the unbundled companies were privatized.

4.9.2 Future opportunities

According to the Federal Government, one of the main points explaining the underperformance of the Nigerian power sector in the 2013 revision of the Roadmap for Power Sector Reform was the underperformance of EPC contractors, and the lessons which were learnt from their underperformance. There has been a push for sharper monitoring and punitive measures that may be implemented regarding EPC contractors, as well as mechanisms to fast-track the implementation of those measures against non-performing EPC contractors. The higher level of monitoring and enforcement is hoped to bring about an improvement in project management and respect for project deadlines.

NERC produced local content regulations for the Nigerian Electricity Supply Industry in 2013.[186] The regulations became law in the first quarter of 2014. The key local content provisions for the electricity supply industry are:

- first consideration is given to Nigerian operators for licences and to Nigerian goods and services in the award of contracts
- a local content plan must be prepared and submitted to NERC for any projects exceeding NGN 15 million (USD 92,000)
- for bids within 1 per cent of each other at the commercial stage, the bid with the highest level of Nigerian content must be selected
- a maximum of 5 per cent of management positions for expatriates and it must be shown that no suitably qualified Nigerian is available for the position
- companies must show that a minimum of 51 per cent of the equipment used for the execution of work is owned by Nigerian subsidiaries
- an annual Nigerian Content Performance report must be submitted sixty days before the end of the financial year
- an annual technology transfer report must be prepared and submitted to NERC

In a presentation on investment opportunities, the Ministry of Power suggested that an average investment of USD 10 billion per year is required in the Nigerian power sector.[187] UK

Regulation, February 2011. <http://www.nigeriaelectricityprivatisation.com/wp-content/uploads/downloads/2011/02/NERC_BPE_CPCS_February_2011_Roadshow.pdf>.

[186] NERC, Regulations on National Content Development for the Nigerian Electricity Supply Industry 2013. <http://www.nercng.org/nercdocs/Regulations%20on%20National%20Content%20Development%20for%20the%20Nigerian%20Electricity%20Supply%20Industry%202013.pdf>.

Trade and Investment estimates that USD 2.6 to 5 billion of investment is needed in transmission and distribution infrastructure and equipment to match the generation capacity growth, whilst TCN's Managing Director predicts a significantly larger investment.[188] The following opportunities for international manufacturers have been identified:

- gas infrastructure, especially the supply of gas to power plants; estimated need for the construction of 2,000 km of pipelines by 2017
- rehabilitation and maintenance of the assets acquired under privatization. Potential expansions of power plants after the maintenance
- new IPP gas-fired power plants
- an expected increase in greenfield power plant projects[189]
- developing and repairing large and small sized hydropower plants, 370 sites identified for small scale hydropower projects[190]
- solar power projects in the first stage of 'Light-up Nigeria' and HQMC of South Korea will invest USD 30 billion in solar power in Nigeria[191]
- wind power projects in the second stage of 'Light-up Nigeria' if the research supports the development of wind power
- manufacturing companies signing a Memorandum of Understanding with TCN for the rehabilitation, upgrade and construction of the transmission lines, transformers and substations
- planning and construction of the 765 KV super grid
- the reassignment of contracts for partially complete projects
- planning and constructing embedded generation and independent electricity distribution networks
- supply and installation of meters, for example, USD 150 million investments will be made in Eko Electricity Distribution Company for metering and improving the distribution network.

The Ministry of Power's publication on investment opportunities in the Nigerian power sector suggests the following support services, in addition to the infrastructural developments suggested above:[192]

- specialised training for electricity industry technicians and engineers

[187] Ishaku, D., Current Status and Investment Opportunities in the Nigerian Power Sector, 11 October 2012. <http://www.unido.or.jp/download/Federal_Ministry_of_Power_Nigeria.pdf>.
[188] UK Trade and Investment, Exporting to Nigeria, 28 March 2014. <https://www.gov.uk/government/publications/exporting-to-nigeria/exporting-to-nigeria>.
[189] Wallis, W., "Nigerian power plant wins £750m of finance," Financial Times, 5 May 2014. <http://www.ft.com/cms/s/0/d260abce-d461-11e3-a122-00144feabdc0.html#axzz311NZJvBZ>.
[190] Ishaku, D., Current Status and Investment Opportunities in the Nigerian Power Sector, 11 October 2012. <http://www.unido.or.jp/download/Federal_Ministry_of_Power_Nigeria.pdf>.
[191] Onuba, I., "Korean firm to invest $30bn in Nigeria's solar plant," Punch, 25 November 2012. <http://www.punchng.com/business/money/korean-firm-to-invest-30bn-in-nigerias-solar-plant/>.
[192] Federal Republic of Nigeria, Ministry of Power, "Investment Opportunities in the Nigerian Power Sector." <http://www.power.gov.ng/download/Publication%20on%20Investment%20opportunities%20in%20the%20Nigerian%20Power%20Sector.pdf>.

- construction of assembly plans for intermediary power equipment and accessories, including meters
- establishing consultancies in regulatory and consumer education initiatives
- power sector-specific equipment testing, calibration and logistics services
- setting up ventures for manufacturing energy efficiency products

5. Kenya

5.1 Electricity sector structure and organisations

5.1.1 Generation, transmission, distribution and supply companies

The Kenyan power sector has become a relatively open market with a degree of private participation. In the past, the generation, transmission, distribution and supply of electricity were the exclusive responsibilities of Kenya Power and Lighting Company (KPLC), who has since rebranded to Kenya Power. In the mid-1990s, the Kenyan government expressed their intention to separate the regulatory and commercial functions of the power sector and facilitate restructuring in order to promote private sector investment. The electricity industry was eventually unbundled in 1997. Today, the generation of electricity has been liberalised, with several licensed Independent Power Producers (IPPs) in operation, and responsibility for the construction and operation of new transmission lines has been conferred to Kenya Electricity Transmission Company (KETRACO).[193]

Kenya Electricity Generation Company (KenGen) is the leading electrical power generation company in Kenya, supplying the country with 72 per cent of its electricity in 2013. KenGen is 70 per cent owned by the Government of Kenya and 30 per cent by the public. KenGen owns 24 power stations, whose installed capacity amounted to 1,239 MW in 2013.[194]

A small but successful IPP procurement programme has been running since the mid-1990s. Between 1996 and 2013, Kenya Power signed 12 power purchase agreements (PPAs) with IPPs for a combined capacity of 1,194 MW, of which 469 MW is currently operational (see Figure 5.1).[197]

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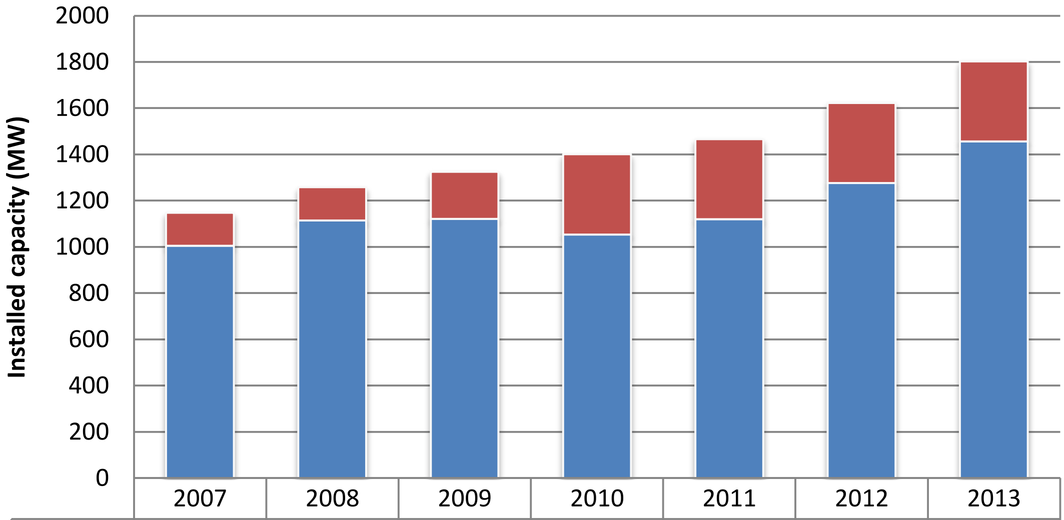
[193] Norton Rose Fulbright, "Investing in the African Electricity Sector: Kenya," July 2013. <http://www.nortonrosefulbright.com/files/investing-in-power-in-kenya-100614.pdf>.
[194] KenGen, "Annual Report 2013," July 2013. <http://www.kengen.co.ke/documents/KenGen%20Annual%20report%202013.pdf>.
[197] The World Bank, Addendum to Private Sector Power Generation Support Project, 11 March 2014. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/03/17/000333037_20140317102751/Rendered/PDF/839230PAD0IDA0010Box382166B00OUO090.pdf>.

Figure 5.1: Installed capacity of KenGen and IPPs 2007-2013



	2007	2008	2009	2010	2011	2012	2013
IPP	143	143	204	347	347	347	347
KenGen	1005	1115	1121	1054	1120	1276	1456

Source: KenGen, "Annual Report 2013," July 2013.
<http://www.kengen.co.ke/documents/KenGen%20Annual%20report%202013.pdf>.

Kenya Power is a publicly listed company that owns transmission and distribution assets in Kenya. The Government of Kenya holds 50.1 per cent equity.[198] Kenya Power buys electricity in bulk from KenGen, IPPs, Tanzania and Uganda for transmission, distribution and supply.

State-owned KETRACO was created to accelerate the development of the transmission network by building new high-voltage transmission infrastructure which will form the backbone of the National Transmission Grid. Its main function is to plan, design, build, operate and maintain new electricity transmission lines and associated substations. Kenya Power maintains ownership and operates the transmission lines which existed before the conception of KETRACO.

5.1.2 Ministry and regulatory agencies

The Ministry of Energy and Petroleum is responsible for the formulation of energy policy in Kenya. It has four main departments: renewable energy, petroleum energy, electrical power development, and geo-exploration.

The Energy Regulation Commission (ERC) was set up in 2007 to be an independent energy sector regulatory agency. ERC sets and adjusts the electricity tariff schedule, formulates the licensing process, administers licenses, makes policy recommendations to the Ministry of Energy and Petroleum, formulates and enforces environmental, health, safety and quality codes, approves PPAs, handles disputes and prepares the national energy plan.

[198] Kenya Power, "Annual Report and Financial Statements 2013," July 2013.
<http://www.kenyapower.co.ke/AR2013/KENYA%20POWER%20ANNUAL%20REPORT%2020122013%20FA%20127,128.pdf>.

5.1.3 Other organisations

Industry associations and other organisations relevant to the Kenyan energy sector are:

- Kenya Nuclear Electricity Board (KNEB): formed and funded by the Government in 2010 to fast-track the development of nuclear energy power generation in Kenya. KNEB undertakes nuclear studies, develops human resources and prepares an International Atomic Agency approved roadmap for nuclear power projects.
- The Geothermal Development Company (GDC): a 100 per cent state-owned special purpose company set up to fast-track the development of geothermal resources in Kenya.[199]
- Energy Tribunal: a quasi-judicial body which hears appeals against the decisions of ERC.
- The Centre for Energy Efficiency and Conservation (CEEC): established to promote energy efficiency and conservation efforts.

5.2 Energy and electricity policy

5.2.1 Key policies

The key policies governing the Kenyan power sector are:

<u>Electric Power Act 1997</u>

The Act led to the formation of KenGen and the unbundling of the generation and the transmission and distribution functions.

<u>The Energy Act 2006</u>

The Act established ERC and the Rural Electrification Agency. It paved the way for private companies to be involved in transmission and distribution. The Act provided a unified legal framework for the electricity, renewable energy and downstream petroleum sub-sectors.

<u>Kenya Vision 2030, 2008</u>

Kenya Vision 2030 is the country's development blueprint covering 2008 to 2030. Energy is identified as one of the infrastructural enablers upon which the economic, social and political pillars of the long-term strategy will be built. Medium-term plans are produced every five years with the latest one covering 2013–2017. The 5,538 MW installed capacity target was set for 2017.[200]

<u>Kenya Electricity Grid Code 2008</u>

The Code is the primary technical document of the electricity industry, collating the major technical regulations covering all aspects of the power supply chain.

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[199] Energy Regulatory Commission, Electricity Supply Industry in Kenya. <http://www.erc.go.ke/index.php?option=com_content&view=article&id=107&Itemid=625&limitstart=1>.
[200] Kenya Vision 2030, "Second Medium Term Plan (2013–2017)," 2013. <http://www.vision2030.go.ke/cms/vds/Second_Medium_Term_Plan_2013_-_20171.pdf>.

Least Cost Power Development Plan (LCPDP), March 2011, 2010–2031

LCPDP complements Kenya Vision 2030 by focusing upon electricity generation. Short-term, 2010–2015, and long-term, 2016–2031, implementation plans are provided.[201]

Draft National Energy Policy and Draft Energy Bill 2014

A new energy policy has been drafted in order to align with energy policy, Kenya Vision 2030 and the Constitution of Kenya 2010 and update in accordance with changes in the Kenyan power sector. In March 2014, the Kenyan public was invited to pass comments on the fifth draft of the policy.

5.2.2 Renewable energy policy

Kenya has no designated renewable energy policy. The renewable energy strategy is incorporated as part of the energy policies. The targets for electricity generation through renewable sources by 2017 are shown in Table 5.1. The renewable energy targets are identical in the medium-term plan 2013-2017 of the Vision 2030 and the Draft National Energy Policy.

Table 5.1: Renewable electricity targets in Kenya 2013–2017

Technology	**Cumulative installed capacity (MW)**							
	Oct 2013	**April 2014**	**Oct 2014**	**Apr 2015**	**Oct 2015**	**Apr 2016**	**Oct 2016**	**Feb 2017**
Hydro	770	794	794	794	794	794	794	794
Geothermal	241	331	507	697	747	952	1102	1887
Wind	5	5	5	25	85	385	635	635
RE total	1,016	1,130	1,306	1,516	1,626	2,131	2,531	3,316
Total	1,664	1,775	2,114	2,342	2,152	4,617	5,017	6,762
RE ratio	61%	64%	62%	65%	76%	46%	50%	49%

Source: Republic of Kenya, Draft National Energy Policy, 24 February 2014.
<http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.

The feed-in tariff rates for electricity produced from renewable energy sources were included in the Draft National Energy Policy 2014 as shown in Table 5.2. The tariff rates determine the price that Kenya Power must buy electricity produced from renewable energy sources from KenGen and IPPs in power purchase agreements.

[201] Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011.
<http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

Table 5.2: Feed-in tariff system in Kenya (USD)

Technology	Installed capacity (MW)	Standard FiT (USD/kWh)	Percentage escalable portion of the tariff*	Max cumulative capacity to qualify for FIT (MW)
Wind	0.5–10	0.11	12	N/A
	10.1–50	0.11	12	500
Hydro	0.5–10	0.105	8	N/A
	10.1–20	0.0825	8	200
Biomass	0.5–10	0.10	15	N/A
	10.1–40	0.10	15	200
Biogas	0.2–10	0.10	15	N/A
Solar (grid)	0.5–10	0.12	8	N/A
	10.1–40	0.12	12	100
Solar (off-grid)	0.5–10	0.20	8	N/A

Note: * the escalable portion includes operation and maintenance, insurance costs and return on equity expenses that are indexed to inflation and exchange rates.
Source: Republic of Kenya, Draft National Energy Policy, 24 February 2014. <http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.

Three renewable energy developments are financed by the Climate Investment Fund's Scale-Up Renewable Energy Programme (SREP). The developments are Menengai geothermal project, hybrid mini-grid systems and solar water heating.

A feasibility study for developing renewable electricity generation options, including regulatory instruments and guidelines for their implementation, has been undertaken and a Green Energy Facility has been set up to pool donor contributions for renewable energy projects.[202]

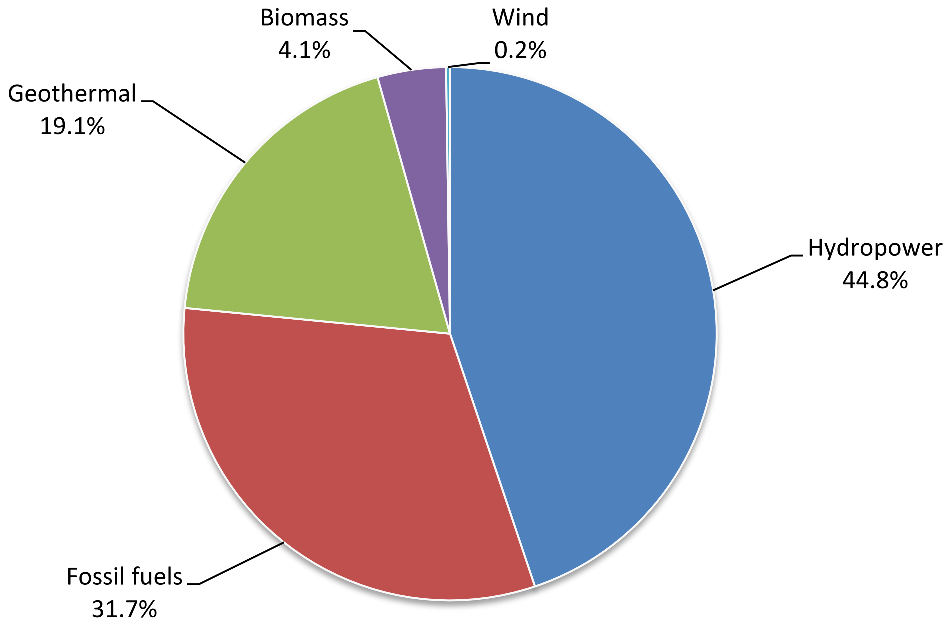
5.3 Power generation

5.3.1 Current generation

Figure 5.2 displays the electricity generation mix in Kenya in 2011.

[202] Republic of Kenya, Scaling-Up Renewable Energy Program (SREP), July 2011. <https://www.climateinvestmentfunds.org/cifnet/sites/default/files/Kenya%20SREP%20Investment%20Plan%20-%20Endorsed.pdf>.

Figure 5.2: Kenya electricity generation mix 2011 (total 7,618 GWh)

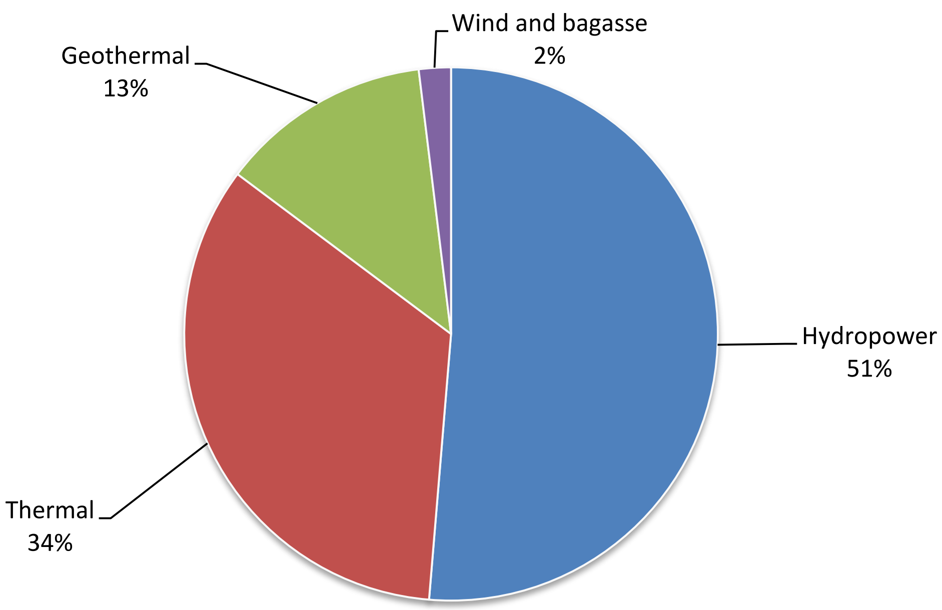


Source: US Energy Information Administration, International Energy Statistics. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>.

Hydropower supplies a large proportion of Kenya's electricity. However, with no further developments planned, its share in electricity production is set to decrease. Kenya and Ethiopia are the only African nations producing electricity using geothermal energy to generate electricity and Kenya is currently the largest producer of electricity from geothermal sources in Africa. Thermal generation is comprised of 452 MW of diesel generators, 60 MW of gas turbines and 30 MW at an emergency power plant for voltage support in Western Kenya. The Kenyan thermal power plants run on imported petroleum fuels.

The most up-to-date government document estimated that Kenya's installed capacity would be 1,684 MW as of March 2014 whilst KenGen estimated Kenya's installed capacity to be 1,712 MW in mid-2013. The installed capacity mix according to KenGen is shown in Figure 5.3, with further information on the existing power plants and their installed capacity in Table 5.3.

Figure 5.3: Installed capacity mix 2013 (total ~1,712 MW)



Source: KenGen, "Annual Report 2013," July 2013.
<http://www.kengen.co.ke/documents/KenGen%20Annual%20report%202013.pdf>.

Table 5.3: Power stations in Kenya

Type	Owner	Name	Installed capacity (MW)	Year of operation
Hydropower	KenGen	Gitaru	225	1999
		Gogo	2	1957
		Kamburu	94.2	1974
		Kiambere	168	1988
		Kindaruma	72	1968
		Masinga	40	1981
		Mesco	0.38	1930
		Ndula	2	1924
		Sagana	1.5	1956
		Sondu	60	2007
		Sosiani	0.4	1955
		Tana	20	1954
		Turkwel	106	1991
		Wanji	7.4	1952
	Imenti Tea Factory	Imenti Tea Factory	1	2008
	Sub-Total		**799.9**	
Geothermal	KenGen	Olkaria I	45	1981
		Olkaria II	105	2003
		Eburru	2.5	2012

		Wellhead (Pilot)	5	2012
	OrPower4	Oklaria III	48 (84)	2009
	Sub-total		**205.5**	
Thermal	KenGen	Kipevu III Diesel	120	2011
		Kipevu I Diesel	73.5	1999
		Embakasi Gas Turbine	60	N/A
		Lamu Diesel	2.9	1989
		Garissa	6.7	1996
	Aggreko	Emergency power plants	120	2012
	Rabai	Rabai Diesel (convertible to LPG)	90	2009
	Tsavo	Kipevu II Diesel	74	2002
	Iberafrica	Nairobi South Diesel	45	1997
	Westmont	Westmont	46	1997
	Thika Power	Thika Diesel	87	2012
	Sub-total		**725.1**	
Wind	KenGen	Ngong I	5.1	1993
Cogeneration	Mumias Sugar Company	Mumias	26	2009
Total			1,761.6	

Note: in addition, the Rural Electrification Authority owns 9 MW of capacity. Source: KenGen, "Annual Report 2013," July 2013. <http://www.kengen.co.ke/documents/KenGen%20Annual%20report%202013.pdf>; The Infrastructure Consortium for Africa, "When the Power Comes," November 2011. <http://www.icafrica.org/fileadmin/documents/Knowledge/Energy/ICA_WHEN%20THE%20POWER%20COMES_report.pdf>.

5.3.2 Planned projects and generation targets

Table 5.4 shows the planned installed capacity additions by technology type for every half a year period until February 2017 as set out in the Draft National Energy Policy.

Table 5.4: Planned installed capacity additions in Kenya 2014–2017 (MW)

Technology	**New capacity additions**							
	April 2014	**Oct 2014**	**April 2015**	**Oct 2015**	**April 2016**	**Oct 2016**	**Feb 2017**	**Total**
Hydro	24	0	0	0	0	0	0	24
Thermal	87	163	0	0	0	0	0	250
Geothermal	90	176	190	50	205	150	785	1,646
Wind	0	0	20	60	300	250	0	630
Coal	0	0	0	0	960	0	960	1,920
LNG	0	0	0	700	350	0	0	1,050

Cogeneration	0	0	18	0	0	0	0	18
Total	201	339	228	810	1,815	400	1,745	5,538

Source: Republic of Kenya, Draft National Energy Policy, 24 February 2014.
<http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.

The Draft National Energy Policy Draft sets the target of at least 5,000 MW of new generation capacity by 2016, taking overall installed capacity to over 6,600 MW. The Kenya Vision 2030 Least Cost Power Development Plan sets a target of 21,620 MW by 2031 and Kenya's planned installed capacity mix in 2031 is displayed in Figure 5.5.[203] The generation mix for 2030 differs in the Draft National Energy Policy as importing electricity is not mentioned and wind and coal are given significantly higher generation targets. A list of planned generation projects can be found in Appendix 9.3.[204]

There are no planned large hydropower projects in Kenya. There are two key reasons cited for the lack of future development of hydropower.[205] First, hydropower plants are vulnerable to shortages of rainfall. Second, hydropower projects are capital intensive thus pose a higher risk. Small-scale hydropower will be developed, however, with feasibility studies completed or underway for 26 projects.

Kenya will continue to develop geothermal generation capacity. It is estimated that at present, only 3 per cent of the country's geothermal potential has been exploited.[206] Geothermal power will hold the largest share in Kenya's electricity generation mix by 2030.

Ten companies will compete for the bid to construct a 960 MW coal-fired power station in Lamu. The expected commission date is 2016. Coal is projected to provide 4,500 MW of electricity in Kenya by 2030.[207]

The role of natural gas for Kenya's electricity sector will be clearer upon the production of a Petroleum Master Plan, which the World Bank is currently helping with.[208] The number of gas-fired power stations planned for 2030 is likely to be larger than that planned for 2030 in the Least Cost Development Plan (see Figure 5.5). A 700 MW LNG import and export facility at

[203] Kenya Vision 2030, Energy Generation of 23,000 MW and Distribution, <http://www.vision2030.go.ke/index.php/pillars/project/Enablers%20and%20Macro/2>.
[204] Ibid.; Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.
[205] Ibid.
[206] Roos, J., "Energy Infrastructure Development in East Africa: Big Potential Meets Big Roadblocks," Renewable Energy World, 13 June 2014. <http://www.renewableenergyworld.com/rea/news/article/2014/06/energy-infrastructure-development-in-east-africa-big-potential-meets-big-roadblocks?cmpid=WNL-Wednesday-June18-2014>.
[207] Ibid.
[208] Senelwa, K., "World Bank helps Kenya to develop new petroleum master plan," The East African, 4 January 2014. <http://www.theeastafrican.co.ke/business/World-Bank-helps-Kenya-to-develop-new-petroleum-master-plan/-/2560/2134136/-/3kjn4vz/-/index.html>.

Dongo Kundu will be commissioned by 2016, which 12 companies have been shortlisted to bid for.[209]

In 2024, 1,000 MW of nuclear power is expected to be commissioned and additional units each 1,000 MW are expected to be commissioned in 2026, 2029 and 2031. One of the reasons given for investing in nuclear power is that power demand will increase significantly through the development of trade in the East Africa Power Pool (EAPP).[210]

UK IPP Tower Power began constructing the first biomass-based commercial power plant in 2012. It will initially have a capacity of 11.5 MW but can be expanded to 30 MW in the future. The plant will be fuelled by Mathenge. A second 12 MW plant will be developed at Kinango, which will be fuelled by sisal and wheat waste.[211]

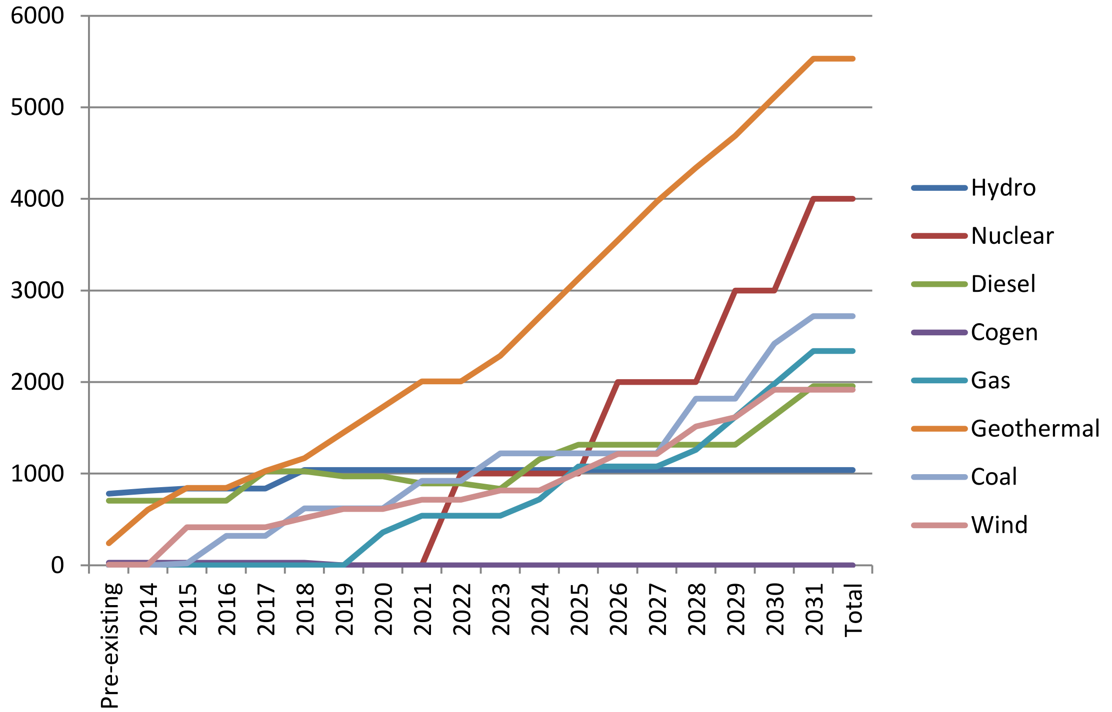
Table 5.5: Annual installed capacity additions 2014–2031 (MW)

Year	Hydro	Nuclear	Diesel	Cogen	Gas	Geothermal	Coal	Wind
Pre-existing	782	0	705	26	0	241	0	5
2014	32	0	0	0	0	367	0	0
2015	25	0	0	0	0	235	20	410
2016	0	0	0	0	0	0	300	0
2017	0	0	320	0	0	185	0	0
2018	200	0	0	0	0	140	300	100
2019	0	0	(56)	(26)	0	280	0	100
2020	0	0	0	0	360	280	0	0
2021	0	0	(74)	0	180	280	300	100
2022	0	1,000	0	0	0	0	0	0
2023	0	0	(60)	0	0	280	300	100
2024	0	0	320	0	180	420	0	0
2025	0	0	160	0	360	420	0	201
2026	0	1,000	0	0	0	420	0	200
2027	0	0	0	0	0	420	0	0
2028	0	0	0	0	180	372	600	300
2029	0	1,000	0	0	360	350	0	100
2030	0	0	320	0	360	420	600	300
2031	0	1,000	320	0	360	420	300	0
Total	**1,039**	**4,000**	**1,955**	**0**	**2,340**	**5,530**	**2,720**	**1,916**

Source: Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

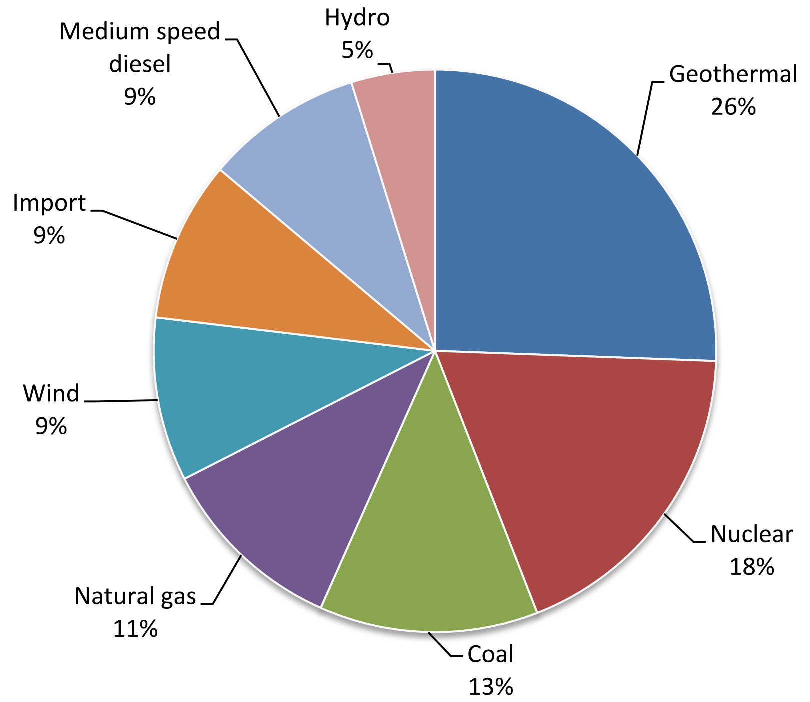
[209] Kangathe, K., "Kenya: Govt Shortlists 22 Bidders for Coal, LNG Plants," All Africa, 27 January 2014. <http://allafrica.com/stories/201401280243.html>.
[210] Republic of Kenya, Draft National Energy Policy, 24 February 2014. <http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.
[211] Macharia, N., "Tower Power to develop biomass power plants," Kenyan Business Review, 18 January 2012. <http://www.kenyanbusinessreview.com/492/tower-power-to-develop-biomass-power-plants/>.

Figure 5.4: Installed capacity by type in Kenya 2014–2031 (MW)



Source: Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

Figure 5.5: Installed capacity mix in Kenya 2031 (total 21,620 MW)



Source: Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

5.4 Demand and consumption

5.4.1 Electricity consumption

The consumption of electricity has been on a strong upwards trend since 2004 due to accelerated economic growth in Kenya. A suppressed or unrealised demand of 100 MW has been assumed. The reasons for the suppressed demand are supply shortages at peak demand, industrial customers switch off machinery to avoid their factories running under poor voltages, some customers have been disconnected and there are new customers waiting to be connected having fully paid.[212] The commercial and industrial sectors occupy a relatively small portion of Kenya Power's customer base but account for 60 per cent of electricity sales (see Figure 5.6).

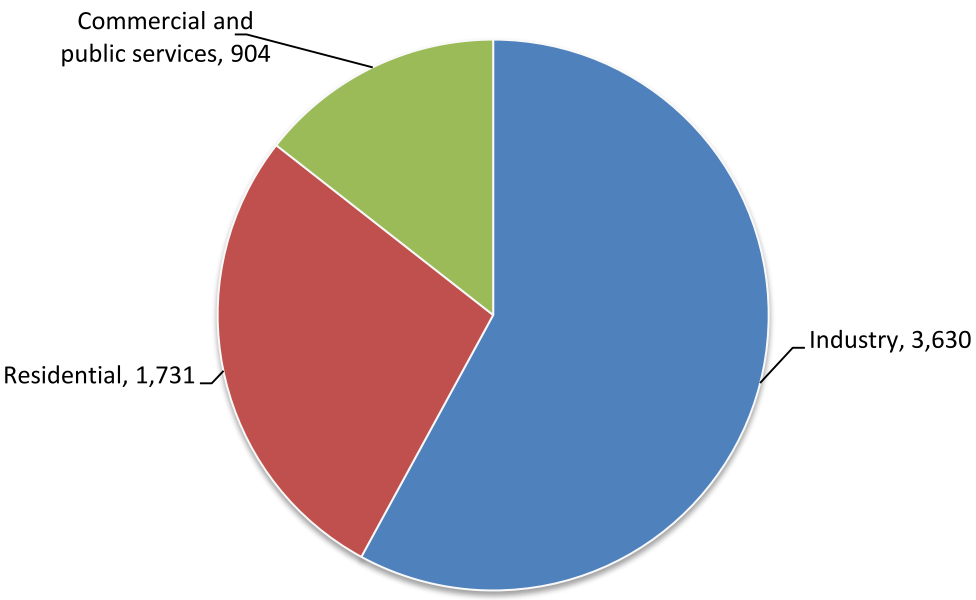
Table 5.6: Electricity consumption and demand in Kenya 2004–2013

Year	Electricity generated (GWh)	Electricity sold (GWh)	Peak demand (MW)	Number of consumers
2004/5	5,347	4,379	899	735,144
2005/6	5,697	4,580	920	802,249
2006/7	6,169	5,065	987	924,329
2007/8	6,385	5,322	1,044	1,060,383
2008/9	6,489	5,432	1,072	1,267,198
2009/10	6,692	5,642	1,107	1,463,639
2010/11	7,303	6,123	1,194	1,753,348
2011/12	7,670	6,341	1,236	2,038,625
2012/13	8,087	6,581	1,354	2,330,962
Average annual growth	**5.3**	**5.5**	**4.7**	**15.7**

Source: Kenya Power, "Annual Report and Financial Statements 2013," July 2013. <http://www.kenyapower.co.ke/AR2013/KENYA%20POWER%20ANNUAL%20REPORT%2020122013%20FA%20127, 128.pdf>.

[212] Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

Figure 5.6: Consumers of electricity in Kenya 2010 (total 6,265 GWh)



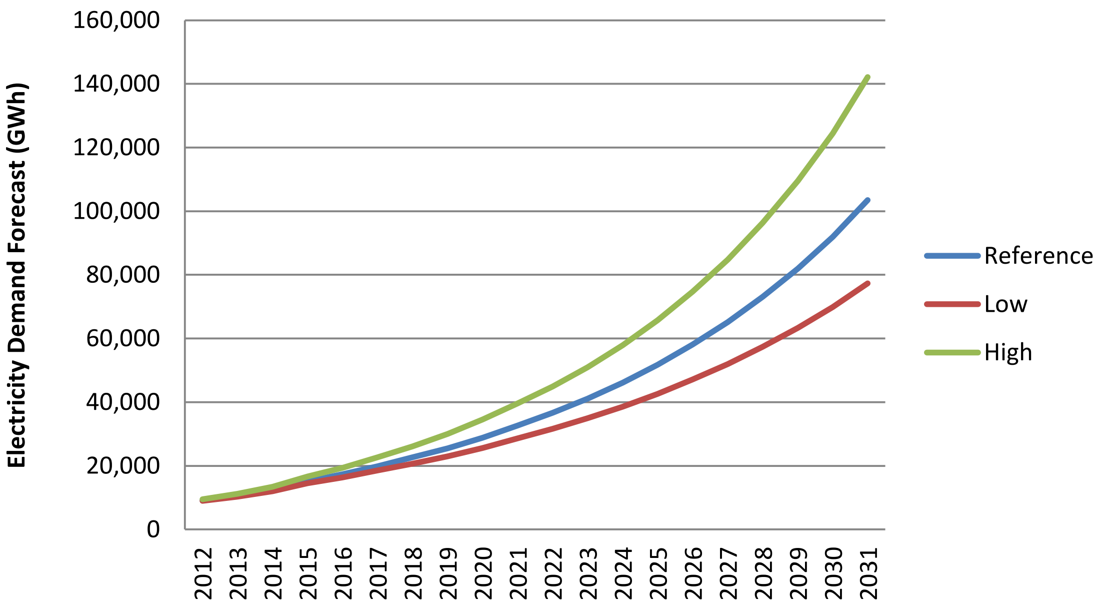
Source: International Energy Agency, Kenya: Electricity and Heat for 2010.
<http://www.iea.org/statistics/statisticssearch/report/?country=KENYA&product=electricityandheat&year=2010>.

5.4.2 Projected demand

The peak demand is projected to grow from 1,354 MW as of June 2013 to 3,400 MW by 2015 and to 5,359 MW by 2017. Annual energy consumption is projected to increase from 8,087 GWh in 2012/13 to 32,862 GWh in 2016/17. It is projected that by 2030, peak demand will be 18,000 MW against an installed capacity of close to 22,000 MW.

Electricity demand is expected to grow further with the development of energy intensive industries. Major drivers of the electricity demand include industrial parks, Lamu Port and New Transport Corridor Development to Southern Sudan and Ethiopia (LAPPSET) projects, resort cities, iron and steel smelting industry, the standard gauge railway and the light rail. Figure 5.7 shows the low, reference and high growth in demand for electricity. Due to suppressed demand, the annual growth in demand for electricity was forecasted to rise by an average of 16.8 per cent until 2017, after which it will settle to 12 per cent.

Figure 5.7: Load forecast in Kenya 2012–2031



Source: Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011–2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

5.5 Transmission and distribution

5.5.1 Situation and problems

As of 2013, the transmission and distribution lines totalled 49,818 km.[213] The existing transmission network is comprised of 1,331 km of 220 kV lines and 2,436 km of 132 kV lines, and is interconnected with Uganda through a 132 kV double circuit line. There were nine generation substations with a transformation capacity of 1,846 MVA and forty-five transmission substations with a capacity of 3,076 MVA. The existing transmission system capacity is severely constrained particularly during peak hours. The problem is partly due to inadequate reactive power, which is used to manage voltage levels, in major load centres and transmission constraints particularly in the Western and Nairobi regions. Transmission losses cost Kenya an estimated USD 17 million in 2012.[214]

The distribution substations and distribution transformers capacities as of June 2013 were 2,800 MVA and 6,195 MVA, respectively. The distribution network is comprised of 1,097 km of 66 kV lines, 16,136 km of 33 kV lines, and 28,818 km of 11kV lines. The distribution assets are owned by the Kenyan Government, Kenya Power and the Rural Electrification Authority.

[213] Kenya Power, "Annual Report and Financial Statements 2013," July 2013. <http://www.kenyapower.co.ke/AR2013/KENYA%20POWER%20ANNUAL%20REPORT%2020122013%20FA%20127,128.pdf>.
[214] Republic of Kenya, Draft National Energy Policy, 24 February 2014. <http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.

Table 5.7: Targeted and actual system losses in Kenya 2008–2014

	2008	2009	2010	2011	2012	2013	2014
Targeted transmission losses (per cent)	3.6%	3.4%	3.5%	3.5%	3.5%	3.5%	3.5%
Targeted distribution losses (per cent)	13.0%	12.9%	12.4%	12.0%	11.5%	11.0%	11.0%
Targeted technical losses (per cent)	13.2%	13.1%	12.9%	12.8%	12.5%	12.0%	12.0%
Targeted non-technical losses (per cent)	3.4%	3.2%	3.0%	2.8%	2.5%	2.5%	2.5%
Actual system losses (GWh)	1,062	1,057	1,068	1,180	1,329	1,507	N/A
Targeted total losses (per cent)	16.6%	16.3%	15.9%	15.5%	15.0%	14.5%	14.5%
Actual total losses (per cent)	16.6%	16.3%	16.0%	16.2%	17.3%	18.6%	N/A

Source: Kenya Power, "Annual Report and Financial Statements 2013," July 2013. <http://www.kenyapower.co.ke/AR2013/KENYA%20POWER%20ANNUAL%20REPORT%2020122013%20FA%20127, 128.pdf>; Republic of Kenya, Draft National Energy Policy, 24 February 2014. <http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.

One of the recommendations to improve transmission and distribution under Sessional Paper No. 4 of 2004, which lead to the Energy Act 2006, was to unbundle transmission and distribution functions. The unbundling began in 2008 with the establishment of KETRACO as a transmission entity.

5.5.2 Future plans

KETRACO is currently working on many transmission line projects. The end goal is to enhance the transmission grid to be able to wheel an additional 5,000 MW by 2016. A full list of KETRACO's completed, ongoing and future projects can be found in Appendix 9.4.

KETRACO has identified 6,270 km transmission lines priority projects for implementation between 2011 and 2017 made up of 2,081 km of 132 kV, 1,278 km of 220 kV and 2,299 km of 400 kV AC lines as well as a 612 km 500 kV HVDC line. It is projected that by 2031 KETRACO will have constructed 16,000 km of transmission lines. Kenya Power announced in January 2014 that they would invest USD 600 million in upgrading and expanding the distribution network over the next three years.[216]

There are further plans for regional interconnection, in addition to the current interconnector with Uganda. A transmission line between Kenya and Ethiopia is currently under construction and a transmission line with Tanzania is in the planning stages with a view to connecting with the Southern African Power Pool (SAPP) in the future.

[216] Kenya Power, "Kenya Power to invest USD 600 million in power network," 16 January 2014. <http://www.kplc.co.ke/content/item/91>.

5.6 Rural electrification

The World Bank calculated that only 19.2 per cent of Kenyans had access to electricity in 2011.[218] The Rural Electrification Authority (REA) estimated that 26 per cent of households had access to electricity in June 2013. The Rural Electrification Programme started in 1973 to increase access to electricity in rural areas. The REA was established in 2007 to accelerate the slow implementation of the rural electrification programme. Seventy-five per cent of the country's population is concentrated in 10 per cent of its landmass. Consequently, the strategy for rural electrification is mainly grid extensions. The majority of off-grid electrification takes the form of solar PV systems and is propelled forward by the private sector. As of mid-2013, there were 29 off-grid power generation installations.[219]

The Ministry of Energy's Rural Electrification Master Plan detailed its intention to electrify all public facilities by 2012 and 40 per cent of rural households by 2020. As of June 2013, the electrification of all designated public facilities had not been achieved, as shown in Table 5.8. There are other kinds of public facilities, such as primary schools, administrative centres and religious buildings, in need of an electrical connection which were not targeted in the Master Plan.

Table 5.8: Access to electricity for public facilities in Kenya 2013

Public facility	Electrified	Non-electrified
Trading centres	10,429	2,706
Secondary schools	8,195	0
Health centres	4,543	0
Total	23,167	2,706
Percentage	90%	10%

Source: Rural Electrification Authority, Counties' Electrification Status.
<http://www.rea.co.ke/index.php?option=com_docman&task=cat_view&gid=5&Itemid=505>.

Connection fees are expensive in Kenya. An electricity connection fee was about 400 USD in 2011 and Kenya Power has proposed raising the fee for a new connection to approximately USD 1,500 in September 2014.[220] High connection fees have made grid electricity unaffordable for many Kenyans in both rural and urban areas. It is estimated that hundreds of thousands of people live within grid-connected areas but are unable to afford a connection or the monthly electricity bill. As a result, Kenya is signing loans for USD 840 million in order to continue

[218] The World Bank, Access to Electricity. <http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>.
[219] Rural Electrification Authority, "REA Newsletter June 2013 Issue."
<http://www.rea.co.ke/index.php?option=com_docman&task=cat_view&gid=4&Itemid=505>.
[220] Ayieko, Z., Rural Electrification Programme in Kenya, Rural Electrification Authority, November 2011.
<http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1327690230600/8397692-1327691237767/Rural_Electrification_in_Kenya_presentation_Final_11thNov2011.pdf>.

subsidizing new electricity connections through their ‘Stima Loan’ system, in which a loan is repaid over two years by low-income families.[221]

The National Energy Policy set a target for 40 per cent of Kenyans to have access to electricity by 2016 and 100 per cent by 2020. Between 2014 and 2018, the Rural Electrification Master Plan is scheduled to be updated and the Government plans for REA to become the National Electrification and Renewable Energy Authority (NERA), hence the functions of promoting rural electrification and renewable energy investments will be combined in one organization.[223]

The World Bank and JICA each contributed USD 330 million to the Kenya Electricity Expansion Programme (KEEP). The total project budget is USD 1.3 billion. There are still bids and requests for expressions of interest for procurement related to the programme. The programme has the following four components:

- development of geothermal generation capacity
- construction of 132 kV transmission lines
- expansion and upgrade of the distribution lines, connecting an additional 300,000 customers over the period of 2011–2016
- institutional development and operational support

5.7 Tariffs

Electricity tariff schedules are set and regulated by ERC. Table 5.9 displays the electricity consumer categories used in Kenya.

Table 5.9: Tariff categories in Kenya

Customer classification		Description
Domestic Consumers	DC	Supply at 240 or 415 volts and consumption does not exceed 15,000 units per billing period.
Non-domestic Small Commercial Consumers	SC	Supply at 240 or 415 volts and consumption does not exceed 15,000 units per billing period.
Commercial and Industrial Consumers	CI1	Supply at 415 volts three phase four-wire and consumption exceeds 15,000 units per billing period.
	CI2	Supply at 11 kV.
	CI3	Supply at 33 kV.
	CI4	Supply at 66 kV.
	CI5	Supply at 132 kV.
Interruptible off-peak	IT	Consumption does not exceed 15,000 units per billing period. Electricity available in off-peak periods only. Peak demand is a maximum of 16 hours per day.

[221] Munda, C., “Kenya: Mega Loans to Subsidise Power Connection Costs,” All Africa, 7 May 2014. <http://allafrica.com/stories/201405071237.html?viewall=1>.
[223] Republic of Kenya, Draft National Energy Policy, 24 February 2014. <http://www.kengen.co.ke/documents/National%20Energy%20Policy%20-%20Final%20Draft%20-%2027%20Feb%202014.pdf>.

Street lighting	SL	Supply at 240 or 415 volts.

Source: Energy Regulatory Commission, Schedule of Tariffs, December 2013. <http://www.kenyapower.co.ke/docs/Tariff%Guide/Schedule%20of%20Tariffs%202013.pdf>.

The tariff rates shown in Table 5.10 are effective from 1st July 2014 until 1st July 2015. There are no changes proposed to the demand charge for 2015. It is possible for a Domestic Consumer or Non-domestic Small Commercial Consumer to also be an Interruptible off-peak consumer through the same supply terminal, however, the fixed charge must be paid twice which totals to USD 3.43. It is possible for customers to pay for electricity up front in Kenya using a pre-paid meter.

Table 5.10: Electricity tariff rates in Kenya (USc)

Customer	From 1st July 2014			From 1st July 2015	
	Fixed charge (per month)	Energy charge (per kWh)	Demand charge (per kVA)	Fixed charge (per month)	Energy charge (per kWh)
DC	171.27	0–50 – 2.85	N/A	171.27	0–50 – 2.85
		50–1,500 – 15.62			50–1,500 – 14.56
		1,500 + – 24.63			1,500 + – 23.49
SC	171.27	15.99	N/A	171.27	15.41
CI1	2,284.62	10.79	913.45	2,854.52	10.50
CI2	5,138.15	9.42	593.74	5,138.15	9.13
CI3	6,279.96	8.85	308.29	6,279.96	8.56
CI4	7,421.77	8.62	251.20	7,421.77	8.34
CI5	19,410.77	8.39	251.20	19,410.77	8.11
IT	171.27	15.70	N/A	171.27	15.41
SL	228.36	12.85	N/A	228.36	12.56

Source: Energy Regulatory Commission, Schedule of Tariffs, December 2013. <http://www.kenyapower.co.ke/docs/Tariff%Guide/Schedule%20of%20Tariffs%202013.pdf>. Exchange rate, 1 KES = 0.0114181 USD, 19 May 2014. <http://www.xe.com>.

Table 5.10 displays the core tariff set by the Energy Regulatory commission. However, there are surcharges, which cumulatively are reported to cost the customer more than the core tariff itself. They are listed in Table 5.11. There are various formulas for the variable charges which are given in the ERC schedule of tariffs.

Table 5.11: Electricity tariff surcharges in Kenya

Surcharge	Rates and details
Fuel Cost Charge	Variable rate per kWh, published monthly by Kenya Power in the Kenya Gazette. The charge is meant to reflect the cost of generating electricity during the previous month.
Foreign Exchange Rate Fluctuation Adjustment (FERFA)	Variable rate per kWh, published monthly by Kenya Power in the Kenya Gazette.

Security Support Facility	Variable rate per kWh, published monthly by Kenya Power in the Kenya Gazette. It will be paid monthly from when the first 50 MW of Lake Turkana Wind Power Limited is in operation until EUR 42.6 million has been reached.
Inflation Adjustment	Variable rate per kWh, published biannually by Kenya Power in the Kenya Gazette.
Water Resource Management Levy	Variable rate per kWh, published monthly by Kenya Power in the Kenya Gazette. Charge for water used by hydro power plants that have a capacity equal or above 1 MW.
Electricity Regulation Commission Levy	3 Kenya cents per kWh.
Rural Electrification Programme Levy	5 per cent of the core tariff.
VAT	16 per cent is charged to the fixed charge, demand charge, FERFA, fuel cost charge and taxable value of electricity energy consumed in a manner required by the Government.

Source: Energy Regulatory Commission, Schedule of Tariffs, December 2013. <http://www.kenyapower.co.ke/docs/Tariff%Guide/Schedule%20of%20Tariffs%202013.pdf>. Exchange rate, 1 KES = 0.0114181 USD, 19 May 2014. <http://www.xe.com>.

5.8 International manufacturers

ABB

In 2007, ABB signed a USD 25 million contract with KPLC (now Kenya Power) to upgrade and expand the system that controls Kenya's transmission and distribution network in the capital, Nairobi. ABB supplied the original Supervisory Control and Data Acquisition/Energy Management (SCADA) System 20 years earlier. The SCADA system is comprised of five control centres equipped with redundant computer systems and ABB Network Manager SCADA/EMS software for the operation, control, analysis and enhancement of the electrical network, and for power generation management. To enable the reliable operation of the control system, the centres are linked to more than 90 substations and power stations by over 1,300 km of Optical Ground Wire, ABB FOX 515 multiplexers, ABB ETL 600 Digital Power Line Carrier and radio communications.[224]

In 2012, ABB won two orders worth close to USD 11 million from Kenya Power to supply two new air-insulated switchgear 132/33 kV substations at Kitale and Awendo and extend two existing 132 kV substations in Eldoret and Kisii. As part of the contract, ABB is responsible for the design, engineering, supply and installation of the substations and extensions, including civil works. Some of the main products supplied included high- and medium-voltage products,

[224] ABB, "ABB wins $25 million power order from Kenya," 29 August 2007. <http://www.abb.com/cawp/seitp202/4ebf015ed116db0bc1257346003b12a1.aspx>.

switchgear and power transformers, as well as substation automation, control and protection systems.[225] The project is part of the KEEP programme (See Section 5.6).

ABB was the only vendor with a substation automation system or products presentation at the East African Power Industry Conference 2013 in Nairobi.[226]

Siemens

In 2011, KETRACO entered into a KES 2.7 billion (USD 30.7 million) contract with Siemens Energy for the extension of two high-voltage substations, Rabai and Embakasi. The scope of supply included the installation of an 8 km underground 220 kV cable. Although erecting underground cables is expensive, it was the only alternative, because the site falls on a flight path and installing normal towers could pose a threat to airplanes landing at the Jomo Kenyatta International Airport. The extension of the 220 kV substations was an essential part of the Mombasa-Nairobi transmission line project. The line transfers electricity from thermal power stations in the coastal area to Nairobi. The works improved the system stability and reliability, reduced technical losses and will help develop regional power trade. Completion time of the project was 20 months.[227] In 2012, Siemens signed a further EUR 15.8 million contract with KETRACO to build a substation at Suswa.[228]

A number of power distribution system improvement contracts with Kenya Power have been awarded to Siemens India and KEC International (India) Ltd. The contracts are valued at KES 1.13 billion (USD 12.8 million). Siemens will establish new substations in Gatundu, Juja, Kangema, Tala and Mwea at a cost of KES 403 million (USD 4.6 million).

OSRAM, a Siemens company, developed a project with energy-saving lamps, which can be recharged at small off-grid solar ‘filling stations’, which provide light for people on the shore of Lake Victoria. The ‘Energy for All’ project initiated by OSRAM and the Global Nature Fund aims to provide neighbouring communities of the lake with clean and safe light at a low cost.[229]

GE

In 2012, GE agreed to develop 1,000 MW of power with the Kenyan Government and was in talks with Kenya Power about a power purchase agreement. The power projects are likely to

[225] ABB, “ABB wins substations order in Kenya,” 16 April 2012.
<http://www.abb.com/cawp/seitp202/b4de497afce29a61c1257a0c00471484.aspx>.
[226] ABB, “Thank you for visiting us at EAPIC 2013 in Nairobi,” October 2013.
<http://www.abb.com/product/ap/db0003db004281/9829e96bcd18b577c1257be90043874c.aspx>.
[227] “Siemens to Extend Substations in Kenya,” Transmission & Distribution World, 1 April 2011.
<http://tdworld.com/substations/siemens-extend-substations-kenya>.
[228] Siemens, “Kenya’s KETRACO signs EPC contract for Mega Suswa substation,” 30 March 2012.
<http://www.siemens.co.za/en/news_press/news2012/kenyas_ketraco_signs_epc_contract_for_mega_suswa_substation.htm>.
[229] Siemens, Siemens in Kenya. <http://africa.siemens.com/en/siemens-in-africa/country-profiles/kenya.htm>.

be developed over five to 10 years. A price was not given for the partnership in which GE will provide technology and equipment.[230]

In 2013, GE won a contract to supply turbines to a Kenyan wind-power park. The 60.8 MW Kinangop Wind Park is set to come online in the middle of 2015. GE said it will provide 38 turbines, each with a 1.6 MW capacity, for the project developer Iberdrola Engineering. GE joins Danish wind firm Vestas in supplying Kenyan wind farms but did not specify the value of the contract.[231] GE is also developing the Kipeto 100 MW wind farm and is arranging for the project to be financed by USAID's Power Africa programme in a deal estimated at USD 300 million.

Mitsubishi Heavy Industries (MHI)

MHI has supplied five geothermal power generation units to KenGen: three units (15MW each) for Olkaria I that went on-stream in the 1980s and two units (35 MW each) for Olkaria II completed in 2003.[232] MHI received a full-turnkey order from KenGen to expand Oklaria II by 35 MW with an additional third unit, their sixth in total. The extension was completed at the end of 2009.

It has been reported that the Japanese Government will announce that it will give technical assistance through JICA and financial support to East African countries for further geothermal developments.[233] Kenya's Geothermal Development Company (GDC) reported that 19 companies are bidding for the development of eight 100 MW geothermal plant developments at Bogoria-Silali, including Toshiba, Mitsubishi, Alstom and GE. GDC plans to select a different company to build each plant.[234]

Toyota Tsusho and Hyundai Engineering

A USD 384 million contract was awarded for the expansion of Olkaria I and the construction of Olkaria IV to Toyota Tsusho and Hyundai Engineering. Each plant will have an output of 140 MW. The construction of Oklaria IV is scheduled to be completed in June 2014 whilst the extension to Oklaria l is due to be completed in September 2014.[235] Toshiba are providing four

[230] Ombok, E., "General Electric to Develop 1,000 Megawatts in Kenya," Bloomberg, 26 October 2012. <http://www.bloomberg.com/news/2012-10-26/general-electric-to-develop-1-000-megawatts-in-kenya-correct-.html>.
[231] "GE to supply turbines for Kenya's biggest wind-power plant," Business Day Live, 17 December 2013. <http://www.bdlive.co.za/africa/africanbusiness/2013/12/17/ge-to-supply-turbines-for-kenyas-biggest-wind-power-plant>.
[232] Power Technology, Kenya Electricity Generating Company Olkaria II Expansion, Nairobi, Kenya. < http://www.power-technology.com/projects/olkariageothermal/ >.
[233] "Japan to announce assistance to geothermal projects in Eastern Africa," Think Geoenergy, 30 May 2013. <http://thinkgeoenergy.com/archives/15643>.
[234] "19 companies bidding for 800 MW development at Bogoria-Silali in Kenya," Think Geoenergy, 5 September 2011. <http://thinkgeoenergy.com/archives/8538>.
[235] "Toyota Tsusho, Hyundai Engineering awarded geothermal project in Kenya," SeeNews, 7 November 2011. <http://renewables.seenews.com/news/toyota-tsusho-hyundai-engineering-awarded-geothermal-project-in-kenya-158955>; Awori, D., Oklaria Geothermal Project, Totyota Tsusho Corporation. <http://www.keieiken.co.jp/english/kenya/pdf/toyotsu.pdf>.

70 MW steam turbine generators for the two projects. Honeywell was selected to provide the Experion Process Knowledge System control systems for the two geothermal plants.

Isloux Corsán

In 2011, the Spanish energy infrastructure construction company Isolux Corsán won the tender for the construction of the longest high-voltage electrical transmission line in Kenya and one of the longest in Africa. Construction work on the 428 km 400 KV line was completed in 2013. The contract signed with KETRACO was worth EUR 142 million. The project will enable power to be evacuated from the largest wind farm in sub-Saharan Africa at 300 MW located near to Lake Turkana which will begin generating electricity in 2015.

5.9 Risks and opportunities

5.9.1 Issues

Hydrological shocks

Kenya's current dependence upon hydropower means that the power supply is vulnerable to droughts. In 2011–2012, Eastern Africa suffered a severe drought and Kenya's electricity generation plummeted. The frequency of the droughts has made hydroelectric power a liability for the electricity supply in Kenya. Electricity has been rationed and businesses are forced to resort to expensive diesel-powered generators. On the other hand, heavy rainfall following the droughts has caused damage to distribution network in Kenya and some of the water which could be used for hydropower generation is lost due to inadequate storage.[236]

Geothermal power

Kenya is investing in geothermal projects but they are typically far away from settlements. Because of the distance between the generation capacity and demand centres, heavy investment in transmission lines and related infrastructure is required. In addition, geothermal electricity is capital intensive and has long lead times.

Distribution

There are high levels of distribution losses. The distribution network has limited redundancy and aged installations which render the distribution network unreliable. Most of the distribution lines are overhead, hence prone to corrosion and changes in the climate. Extensions of the grid to small, rural communities involve high installation, operating and maintenance costs. The World Bank is of the opinion that Kenya's focus on electricity supply service expansion to rural areas led to underinvestment in strengthening the backbone transmission and distribution system.[237]

[236] Doya, D., "Kenya Power to Spend $1.2 billion to Improve Distribution," Bloomberg, 17 April 2013. <http://www.bloomberg.com/news/2013-04-17/kenya-power-to-spend-1-2-billion-to-improve-distribution.html>.
[237] Kapika, J., and Eberhard, A., "Power-Sector Reform and Regulation in Africa," 2013. <http://www.gsb.uct.ac.za/files/Kenya.pdf>.

Unaffordable electricity

The tariff rates and connection charges are relatively high in Kenya. Because of the high prices coupled with the frequency of power shortages, energy intensive industry and manufacturers have relocated to other countries in Africa and local businesses have been forced to shut down as the tariff rates are causing them to run at a loss. Even with loans and subsidies, grid-connected electricity supply is too expensive for the majority of people in Kenya. There is consequently a low level of users of electricity which makes it difficult to raise the funds for the necessary maintenance of the transmission and distribution network and it is difficult for investors to make a return.[238]

Incentives for private investment

There has been a low level of private investment in the Kenyan power sector. The incentives for private sector investments, particularly financial ones, are insufficient. In 2012, the World Bank provided a USD 166 million partial risk guarantee as investors were concerned about the security of making a return on their investment. The guarantee was for a large-scale private investment in the Kenyan power sector and similar arrangements could be provided for major IPP projects in the future.[239]

5.9.2 Future opportunities

The Ministry of Finance claimed that USD 19.8 billion of investment is needed in the energy sector from 2012 to 2020.[240] In 2013, it was reported that the Energy Minister estimated that USD 10–15 billion needs to be invested for Kenya to reach the installed generation capacity target of 5,500 MW by 2017.[241] From the Kenya Investment Authority and the above discussion the following opportunities for suppliers in the Kenyan electricity sector have been identified:[242]

- supplies and services for drilling rigs, geo-exploration tools and equipment for the drilling of geothermal wells
- steam field design, equipment supply and steam pipeline construction services
- further developments at the Olkaria geothermal site and other geothermal projects such as Menengai, Longonot and Akiira
- equipment for coal exploration and the infrastructure associated with coal mining. A couple of large scale coal-fired power plants

[238] Moyaka, J., "Manufacturers say energy problems, inefficiency threaten Kenya's competitiveness," Sabah, 9 May 2012. <http://sabahionline.com/en_GB/articles/hoa/articles/features/2012/05/09/feature-01>.
[239] The World Bank, Kenya Private Sector Power Generation Support Prioject, 28 February 2012. <http://www.worldbank.org/projects/P122671/partial-risk-guarantees-ipps-kenya?lang=en>.
[240] Republic of Kenya, Ministry of Finance, Public Private Partnerships in Kenya. <http://dosstest.polymita.com/polymitaImages/public/Publications/Investment%20Opportunities/Public%20Private%20Partnership%20in%20Kenya.pdf>.
[241] Williams, D., "$15bn power drive for Kenya," Power Engineering International, 31 October 2013. <http://www.powerengineeringint.com/articles/2013/10/15bn-power-drive-for-kenya.html>.
[242] Kenya Investment Authority, Energy. <http://www.investmentkenya.com/opportunities/energy>.

- the construction and operation of a solar PV panel plant. Opportunities also exist for associated components and accessories, such as charge controllers, inverters and PV batteries
- solar powered water heaters for domestic and commercial use
- equipment and services for wind farms financed by private companies and the 50 MW Isolo wind power generation to be constructed by 2016
- the manufacturing of small hydropower turbines
- construction of oil and gas pipeline networks
- development and construction of the Mombasa petroleum trading hub comprised of two offshore jetties.
- engineering, procurement and construction of oil and gas storage facilities
- design and construction of oil refinery
- the establishment of a jetty, storage and regasification facility, transportation vessels and the development of power generation at an LNG facility in Dongo Kundu
- the construction and operation of a transformer manufacturing plant with the potential to export to neighboring East African nations
- manufacturing switchgears, insulators and electricity energy meters
- various transmission network projects with KETRACO, including the construction of major transmission lines (6,270 km planned for 2011–2017), regional interconnection, reduction of transmission losses and improvement of the terminal voltage, network coverage and the reduction of losses
- reinforcement and extension of the distribution network
- a tender has been planned for the installation of smart metering across Kenya

6. Mozambique

6.1 Electricity sector structure and organisations

6.1.1 Generation, transmission, distribution and supply companies

Electricidade de Moçambique (EDM) is a fully state-owned vertically-integrated power utility. EDM owns the national grid but there are smaller regional grids owned by the Ministry of Energy through district governmental bodies. EDM only generates 10 per cent of the electricity that it transmits and distributes.

Hidroeléctrica de Cahora Bassa (HCB) is an Independent Power Producer (IPP) who owns and operates the 2,075 MW Cahora Bassa hydropower plant, which generates approximately 90 per cent of Mozambique electricity. HCB owns further electricity infrastructure, such as the Songo converter substation and the Matambo substation, which allows it to supply the Southern African Power Pool (SAPP). It jointly owns a HVDC transmission line with Eskom, which runs from Cahora Bassa to South Africa, through which 65 per cent of the generated electricity is exported (electricity for domestic use in the south of Mozambique is then imported back). In 2012, the Mozambique government had a 92.5 per cent share in HCB whilst the Portuguese state transmission company Redes Energéticas Nacionais (REN) owns the rest. REN will exchange its share in the Cahora Bassa hydropower plant with the Mozambique Government for a share in the transmission lines under construction from Cahora Bassa to Maputo (see Section 6.5.2).[243]

The Mozambique Transmission Company (MOTRACO) is an independent transmission company, owned by EDM, Eskom and Swaziland Electricity Board in equal shares, which supplies power to the Mozal aluminium smelter in Maputo. The company was established in response to the transmission issues created by the construction of the Mozal aluminium smelter 1997. At that time, EDM did not have sufficient transmission wheeling capacity to supply the Mozal smelter, while Eskom did not have a licence to sell electricity in Mozambique. International transmission lines of 400 kV have since been installed, through which Eskom supplies the Swaziland Electricity Board and the Mozal aluminium smelter. The end date of Eskom’s supply contract is 2025.[244]

Mozambique is part of the SAPP, through which southern African nations form interconnected grids. Any restructuring of Mozambique’s power sector must consider that the vertically-integrated South African utility, Eskom, dominates the regional market and Mozambique engages in significant power trade with them (See Section 3.1.1).

[243] Fauvet, P., “Mozambique to own Cahora Bassa,” IOL Business Report, 15 April 2012. <http://www.iol.co.za/business/international/mozambique-to-own-cahora-bassa-1.1276132#.U7UUmpRdWig>.
[244] Hogan, B., “Motraco contract running to 2025 – Minister,” Politics Web, 21 April 2010. <http://www.politicsweb.co.za/politicsweb/view/politicsweb/en/page71619?oid=172495&sn=Detail>.

6.1.2 Ministry and regulatory agencies

The Council of Ministers is in charge of approving energy sector policy and taking major decisions related to energy. It authorizes the construction of new power stations over 100 MVA.

The Ministry of Energy (MoE), created in 2000, is responsible for managing the energy sector by setting policy objectives and regulating the energy sector. The MoE is composed of three main directorates: electrical energy, renewable energy and fuel (excluding biofuel).

The power sector in Mozambique does not have an independent regulator at present, the MoE is the current regulator. The Conselho Nacional de Electricidade (CNELEC) was established in 1997 by the Electricity Law as an advisory body for the MoE. CNELEC advises the MoE on the granting of concessions for power projects, the establishment of the electricity tariff schedule and the mediation and resolution of disputes between concessionaires in the power sector, and between concessionaires and consumers in the supply of electricity. The Energy Reform and Access Project (ERAP) initiated in 2003 aimed to expand the functions of CNELEC's functions by making it Mozambique's fully independent electricity sector regulator but CNELEC remains an advisory body due to insufficient funding.

6.1.3 Other organisations

Industry associations and other organisations relevant to the Mozambican energy sector are:

- Unidade Técnica de Implementação dos Projectos Hidroelétricos (UTIP): established in 1996 and is the technical unit for the implementation of hydropower projects in Mozambique through studies detailing the financial, technical and legal conditions for the realization of hydropower projects.
- Empresa Nacional de Hidrocarbonetos (ENH): Mozambique's national oil company.

6.2 Energy and electricity policy

6.2.1 Key policies

The following summarises the key policies relevant to the electricity sector in Mozambique: [246]

<u>Decree no. 28 1995</u>

The Decree corporatized EDM and defined its role.

[246] Cuamba, B. et al., "Investment Incentives for Renewable Energy in Southern Africa: The case of Mozambique," International Institute for Sustainable Development, January 2013. <http://www.iisd.org/pdf/2013/investment_%20incentives_%20mozambique.pdf>; Chambal, H., "Energy Security in Mozambique," International Institute for Sustainable Development, 2010. <http://www.iisd.org/tkn/pdf/energy_security_mozambique.pdf>; "Mozambique Renewables Readiness Assessment 2013," IRENA, 2012. <http://www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf>.

Energy Law 1997 (Law no. 21)

The Law sets out the objectives to: increase the level of access to energy in order to support social and economic development activities, increase electricity exports to neighbouring countries, construct new generation and transmission infrastructure and update the energy sector legislation to attract private investors. The Law led to the creation of CNELEC.

Ministerial Decree no. 20 1997

The Decree established the National Directorate for Energy within the MoE.

National Energy Policy 1998 (Decree no. 5)

The National Energy Policy builds upon the Energy Law 1997, and sets out the policies and general legal framework for the organization of the energy sector.

Decree no. 8 2000

The Decree further specifies procedures concerning concessions for all parts of electricity supply chain. The Decree contains the most up to date electricity law and regulations.

The Energy Sector Strategy 2000, 2009 (Decree no. 24, Resolution No. 10)

The Strategy is the implementation of the 1998 Energy Policy, which includes an increased role for the private sector, development of competitive markets and the need for regulation.

It was updated in 2009 but the scope of the update was up to 2013. The 2009 Strategy sets guidelines for power, petroleum and biomass use, which account for new challenges in those areas.[247] The objectives set were:

- to provide greater access to electricity and energy in rural areas
- to discourage the non-sustainable use of wood and promote sustainable production of biofuels
- to diversify energy sources
- to implement a cost-reflective tariff system
- to engage in international cooperation, in particular with the SAPP

The demand forecast in the Strategy was 6 per cent annual growth across the four years.[248] In actuality, demand grew by 14 per cent annually.

[247] Miranda, Mozambique Legal News, July 2009. <http://www.mirandalawfirm.com/uploadedfiles/39/17/0001739.pdf>; Rocha, P. and Henriques, F., "The Energy Regulations and Markets Reviews: Mozambique," June 2013. <http://www.mozambiquelegalcircle.com/xms/files/Publicacoes/2013/Mozambique_The_Energy_Regulation_and_Markets_Review.pdf>.

[248] Republic of Mozambique, Ministry of Energy, Plano Estrategico do Sector de Energia (2009 -2013). <https://energypedia.info/images/0/06/PT_Plano_Estrategico_de_Energia_Minist%C3%A9rio_da_Energia.pdf>.

Decree No. 25 2000

The role of CNELEC was further defined in the Decree.

Electricity Master Plan 2004–2020

The expansion plan of the national grid up to 2020 was specified. An access to electricity target of 15–20 per cent of the population by 2020 was set.

Decree no. 42 2005

The Decree determined the methodology by which the tariff schedule is set.

Decree no. 43 2005

The Decree designated EDM as the national electricity company whose responsibility includes operating the transmission network.

6.2.2 Renewable energy policy

Mozambique's policies on renewable electricity generation uptake are relatively limited. The following outlines two of the more significant recent policies.

Development of New and Renewable Energy Policy 2009 (Resolution no. 62)

The Policy promotes the use of clean, efficient and sustainable renewable and alternative energy sources. In 2011, the Strategy for New and Renewable Energy Development 2011–2025 was adopted to implement the policy. The strategy involves a combination of grid extensions and off-grid developments. No feed-in tariff system exists for renewable energy in Mozambique. However, Mozambique has produced renewable energy 'atlas' which maps potential sites for renewable energy developments with an evaluation of their technical and economic feasibility.[249] As a result, a feed-in tariff system is under consideration.

An access level to electricity for lighting was targeted at 100 per cent in the short to medium-term. The planned developments for each renewable electricity technology in the 2011–2025 strategy are outlined in Table 6.1. The National Programme and New Renewable Energy (PNENR) sets out actions for the increased use of renewable energy sources.

Table 6.1: Renewable electricity development plans in draft strategy for New and Renewable Energy Development 2011–2025

Electricity Source	Plans
Small-scale hydro	A program to develop concessions for projects below 15 MW is suggested. The installation of up to 125 MW of hydropower for peak demand will be promoted.
Wind	Calls for wind mapping to be completed and pilot wind farms to be established. 10,000 mini-wind generators will be installed.

[249] Renewable Energy Atlas of Mozambique, 2014. <http://www.atlasrenovaveis.co.mz/en>.

Biomass	The planned use of biomass is limited to the transport sector and no plans were made for the use of biomass in the power sector.
Solar	The use of solar PV is limited to rural off-grid electrification, in systems such as solar water heaters in buildings. 100,000 solar water heaters will be installed. It suggested that EDM launches a solar thermal systems scheme for consumers.

Source: Hankins, M., "A Renewable Energy Plan for Mozambique," Justica Ambienta!, September 2009. <http://www.internationalrivers.org/files/attached-files/clean_energy_for_mz_30_9_09.pdf>; Republic of Mozambique, Ministry of Energy, Estrategia De Desenvolvimento De Energias Novas E Renovaveis, Para O Periodo De 2011 – 2025. <https://energypedia.info/images/f/fa/PT-Estrategias_de_Desenvolvimento_de_E._Novas_e_Renovaveis-Ministerio_da_Energia.pdf>.

Strategy and Policy of Biofuel 2009 (Resolution no. 22)

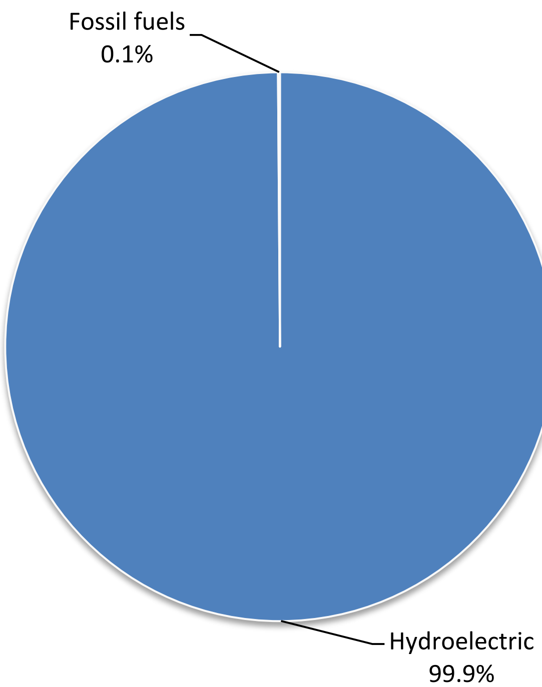
The Strategy identifies biofuel's capacity to deliver on economic and energy policy objectives. The objectives are to promote the use of agro-energy resources for: energy and food security, socio-economic development and reduced dependence upon fuel imports.

6.3 Generation

6.3.1 Current generation

Figure 6.1 shows Mozambique's power generation mix in 2011 including exports, and the total dominance of hydroelectric power.

Figure 6.1: Mozambique electricity generation mix 2011 (total 16,661 GWh)



Source: US Energy Information Administration, International Energy Statistics. <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm>.

The generation capacity in Mozambique is dominated by the 2,075 MW Cahora Bassa hydropower station, which generates approximately 15,000 GWh annually. The overall installed capacity for Mozambique was 2,308 MW in January 2013.[250]

In 2012, the total electricity distributed in Mozambique by EDM was 4,251 GWh.[251] Ninety-one per cent of the electricity supplied by EDM came from Cahora Bassa. EDM's annual report highlights that only about 3,500 GWh of Cahora Bassas's overall 15,000 GWh annual electricity generation was used domestically in 2011 and 2012.[252] The rest of the electricity was exported to South Africa, Zimbabwe and Malawi. Eskom reported that in 2013, the performance of Cahora Bassa was deteriorating due to flooding.[253] EDM generated 263 GWh, which accounted for 6 per cent of the electricity supplied in Mozambique. The remaining 1 per cent and 2 per cent of Mozambique's electricity supply came from IPPs and imports, respectively.

The Scottish power generation company Aggreko built a 100 MW interim gas-fired power station in the Ressano Garcia area in 2012 and expanded the power station to 232 MW in 2013, out of which 47 MW of is allocated to EDM, as well as supplying Eskom and NamPower.[255] Gas is the second largest source of electrical power in Mozambique. The power stations owned by EDM and their installed and available capacity as of 2011 are listed in Table 6.2. Many of the diesel-fired thermal plants are dated or out of order.

Table 6.2: EDM's power stations 2011

Power station	Type	Installed capacity (MW)	Available capacity
Nacala	Diesel	9.9	1.2
Pemba	Diesel	8.5	1.3
Quelimane	Diesel	6.88	6.8
Nampula	Diesel	6.4	5.2
Ibane Velha	Diesel	3.72	0
Lionde	Diesel	3.43	0
Lichinga	Diesel	2.83	1.32
Xai-Xai	Diesel	2.67	0
Ibane Nova	Diesel	2.4	2.2
Motepuez	Diesel	1.22	1
Angoche	Diesel	0.91	0.75
Mocuba	Diesel	0.84	0

[250] Southern African Power Pool, Demand & Supply. <http://www.sapp.co.zw/demand.html>.
[251] EDM, Statistical Summary 2012. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=177&tmpl=component&format=raw&Itemid=68&lang=en>.
[252] "Mozambique's Cahora Bassa Hydroelectric dam to sell 4.4 pct more power to South Africa's Eskom in 2013," Macau Hub, 19 October 2012. <http://www.macauhub.com.mo/en/2012/10/19/mozambique%E2%80%99s-cahora-bassa-hydroelectric-dam-to-sell-4-4-pct-more-power-to-south-africa%E2%80%99s-eskom-in-2013/>.
[253] "South Africa: Cahora Bassa Power to South Africa Fully Restored," AllAfrica, 19 November 2012. <http://allafrica.com/stories/201211200676.html>; Eskom, "Integrated Report," 2013. <http://integratedreport.eskom.co.za/integrated_report_2013/pdf/full.pdf>.
[255] Aggreko, "Aggreko Power Plant Expanded to Supply Power to Namibia and Mozambique," 29 August 2013. <http://www.aggreko.com/media-centre/press-releases/power-plant-mozambique-namibia-expanded/?en-GB>.

Tete	Diesel	0.82	0.3
Cuamba	Diesel	0.42	0
Massingir	Diesel	0.32	0.19
Sub-total	**Diesel**	**51.26**	**19.26**
Maputo	Gas	78.5	53
Beira	Gas	14	12
Vilanculos – Temane	Gas	5.62	4.68
Nova Mambone	Gas	0.28	0.28
Sub-total	**Gas**	**98.43**	**69.96**
Mavuzi	Hydro	52	35
Chicamba	Hydro	38.4	36
Coruma	Hydro	16.6	16
Lichinga	Hydro	0.75	0.6
Sub-total	**Hydro**	**108.85**	**88.10**
Total	**All**	**258.50**	**178.32**

Source: EDM, Annual Statistical Report 2011. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=165&tmpl=component&format=raw&Itemid=68&lang=en>.

6.3.2 Planned projects and generation targets

Power projects worth USD 12 billion are estimated to be in the pipeline, as the country attempts to monetize and exploit its coal and natural gas resources. The Japanese Prime Minister Shinzo Abe, on a visit to Mozambique in early 2014, pledged USD 174 million for the new gas-fired power station in Maputo.[256] Mozambique is building new power stations but does have the option of renegotiation their power purchase agreement with South Africa for the electricity generated by the Cahora Bassa so that more of its electricity can be used in Mozambique.[257]

In presentations by the MoE, the potential for various energy sources was outlined. Estimates for potential installed capacity include: 18,000 MW from hydropower (90,000 GWh annually), 5,500 MW from natural gas reserves (160 tcf), 5,000 MW from coal reserves (25 billion tons), 23,000 MW from solar power and 3,900 MW from wind power.[258] The future generation mix forecast by the Minister at the Powering Africa conference in Maputo in 2014 was 55 per cent from renewables (including hydropower), 25 per cent from coal and 20 per cent from gas by 2030.[259] The planned projects are listed in Table 6.3. There are currently no official documents with future generation or generation mix targets set by the Ministry of Energy or EDM.

[256] “Mozambique: Japan to Finance New Maputo Power Station,” AllAfrica, 14 January 2014. <http://allafrica.com/stories/201401140941.html>.

[257] “Mozambique needs to negotiate larger share of power from Cahora Bassa with South Africa,” Macau Hub, 25th April 2014. <http://www.macauhub.com.mo/en/2014/04/25/mozambique-needs-to-negotiate-larger-share-of-power-from-cahora-bassa-with-south-africa/>.

[258] Manda, A., Energy Sector Investment Opportunities, Ministry of Energy, 20 March 2014. <http://www.cpi.co.mz/index.php/en/2012-03-14-03-21-37/library/cat_view/5-eventos-mz-jp?start=5>.

[259] “Why Mozambique’s energy sector is attractive to investors,” Homestring, 13 May 2014. <https://www.homestrings.com/news-and-analysis/2014/may/13/why-mozambique-s-energy-sector-is-attractive-to-investors/#.U334H9JdWig>.

Table 6.3: Planned installed capacity additions in Mozambique

Power plant	Type	Installed capacity (MW)	Status	Year of commission
Ressano Garcia (Sasol and EDM)	Gas	160	Under construction	2014
Kuvaninga	Gas	40	Commercial agreement	2015
Mavuzi 3	Hydropower	60	Conceptual	2015
Ressano Garcia (Gigawatt)	Gas	118	Commercial agreement	2016
Moatize	Coal	600 (2,400)	Commercial agreement	2016
Benga	Coal	2,000	Commercial agreement	2017
Alto Malema	Hydropower	60	Feasibility	2017
Boroma	Hydropower	200	Feasibility	2017
Lurio	Hydropower	120	Feasibility	2017
Ncondezi	Coal	300 (1,800)	Feasibility	2018
Mphanda Nkuwa	Hydropower	1,500	Commercial agreement	2018
Maputo	Gas	100	Commercial agreement	2018
Lupata	Hydropower	600	Feasibility	2018
Cahora Bassa North Bank	Hydropower	1,245	Feasibility	2018
Temane	Gas	50	Pre-feasibility	N/A
Massingir	Hydropower	25	Pre-feasibility	N/A

Source: EDM, Overview of Mozambique Electricity Sector: Opportunities and Challenges,2013. <http://www.usea.org/sites/default/files/event-/Mozambique%20Power%20Sector.pdf>; Manda, A., Country Report, Ministry of Energy, 4 June 2013. <http://eneken.ieej.or.jp/data/5007.pdf>; Ncondezi Energy, Power Project. <http://www.ncondezicoal.com/power-project.aspx>.

6.4 Consumption

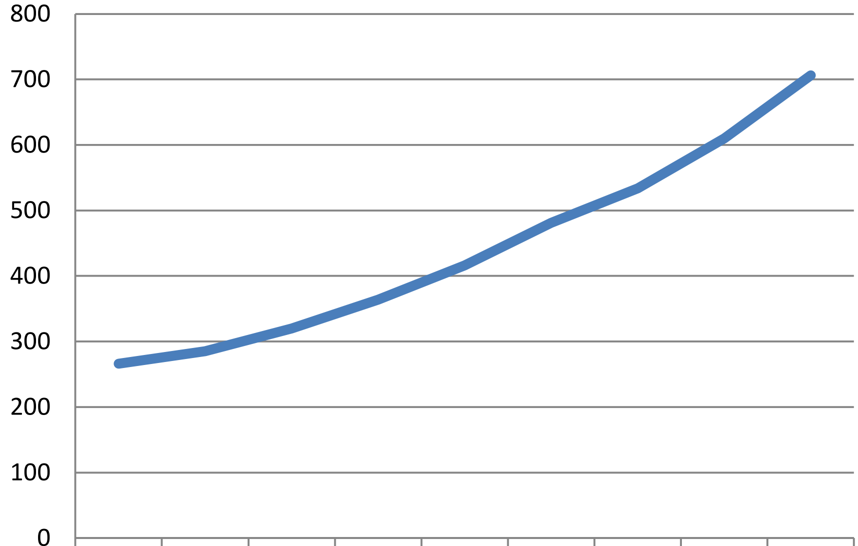
6.4.1 Electricity consumption

Most of Mozambique's primary energy demand is met by traditional biofuels such as wood, charcoal and agro/animal waste. In 2012, EDM calculated electricity consumption to be 3,921.8 GWh, which results in 165 kWh per capita. Mozambique has three separate regional distribution areas (two of which are interconnected, see Section 6.5.1). Out of the 4,251 GWh of distributed electricity in 2012, 2,297 GWh went to the Southern Region (including Maputo) Distributor, 870 GWh went to the Central Region Distributor, 502 GWh went to the Northern Region Distributor, 253 GWh went to Special Customers and the remaining 329 GWh was exported. The southern area of Mozambique, where the capital Maputo is located, consumes over 50 per cent of the electricity in Mozambique. EDM had 1,140,835 customers in 2012 which is about double the number of customers in 2008.[260]

[260] EDM, Statistical Summary 2012. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=177&tmpl=component&format=raw&Itemid=68&lang=en>.

In the same year, peak demand stood at 706 MW and the load factor was 0.65.[261] The peak demand excludes the Mozal aluminum smelter, which requires 750 MW and is supplied wholly by Eskom as part of a buy-back agreement for the electricity supplied by Cahora Bassa to South Africa with the power wheeled by MOTRACO.[262] The evolution of the peak demand between 2004 and 2012 is shown in Figure 6.2.

Figure 6.2: Peak demand in Mozambique 2004–2012



	2004	2005	2006	2007	2008	2009	2010	2011	2012
Peak Demand (MW)	266	285	320	364	416	481	534	610	706

Source: EDM, Statistical Summary 2012. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=165&tmpl=component&format=raw&Itemid=68&lang=en>.

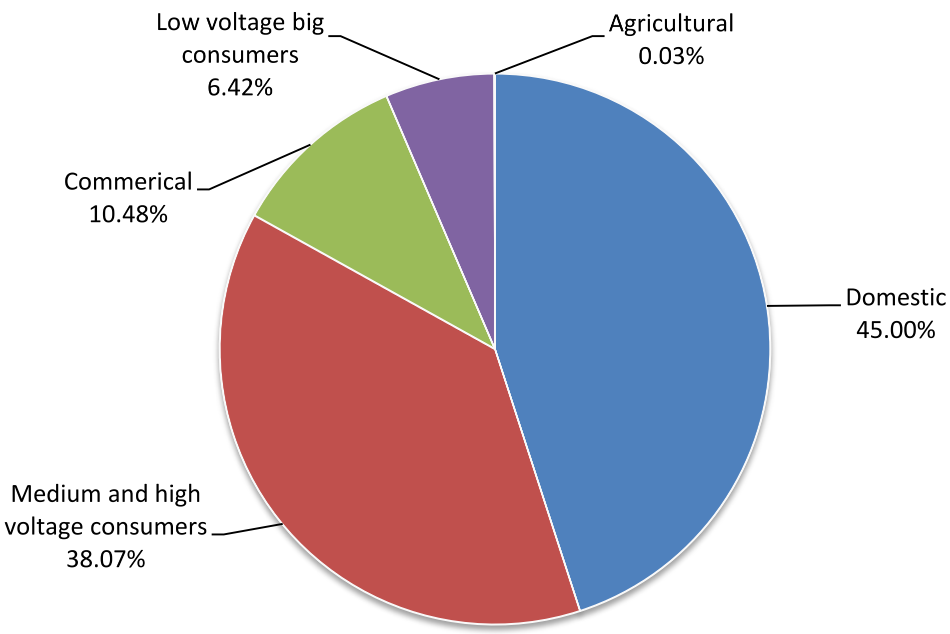
On average, the electricity demand has been growing by 13 per cent a year in Mozambique. Domestic electricity consumption increased by 725 GWh from 2011 to 2012, over a 15 per cent increase. In context, the average Southern African Power Pool country's electricity consumption growth was 2 per cent and only Angola had a higher growth in consumption out of the SAPP members.[263] The growth in domestic consumption has partially contributed towards Mozambique exporting half as much electricity in 2012 compared to 2008. The consumption of electricity distributed by different sectors (excluding exports, public lighting and EDM's own consumption) is displayed in Figure 6.3.

[261] EDM, Statistical Summary 2012. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=177&tmpl=component&format=raw&Itemid=68&lang=en>.

[262] "The Potential of Regional Power Sector Integration," Economic Consulting Associates, August 2009. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/05/09/000442464_20130509112003/Rendered/INDEX/773070v30ESMAP0ora0Bassa0Generation.txt>.

[263] Chambal, H., "Energy Security in Mozambique," International Institute for Sustainable Development, 2010. <http://www.iisd.org/tkn/pdf/energy_security_mozambique.pdf>; "Mozambique: Electricity Consumption Up By 15 Per Cent," AllAfrica, 2 May 2012. <http://allafrica.com/stories/201205020953.html>.

Figure 6.3: Consumers of electricity in Mozambique 2011 (total 2,339 GWh)



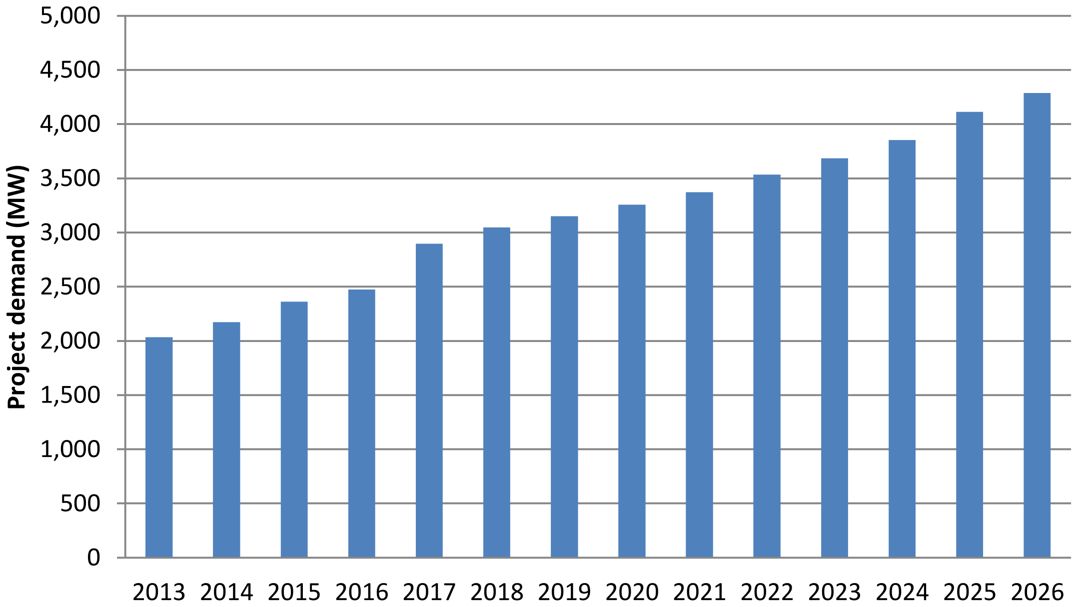
Source: EDM, Annual Statistical Report 2011. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=165&tmpl=component&format=raw&Itemid=68&lang=en>.

6.4.2 Projected demand

The MoE forecasted the electricity demand for the whole of Mozambique in Figure 6.4. The peak demand is projected to increase annually by 180 MW, an average annual increase of 6 per cent from 2013 to 2026. A projection of the annual demand rate growth by Frost & Sullivan analysts is significantly higher at 14 per cent, which would be a continuation of the pattern of demand growth over the last five years.[264] The economic growth resulting from the gas resources will have a significant impact on future power demand. Mozambique has the potential to become a major exporter in the SAPP which has an annual shortage of electricity estimated to be 2,000 MW.[265] Between 2014 and 2016, Mozambique will contribute 750 MW of their installed capacity to the SAPP.[266] Figure 6.4 includes the demand from large industrial customers, such as the Mozal aluminium smelter.

[264] "Demand for electricity in Mozambique to grow 14 per cent a year," ESI-Africa, 11 February 2013. <http://www.esi-africa.com/demand-for-electricity-in-mozambique-to-grow-14-a-year/>.
[265] Namburete, S., Mozambique Hydropower Competences, Ministry of Energy, 6 June 2012. <http://www.intpow.no/index.php?id=1344&download=1>.
[266] Southern Africa Power Pool, Annual Report 2013. <http://www.sapp.co.zw/docs/22867%20Annual%20Report%20New.pdf>.

Figure 6.4: Load forecast in Mozambique 2013–2026



Source: Manda, A., Country Report, Ministry of Energy, 4 June 2013. <http://eneken.ieej.or.jp/data/5007.pdf>.

6.5 Transmission and distribution

6.5.1 Situation and problems

Mozambique has two separate transmission systems: the Central-Northern System and the Southern System. The two systems are not interconnected. There is transfer capacity between the central and northern region but it is limited, because of this, EDM divides the transmission system into three systems.[267] First, the Central-Northern and Tete System is a 220 kV system covering nearly 1,000 km from Songo substation to Nampula with 110 kV lines extending to Lichinga, Pemba and Nacala. Second, the Central System has 110 kV lines connecting hydropower stations to consumers within the Beira-Manica corridor. Third, the Southern System is a 110 kV network from Maputo to Xai-Xai, Chokwe and Inhambane; a 275 kV line from Komatipoort in South Africa to Infulune substation; a 400 kV line from Arnot in South Africa to Maputo and a 400 kV line from South Africa via Swaziland.[268]

Mozambique had a total of 4,998 km of transmission lines as of 2011, over half of which are 110 kV, and 12,922 km of medium-voltage distribution lines. The transformation capacity was 4,275 MVA excluding MOTRACO who owned 1,200 MVA of transformer capacity in 2011.

The Southern System transmission grid has interconnectors with South Africa and Swaziland. At present, the transmission network is insufficient to efficiently transmit electricity from

[267] "Mozambique Renewables Readiness Assessment 2013," IRENA, 2012. <http://www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf>.
[268] MOTRACO Presentation, Southern Africa Power Pool, 20 September 2005. <http://www.sapp.co.zw/documents/ICT%20opportunties%20in%20SADC.pdf>.

Cahora Bassa through Mozambican territory to the capital in south, Maputo, where the greatest demand lies. Mozambique has to transmit the electricity through a 533 kV HVDC line to South Africa. The lack of adequate transmission lines within Mozambique from Cahora Bassa is problematic because Mozambique ends up importing electricity back from South Africa at a cost in order to meet their electricity demand. A small proportion of the electricity produced by Cahora Bassa directly supplies the Central-Northern System.

Mozambique is a scarcely-populated large country, thus has high transmission losses as the generation sources are situated far from load centres. EDM estimated that theft and vandalism to the transmission and distribution network cost USD 2.7 million in 2011.[269] Transmission losses and distribution losses are displayed in Table 6.4.

Table 6.4: System losses in Mozambique 2011 (GWh)

Year	2010	2011	2012
Transmission losses	137	159	300
Distribution losses	611	649	567
Total technical and non-technical losses (per cent)	26%	25%	23%

Source: EDM, Statistical Summary 2012. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=177&tmpl=component&format=raw&Itemid=68&lang=en>; EDM, Annual Statistical Report 2011. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=165&tmpl=component&format=raw&Itemid=68&lang=en >.

6.5.2 Future plans

There are two large-scale transmission projects planned for Mozambique. First, the Central Transmission Backbone project (CESUL) will add nearly 1,270 km of 800 kV transmission lines, 1,350 km of 400 kV transmission lines and eight new or extended substations at the cost of USD 1.8 billion.[270] The project will connect Tete, where the Cahora Bassa dam is located, to Maputo, thus connecting Mozambique's two separate transmission systems, to facilitate domestic use and exports of electricity. Construction is expected to begin in 2014 and the new transmission system will be commissioned in 2017.[271]

Second, a pre-feasibility study was undertaken for a project to interconnect the central and northern transmission systems. The National Director for Energy said that the project is an alternative to the failed project between Mozambique and Malawi intending to interconnect

[269] EDM, Annual Statistical Report 2011. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=165&tmpl=component&format=raw&Itemid=68&lang=en >.
[270] Norton Rose Fulbright, "Investing in the African electricity sector: Mozambique," July 2013. <http://www.nortonrosefulbright.com/files/investing-in-power-in-mozambique-100590.pdf>.
[271] EDM, "Mozambique Regional Transmission Backbone Project," April 2011. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_download&gid=76&Itemid=41&lang=pt>.

Malawi to the SAPP.[272] Although since this announcement, the Mozambique-Malawi interconnector might take priority as a Memorandum of Agreement was signed by the two Governments in April 2013 and Mozambique has applied for funding.[273]

There are a number of transmission bottlenecks in the existing transmission and distribution network. Any new power plant generation projects will require enhancement of the grid in order to evacuate the power to users.

6.6 Rural electrification

The World Bank estimates that 20.2 per cent of people in Mozambique had access to electricity in 2011, whilst EDM estimated 22 per cent in 2012.[274] In 2006, access to electricity was under 10 per cent. In 2012, 22 per cent of northern Mozambique, 14 per cent of central Mozambique and 50 per cent of southern Mozambique had access to electricity.[275] The Fundo Nacional de Energia (FUNAE), founded in 1997, is the rural electrification authority in Mozambique. FUNAE is supported by donors to fund off-grid projects, such as diesel generators and solar PV projects.

The World Bank's Energy Reform and Access Project took place between 2003 and 2011 in Mozambique. In total, 214 pilot residential and 270 public building solar PV systems were installed and 68,000 new households were connected to the grid.[276]

In 2014, the Energy Minister announced that the Government of Mozambique invested USD 530 million in rural electrification over the past five years. The number of district capitals with electricity had risen from 51 in 2004 to 121 (out of 128) in 2014. He further claimed that 40 per cent of the population had access to electricity in 2014 with 6.5 million grid-connected and 3.7 million receiving electricity from solar panels. The Mozambique Proposed Economic and Social Plan for 2013 aimed for 24.1 per cent of the population to be grid-connected whilst a further 12.3 per cent of the population would have access to off-grid renewable technology.

The Energy Minister is of the opinion that a further USD 2.4 billion needs to be invested for the country to be fully electrified. EDM has performed well in achieving access to the network.

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[272] "Mozambican government plans to build Central-North power transmission line," Macau Hub, 17 February 2012. <http://www.macauhub.com.mo/en/2012/02/17/mozambican-government-plans-to-build-central-north-power-transmission-line/>.
[273] Southern African Power Pool, Annual Report 2013. <http://www.sapp.co.zw/docs/22867%20Annual%20Report%20New.pdf>.
[274] The World Bank, Access to Electricity, 2011. <http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>.
[275] EDM, Annual Statistical Report 2011. <http://www.edm.co.mz/index.php?option=com_docman&task=doc_view&gid=165&tmpl=component&format=raw&Itemid=68&lang=en>.
[276] The World Bank, Energy Reform and Access Project, 27 September 2012. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/03/28/000333037_20140328102622/Rendered/PDF/ICR23820P069180C0disclosed030260140.pdf>.

However, because of the high technical losses and low tariffs, every connection made and every kWh of electricity delivered to rural communities results in a loss for EDM.[277]

As things stand, FUNAE has much work to do but lacks the institutional structure and technical expertise.[278] The current policy framework for renewable energy is insufficient to support a large number of off-grid projects. The Renewable Energy Atlas Study on rural electrification study on 10,000 villages concluded that grid extension in the denser areas, such as Zambezia and Nampula provinces, was preferable.[280] For other areas in which off-grid power solutions were preferred, hybrid solar and diesel solutions were identified as the least costly solution, apart from sites suitable for the development of mini-hydro (under 5 MW). Mini-hydro is the least costly fully-renewable solution but the resources only allow for the development of mini-hydro in 300 sites in Mozambique.

6.7 Tariffs

Tariff rates are set by contract rather than being subject to regulatory approval from CNELEC. They are set by the Ministry of Finance. The tariff rates are very close to the average for countries in the SAPP. Mozambique offers a pre-paid option for customers. The tariff system is relatively simple in Mozambique with only two tariff categories, household and major consumers, which are further broken down on the basis of electricity consumption and voltage supply (see Table 6.5).

Table 6.5: Tariff rates in Mozambique (USc)

Customer	Recorded consumption (kWh)	Fixed charge	Social tariff (per kWh)	Domestic rate (per kWh)	Agriculture tariff (per kWh)	General tariff (per kWh)
Household	0 to 100	N/A	0.3	N/A	N/A	N/A
	0 to 300	2711.22	N/A	0.79	0.85	0.94
	301 to 500	2711.22	N/A	1.12	1.21	1.35
	500+	2711.22	N/A	1.18	1.32	1.47
	Prepayment	N/A	0.3	1.01	1.17	1.35
Major Consumer	Low-voltage	79.38	N/A	N/A	N/A	41.11
	Medium-voltage	372.61	N/A	N/A	45.82	45.86
	High-voltage	372.61	N/A	N/A	N/A	50.42

[277] Norplan, “Impact Assessment of Rural Electrification,” 28 October 2013. <multiconsult.episerverhotell.net/Documents/Rapporter/Impact_Assessment_of_Rural_Electrification_Projects_in_Mozambique_draft_Final_Report_23.10.2013_New_Format.pdf>.
[278] “Mozambique Renewables Readiness Assessment 2012,” IRENA, 2012. <http://www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf>.
[278] Ibid.
[280] Renewable Energy Atlas of Mozambique, 2014. <http://www.atlasrenovaveis.co.mz/en>.

Source: EDM, Tarifarios de Energia Electrica, 17 September 2013. <http://www.edm.co.mz/index.php?option=com_content&view=article&id=121&Itemid=83&lang=pt>. Exchange rate, 1.00 MZN = 0.031766 USD, 19 June 2014. <http://www.xe.com/>.

6.8 International manufacturers

The activities of international suppliers in Mozambique's power sector are detailed below:

ABB

ABB opened an office in Maputo in 2012 in order to increase their local presence in the Mozambican electrical engineering market.

In 2003, ABB rehabilitated and reinforced the transmission and distribution network for two of Mozambique's largest cities, Maputo and Matola. The contract awarded by EDM was worth USD 7.5 million.[281]

In 2011, ABB won an USD 6.7 million order from JSPL Mozambique Minerais LDA, a subsidiary of Jindal Steel and Power Limited, for a 220/33 kV turnkey substation to electrify an open cast coal mine at a mining concession near the Chirodzi village in Tete.[282] The substation was the fourth project that ABB had undertaken in Mozambique from 2008 to 2011. The other projects were located in Moatize, Vale and Benga.

In 2012, ABB won a USD 50 million contract from HCB to refurbish the HVDC converter station in Songo. The converter station and associated high-power equipment are key components in the HVDC converter link transmitting electricity from the 2,075 MW Cahora Bassa hydropower station over 1,417 km to the grid in South Africa. The refurbishment project involved replacement of key equipment, including high-voltage transformers and DC smoothing reactors. The project has helped HCB to meet their power purchase agreement with Eskom.

In late 2013, ABB won an order worth about USD 20 million from Aarsleff-Seth JV to supply equipment and engineering services for two new substations that will extend the transmission network. The order also includes the rehabilitation and extension of nine existing transmission substations that will help to reinforce the grid. The substations are owned and operated by EDM.[283]

Siemens

Siemens opened an office in Maputo in 2013.

Siemens commissioned the world's first long distance, thyristor-operated HVDC transmission system between Cahora Bassa power station and South Africa in 1975. Siemens refurbished

[281] ABB, "ABB wins R60 million substation and power distribution equipment orders in Mozambique," 13 May 2003. <http://www.abb.pt/cawp/seitp202/c1919e920283fded85256d2500541bdc.aspx>.
[282] "ABB win R72 million power systems order in Mozambique," ESI-Africa, 13 December 2011. <http://www.esi-africa.com/abb-win-r72-million-power-systems-order-in-mozambique/>.
[283] ABB, "ABB wins $20 million order to strengthen Mozambique's power transmission grid," 18 February 2014. <http://www.abb.com/cawp/seitp202/b7053529d30924ffc1257c830032f5bc.aspx>.

the converter stations and replaced DC control with a digital, computerized system in 1995 and 1998.

In 2002, Siemens received a long-distance power transmission project from MOTRACO which was designed to supply electricity to the Mozal aluminium smelter in Maputo. Two fixed series capacitor banks were installed.

Siemens rehabilitated the distribution networks for Nampula and Nacala in northern Mozambique. Existing medium- and low-voltage networks were improved and new networks were constructed so that 2,000 consumers were reconnected. Transformers, substations and 33 kV and 11 kV lines were installed.

In 2013, Siemens received a contract worth over USD 150 million to install the electricity supply at the Nacala-a-Velha port. The project includes installing a high-voltage substation and several transformers.[285]

Alstom

Alstom signed a contract valued at EUR 40 million with HCB in 2002, for the complete refurbishment of the Cahora Bassa hydro power station. The turnkey contract covered the rehabilitation of turbines, the generator, the electrical balance of plant, hydro-mechanical equipment and supply of control systems for two central control operator stations, as well as training of local staff.[286]

Wärtislä

Wärtsilä signed a contract to engineer, supply and install one of the Ressano Garcia power plants in 2012. The contract was signed with the joint venture Central Termica de Ressano Garcia, owned by Sasol and EDM. The plant will be powered by a total of 18 Wärtsilä 34SG engines running on natural gas, with the gas fed from the Pande and Temane gas fields. In addition to the power plant itself, the turnkey contract includes the construction of a sub-station and a gas pipeline. The value of the power plant contract is EUR 138 million. The power plant was scheduled for completion by May 2014 but no announcement of its completion had been released as of July 2014, and the electricity produced will be sold to EDM. A three-year service agreement was signed in 2013.

GS Engineering & Construction

[285] "Mozambique: Siemens to Install Electricity Supply for Nacala-a-Velha Port," AllAfrica, 19 July 2013. <allafrica.com/stories/201307210032.html>.
[286] "ALSTOM wins major hydro refurbishment order in Mozambique," Power Engineering, 10 December 2012. <http://www.power-eng.com/articles/2002/12/alstom-wins-major-hydro-refurbishment-order-in-mozambique.html>.

The Korean GS Engineering & Construction was awarded an EPC contract from ACWA Power who is the lead developer of the 600 MW Moatize coal-fired power plant. The plant is an IPP green field development.[288]

TSK

In June 2014, Standard Bank provided Mozambican company Gigawatt with USD 170 million for a 118 MW gas-fired power plant in Ressano Garcia. Spanish engineering and technology company TSK was awarded a EUR 90 million contract to build the plant and it is expected that the construction of a substation will be added to the contract. The contract could increase to EUR 150 million depending on the number of years of operation and maintenance. Construction of the plant will take up to 18 months and 13 turbines will be supplied by Rolls Royce.[289]

6.9 Risks and opportunities

6.9.1 Issues

Transmission

Mozambique is a large country and the generation sources are mostly on the west, whereas the largest demand centre is Maputo in the south-east of the country. The electricity produced at Cahora Bassa has long distances to cover before reaching Maputo. Furthermore, the Mozambican National Resistance (RENAMO) targeted the national grid during the civil war, meaning that repairs and rehabilitation still need to be undertaken. Consequently, transmission losses are high. In conjunction with the low population density, the high transmission losses are a serious barrier to grid-connected rural electrification.

The Central Transmission Backbone project could help the situation to improve as power will be evacuated from Cahora Bassa through high-voltage lines to Maputo. Furthermore, the gas resources in the north can help to reduce the transmission distances to certain areas of the country. EDM has estimated that it needs to spend USD 2 billion on the transmission network in the next five to ten years to meet growing demand.[290]

Weak customer base

Mozambique is a very poor country, which is still recovering from a 15 civil war. The population density and level of urbanisation are very low. Besides the Mozal aluminum smelter, industrial activity is low in Mozambique – although with the coal and gas discoveries, the country could see a surge in industrial activity.

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[288] "Mozambique approves 600 MW coal fired power station," ESI-Africa, 17 March 2014. <http://www.esi-africa.com/mozambique-approves-600-mw-coal-fired-power-station/>.

[289] TSK, "TSK awarded 120 MW generation plant in Mozambique," 26 June 2014. <en.grupotsk.com/noticias/tsk-se-adjudica-una-planta-de-generacion-de-120-mw-en-mozambique>.

[290] "Mozambique's power company needs USD 2 billion to cover increased demand," Macau Hub, 28 Feburary 2014. <http://www.macauhub.com.mo/en/2014/02/28/mozambique%E2%80%99s-power-company-needs-us2-billion-to-cover-increased-demand/>.

The tariff rates must increase for EDM to be financially viable but the hiked tariff rates risk becoming unaffordable for many Mozambicans, 60 per cent of whom lived off less than USD 1.25 a day in 2009.[291] Mozambique lacks a long-term strategy for the development of the electricity tariff system. As of yet there is no independent regulator to produce a mid- to long-term strategy for the evolution of tariff schedules in order to reach a compromise on cost-reflective and affordable tariff rates.

Institutional weakness

The energy policy and institutional capacity is much weaker than many other African countries. The role of each organization is not clearly defined and there is no clarity upon whether or not CNELEC has adopted the independent regulatory role in the Mozambican power sector.[292] The policy is vague and fails to specify concrete, measurable targets for electricity generation, transmission and distribution, as well as the expected level of required investment and the party responsible for implementation.[293] Many of the objectives set out in the policies are for further research and planning. The latest power sector-wide strategy covered up to 2013 - the strategy severely underestimated the electricity demand growth yet no update or new power sector policy has been created post-2013 which is adjusted according to the rapid growth in demand. Despite the absence of clear policy, there is still a reasonably high level of planned power plant and transmission improvements taking place.

However, one area in which the poor electricity policy is especially problematic is exploiting renewable energy and off-grid electrification. The 2011–2025 Strategy fails to set out staggered electrification or renewable energy development targets. The renewable energy potential 'atlas' of Mozambique provides institutions with the means to improve the specificity of the implementation of the policy's objectives.

Role within the wider region

Historically, the Cahora Bassa dam was built for the energy needs of South Africa. The SAPP has a shortage of power and HCB is now majority owned by Mozambique, which means that Mozambique can negotiate higher tariff rates for its electricity yet the SAPP tariff rates are still not cost-reflective.[295] At the moment, 65 per cent of the electricity from Cahora Bassa is exported through the HVDC line to South Africa and South Africa receives cheap electricity in return for transmitting electricity (actually generated from mostly coal-fired power stations) back to Maputo and Matola.[296] The Cahora Bassa contract terms with South Africa do not leave

[291] United Nations, Human Development Report 2013. <http://hdr.undp.org/sites/default/files/reports/14/hdr2013_en_complete.pdf>.

[292] "Mozambique Renewables Readiness Assessment 2012," IRENA, 2012. <http://www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf>.

[293] Ibid.

[295] "The Potential of Regional Power Sector Integration," Economic Consulting Associates, August 2009. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/05/09/000442464_20130509112003/Rendered/INDEX/773070v30ESMAP0ora0Bassa0Generation.txt>.

[296] Ibid.; "Mozambique Renewables Readiness Assessment 2013," IRENA, 2012. <http://www.irena.org/DocumentDownloads/Publications/IRENA%20Mozambique%20RRA.pdf>.

enough electricity for the domestic Mozambican market.[297] To accommodate for the shortfall, additional power over the contractual allowance is bought from Eskom but is charged at seven times the price. This accounted for 40 per cent of EDM's budget in 2013.[298]

There is a growing conflict of interests between building infrastructure for export and improving the domestic power situation. With low electrification rates and erratic power supply in Mozambique, it causes political unrest when the electricity generated from new major projects, such as Mphanda Nkuwa, will be exported without the improvement of Mozambique's power sector taking priority. The Mphanda Nkuwa project failed adhere to any of the seven priorities set out by the World Commission on Dams, in particular highlighting that large-scale projects do not fit the needs of a country with only 22 per cent of the population with access to electricity.[299]

6.9.2 Future opportunities

Power projects are thought to be worth an estimated USD 12 billion in the short to mid-term.[300] Mozambique's investment promotion centre stated that 418 foreign investment power projects worth USD 1.4 billion were agreed on in 2013 alone.

The 'mega-project' legislation of 2011 applies to any relationship between the state and a private party for investments and developments in Mozambique, hence the legislation applies to the power sector. The three major stipulations of the legislation are:[302]

1) there must be a 5–20 per cent equity offered to Mozambicans in any project, preferably through an offer on the stock exchange
2) it is mandatory for Mozambican companies to participate in any project on terms to be negotiated and agreed upon in the contract
3) any large project must pay at least 35 per cent of generated revenue each fiscal year to Mozambique's government in taxes

The following opportunities have been identified for international suppliers:

- major hydropower plant developments, such as Cahora Bassa North Bank and Mphanda Nkuwa
- small hydropower projects, including mini-grids for certain projects

[297] "Mozambique needs to negotiate larger share of power from Cahora Bassa with South Africa," Macau Hub, 25 April 2014. <http://www.macauhub.com.mo/en/2014/04/25/mozambique-needs-to-negotiate-larger-share-of-power-from-cahora-bassa-with-south-africa/>.
[298] "Mozambique: Mozambican Electricity Tariffs 'Unsustainable'," AllAfrica, 24 March 2014. <http://allafrica.com/stories/201403250466.html?viewall=1>.
[299] Ribiero, D. and Ambiental, J., "An Analysis of the Mphanda Nkuwa Dam Project Against the World Commission on Dams (WCD) Guidelines," January 2004. <http://www.internationalrivers.org/files/attached-files/040101mphanda.pdf>.
[300] "Projects planned for Mozambique's power sector," ESI-Africa, 27 March 2014. <http://www.esi-africa.com/projects-planned-for-mozambiques-power-sector/>.
[302] Chatham House, "New Investment Frontiers: Angola and Mozambique," 11 April 2013. <http://www.chathamhouse.org/sites/default/files/public/Research/Africa/110413Summary.pdf>.

- maintenance and replacement of parts for Cahora Bassa
- an estimated USD 2 billion needs to be spent on the transmission and distribution infrastructure in Mozambique on rehabilitation and extensions. Work on the CESUL project and further connection of district capitals, including transmission lines, transformers and substations
- extension of the transmission infrastructure to neighboring countries, such as Malawi
- natural gas infrastructure including (export) pipelines, storage, gas-to-liquids facilities and an LNG facility
- gas-fired power plants and their associated turbines
- supplying the heavy equipment for coal mining and the construction of affiliated power plants
- the provision of alternative energy systems, particularly for rural off-grid electrification. The Atlas of Renewable Energy in Mozambique provides a comprehensive guide of potential renewable energy sites and could be the catalyst for improved renewable energy incentives.[303] The recommendations of the Atlas would suggest that, for suppliers, the solar PV industry and diesel generators will provide many opportunities

[303] Renewable Energy Atlas of Mozambique, 2014. <http://www.atlasrenovaveis.co.mz/en>.

7. Tanzania

7.1 Electricity sector structure and organisations

7.1.1 Generation, transmission, distribution and supply companies

Tanzania Electricity Supply Company Ltd (TANESCO) is the vertically-integrated state-owned company in the United Republic of Tanzania power sector.[304] Power sector reforms began in 1992 on the back of a drought and advice on the privatisation process from the World Bank and International Monetary Fund. The reform allowed for Independent Power Producers (IPPs) to develop hydro and thermal generation capacity. In 1999, the Tanzania Government committed to more radical reform plans, including sector unbundling and privatisation of distribution assets followed by privatisation of generation and transmission assets. The unbundling never occurred. Instead, in 2002, a South African engineering management consultancy NETGroup Solutions were contracted for four years to manage TANESCO. In 2005, a new government came in and decided against privatising TANESCO. In June 2014, the Government approved the Electricity Supply Industry Reform Strategy and Roadmap which includes unbundling TANESCO.[305] By June 2018, the generation segment of TANESCO will have been unbundled and TANESCO will be fully privatised by 2025.

IPPs are present in Tazania, such as Sonagas and Independent Power Tanzania, who provide additional electricity for TANESCO. In 2009, IPP power plants accounted for 29 per cent of Tanzania's installed capacity.[306] Mtwara Energy Project (MEP) in southern Tanzania is a unique integrated upstream gas production and electricity generation project by the IPP Artumus Group.

Zanzibar has a separate electrical utility company called Zanzibar Electricity Company (ZECO). ZECO has about 126,000 customers and covers 80 per cent of the islands.[307] Most of the electricity distributed comes from mainland Tanzania through a subsea cable that was completed in 2012. Out of the three main inhabited islands in the Zanzibar Archipelago, Unguja (commonly referred to as Zanzibar) and Pemba are connected to the national grid but Mafia is not.

7.1.2 Ministry and regulatory agencies

The Ministry of Energy and Minerals (MEM) formulates the policy for the power sector and regulates the upstream gas industry. MEM generally acts as the principal negotiator on IPP projects.

[304] Although the official name is 'United Republic of Tanzania', 'Tanzania' is used throughout.
[305] "Tanzania: Cabinet Okays TANESCO Reform," AllAfrica, 23 June 2014.
<http://allafrica.com/stories/201406230677.html>.
[306] Kapika, J., and Eberhard, A., "Power-Sector Reform and Regulation in Africa," 2013.
<http://www.gsb.uct.ac.za/files/Tanzania.pdf>.
[307] Millennium Challenge Corporation, Turning Blackouts into Opportunities.
<http://www.mcc.gov/pages/press/story/story-turning-blackouts-into-opportunities>.

Energy and Water Utilities Regulatory Authority (EWURA) is the independent power sector regulatory authority. It became operational in 2006. It approves the tariff schedule and the terms and conditions of electricity supply. It has the right to permit the procurement of new generation capacity, which is a function that regulatory institutions do not usually have.

7.1.3 Other organisations

Industry associations and other organisations relevant to the Tanzanian power sector are:

- The Tanzania Atomic Energy Commission: established in 2003 as the official government body responsible for all nuclear energy matters in Tanzania. Tanzania has uranium deposits and could become the second-largest producer of uranium in the world after Kazakhstan.[308]
- The Tanzania Renewable Energy Association (TAREA): a non-governmental organization promoting the accessibility and use of renewable energy in Tanzania. The association was formerly limited to the promotion of solar power.
- Geothermal Power Tanzania (GPT): the subsidiary of Geothermal Power Limited who owns six concessions for geothermal power in Tanzania. GTP is currently undertaking geothermal exploration in Tanzania.

7.2 Energy and electricity policy

7.2.1 Key policies

The key policies governing the power sector in Tanzania are:

<u>Petroleum Act 1980</u>

The Act is the legislation concerning upstream oil and gas operations.

<u>National Energy Policy 1992, 2003</u>

The 1992 policy's main objectives were to increase generation from hydropower, natural gas and coal resources, improve land management and wood fuel technologies, minimise energy price fluctuations and ensure energy security. The revised 2003 policy takes into account structural changes in the economy and political changes. The 2003 edition is currently under review to give prominence to biomass and bio-fuels.[309]

<u>Energy and Water Utility Regulatory Authority Act 2001</u>

The Act facilitated the formation of EWURA five years later.

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[308] "Tanzania expected to become second-biggest uranium producer," Mining Weekly, 11 October 2013. <http://www.miningweekly.com/article/tanzania-expected-to-become-the-second-biggest-uranium-producer-2013-10-11>.

[309] Mwakyusa, A., "Tanzania: Dar to Review National Energy Policy," AllAfrica, 18 September 2013. <http://allafrica.com/stories/201309180920.html>.

Poverty Reduction Strategy 2005, 2010

The 2005 strategy outlined the goals for achieving poverty reduction, one of which was the provision of reliable and affordable energy to consumers. The operational targets were the liberalisation of the power sector and to increase Production Shared Agreements for the exploitation of natural resources. In the 2010 strategy, new generation capacity was prioritised with a target of 1,722 MW by 2015.

Rural Energy Act 2005

The Act established the Rural Energy Board, Fund and Agency to promote rural electrification.

Electricity Act 2008

The Act provided the means to facilitate and regulate generation, transmission, transformation, distribution, supply and use of electric energy for both cross-border trade and rural electrification. It opened up the Tanzanian electricity sector to private companies.

Power System Master Plan 2009–2031

Short- and medium-term projects were identified to replace the short-term emergency generation plants called upon due to the shortage in generation capacity as droughts were affecting the performance of Tanzania’s hydropower stations. The identified projects include interconnector transmission lines and developing power purchase agreements with neighbouring countries, new generation capacity, the expansion of the high-voltage transmission network and further studies into wind energy.

Natural Gas Policy 2013

The Policy was approved in November 2013 but is not yet in force. It sets out the government vision for mid- and downstream gas developments in Tanzania.

Electricity Supply Industry Reform Strategy and Roadmap 2014–2025

The Roadmap was released on 30th June 2014 and targets an increase from 1,538 MW to at least 10,000 MW by 2025. To achieve the target, the Government is reforming Tanzania’s electricity supply industry. The major activity and financing required for the stages of the reforms are shown in Table 7.1.

Table 7.1: Tanzanian power sector reform plan

Stage	**Major activity**	**Amount (USD millions)**
Immediate-term (2014–2015)	TANESCO turn-around and preparations for short-term	344.9
Short-term (2015–2018)	Unbundling of generation from transmission and distribution segments	386.9
Medium-term (2018–2021)	Unbundling of distribution from transmission segment	414.5

Long-term (2021–2025)	Introduction of retail competition market and preparation for listing generation and distribution companies on the Tanzania stock exchange	344.9
Total		**1,491.3**

Source: United Republic of Tanzania, Electricity Supply Industry Reform Strategy and Roadmap 2014–2025, 30 June 2014. <http://www.tanesco.co.tz/index.php?option=com_content&view=article&id=436:tanzania-supply-industry-reform-strategy-and-loadmap-2014-2015&catid=3:newsflash?>.

7.2.2 Renewable energy policy

At present, Tanzania does not have a renewable energy policy.[310] A government aim of 260 MW of grid-connected power generated from renewable sources by 2016 was indicated in the Power System Master Plan.

Nonetheless, a feed-in tariff scheme has been in place for Small Power Producers (SPP, 100 kW to 10 MW) since 2008 (see Table 7.2). For renewable electricity projects over 10 MW, the feed-in tariff rates are negotiable. The feed-in tariff schedule is adjusted annually by EWURA. The adjustments are based upon the supposed generation costs for electricity supplied by TANESCO's hydropower and thermal plants (see Section 7.3). This ensures that TANESCO does not pay more for electricity from renewable sources than they would from other available options. Consequently, the tariff rates are undifferentiated for renewable energy technologies and there is no guaranteed price over the long-term regardless of any power purchase agreements.

Separate tariff rates exist for renewable electricity connected to the main grid and connected to isolated mini-grids, as the avoided costs for TANESCO differ. In addition, the generation costs for TANESCO are higher in the dry season (August to November), as expensive thermal power plants generate more electricity to compensate for lower generation from hydropower sources. Consequently, the feed-in tariff varies according to the season.[311]

Table 7.2: Feed-in tariff system in Tanzania (USc per kWh)

Connection	Time	2012	2013
Main grid	Dry season	N/A	12.7
	Wet season	N/A	9.5
	Standardized	9.3	10.6
Mini-grid	Standardized	29.4	29.6

Source: EWURA, Small Power Projects 2014. <http://www.ewura.go.tz/newsite/index.php/sppmenu/165-small-power-projects-2014>. Exchange rate, 1 TZS = 0.000604780 USD, 16 June 2014. <www.xe.com>

No particular governmental energy efficiency projects are underway.

[310] Mnzava, A., Current National Energy Policy of Tanzania and Challenges on Supporting Renewable Energy Sector, 2013. <http://www.costech.or.tz/wp-content/uploads/2012/11/TAREA-Presentation-on-the-National-Energy-policy-and-Renewables1.pdf>.
[311] REEEP Policy Database, Tanzania. <http://www.reegle.info/policy-and-regulatory-overviews/TZ>.

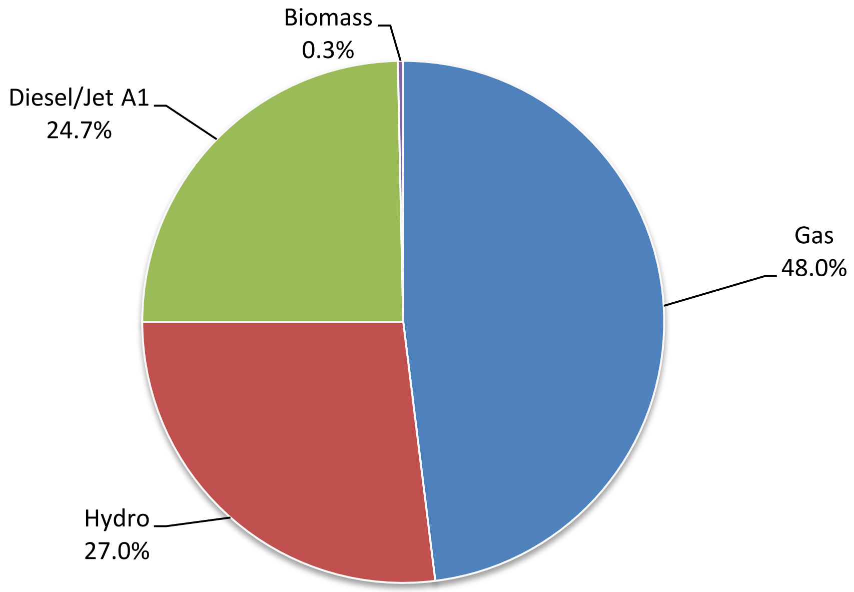
Biomass Energy Strategy (BEST) Tanzania

The development of BEST for Tanzania was supported by the European Union's Energy Initiative from 2012 to 2014. BEST identifies means to ensure "a sustainable supply of biomass energy, to raise efficiency in the production and use of biomass, to promote access to alternative energy sources and to ensure the institutional environment for the implementation of the strategy."[313] The main conclusion of the study was that forestry biomass demand in Tanzania is unsustainable.

7.3 Generation

7.3.1 Current generation

Figure 7.1: Tanzania electricity generation mix 2013 (total 5,767 GWh)



Source: EWURA, Annual Report 2013, December 2013. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>.

According to the Reform Strategy and Roadmap, Tanzania's installed capacity was 1,583 MW as of May 2014, up from 1,103 MW in 2011.[314] In terms of installed capacity hydropower accounted for 561 MW (35 per cent), gas-fired plants for 527 MW (34 per cent) and liquid fuel plants for 495 MW (34 per cent).

[313] EUEI, Biomass Energy Strategy (BEST) Tanzania, April 2014. <http://www.euei-pdf.org/sites/default/files/files/field_pblctn_file/BEST%20Biomass%20Energy%20Strategy%20Tanzania_Final%20Version%20April%202014.pdf>.

[314] EWURA, Annual Report 2013, December 2013. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>; United Republic of Tanzania, Electricity Supply Industry Reform Strategy and Roadmap 2014–2025, 30 June 2014. <http://www.tanesco.co.tz/index.php?option=com_content&view=article&id=436:tanzania-supply-industry-reform-strategy-and-loadmap-2014-2015&catid=3:newsflash?>.

Hydropower's share in the generation mix (27 per cent) displayed in Figure 7.1 was relatively low compared with hydropower's share in the installed capacity mix (35 per cent). The share was lower due to extended droughts which have led to a downfall in hydropower generation and an effort to increase investment in climate-neutral generation sources. The available generation capacity is closer to 950 MW because of droughts, infrastructure breakdowns, insufficient finance for liquid fuels and a poor gas supply because of inadequate production and midstream gas infrastructure.

Emergency Power Producers (EPPs) which use diesel generators have been hired for the short-term to cope with the downfall in available generation capacity. TANESCO pays TZS 26 billion (USD 15.7 million) per month for emergency power from Symbion and Aggreko. As of June 2013, 205 MW were in use.[315] The Energy Minister and the TANESCO board announced that the contracts with Symbion and Aggreko would end in October 2014 as rainfall has improved and projects under construction will come online in the course of 2014.

In June 2013, TANESCO possessed 58 per cent of installed capacity in Tanzania, IPPs possessed 27 per cent, EPPs possessed 13 per cent and imports from Uganda and Zambia contributed 1 per cent.[317] Tanzania has a policy not to import or export more than 25 per cent of total available capacity.[318] Table 7.3 lists the power plants in Tanzania with their installed capacity. Emergency temporary power plants, of which there are four, are not included.

Table 7.3: Power stations in Tanzania

Power plant name	Owner	Type	Installed capacity (MW)	Year of operation
Kidatu	TANESCO	Hydropower	204	1976
Kihansai	TANESCO	Hydropower	180	2000
Mtera	TANESCO	Hydropower	80	1979
New Pangani Falls	TANESCO	Hydropower	68	1994
Hale	TANESCO	Hydropower	21	1964
Nyumba ya Mungu	TANESCO	Hydropower	8	1969
Mwenga	Mufindi Tea Company	Hydropower	4	2012
Sub-total		**Hydropower**	**565**	
Ubungo I	TANESCO	Gas	102	1994 (2010)
Ubungo II	TANESCO	Gas	105	2012
Tegeta	TANESCO	Gas	45	2011
Mtwara/Lindi	TANESCO	Gas	18	2007

315 Mwalimu, S., "Tanesco won't renew costly contract with US company," The Citizen, 29 December 2013. <http://www.thecitizen.co.tz/News/Tanesco-won-t-renew-costly--contract-with-US-company/-/1840392/2128128/-/tpfe2sz/-/index.html>.

317 EWURA, Annual Report 2013, December 2013. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>.

318 Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>

Somanga	TANESCO	Gas	7.5	2010
Sonagas	Sonagas	Gas	189	2004
Ubungo	Symbion	Gas (Jet A1)	112	2011
Sub-total		**Gas**	**578.5**	
ZUZU - Dodoma	TANESCO	Diesel	7.4	1980
Mwanza	TANESCO	Heavy fuel oil	63	2013
Isolated diesel generation	TANESCO	Oil	81	N/A
Tegeta	IPTL	Oil	103	2011
Sub-total		**Oil**	**254.4**	
Moshi	TPC sugar factory	Biomass	17.5	2009
TANWAT	TANWAT	Biomass	2	1995
Sub-total		**Biomass**	**19.5**	
Total			**1417.4**	

Source: TANESCO, Thermal Power Plant. <http://www.tanesco.co.tz/index.php?option=com_content&view=article&id=78&Itemid=167>; EWURA, Electricity. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>; Greacen, C., IFC Investment Climate Infrastructure Workshop on Small Power Producers, 30 April 2013. <http://palangthai.files.wordpress.com/2013/04/30apr2013-tz-sppexperience-greacen.pptx>; United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>; EWURA, Annual Report 2013, December 2013. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>.

7.3.2 Planned projects and generation targets

In the short-term, Tanzania will be reliant upon expensive oil-fired generation and emergency power plants until late-2014 and 2015 when the gas pipeline from Mnazi bay gas fields to Dar es Salaam is complete.[319] TANESCO has stated that future generation will be dominated by coal and gas power plants. The latest government power sector strategy assumed that the natural gas proven reserves were 880 bcf in Songo Songo and 262 bcf in Mnazi Bay.

The installed capacity target for 2035 was 9,610 MW in the Power System Master Plan in 2012. The installed capacity mix will consist of 3,305 MW hydro, 2,200 MW gas, 3,800 MW coal, 120 MW solar, 100 MW wind, 40 MW cogeneration, as shown in Figure 7.2.[320] The projected installed capacity in the Reform Strategy and Roadmap 2014 greatly differs from the 2012 Power System Master Plan as shown in Table 7.4. The Reform Strategy and Roadmap aims for 10,798 MW by 2025, which is larger than the projected installed capacity for 2035 set by the Power System Master Plan in 2012.

[319] "Tanzania seeks $100 mln World Bank loan for emergency power," Reuters, 4 March 2013. <http://www.reuters.com/article/2013/03/04/tanzania-energy-idUSL6N0BWE2F20130304>.
[320] United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

Tanzania will begin importing power from Ethiopia via Kenya in 2016 and exporting power to Zambia, Mozambique, Burundi and Rwanda in 2018. Although hydropower will account for a third of the installed capacity mix, the Government plans for hydropower to generate just 7 per cent of the electricity supply in Tanzania in 2035. The required investment in the power sector is estimated to be a total of USD 40.8 billion, of which approximately USD 27 billion will be spent on power stations.

Table 7.4 outlines the development of generation capacity up to 2034 and the annual installed capacity additions for each generation technology. A list of the planned projects to achieve the targets can be found in Appendix 9.5.

Table 7.4: Planned installed capacity additions in Tanzania 2014–2034 (MW)

Year	Total installed capacity	Gas capacity addition	Hydropower capacity addition	Oil capacity addition	Coal capacity addition	Renewable capacity addition
2014	1,578	368	0	(167)	0	0
2015	2,158	690	0	(150)	0	40
2016	3,478	810	0	0	200	110
2018	4,375	0	38	0	1,000	110
2020	4,773	0	98	0	300	0
2022	5,375	0	502	0	100	0
2024	5,927	0	452	(100)	200	0
2025*	***10,798***	***3,968***	***1,529***	***0***	***2,900***	***500***
2026	6,517	(187)	677	0	100	0
2028	7,206	0	489	0	200	0
2030	7,851	(100)	145	0	800	0
2032	8,610	(141)	600	(60)	400	(40)
2034	9,310	0	0	0	300	0

Note: the figures in brackets represent a decrease in installed capacity and * the figures in italics and bold are from the Electricity Supply Industry Reform Strategy and Roadmap 2014. Source: United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>; United Republic of Tanzania, Electricity Supply Industry Reform Strategy and Roadmap 2014–2025, 30 June 2014.

In early 2014, Zanzibar expressed that they wanted to develop their own generation capacity to desist from power dependency and worsening relations with TANESCO because of the price of the power bill and threats from TANESCO to cut off the power.[322]

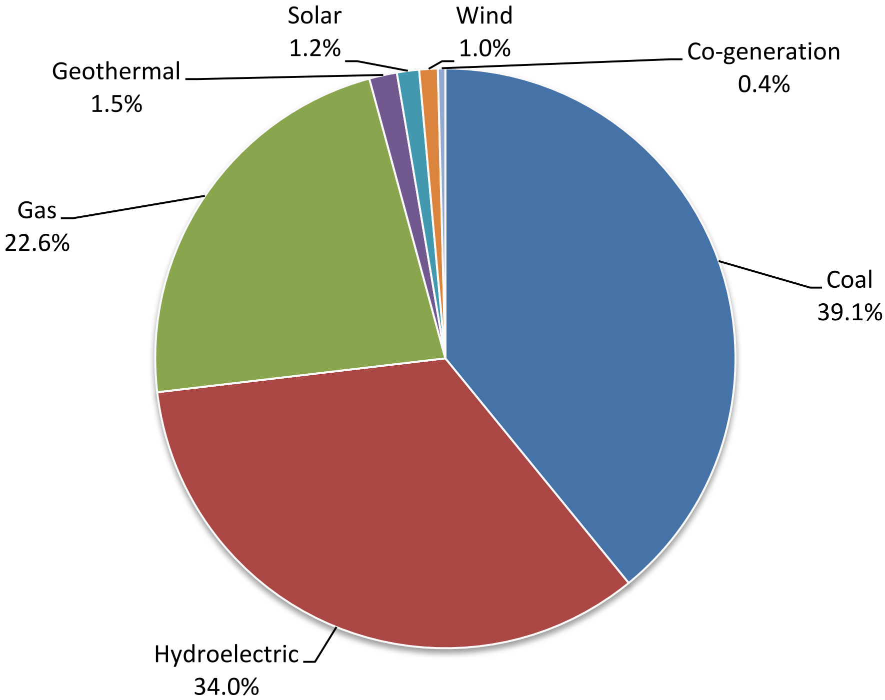
The new Small Power Producer framework set up in 2009 should facilitate the development of small hydro and biomass projects across Tanzania. Tanzania is one of the pilot countries for the

[322] Zablon, A., "Zanzibar wants own power generation," East African Business Week, 7 April 2014. <http://www.busiweek.com/index1.php?Ctp=2&pI=920&pLv=3&srI=53&spI=20&cI=11>.

Climate Investment Fund's Scaling Up Renewable Energy programme.[323] The programme is supporting geothermal power development and 47 MW of other renewable energy projects.

Geothermal Power Tanzania is planning to build a 150 MW geothermal power plant in the south of Tanzania by 2018.[324] They intend to produce 2 MW from a wellhead by 2014. Tanzania is located in the same rift valley as Kenya which generates nearly 20 per cent of its electricity through geothermal sources (see Section 5.3.1). The Ministry of Energy and Minerals estimates that Tanzania has 650 MW of geothermal potential. However, geothermal power was not included in the Power System Master Plan but has been included in Figure 7.2.[325]

Figure 7.2: Tanzania installed capacity mix 2035 (total 9,610 MW)



Source: United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

[323] TANESCO, Scaling up Renewable Energy Program. <http://www.tanesco.co.tz/index.php?option=com_remository&Itemid=221&func=select&id=19>.

[324] Jerving, S., "Geothermal Power Tanzania Plans First Steam Generation Next Year," Bloomberg, 21 June 2013. <http://www.bloomberg.com/news/2013-06-21/geothermal-power-tanzania-plans-first-steam-generation-next-year.html>.

[325] United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

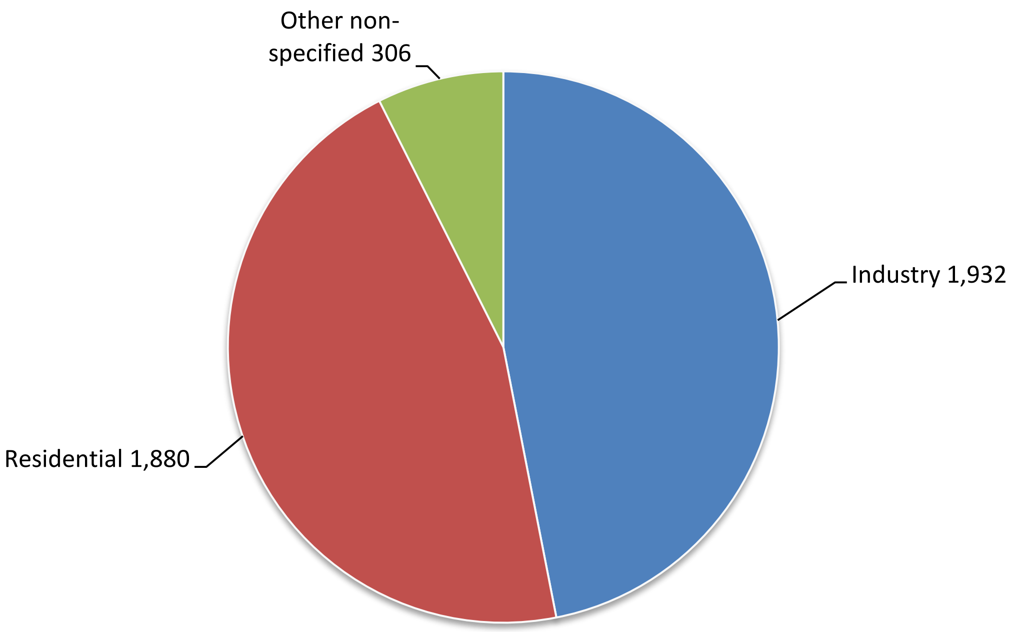
7.4 Consumption

7.4.1 Electricity consumption

The electricity consumption per capita was 81 kWh in 2012.[326] Peak demand was 851 MW in October 2012, up from 821 MW in November 2011.[327] The suppressed or unrealised demand was estimated to be 2.1 per cent (22 GWh) of the electricity supplied. Because of the severity of the frequent droughts which have "often depleted the entire hydropower reservoir system," Tanzania suffers from a constrained supply-demand gap. According to the Electricity Supply Industry Reform Strategy and Roadmap 2014, demand for electricity has been growing between 10 and 15 per cent annually in Tanzania.[328]

Over 80 per cent of TANESCO's revenue comes from 1,700 Large Power Users (users who consume at least 7,500 kWh a month) who form only 0.24 per cent of their customer base. At the end of 2012, 1,040,000 customers were connected to the grid. The breakdown of electricity consumer groups in Tanzania is displayed in Figure 7.3.

Figure 7.3: Consumers of electricity in Tanzania 2011 (total 4,118 GWh)



Source: IEA, Tanzania, United Republic of: Electricity and Heat for 2011. <http://www.iea.org/statistics/statisticssearch/report/?country=TANZANIA&product=electricityandheat&year=2011>.

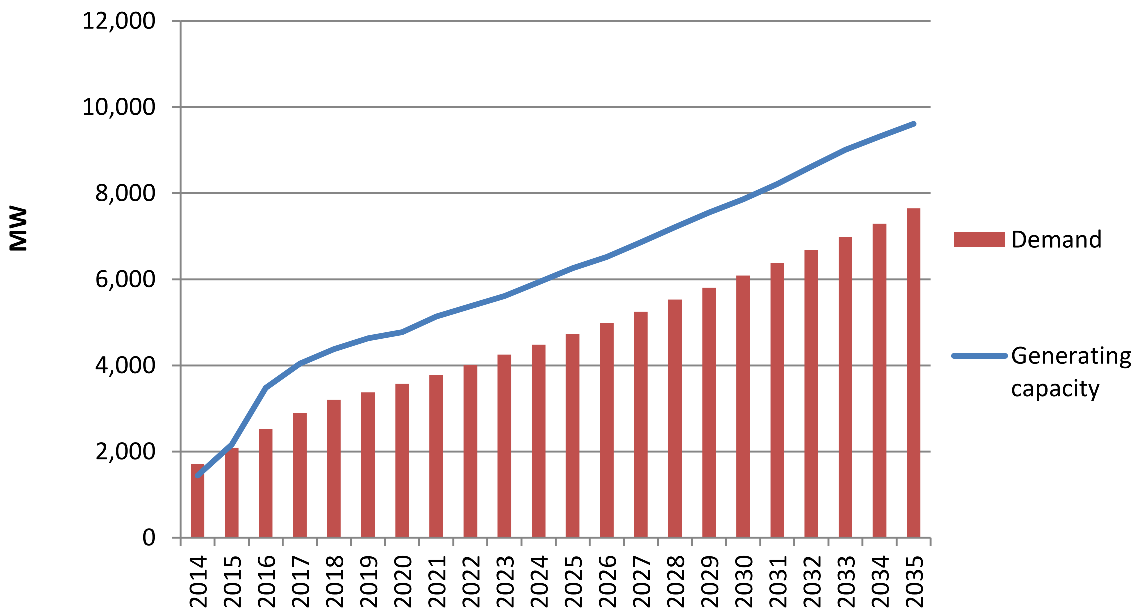
[326] Ibid.
[327] EWURA, Annual Report 2013, December 2013. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>.
[328] United Republic of Tanzania, Electricity Supply Industry Reform Strategy and Roadmap 2014–2025, 30 June 2014. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

7.4.2 Projected demand

The five-year Power System Master Plan from 2011/12 sets a target for electricity consumption per capita to rise to 200 kWh by 2015/16.[329] Figure 7.4 compares the base case forecasted demand against expected installed capacity growth up to 2035, during which time the annual growth in demand is approximately 8 per cent. Tanzania hopes to achieve a 15–20 per cent system reserve margin. The installed capacity predicted for 2014 was not achieved by 140 MW. The actual installed capacity for 2014 is included in Figure 7.4, which highlights that generation capacity additions are already running behind schedule.

According to an IPP Edenville Energy, demand is expected to increase 11–13 per cent annually over the next few years.[330] There is a higher level of planned capacity additions in the 2014 Reform Strategy and Roadmap which suggests that the projected demand for electricity could be higher than predicted in Figure 7.4. No updated load forecasting studies are referenced and it appears as though the increased projected installed capacity is stipulated as the level necessary to achieve Tanzania's economic and development goals.

Figure 7.4: Load forecast and installed capacity in Tanzania 2014–2035



Source: United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

High demands for electricity are expected from the Mtwara transportation corridor (200 MW by 2016) and mining activities. Agriculture features as the backbone of the economy in Tanzania's development plan, hence Tanzania's development path is not as energy intensive as that of some other African nations, whose economic growth is centred around mining and

[329] Ibid.
[330] Edenville Energy Plc, The need for coal in Tanzania. <http://www.edenville-energy.com/tanzania_coal.html>.

industrial activities. Major anticipated loads over 50 MW are the Mchuchuma iron smelter and Lindi LNG plant, both expected to come online in 2018.

7.5 Transmission and distribution

7.5.1 Situation and problems

In late 2012, the transmission system consisted of 43 substations and 4,816 km of transmission lines. The transmission grid consists of 2,732 km of 220 kV lines, 1,538 km of 132 kV lines and 546 km of 66 kV lines.[331] The national grid includes subsea cables to Pemba and Unguja islands, Zanzibar. The distribution network totals 26,565 km of lines.

The Energy Development and Access Expansion Project 2008 included a grant approved by the World Bank to improve TANESCO's transmission and distribution grid until 2015. Total system losses were 25 per cent in 2011, with 5.3 per cent for transmission and 19.7 per cent for distribution. Through 2011 to 2013, the Technical Loss Reduction Programme took place as part of the Power System Master Plan. The programme included four transmission reinforcement projects. Electricity losses have improved to 18.8 per cent as of January 2014 for the Dar es Salaam, Kilimanjaro and Arusha regions which the programme targeted.[332]

7.5.2 Future plans

A major transmission project in Tanzania is underway, known as the Backbone Transmission Investment Project (BTIP). The first phase involves the construction of 647 km of the first 400 kV transmission line in Tanzania from Iringa to Shinyanga. Between 2016 and 2020, there are 5,400 km of transmission lines planned. Between 2020 and 2030, there are at least 1,650 km planned transmission lines. There are long-term plans for interconnection with surrounding countries, as shown in Table 7.5.

Table 7.5: Planned international transmission lines in Tanzania

Country	Voltage (kV)	Scheduled operation
Uganda	220	2015
Zambia	400	2016
Kenya	400	2016
Rwanda and Burundi	220	2016
Malawi	220	2021
Mozambique	220	N/A

Source: United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

331 TANESCO, Transmission. <http://www.tanesco.co.tz/index.php?option=com_content&view=article&id=51&Itemid=159>.

332 The World Bank, TZ-Energy Development & Access Expansion, 3 May 2014. <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/AFR/2014/05/03/090224b08242e1ea/1_0/Rendered/PDF/Tanzania000TZ00Report000Sequence011.pdf>.

Tanzania is attempting to reduce distribution losses to 18 per cent over the period of 2013 to 2015. Measures include capacitor installation, conversion of 11 kV lines to 33 kV, new MV/LV transformers and new HV/MV substation. The targeted system losses in the Electricity Supply Industry Reform Strategy and Reform are shown in Table 7.6. Technical losses accounted for 14 per cent out of 25 per cent of the total losses in 2010. The Power System Master Plan highlights the need to analyse the causes of the losses. Improving the level of losses to an acceptable level is a key component of Tanzania's plans to ready TANESCO for unbundling.

Table 7.6: Forecasted system losses in Tanzania (per cent)

Year	2014	2015	2018	2021	2025
Total system losses	19%	18%	16%	14%	12%

United Republic of Tanzania, Electricity Supply Industry Reform Strategy and Roadmap 2014–2025, 30 June 2014. <http://www.tanesco.co.tz/index.php?option=com_content&view=article&id=436:tanzania-supply-industry-reform-strategy-and-loadmap-2014-2015&catid=3:newsflash?>.

7.6 Rural electrification

According to the World Bank's estimate, 15 per cent of the population had access to electricity in Tanzania in 2011.[333] The Tanzania Power System Master Plan estimated that 18.4 per cent of the population had access to electricity in 2012.[334] As of March 2014, 24 per cent of the population had access to electricity according to the Reform Strategy and Roadmap. Approximately 70 per cent of Tanzania's population lives in rural areas in which only seven per cent has access to an electricity connection.

As a result of the Rural Energy Act 2005, the Rural Energy Agency (REA) began operating in Tanzania in 2007 to promote the provision of energy to rural communities. REA consists of two parts. One part is the Rural Energy Fund which provides grants for the implementation of projects and the fund is the mechanism by which REA fulfils its mandate. The other part is the Rural Energy Board which consists of representatives from ministries, funding sources, partners and consumers. The representatives in the Rural Energy Board help to facilitate rural electrification.

REA provides TANESCO with funds for grid-extension projects. Two of REA's projects are: the Tanzania Energy Development and Access Project (TEDAP) which is a USD 25 million off-grid project aiming to create a sustainable solar PV market;[336] and the Lighting Rural Tanzania competition awards grants for local innovative off-grid energy solutions for rural communities and is also supported by the Africa Renewable Energy Access (AFREA) programme.

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[333] The World Bank, Access to Electricity. <http://data.worldbank.org/indicator/EG.ELC.ACCS.ZS>.

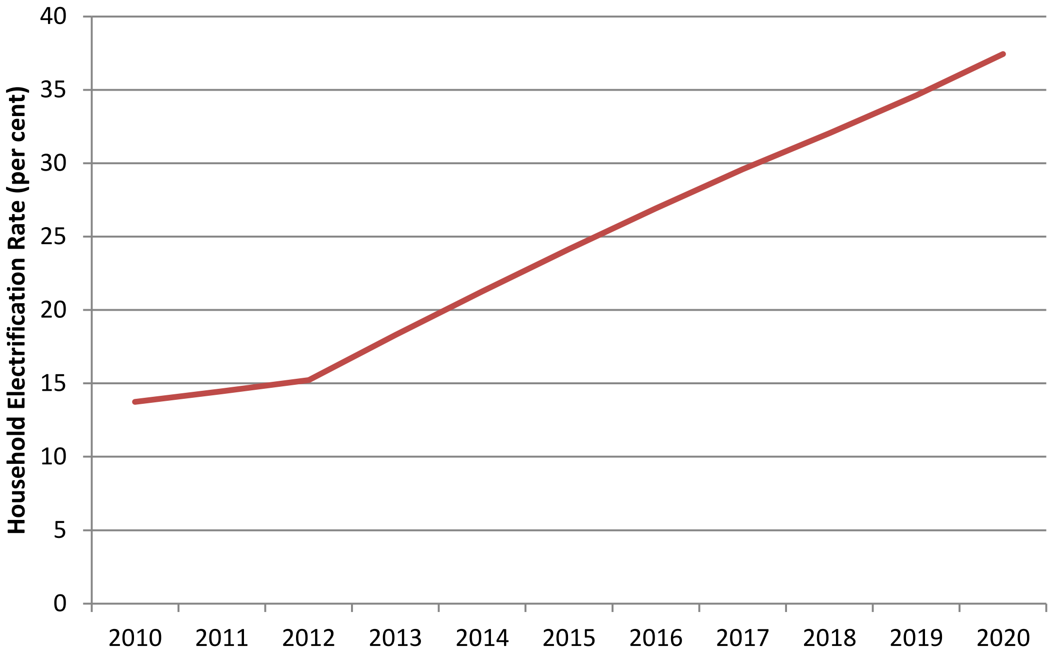
[334] United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

[336] Uisso, J., Rural Energy Agency and Innovation in Delivery of Modern Energy Services to Rural Areas, United Republic of Tanzania, Rural Energy Agency. <http://www.esmap.org/sites/esmap.org/files/4b.%20TANZANIA_Innovation%20in%20Delivery%20of%20Services.pdf>.

In 2014, Tanzania committed to investing USD 300 million in a three-year rural electrification programme. It is hoped that access to electricity will rise to 30 per cent by 2017.[337] An average of 250,000 new customers receiving an electricity connection per annum must be achieved to attain the target. The Government has reduced connection fees since 2013 to make the rate of connections feasible. In rural areas, a single phase connection within 30 metres of the service line costs TZS 337,740 (USD 203) if an electric pole is required and TZS 177,000 (USD 107) if not required. In urban areas, the connection fee costs TZS 515,618 (USD 311) if an electric pole is required and TZS 320,960 (USD 196) if not required. The connection fee for customers requiring a single phase connection with two electric poles is TZS 454,654 (USD 274) in rural areas and TZS 696,670 (USD 420) in urban areas.[338] In the southern regions of Mtwara and Lindi, heavily subsidised connection fees are available to dwellers.[339]

The long-term electrification target is for 75 per cent electrification of households by 2033. The planned development of the percentage of the population with access to electricity in Tanzania is shown in Table 7.7.

Table 7.7: Access to electricity targets in Tanzania (per cent)



Source: United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

[337] Mumero, M., "Tanzania to invest US$300 million in rural electrification until 2017," African Review, 6 January 2014. <http://www.africanreview.com/energy-a-power/power-generation/tanzania-to-invest-us-300-million-in-rural-electrification>.
[338] "Tanzania: TANESCO Overwhelmed By Customers Needing Power Connections," AllAfrica, 8 June 2013. <http://allafrica.com/stories/201306101707.html>.
[339] Msyani, C., Current status of energy sector in Tanzania, USEA, 25 February 2013. <http://www.usea.org/sites/default/files/event-/Tanzania%20Power%20Sector.pdf>.

7.7 Tariffs

EWURA approved of tariff rates in Tanzania rising by 40 per cent at the beginning of 2014 on the grounds of TANESCO's higher operating costs because of reduced electricity supply from hydropower sources. It costs USD 0.50 per kWh for TANESCO to generate electricity from thermal power plants and buy electricity from emergency power producers, which it sells to customers for USD 0.12 per kWh.[340] There are worries that the higher prices will lead to an increase in deforestation as biomass sources will be used as an alternative by customers who cannot afford the hiked grid-connected electricity tariff rates. The tariff categories are displayed in Table 7.8.

Table 7.8: Tariff categories in Tanzania

Tariff category	Description
Domestic low usage tariff (D1)	Domestic customers whose consumption averages less than 75 kWh per month. TANESCO subsidizes these customers by not subjecting them to a service charge. Power is supplied at a low-voltage (230 V) and single phase.
General usage tariff (T1)	Customers who use power for general purposes including residential, small commercial use, light industry, public lighting and billboards. Power is supplied at low-voltage (230 V) single phase and three phase (400 V).
Low-voltage maximum demand usage tariff (T2)	Power is metered at 400 V and average consumption is over 7,500 kWh per meter reading period and demand doesn't exceed 500 KVA per meter reading period.
Medium-voltage maximum demand usage tariff (T3 MV)	Customers connected at medium-voltage.
High-voltage maximum demand usage tariff (T3 HV)	Customers connected at high-voltage including ZECO, Bulyanhulu gold mine and Twiga Cement.

Source: TANESCO, New Tariffs, 6 January 2014.
<http://www.tanesco.co.tz/index.php?option=com_docman&Itemid=275>.

The tariff schedule for customers in Tanzania is shown in Table 7.9. The service charge is billed monthly, the energy charge is billed per kWh and the demand charge is billed monthly on the basis of kVA of contract demand.

Table 7.9: Electricity tariff rates in Tanzania (USc)

Customer category	Component	2013	2014	2015
D1	Service charge	N/A	N/A	N/A
	Energy charge (0–75 kWh)	3.6	6.0	6.0

[340] Lyimo, H., "Tanzania: No Respite for 2014 As Hiked Electricity Tariff Takes Effect," AllAfrica, 31 December 2013. <http://allafrica.com/stories/201312310017.html>.

	Energy charge (>75 kWh)	16.4	21.1	21.1
T1	Service charge	231.2	332.3	332.3
	Energy charge	13.3	18.4	18.4
	Demand charge	N/A	N/A	N/A
T2	Service charge	856.8	856.8	846.8
	Energy charge	7.9	12.3	12.3
	Demand charge	1,020.0	903.2	903.2
T3 MV	Service charge	856.8	1,009.4	1,009.4
	Energy charge	7.1	9.8	9.8
	Demand charge	874.1	794.6	794.6
T3 HV	Service charge	856.8	N/A	N/A
	Energy charge	6.4	9.6	9.6
	Demand charge	727.1	996.3	996.3

Note: the tariff rates given do not include VAT and 1 per cent levy to EWURA. Source: TANESCO, New Tariffs, 6 January 2014. <http://www.tanesco.co.tz/index.php?option=com_docman&Itemid=275>. Exchange rate, 1 TZS = 0.000602000 USD, 27 May 2014. <http://www.xe.com/>.

7.8 International manufacturers

<u>ABB</u>

The Ubungo I thermal power station is installed with ABB's GT10 turbines. The turbines initially ran on liquid fuels, but were later upgraded and converted to run on natural gas.[341]

In 2004, the Tanzanian sugar manufacturer Kagera Sugar, located near Lake Victoria, placed a USD 0.3 million contract for ABB's medium voltage division to supply, install and commission a new 17-panel 11 kV switchboard, transformers and power factor correction equipment to harmonise the ratio of real power flowing towards the load, to the apparent power in the circuit. The electricity will feed a sugar mill.[342]

ABB has an 'Access to Electricity programme' in the south of Tanzania. ABB partnered with local authorities and the global conservation organization WWF to set up a mini-grid, supplied with electricity by a diesel generator, to provide the village of Ngarambe with four hours of electricity each night. The generator has replaced traditional, costly kerosene. ABB supplied the generator, installed underground cables and low-voltage equipment, and trained local people to run the power supply.[343]

[341] GE, Distributed Generation for a developing nation. <http://www.ge-spark.com/spark/songas/en/project-timeline/>; Gryphon, Ubungo Gas Turbine Power Plant Expansion. <http://www.gryphoneng.com/projects/1275-Gry.pdf>.
[342] Czaernowalow, M., "ABB awarded R3,3m Tanzania contract," Engineering News, 2 February 2004. <http://www.engineeringnews.co.za/article/abb-awarded-r33m-tanzania-contract-2004-02-02>.
[343] ABB, Access to electricity: The power to change lives. <http://www.abb.com/cawp/abbzh258/051d295b8c237da0c1256f6500462ea5.aspx>.

In 2013, ABB won a contract for the major overhaul on high-voltage circuit breakers worth USD 1.4 million.[344]

Siemens

For the expansion of Tanzania's power generation capacity at Ubungo II power plant in 2011, Siemens supplied three SGT-800 gas turbines with a combined capacity of 100 MW.[345] Norwegian company Jacobsen Elektro constructed the plant for TANESCO.

Siemens has completed various projects for TANESCO to help build and rehabilitate the country's power infrastructure. These projects include various rural electrification projects, such as a power transmission and distribution project to supply electricity to the Tarime District in the remote Mara region. Siemens was also contracted by TANESCO to supply, install and commission Power Line Carrier equipment throughout Tanzania.[346]

GE

The Ubungo I gas-fired power station utilizes GE's LM6000 turbines, which along with ABB's turbines, were upgraded to use natural gas.

TANESCO awarded a contract to a consortium of Symbion Power and GE for the design of the Mtwara Power plant. It is a Public Private Partnership in which the US consortium provides technology expertise. The total expenditure of the power plant project amounts to USD 1 billion, with which a 400 MW gas-fired power plant will be built in Mtwara together with 650 km of transmission lines.[347]

Alstom

In 2003, Alstom won an order worth EUR 13 million to upgrade two GT10A turbines at the Ubungo I power station in Dar es Salaam. The contract was part of the USD 250 million Songo Songo Gas Development and Power Generation Project. The modernising of the turbines was done through supplying new GT10B2 gas generators, power turbines and control systems to both units.[348]

[344] TANESCO, Notification of Tender Awarded 2013. <http://www.tanesco.co.tz/index.php?option=com_docman&Itemid=175>.
[345] "Siemens to supply gas turbines for Ubungo power plant in Tanzania," Spencer Ogden Power, 12 July 2011. <http://www.sopower.co.uk/news/siemens-to-supply-gas-turbines-for-ubungo-power-plant-in-tanzania-news-11931210111>.
[346] Siemens, Siemens in Tanzania. <http://africa.siemens.com/en/siemens-in-africa/country-profiles/tanzania.htm>.
[347] "Construction on Mtwara gas plant project starts," Daily News, 7 July 2013. <http://www.dailynews.co.tz/index.php/local-news/19592-construction-on-mtwara-gas-plant-project-starts>; "GE signs deal with Tanzania to help build 400MW power plant." Reuters, 21 June 2013. <http://www.reuters.com/article/2013/06/21/tanzania-electricity-idUSL5N0EX0P120130621>.
[348] Alstom, "Alstom awarded order for modernisation of power station in Tanzania," 2 January 2012. <http://www.alstom.com/press-centre/2003/2/ALSTOM-awarded-order-for-modernisation-of-power-station-in-Tanzania-20030225/>.

In 2010, Alstom won a contract with Symbion Power to rehabilitate and expand transmission and distribution substations which span across six regions in Tanzania. The project was part of the Millennium Challenge Corporation project.[349]

Sumitomo

The President of Tanzania visited the head office of Sumitomo Corporation in Tokyo in May 2013. During the visit, the Government of Tanzania and Sumitomo Corporation signed a Memorandum of Understanding to promote cooperation in the construction of the Kinyerezi 240 MW gas-fired combined-cycle power plant, for which Sumitomo Corporation signed an EPC contract in June 2012. The plant will cost USD 413 million.[350]

Wärtsilä

In 2006, Finnish-based Wärtsilä signed an EPC contract to build a 100 MW gas-fired power plant at Ubungo for TANESCO at a cost of EUR 57 million. The plant was equipped with 12 20-cylinder Wärtsilä 34 SG generating sets.[351] An operational and management agreement was also signed. In 2013, Wärtsilä was contracted to supply additional spare parts for the Wärtsilä generating sets which are used at the Ubungo gas plant. The deal was worth approximately USD 8.3 million.[352]

Isloux Corsán

Spanish energy infrastructure company Isloux Corsán was awarded a contract by TANESCO for transmission and distribution projects in Tanzania in 2013. The contract includes the supply and installation of systems for medium- and low-voltage in the district of Njombe and the Ruvuma region, to be constructed alongside the 22 kV Makambo-Songea transmission line. The projects are scheduled to be completed within 24 months and have a budget of EUR 26 million, which will be financed by the Swedish International Development Agency.[353]

[349] Alstom, "Alstom supports development in Tanzania with the inauguration of the Millennium Challenge project," 18 September 2013. <http://www.alstom.com/press-centre/2013/9/alstom-supports-development-in-tanzania-with-the-inauguration-of-the-millennium-challenge-project/>.
[350] Ng'wanakilala, F., "Tanzania signs $414mln power plant deal with Japan's Sumitomo Corp," Reuters, 31 May 2013. <http://www.reuters.com/article/2013/05/31/tanzania-electricity-idUSL5N0EC36A20130531>; Sumitomo Corporation, "His Excellency President Kikwete of Tanzania visits Sumitomo Corporaton's head office," 7 June 2013. <http://www.sumitomocorp.co.jp/english/company/topics/20130607-01/>.
[351] Wartsila, "Wartisla supplies power to Tanzania," 25 July 2006. <http://www.wartsila.com/en/press-releases/Wartsila-supplies-power-to-Tanzania>.
[352] TANESCO, Notification of Tender Awarded 2013. <http://www.tanesco.co.tz/index.php?option=com_docman&Itemid=175>.
[353] Isloux Corsán, "Isloux Corsán continues to grow in Africa with new contracts in Rwanda, Tanzania, Uganda and Congo," 5 February 2014. <http://www.isoluxcorsan.com/en/communication/press-releases/isolux-corsan-continues-to-grow-in-africa-with-new-contracts-in-rwanda-tanzania-uganda-and-congo.html>.

7.9 Risks and opportunities

7.9.1 Issues

Hydropower

Tanzania's reliance upon hydropower for its generation capacity is extremely problematic given the frequency and severity of droughts in the region. Since 2005, there have been at least four droughts. These droughts were thought to have resulted in economic losses as high as four per cent of Tanzania's GDP.[354] The lack of diversity in generation capacity has led to outages and power rationing in the country and expensive temporary replacement diesel-fuelled emergency power plants, which has led to serious financial difficulties for TANESCO.

The construction of new hydropower plants will require updates of outdated feasibility reports. Tanzania has failed to increase its generation capacity through regional trade with Eastern African countries as Tanzania only imports 9 MW of power from Uganda, 5 MW from Zambia and 5 MW from Kenya.[355] The transmission line interconnector with Ethiopia planned for 2016 will facilitate 200 MW of electricity imports in comparison.

Disinvestment

Between 1996 and 2006, the power sector was not heavily invested in. Post-2006, only small-scale projects were implemented. Between 2000 and 2010, only 300 MW of installed capacity was added to the grid.[356] However, demand kept increasing during that period and as a result in 2010, electricity demand exceeded available capacity by 33 per cent.[357] Demand is expected to increase 11–13 per cent over the next few years.[358] There are insufficient incentives for private investors and tariff rates are too low to make sufficient returns.

TANESCO faces serious financial difficulties and operates at a loss, estimated to be USD 30 million a month by the World Bank.[359] TANESCO was owed TZS 233 billion (USD 14 million) in unpaid electricity bills as of December 2013, which has led to the formation of a debt collection programme.[360] TANESCO must pay one of the emergency power producers, Dowans, USD 77 million after a court case for the breach of contract over refusing to pay Dowans simply

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354 Roos, J., "Energy Infrastructure Development in East Africa: Big Potential Meet Big Roadblocks," Renewable Energy World, 13 June 2014. <http://www.renewableenergyworld.com/rea/news/article/2014/06/energy-infrastructure-development-in-east-africa-big-potential-meets-big-roadblocks?cmpid=WNL-Wednesday-June18-2014>.

355 United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

356 Kapika, J., and Eberhard, A., "Power-Sector Reform and Regulation in Africa," 2013. <http://www.gsb.uct.ac.za/files/Tanzania.pdf>.

357 Edenville Energy Plc, The need for coal in Tanzania. <http://www.edenville-energy.com/tanzania_coal.html>.

358 Ibid.

359 Manson, K., "Infrastructure: Power and port projects will ease Tanzania's energy supply and congestion," Financial Times, 30 September 2013. <http://www.ft.com/cms/s/0/8f894a80-1ebe-11e3-b80b-00144feab7de.html#axzz32vBqREYj>.

360 "Tanzania owed 233bn/- in unpaid power bills," Tanzania Daily News, 16 January 2014. <http://www.dailynews.co.tz/index.php/local-news/27054-tanesco-owed-233bn-in-unpaid-power-bills>.

because TANESCO no longer needed the extra power as the drought had ceased.[361] The previous bad experience with IPPs could be a barrier to Tanzania's openness to private companies' participation in the power sector. The financial difficulties mean that TANESCO needs to significantly improve its financial performance in order for the power reform process to be successful.

Low electrification rates

The electrification rate is very low in Tanzania. Part of the explanation is that the population density is low with three-quarters of the population living in rural areas in 2011, which makes it too expensive to extend the national grid.[362] Furthermore, the Government lacks the financial resources for large-scale rural electrification programmes. Before January 2013, the connection fee was USD 284 without a pole and USD 845 with a pole. However, in January 2013, the connection fees were reduced by 60 and 70 per cent in rural areas and 29 per cent and 60 per cent in urban areas depending upon whether an electricity pole is required.[363] This has led to an inundation of new TANESCO customers wanting to be connected to the grid but TANESCO faces a shortage in the supply of electricity poles, conductors and meters required for the connections.[364]

Resources

The natural resources which could be used to improve the country's power supply are found in the south-west (coal and hydro) and south-east (natural gas) of the country whilst large loads are located in the north-west of the country which creates the need for long-distance transmission lines with potentially high losses.

The use of biomass is at present unsustainable and is unregulated. Long-term planning regarding biomass is only just taking place.

7.9.2 Future opportunities

The US Government's Power Africa scheme, which includes Tanzania as one of six priority countries, will commit more than USD 7 billion to African countries to increase power generation. From 2013 to 2017, USD 11.4 billion will be invested in the power sector in Tanzania, 75 per cent of which is for power plants. The following opportunities have been identified by Tanzania Investment Centre and from the above discussion:

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[361] Mwanmumyange, J., "Court deals Tanesco huge blow, orders firm to pay up $77.5 million," The East African, 6 April 2013. <http://www.theeastafrican.co.ke/news/Court-orders-Tanesco-to-pay-up-USD77-million-/-/2558/1741356/-/dkc7dy/-/index.html>.

[362] CIA, The World Factbook, Tanzania, 20 June 2014. <https://www.cia.gov/library/publications/the-world-factbook/geos/tz.html>.

[363] Msyani, C., Current status of energy sector in Tanzania, USEA, 25 February 2013. <http://www.usea.org/sites/default/files/event-/Tanzania%20Power%20Sector.pdf>.

[364] "Tanzania: TANESCO Overwhelmed By Customers Needing Power Connection," AllAfrica, 8 June 2013. <http://allafrica.com/stories/201306101707.html>; EWURA, Annual Report 2013, December 2013. <http://www.ewura.go.tz/newsite/index.php/2012-03-09-08-22-52/electricity>.

- equipment and services for geothermal exploration and development
- construction of petroleum pipelines, petroleum products offloading terminals, storage and distribution facilities
- development of wind farms along the coastlines and Zanzibar. Singida and Iringa are two large wind farms under development
- supply equipment and services for on-grid solar projects and the local solar PV market. Tanzania has high levels of solar radiation, ranging between 2,800–3,500 hours of sunshine per year and a global radiation of 4–7 kWh per m^2 a day[365]
- renewable energy based mini-grid projects, mostly mini-hydro or biomass power plants
- the engineering, design and construction of coal-fired power plants
- the design and construction of gas-fired power plants and supplying gas turbines
- related gas infrastructure, such as pipelines, processing facilities and LNG plants
- USD 806 million will be invested in transmission projects up to 2017, especially substations
- Improving the technical performance and level of access to electricity to meet the targets set out for the unbundling of TANESCO
- high-voltage transmission lines for regional interconnection
- USD 2.2 billion will be spent on distribution projects up to 2017

[365] "Power and Renewable Energy sector in Tanzania," UK Trade & Investment, 24 January 2013. <http://opentoexport.com/article/power-and-renewable-energy-sector-in-tanzania/>.

8. Conclusion

The conclusion of this report involves a comparison of the power sector of the countries discussed in the report in terms of opportunities and risks for international suppliers. This exercise supplements the specific areas of opportunity identified at the end of each country analysis and gives further insights into the nature of conducting business in sub-Saharan Africa and specific countries.

A variety of factors have been used to produce an illustrative indication of the perceived opportunities and risks in those countries for international suppliers (see Figure 8.1). The comparisons have been based upon a combination of statistical data, other indices and the discussion presented in our report (see Appendix 9.6 for the variables used to assess the opportunities and risks). The opportunity and risk indices are given in Table 8.1 and 8.2.

Table 8.1: Opportunity indices

Measure	Description
National grid coverage	The coverage of the national transmission network. Consideration is given to the length of transmission lines in comparison to the area of the country and the current level of access to electricity.
Installed capacity per thousand inhabitants	The installed capacity was divided by the population size to calculate the number of kW of installed capacity per thousand inhabitants.
Annual forecasted demand	The average annual percentage increase in demand for electricity and the average MW additions to the installed capacity per year were used to rank the countries in terms of annual forecasted demand. The time frame used is dependent upon the figures available in government policy as detailed in the country analyses. For almost every power plant project and MW addition, further opportunities arise for the design, engineering and installment of associated transmission and distribution infrastructure to evacuate the power to load centres and final users.

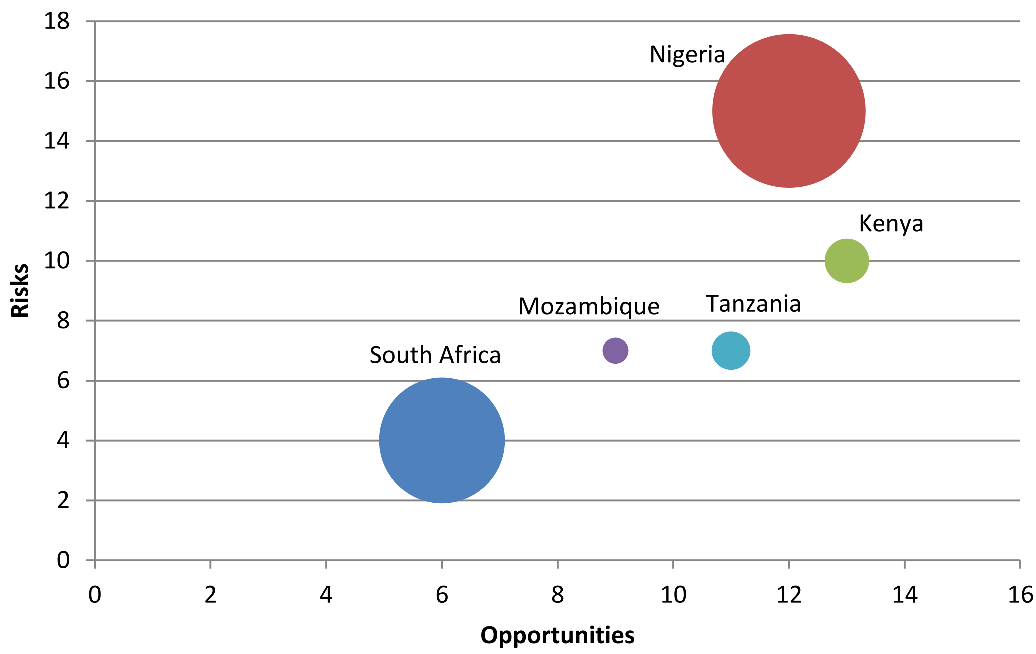
Table 8.2: Risk indices

Measure	Description
Political risk	The likelihood of project construction interrupted by political events in the country.

Security	The potential threat from crime and terrorist attacks. Security companies can be contracted to mitigate the risk but will not be sufficient in all cases.
Corruption	The prevalence of corruption in the country. Unique to the power sector, consideration was also given to whether there is an independent regulatory body.
Local partner and human resources	The uncertainty of local content law applied to international suppliers for the power sector, finding a stable local business partner and the availability of human resources for construction, installation and maintenance. Such an indices cannot be easily summarised on a country-wide level hence was omitted from Figure 8.1 but forms an integral part of business operations in sub-Saharan Africa's power sector.

The countries were ranked using the indices to show the level of opportunity and risk for international suppliers in each country's power sector supply chain as shown in Figure 8.1.

Figure 8.1: Country comparison of risks and opportunities and risks for international suppliers



Note: the size of the circle represents the size of the economy.

Our findings on the opportunities and risks for international suppliers in the selected sub-Saharan African countries are as follows:

Nigeria has a high level of both opportunity and risk. The country has a very large population yet a very per capita low installed capacity. Of the countries studied, Nigeria has the second lowest per capita installed capacity. There is consequently a high level of suppressed demand and numerous planned developments to meet the demand. The power sector reform in

Nigeria has seen a significant rise in private sector participation. The gas industry in particular has helped to push forward the planning for the development of the power sector as gas-fired power stations will continue to dominate Nigeria's electricity generation mix. One of the stumbling blocks for the Nigerian power sector is the lack of gas supply for gas-fired power stations, as well as the insufficient strength of the national grid to transmit the generated electricity. As these issues become well-documented and investment is dedicated to resolving the problems, the opportunities for international suppliers are likely to proliferate. On the other hand, Nigeria's business environment is high risk; it is a relatively unstable and insecure country, particularly in the Niger Delta and the north, and it has high levels of corruption. For many businesses, the size of its economy, which is the largest in Africa, is a strong reason to accept the risks.

Kenya is a lower risk country and it offers a similarly high level of opportunities to Nigeria. The level of access to electricity, the national grid coverage and per capita installed capacity are all very low. In addition, Kenya's average annual forecasted increase in demand is extremely high. The growth in domestic consumption of electricity is largely due to ongoing rural electrification and the growth of energy intensive industries. Oil discoveries in the north are likely to lead to further economic growth, but there has been inter-ethnic violence in the region and further problems could derive from South Sudanese immigrants and Kenya's intervention in Somalia.[366] Since the Westgate shopping centre terrorist attack in 2013, Kenya has not been considered secure, and in fact terrorism is a serious problem. As a result, the level of risk in Kenya is considered to be high, though political stability has improved throughout 2014.[367] Kenya has opened up the electricity industry to the private sector in the form of small power producers. It is notable that the future proposed generation mix in Kenya's electricity policy is one of the most diverse with the natural geothermal resources occupying the largest share of the predicted installed capacity. The establishment of KETRACO to fast-track the development of the national grid has led to an increase in available opportunities for supplying transmission and distribution equipment and maintenance services.

Tanzania and **Mozambique** both have a high level of opportunity and a similar level of risk. Both countries possess large gas and coal reserves, which will be monetized through the construction of gas- and coal-fired power stations to meet domestic power needs. At present, the small-scale of the economies in the two countries partly explains the lower growth in demand for electricity. The natural resources will be all-important in boosting their economies and the associated wealth could encourage a higher electricity demand than forecasted. The national grids in Mozambique and Tanzania require expansion and strengthening to achieve greater coverage and improved technical performance.

[366] Sheekh, N.M. and Mosley, M., "Insecurity in northern Kenya: is the government losing its grip?" 6 January 2014. <http://africanarguments.org/2014/01/06/insecurity-in-northern-kenya-is-the-government-losing-its-grip-by-nuur-mohamud-sheekh-and-jason-mosley/>.

[367] Bunyi, R., "Kenya's political risk steadily falling," Business Daily, 3 March 2014. <http://www.businessdailyafrica.com/Opinion-and-Analysis/Kenya-s-political-risk-steadily-falling/-/539548/2228848/-/s3higsz/-/index.html>.

Mozambique has a unique power sector as Mozambicans consume little electricity compared to the amount of electricity generated in the country because of the Cahora Bassa power station. The annual growth in demand is high in Mozambique, yet the annual planned additions to the installed capacity are relatively low. Mozambique has a relatively small electricity retail market and a large installed capacity. Mozambique has the option to export less electricity through a renegotiated power purchase agreement to use more of Cahora Bassa's electricity domestically. There are planned power stations from which the electricity generated will be exported to the Southern African Power Pool; hence, despite the low domestic demand for electricity, there are many opportunities for suppliers in the Mozambican power sector.

Tanzania's utility TANESCO faces serious financial difficulties which have resulted in the imminent implementation of a power sector reform. The investment climate in the Tanzanian power sector will be clearer upon the implementation of the reforms which are beginning as of mid-2014. Both countries present a medium level of risk from political instability, security threats and corruption.

South Africa has a lower expected growth in demand than other sub-Saharan African countries because their power sector is relatively well-developed and demand has been declining since 2012, in part because Eskom has asked industrial customers to reduce their electricity usage. The annual percentage growth in installed capacity is expected to be quite low because the existing installed capacity is large. However, the annual installed capacity additions are significant and South Africa is making a sustained effort to readdress the shortfall in capacity foreshadowed by two decades of disinvestment. South Africa's generation mix is dominated by coal; in an effort to reduce carbon emissions, opportunities for renewable electricity manufacturing suppliers have become numerous due to the REIPPP programme. The success of the programme is likely to encourage further private investment in the South African power sector. The current demand-supply gap is narrow, the network is constrained and more power generation is needed in the country. There have been blackouts in South Africa and Eskom has been forced to implement load shedding, which highlights the suppressed demand for electricity, the requirement for power station maintenance and the need for more power stations.

The transmission network covers a large amount of the country, the level of access to electricity is high and South Africa is internationally competitive with regards to transmission losses. Regional trade provides South Africa with further customers through exports and increased opportunities for suppliers in the construction of additional generation capacity and high-voltage interconnectors. As part of the REIPPP programme, local content law in the South African power sector has become increasingly demanding. However, because there are many opportunities for suppliers and South Africa is a relatively low risk country with a rather favourable business environment, many international suppliers use South Africa as headquarters for sub-Saharan African operations.

9. Appendices

9.1 Planned projects in South Africa

The capacity additions for South Africa, mostly from the REIPPP program, are listed in Table 9.1.

Table 9.1: Planned capacity additions in South Africa

Name	Type	Owner	Generation capacity (MW)
Eskom			
Medupi	Coal	Eskom	4,800
Kusile	Coal	Eskom	4,800
Ingula	Pumped Storage	Eskom	1,322
Upington	CSP	Eskom	100
Sere	Wind	Eskom	100
REIPPP round one			
Cookhouse	Wind	Africa Clean Energy Developments	140
Dorper	Wind	Rainmaker Energy	100
Kouga	Wind	Red Cap	110
Noblesfontein	Wind	Coria Investments	72.8
MetroWind Van Stadens	Wind	MetroWind	26.2
Dassiesklip	Wind	Klipheuwel - Dassiefontein	26.2
Khi	CSP	Abengoa	50
KaXu	CSP	Abengoa	100
SlimSun Swartland	Solar PV	Slimsun	5
RustMo1	Solar PV	RustMo1	6.8
De Aar	Solar PV	Gestamp Mulilo Consortium	9.7
Konkoonsies	Solar PV	Limarco 77	9.7
Aries	Solar PV	Sevenstones 159	9.7
Greefspan	Solar PV	AE-AMD IPP	10
Herbert	Solar PV	AE-AMD IPP	19.9
Prieska	Solar PV	Gestamp Mulilo Consortium	19.9
Soutpan	Solar PV	Erika Energy	28
Witkop	Solar PV	Core Energy	30
Touwsrivier	Solar PV	CPV Power Plant	36
Letsasi	Solar PV	Consortium including SolarReserve	64
Lesedi	Solar PV	Consortium including SolarReserve	64
Kathu	Solar PV	Lokian Trading & Investments	75
Solar Capital De Aar	Solar PV	Solar Capital	75
REIPPP round two			

Bokpoort	Concentrated solar power	AWA Power Solafrica	50
Stortemelk	Small hydro	Stortemelk	4.4
Neusberg	Small hydro	Kakamas Hydro Electric Power	10
Sishen	Solar PV	Windfall 59 Properties	74
Aurora-Rietvlei	Solar PV	Aurora-Rievlei Solar Power	9
Vredenal	Solar PV	Vredenal	8.8
Dreunberg	Solar PV	Simacel 160	69.6
Jasper	Solar PV	Jasper Power Company	75
Boshoff	Solar PV	Firefly Investments	60
Upington Airport	Solar PV	Sublunary Trading	8.90
De Aar 3	Solar PV	Solar Capital	75
Amakhala Emoyeni	Wind	Amakhala Emoyeni	133.7
Tsitsikamma Community	Wind	Tsitsikamma Community	94.8
West Coast 1	Wind	Aurora	90.8
Waainek	Wind	Waainek	23.3
Grassridge	Wind	Grassridge	59.8
Chaba	Wind	Chaba	21
Gouda	Wind	Blue Falcon 140	135
REIPPP round three			
Adams	Solar PV	Enel Green Power	75
Tom Burke	Solar PV	Enel	60
Mulilo Sonnedix Prieska	Solar PV	Mulilo Sonnedix	75
Paleisheuwel	Solar PV	Electra Capital and Enel	75
Pulida	Solar PV	Enel	75
Mulilo Prieska	Solar PV	Mulilo consortium	75
Gibson Bay	Wind	Red Cap	110
Longyuan Mulilo De Aar 2 North Wind	Wind	Longyuan Mulilo consortium	60
Nojoli	Wind	African Clean Energy Developments	87
Longyuan Mulilo De Aar Maanhaarberg	Wind	Longyuan Mulilo consortium	96
Khobab	Wind	Mainstream Renewable Power	138
Noupoort	Wind	Mainstream Renewable Power	79
Loeriesfontein 2	Wind	Mainstream Renewable Power	138
Pofadder	Concentrated solar power	Xina	100
Karoshoek	Concentrated solar power	Ilangethu	100
Johannesburg	Landfill gas	Ener-G Systems	18

Mkuze	Biomass	Navosync	16

Source: Source: Republic of South Africa, Department of Energy, Renewable Energy IPP Procurement Programme, Bid Window 3 Preferred Bidders' announcement, 4 November 2013. <http://www.energy.gov.za/IPP/List-of-IPP-Preferred-Bidders-Window-three-04Nov2013.pdf>.

9.2 Planned projects in Nigeria

The capacity additions for Nigeria up until 2020, as set out in the Roadmap for Power Sector Reform Revision, are listed in Table 9.2.

Table 9.2: Planned capacity additions in Nigeria

Year	Name	Type	Additional installed capacity (MW)	Total capacity (MW)
2013	Egbin	Gas	1,200	**8,664**
	Afam IV & V	Gas	65	
	Sapele Steam & Gas	Gas	160	
	Delta	Gas	360	
	Geregu	Gas	410	
	Omotosho	Gas	150	
	Olurunsogo	Gas	180	
	Alaoji	Gas	225	
	Olurunsogo	Gas	450	
	Sapele	Gas	450	
	Ihovbor	Gas	450	
	Calabar	Gas	112.5	
	Gbarain	Gas	112.5	
	Geregu Phase II	Gas	434	
	Omotosho Phase II	Gas	450	
	Egbema	Gas	112.5	
	Omoku	Gas	112.5	
	Ibom Power	Gas	115	

	Omoku	Gas	50	
	Trans-Amandi	Gas	24	
	AES	Gas	240	
	Dangote (Obajana)	Gas	44	
	Geometric Power Aba	Gas	132	
	Notore Power	Gas	25	
	Rivers State Govt Afam I & II	Gas	160	
	Agip phase-1	Gas	480	
	Shell (Afam VI)	Gas	650	
	Guara	Hydro	30	
	Jebba	Hydro	450	
	Kainji	Hydro	220	
	Renewables	Renewables	40	
2014	Omotosho	Gas	90	**10,454**
	Kaduna	Oil & Gas	200	
	Alaoji	Gas	225	
	Olurunsogo	Gas	225	
	Calabar	Gas	450	
	Gbarain	Gas	112.5	
	Egbema	Gas	225	
	Omoku	Gas	112.5	
	Ibom Power	Gas	100	
	Small hydro	Small Hydro	20	
2015	Afam IV & V	Gas	276	**12,106**

	Sapele Steam & Gas	Gas	300	
	Delta	Gas	200	
	Alaoji	Gas	512	
	Paras Energy	Gas	50	
	Geometric Power Aba	Gas	44	
	Kainji	Hydro	220	
	Renewables	Renewables	10	
	Small hydro	Small Hydro	40	
2016	WEMPCO	Gas	200	**15,636**
	Century Power	Gas	245	
	Zuma Energy	Gas	200	
	Bresson AS	Gas	60	
	ENCON (Negris)	Gas	100	
	Geometric Power Aba	Gas	250	
	Notore Power	Gas	250	
	MBH Power	Gas	100	
	Azura Power WA	Gas	225	
	SuperTek/Symbion Industries	Gas	100	
	Rivers State Govt Afam I & II	Gas	160	
	Fortune Power	Gas	250	
	Hudson Power	Gas	235	
	Chevron Nigeria	Gas	300	
	Total Fina	Gas	235	
	Agip phase-2	Gas	240	

	Mobil Nigeria	Gas	250	
	Jebba	Hydro	90	
	Mabon	Hydro	40	
2017	Century Power	Gas	250	**21,237**
	Zuma Energy	Gas	200	
	Ethiopie Energy	Gas	400	
	Yellowstone	Gas	150	
	Fortune Power (Akwa Ibom)	Gas	350	
	DIL Power (Dangote)	Gas	135	
	Knox J & L Energy	Gas	250	
	Delta Electric Power	Gas	116	
	ICS Power	Gas	300	
	ENCON (Negris)	Gas	150	
	Geometric Power Aba	Gas	250	
	JBS Windpower	Wind	100	
	Notore Power	Gas	250	
	MBH Power	Gas	200	
	Azura Power WA	Gas	225	
	Fortune Power	Gas	250	
	Genesis Electricity	Gas	250	
	Ikot Abasi	Gas	250	
	Hudson Power	Gas	300	
	Chevron Nigeria	Gas	500	
	Total Fina	Gas	235	

	Agip phase-2	Gas	240	
	Mobil Nigeria	Gas	250	
2018	Ethiopie Energy	Gas	600	**23,311**
	Yellowstone	Gas	200	
	Fortune Power (Akwa Ibom)	Gas	350	
	Knox J & L Energy	Gas	250	
	ICS Power	Gas	324	
	Zungeru	Hydro	350	
2019	Zungeru	Hydro	350	**24,961**
	Mabilla	Hydro	1,300	
2020	Mabilla	Hydro	1,300	**28,261**
	Renewables	Renewables	1,000	
	Coal	Coal	1,000	

Source: Federal Republic of Nigeria, PTFP, "Roadmap for Power Sector Reform: Revision I," August 2013. <http://www.nigeriapowerreform.org/content/Roadmap%20for%20Power%20Sector%20Reform%20-%20Revision%201.pdf>.

9.3 Planned projects in Kenya

The capacity additions for Kenya up until 2031, as set out in the Least Cost Power Development Plan, are listed in Table 9.3.

Table 9.3: Planned capacity additions in Kenya

Year (ending 30th June)	Name	Type	Additional installed capacity (MW)	Total capacity (MW)
2014	Oklaria 4	Geothermal	140	2,852
	Turkana	Wind	300	
	Oklaria 3	Geothermal	36	
	Osiwo	Wind	50	
	Import	Hydro	200	
	Oklaria wellhead	Geothermal	35	
	Kindaruma	Hydro	32	
	Oklaria 1 (units	Geothermal	140	

	4 and 5)			
2015	Small and medium sized	Hydro	25	3,132
	Oklaria	Geothermal	280	
	Athi River Mining Coal	Coal	20	
2016	Import	N/A	400	3,832
	N/A	Coal	300	
2017	N/A	Geothermal	140	4,337
	N/A	Diesel	320	
	Olkaria 1	Geothermal	45	
2018	N/A	Coal	300	5,077
	N/A	Wind	100	
	Mutonga	Hydro	60	
	Lower Grand Falls	Hydro	140	
	N/A	Geothermal	140	
2019	Import	Import	200	5,591
	N/A	Wind	100	
	Oklaria 3	Geothermal	16	
	N/A	Geothermal	280	
2020	N/A	Gas	360	6,431
	Import	Import	200	
	N/A	Geothermal	280	
2021	N/A	Geothermal	280	7,217
	N/A	Coal	300	
	N/A	Gas	180	
	N/A	Wind	100	
2022	N/A	Nuclear	1,000	8,217
2023	N/A	Geothermal	280	8,837
	N/A	Coal	300	
	N/A	Wind	100	
2024	Import	Import	200	9,957
	N/A	Diesel	320	
	N/A	Gas	180	
	N/A	Geothermal	420	
2025	N/A	Geothermal	420	11,097
	N/A	Gas	360	
	N/A	Diesel	160	
	N/A	Wind	200	
2026	N/A	Wind	200	13,117
	N/A	Geothermal	420	
	N/A	Nuclear	1,000	
	Import	Import	400	
2027	N/A	Geothermal	420	13,737
	Import	Import	200	
2028	N/A	Geothermal	420	15,389

	Import	Import	200	
	N/A	Gas	180	
	N/A	Wind	300	
	N/A	Coal	600	
2029	N/A	Gas	360	17,199
	N/A	Wind	100	
	N/A	Geothermal	420	
	N/A	Nuclear	1,000	
2030	N/A	Geothermal	420	19,199
	N/A	Coal	600	
	N/A	Gas	360	
	N/A	Diesel	320	
	N/A	Wind	300	
2031	N/A	Geothermal	420	21,599
	N/A	Coal	300	
	N/A	Gas	360	
	N/A	Diesel	320	
	N/A	Nuclear	1,000	

Source: Republic of Kenya, Updated Least Cost Power Development Plan Study Period: 2011 – 2031, March 2011. <http://www.erc.go.ke/images/docs/LCPDP%202011%20-%202030.pdf>.

9.4 KETRACO's projects

Completed, ongoing and planned transmission line projects in Kenya undertaken by KETRACO are listed in Table 9.4.

Table 9.4: KETRACO's transmission network projects

Locations	Voltage (kV)	Length (km)	Extra details
Completed			
Sondu Miriu - Kisumu	132	50	N/A
Mumias – Rang'ala	132	34	2x23 MVA 132/33 kV substation and 6x33 kV feeder bays.
Rabai – Galu	132	47	A 132/33 kV substation.
Kamburu – Meru	132	122	A 132 kV 23 MVA substation and 4x33 kV feeders.
Chemosit - Kisii	132	62	A 132 kV 23 MVA substation and 5x33 kV 3 phase feeders.
Ongoing			
Thika - Kiganjo	30	132	Single circuit and associated substation.
Ishiara – Kieni – Embu	35	132	A 23 MVA substation.
Sultan Hamud – Wote – Kitui	37	132	2x 5 MVA substations.
Bomet – Sotik	33	132	A 23 MVA substation.
Olkaria – Narok	68	132	A 23 MVA substation.
Lessos – Kabaranet	65	132	A 15 MVA substation.

Nanyuki - Nyahururu	79	132	A 23 MVA substation.
Ethiopia - Kenya	686	500	HDVC bipole and a 400 kV substation.
Oklaria – Lessos – Kisumu	300	220	Double circuit line and a 90 MVA substation.
Kisii – Awendo	44	132	A 23 MVA substation.
Eldoret – Kitale	60	132	A 23 MVA substation.
Kindaruma – Mwingi – Garissa	250	132	A 23 MVA substation.
Nairobi metropolitian ring: substations	N/A	400	Double circuit transmission line. Work on the substations.
Nairobi metropolitian ring: Suswa - Isinya	100	400	Double circuit transmission line.
Lessos – Tororo	127	220	2x75 MVA transformers, double circuit line and upgrading Lessos substation.
Rabai – Malindi – Garsen – Lamu	320	220	Associated substations.
Loiyangalani – Suswa	430	400	N/A
Mombasa – Isinya	475	220/400	Associated substations.
Kilimambogo – Thika – Githambo	67	132	17 km of double circuit lines and 50 km of single circuit lines and a 132 kV double substation.
Planned			
Kenya – Tanzania	510	400	N/A
Kindaruma – Athi River	150	220	A 75 MVA substation.
Sondu – Kendu – Homa Bay	80	132	Single circuit line and 2x75 MVA substations at Homa Bay.
Bairngo – Rongai	80	220	Double circuit line and 2x75 MVA substations.
Arusha – Nairobi	260	400	N/A
Konza – Machakos	45	132	A 23 MVA substation.
Konza – Kajiado	45	132	A 23 MVA substation.
Nyahururu – Maralal	N/A	N/A	N/A
Meru – Isiolo – Nanyuki	75	132	A 23 MVA substation.
Mariakani & Isinya	N/A	400/220	Substation works at Mariakani.
Suswa & Loiyangaliani	N/A	400/220	Work on two substations.
Nairobi metropolitan ring: Suswa – Ngong	45	220	Double circuit line, 2x90 MVA 220/66 kV substation and Ngong.

Source: KETRACO, All Projects. <http://www.ketraco.co.ke/projects/all_projects.html>.

9.5 Planned projects in Tanzania

The capacity additions for Tanzania up until 2035, as set out in the Least Cost Power Development Plan, are listed in Table 9.5.

Table 9.5: Planned capacity additions in Tanzania

Year	Name	Type	Additional installed capacity (MW)	Total capacity (MW)
2014	Somanga TANESCO	Gas	8	1,578
	Symbion 205 ARUSHA	Diesel	50	
	Kinyerezi I	Gas	150	
	Somanga Fungu	Gas	210	
	Mwanza MS diesel	Diesel	60	
2015	Kinyerezi II	Gas	240	2,158
	Zinga	Gas	200	
	Mkuranga	Gas	250	
	Cogen (Sao Hill)	Biomass	10	
	Cogen (Mfindi)	Biomass	30	
2016	Kinyerezi III	Gas	300	3,478
	Somanga Fungu	Gas	110	
	Interconnector (Ethiopia/Kenya)	Import	200	
	Kiwira I	Coal	200	
	Mtwara	Gas	400	
	Solar I	Solar	60	
	Wind I	Wind	50	
2017	Wind II	Wind	50	4,038
	Ngaka I	Coal	200	
	Hale	Hydro	11	
	Coastal Coal	Coal	300	
2018	Rusumo Falls	Hydro	27	4,375
	Mchuchuma I	Coal	300	
	Kiwira II	Coal	200	
	Solar II	Solar	60	
2019	Kakono	Hydro	53	4,628
	Ngaka II	Coal	200	
2020	Mchuchuma II-1	Coal	100	4,773
	Malagarasi	Hydro	45	
2021	Ruhudji	Hydro	358	5,131
2022	Mpanga	Hydro	144	5,375
	Mchuchuma II-2	Coal	100	
2023	Steieglers Gorge I	Hydro	300	5,609
	Songwe Bupigu	Hydro	34	
2024	Masigira	Hydro	118	5,927
	Mchuchuma II-3	Coal	200	

2025	Rumakali	Hydro	520	6,260
2026	Songwe Sofre	Hydro	157	6,517
	Mchuchuma III-1	Coal	100	
2027	Ikondo - Mnyera	Hydro	340	6,857
2028	Mchuchuma III-2	Coal	200	7,206
	Songwe Manolo	Hydro	149	
2029	Taveta - Mnyera	Hydro	145	7,551
	Local Coal I	Coal	200	
2030	Local Coal II	Coal	400	7,851
2031	Local Coal III	Coal	400	8,210
2032	Stieglers Gorge II	Hydro	600	8,610
2033	Local Coal IV	Coal	400	9,010
2034	Local Coal V	Coal	300	9,310
2035	Stieglers Gorge III	Hydro	300	9,610

Source: United Republic of Tanzania, Power System Master Plan 2012 Update, May 2013. <http://www.tanzania.go.tz/egov_uploads/documents/0062_10072013-Power_System_Master_Plan_2012_sw.pdf>.

9.6 Opportunity and risk indices

Table 9.6 and 9.7 show the opportunity and risk indices. The statistics used for the opportunity analysis are taken from sources referenced in the country chapters. The risk indices score is derived from various risk measures which have been gathered.

Table 9.6: Opportunity indices

Country		South Africa	Nigeria	Kenya	Mozambique	Tanzania
National grid coverage	Transmission lines (km)	29,300	13,300	3,700	5,000	4,800
	Area (km^2)	1,220,000	924,000	523,000	802,000	945,000
	Km of transmission lines per 1,000 km^2	24.0	14.4	7.1	6.2	5.1
	Access to electricity (per cent)	85	48	26	22	18
	Ranking	1	2	4	4	5
Installed capacit	Installed capacity (MW)	45,700	6,000	1,700	2,300*	1,500

y per thousand inhabitants	Population (thousands)	52,000	177,000	45,000	25,000	50,000
	Total (kW)	878.8	33.9	37.8	92	30
	Ranking	1	5	4	3	5
Annual forecasted demand	Average MW additions	810	4,750	1,330	190	280
	Percentage growth	2	10	13	10	8
	Ranking	4	5	5	2	1
Total		6	12	13	9	11

Table 9.7: Risk indices

10. Risk rankings	**11. Political risk**	**12. Security**	**Corruption**		**13. Total**
			Independent regulator	**Transparency**	
South Africa	M = 1	16 = 2	Y	72 = 1	4
14. Nigeria	**15.** H = 5	**16.** 33 = 5	**17.** Y	144 = 5	**18.** 15
Kenya	M/H = 3	22 = 3	Y	136 = 4	10
Mozambique	M = 1	21 = 3	N	119 = 3	7
Tanzania	M/H = 3	16 = 2	Y	111 = 2	7

Source: AON, Political Risk Map 2014. <http://www.aon.com/2014politicalriskmap/2014-Political-Risk-Map.pdf>. Political risk ratings range from low risk to very high risk; Global IntAKE, Africa Security Risk. <http://www.globalintake.com/world_risk_map.php?continent=1>. Security ratings are out of 100 per cent; Transparency International, "Corruption Perception Index 2013," December 2013. <http://www.transparency.org>. Corruption perception rankings are out of 177 countries.