

Energy Security in Mozambique

Hélder Chambal

2010

Abstract

Mozambique is endowed with a considerable hydropower potential and is rich in modern energy resources. However, more than 80 percent of the country's population is not connected to the national grid because of inadequate basic infrastructure, the lack of investment, the lack of a market network, and the huge cost of installing an energy grid, among others. The main objective of this study is to explore three energy security dynamics affecting Mozambique: the key drivers of energy availability, accessibility and efficiency for the electricity subsector. The country's natural resources are fundamental to the socioeconomic development of the country, but must be utilized in a sustainable manner in order to benefit the different stakeholders, including communities living in rural areas.

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Hélder Chambal

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<http://www.tradeknowledgenetwork.net>

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This study is part of a larger, multi-region TKN project that seeks to understand better the impacts of trade policy on energy security. It includes case studies and regional analyses from Latin America and Southern Africa. It was made possible through the generous support of the Norwegian Agency for Development Cooperation (NORAD). The project outputs are available on the TKN website.

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Abbreviations and acronyms

CNELEC	National Electricity Council
CPS	Country Partnership Strategy
DANIDA	Danish International Development Agency
DNE	National Directorate for Energy
DoE	Directorate for Economics
EDM	Electricidade de Moçambique
EIA	environmental impact assessment
ERAP	Energy Sector Reform and Access Project
FUNAE	National Energy Fund
GDP	gross domestic product
Gwh	gigawatt hour(s)
HCB	Hidroelectrica de Cahora Bassa
kWh	kilowatt hour(s)
kV	kilovolt(s)
LPG	liquid petroleum gas
MICOA	Ministry for the Coordination of Environmental Affairs
MINAG	Ministry of Agriculture
MoE	Ministry of Energy
MoTraCo	Mozambique Transmission Company
Mozal	Mozambique Aluminum Smelter
MW	megawatt(s)
NORAD	Norwegian Agency for Development Cooperation
PARPA	Plan for the Reduction of Absolute Poverty
PETROMOC	Petróleos de Moçambique
PV	photovoltaic
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SIDA	Swedish International Development Cooperation Agency
TJ	terajoule
USD	U.S. dollar
UTIP	Technical Unit for the Implementation of Hydroelectric Projects
VAT	value-added tax
W	watt(s)

Executive summary

Mozambique is still a young country, having become an independent republic a mere 35 year ago after a long period of colonial rule by Portugal. For about two decades after independence, Mozambique followed a communist/socialist pattern of political system and economic development model with centralized planning. Immediately after independence the new republic plunged into a 16-year civil war that killed or uprooted huge numbers of people and caused extensive damage to social/economic infrastructure and economic development.

This in itself is indicative of the difficulties Mozambique has experienced since independence, while the current status of the country's energy sector is illustrative of many of the specific difficulties that the country has suffered, which has delayed its economic development.

However, in 1987 (i.e. during the civil war) the Mozambique government initiated the Structural Adjustment Program in order to address the challenges of economic development, by reducing government control over the economy, promoting agricultural production, improving the marketing of agricultural products, reducing internal and external trade imbalances, improving resource distribution, and expanding the private sector.

This program, coupled with political reconciliation, produced positive economic results. Today, the economy is not solely dependent on agriculture, and other sectors have emerged, specifically the services sector. Sectors such as energy, construction, tourism, transport, communications, banking and consultancies are considered the key sectors for the economic development of Mozambique.

As a result of the government decision to promote business and boost the economy, most sectors of Mozambique's economy were opened to 100 percent foreign investment, and foreign investors receive the same treatment as domestic investors. Some restrictions remain in effect, such as those on private ownership of land, and mining and management contracts are subject to specific performance requirements, although foreign investment is also protected and encouraged by government.

In the energy sector, it is important to highlight that Mozambique has substantial energy resources, ranging from fossil fuels (natural gas and coal) to renewables (solar, hydro, wind, geothermal and tidal sources of power). However, the exploitation of these resources for national use is limited. In fact, most of Mozambique's primary energy consumption is met by traditional biofuels such as wood, charcoal and agro/animal waste.

Major difficulties are associated with the fact that most hydropower plants were destroyed during the war. But the opportunities available to the energy sector in Mozambique do not rely only on the country's needs, but also on those of the Southern African region as a whole, which have been growing steadily. This suggests that there are good opportunities for power exports from Mozambique in order to take advantage of its energy potential.

Therefore, the strong involvement of the public sector, together with the pro-active participation of the private sector, presents a window of opportunity to overcome the current deficit in the energy sector.

Private sector companies are encouraged to establish their own generating systems, provide electricity to communities in the surrounding areas and also sell their energy surplus to the national power utility, while buying energy from the utility when it is required. In light of this, the government should institute

a friendly regulatory regime for the energy sector; promote investment; and create clear incentives for investors, manufacturers and developers to utilize and promote renewable energies when making investments in the country.

A joint effort to achieve better access to and utilization of the country's energy resources by the government and the private sector will strongly contribute to the country's energy security.

1. Mozambique: Basic facts

Mozambique became an independent republic in 1975 after a long period of colonial rule by Portugal. For about two decades after independence the country followed a communist/socialist political system and economic development model with centralized planning. Immediately after independence the new republic plunged into a 16-year civil war that killed or uprooted huge numbers of people and caused severe damage to social/economic infrastructure and economic development.

In 1992 a ceasefire agreement with the rebel movement was reached and the civil war ended. In 1994 Mozambique adopted a system of multiparty democracy that opened a new era for the country, characterized by the emergence of political and socioeconomic stability. The socioeconomic changes since the introduction of the multiparty system and economic reforms have been rapid.

Mozambique is situated on the southeastern coast of Africa and it shares land borders with Zambia, Malawi, Tanzania, Zimbabwe, Swaziland and South Africa. The total land area of Mozambique is 799,380 km² (98 percent land and 2 percent inland water). For administrative purposes, the country is divided into 11 provinces: Cabo Delgado, Niassa, Nampula, Tete, Zambézia, Manica, Sofala, Inhambane, Gaza, Maputo Province and Maputo City.

According to the National Institute of Statistics, the population of Mozambique in 2009 was estimated to be 21.35 million. The population grows at an annual rate of 1.7 percent. About 45 percent of the population comprises young people below 15 years of age. The working or active population (between ages 15 and 65) constitutes about 50 percent of the total population. About two-thirds of the population live in the coastal zone, which has relatively easy access to food and employment opportunities. Most of the country's towns, tourist attractions, infrastructure facilities, industry and commerce are also located in this area.

The economy of Mozambique is mainly dependent on agriculture, which constitutes 21 percent of gross domestic product (GDP) and the bulk of merchandise exports. Traditional exports include base metals and related articles, shrimp and marine products, sugar cane, cashew nuts, copra, beverages, mineral products, tobacco and cotton. The manufacturing sector includes food processing, tobacco, beverages, aluminum, textiles and footwear. Mozambique is a net importer of services and the key service sector businesses are energy, construction, tourism, transport, communications, banking and consultancies. Mozambique also imports mineral products, consumer goods, and miscellaneous items, equipment, and machinery.

Mozambique's geographical location and natural resource base offer ample scope for investment and the rapid social and economic development of the country. The country is endowed with a variety of natural resources, including forests with diverse wildlife, minerals, water resources with a large potential for hydroelectric power production, and marine resources. Located on the Indian Ocean, Mozambique offers harbour and transportation facilities to land-locked neighbouring countries.

In order to address the challenges of economic development and to manage its mounting external and internal debt, Mozambique initiated its Structural Adjustment Program in 1987. This program aimed at reducing government control over the economy, promoting agricultural production, improving the marketing of agricultural products, reducing internal and external trade imbalances, improving resource distribution, and expanding the private sector. In the process, most of the industries and parastatal enterprises owned by the government were privatized.

The government's liberal economic policies coupled with political reconciliation produced positive economic results. Over the period 1986–89 annual GDP growth increased from 0.9 percent to 5.3 percent, accompanied by an increase in consumption per capita. Inflation fell from 170 percent in 1987 to 40 percent in 1990. In spite of these economic achievements, the external debt remained high compared with GDP and foreign exchange earnings.

Nearly 54 percent of the population lives below the poverty line and 52.2 percent of adults are illiterate. About 15 percent of adults are considered to be HIV-positive. Despite increased vaccination rates and improving access to basic healthcare services, over 60 percent of the population remains without access to health care, and life expectancy (2007) is 40.4 years.

In general, the change in some areas has been remarkable since the early 1990s, with the emergence of functioning national institutions; the holding of four peaceful elections; and the evolution of a new political culture and liberalized economic regime and an increased investment and growth rate. However, significant barriers to private sector initiatives, investment and the creation of a competitive market environment in the economy still remain. Citizens' participation and involvement in economic policymaking and decision making are limited. Corruption, undue administrative delays, a weak legal system, numerous regulations and poor service delivery by public agencies are key challenges in improving private sector confidence in economic governance.

2. Economic reform

Economic reform has been extensive since the late 1980s. More than 1,200 state-owned small and medium-sized enterprises have been privatized, while preparations for the privatization of telecommunications, electricity generation and transmission, ports, and railways are under consideration. When privatizing a parastatal enterprise the government usually selects a strategic foreign investor. The government introduced a value-added tax (VAT) system in 1999 as part of its efforts to increase domestic revenues. Further, customs duties have been reduced and customs management has been streamlined and reformed. The new reforms included revision of the labour law; comprehensive judicial reform and the creation of a commercial court to facilitate the settlement of disputes in the commercial sector; the strengthening of the financial sector; civil service reform; and improved government budget-making, audit and inspection capabilities. In 2005 the government reviewed the Commercial Code and approved a new Commercial Code by Decree no. 2/2005 of 27 December 2005.

In 2007 the new Labour Law was also approved (Law no. 23/2007), which significantly changed many provisions of the old law in order to restructure the legal framework governing labour, employment and social security, although some difficulties still exist, particularly in relation to firing procedures and costs.

According to *Doing Business 2009* (World Bank, 2009), Mozambique was listed as one of the countries engaged in reforms that would make it easier to do business, especially in terms of employing workers, paying taxes and enforcing contracts.

Until recently, all business enterprises in Mozambique needed a licence to operate, irrespective of their size. Certain modifications have been made to the code in the wake of recommendations from various business development initiatives, and new licensing regulations were introduced in 1998. They involve simplified procedures and no requirement for the licensing of Class 3 companies, which are very small enterprises employing up to three people.

The main concern of the business sector is that licensing is still complicated and cumbersome if a company is involved in more than one activity. The licensing procedures are often lengthy and some of them are illogical and expensive in a liberalized business environment. An industrial licence will involve, for example, a topographical map, full drawings of buildings, information about the number and gender of employees and the number of toilets, an environmental impact assessment (EIA), etc. Preparation of the documents involves several government departments and is very time consuming.

Furthermore, the private sector considers the number of inspections carried out by various government departments every year to be discouraging. It is apparently quite common that inspectors from various ministries and local authorities arrive one after the other and check the same things. Visits are totally discretionary and often lead to decisions that are seemingly totally arbitrary. This is very much a problem of government culture and attitudes among civil servants. A number of reform measures are on the cards in the wake of continuous advocacy and lobbying by the business sector and development partners, and the expected changes will be included in the Commercial Code.

However, despite all these constraints, most sectors of Mozambique's economy are open to 100 percent foreign investment, and foreign investors generally receive the same treatment as domestic investors. Some restrictions remain in effect, such as those on the private ownership of land by foreigners, and mining and management contracts are subject to specific performance requirements.

According to the 2005 Commercial Code, the government's investment policy does not limit foreign ownership or control of companies. Mozambique allows 100 percent repatriation of profits and the retention of earned foreign exchange in domestic accounts. However, lengthy registration and approval procedures governed by various laws and regulations, and in some instances a lack of clear statutes, are affecting domestic and foreign investment.

The Investment Promotion Centre, which processes foreign investments, is yet to harmonize its activities to achieve a 'one-stop shop' for investors, who still have to move among various departments to procure licences. Payments and transfers are subject to maximum amounts above which they must be approved by the central bank. Capital transactions, money market instruments and derivatives are subject to controls.

The country still requires further economic reforms; enhanced foreign direct investment; and the development of the agricultural, energy, transportation, telecommunications and tourism sectors. Enhancing economic growth in the agricultural sector is a major challenge. Although about 80 percent of the population engages in small-scale agriculture, the sector suffers from inadequate infrastructure, investment and marketing networks; high costs of production; and low incentives for small-scale farmers due to import competition.

The challenge for the country is to take the opportunity of the momentum provided by the recent economy growth to stabilize and consolidate the economic and social development processes in a sustainable manner.

3. Mozambique: Energy, climate change and sustainable development

The global economy is dependent on oil and other fossil fuels, and this dependency (of producers and consumers alike) is fed through international trade. Weaning the global economy off carbon without

causing economic dislocation poses a tremendous challenge. Governments must move quickly to effect a rapid transition in the sources of energy on which their countries' economies rely, while balancing social economic and environmental concerns.

Not many countries have been implementing proper measures for sustainable development. Nowadays, climate change and the global demand for energy represent a threat to sustainable development. With increasing economic globalization, the issues related to the international regulation of energy and natural resources policies are receiving a great deal of attention.

Mozambique suffers from the consequences of the improper utilization of natural resources, which are distributed highly unevenly around the country, and access to energy in a sustainable manner remains extremely low. This situation is partly due to the high cost of extending networks and increasing the number of connections in remote and relatively low-demand areas using conventional technologies and design standards.

Access to energy is a precondition for economic development and social progress in Mozambique, especially in the peri-urban and rural areas. The government has affirmed in Mozambique's Plan for the Reduction of Absolute Poverty II (PARPA II) the critical role of the energy sector in reducing poverty. The importance of the energy sector is also emphasized in the World Bank's 2008–11 Country Partnership Strategy (CPS), which identifies adequate access to energy resources and services as a key driver of economic growth and poverty alleviation. The CPS prioritizes especially the provision of energy services to rural schools, administrative posts and hospitals/clinics. At the moment, energy-related goals set in PARPA II are being turned into strategies such as the Off-grid and Renewable Energy Strategy, Generation and Transmission Master Plan, North–South (Backbone) Transmission Least-Cost Study, and National Biofuels Strategy.

On the other hand, the impact of energy use on the environment in Mozambique makes the promotion of energy efficiency an important issue. In this regard, it is of paramount importance to promote the efficient use of energy resources, but also to carry out awareness campaigns, mainly with local communities or people living in rural areas, where inefficient energy use is apparent, causing damage to the environment. These activities must be accompanied by a process of harmonization and coordination among the different government entities in order to merge the various policies and strategies, especially regarding natural resources use.

Although many countries are using voluntary labelling to promote energy efficiency, reduce emissions and achieve negative impact on the environment, for countries like Mozambique this is still far from being a reality. However, some measures that can be more easily implemented in the country such as technical regulations and standards are important tools to increase the efficient use of energy and reduce greenhouse gas emissions.

The main issue, however, lies in the way in which countries like Mozambique implement their climate change policies. Measures such as support programs for renewable energy, energy taxation and technical regulations related to energy efficiency need to be implemented in ways that will promote social and economic growth and sustainable development.

A consensus is emerging that technology innovation and transfer can play a major role in protecting the environment while fostering economic development, but achieving the right balance between private and public action is a daunting challenge. In this sense, it is important that countries like Mozambique

have access to these innovative technologies in order to actively achieve their economic and social development without neglecting the environmental concerns that must always be part of their governance and development agendas.

Mozambique aims to align itself with best international practices for efficient energy utilization by raising awareness among its citizens about good environmental practices, diversifying the energy supply matrix, and giving particular emphasis to new and renewable sources of energy and to the opportunities contained within the Clean Development Mechanism established under the Kyoto Protocol.

4. Mozambique's energy sector

Mozambique's government-approved Energy Management Strategy for the Energy Sector (2008–12) establishes policy guidelines and relevant measures for the energy sector based on principles such as:

- increased sustainable access to electricity and liquid fuels;
- the sustainable utilization of wood fuel;
- the promotion of new and renewable sources of energy;
- diversification of the energy matrix;
- the joint planning and integration of energy initiatives with development plans and programs of other sectors;
- sustainable development and environmental protection;
- tariffs reflecting real costs and the incorporation of mitigation measures to protect the environment;
- the promotion of the concept of the productive use of energy and enlarging the approach to energy supply to include the supply of systems and tools;
- institutional coordination and consultation with relevant stakeholders for better development of the energy sector;
- active participation in international cooperation forums, including the Southern African Development Community (SADC); and
- the efficient use of energy.

These principles are fundamental to the development of the energy sector and were established with the aim of developing the country's vast energy resources. These enormous resources have the capacity to satisfy most of the country's domestic energy needs, and include resources such as hydropower, and power generated from natural gas, coal, biomass, solar energy and wind.

According to the Mozambique Energy Management Strategy for the Energy Sector (2008–12) (MoE, 2008), Mozambique is endowed with a considerable hydropower potential, which has been broadly estimated at 12,500 MW, with a corresponding annual energy generation potential of 60,000 Gwh per year.

Approximately 500 MW generated from natural gas plus 5,000 MW generated from coal may be added to this potential. Yet despite this significant potential, we should not expect a rapid shift from biomass to electricity use, because Mozambique is a vast country, with the majority of its population living in

rural communities dispersed throughout its provinces. At present only 13.2 percent of the population has access to electricity. Energy solutions must take this reality into consideration and adapt to it by combining an intensification of electrification in those areas served by the national electricity grid with the adoption of hybrid solutions, in particular for remote areas, using available and sustainable biomass (wood fuel, biofuels and biogas), solar, wind and hydropower resources.

The country's greatest potential lies in the Zambezi River basin at sites such as Cahora Bassa North and Mphanda Nkuwa. So far, about 2,200 MW of generating capacity has been developed. In addition, the potential for small hydropower projects is 190 MW, which includes 6 MW of micro hydro ($MW \leq 2$), 18 MW of mini hydro ($2 < MW \leq 8$) and 166 MW of small hydro ($8 < MW < 15$). Potential sites for these micro hydropower schemes are located in the mountainous terrain and perennial streams and rivers of Manica, Tete and Niassa provinces (MoE, 2009).

Mozambique receives a considerable amount of sunshine. With an annual average radiation of 5 kWh per m² per day, it offers very favourable conditions for photovoltaic (PV) and solar thermal energy development.

According to the Ministry of Energy (MoE), at the household level, energy is mainly used for cooking and lighting (MoE, 2009). The principal energy source for the majority of Mozambicans is biomass, particularly wood fuel, and biomass coming from an estimated 30.6 million hectares of forests (wood fuel and charcoal) represents 80 percent of the energy consumed by households. Within rural communities, this accounts for nearly all the energy consumed. Charcoal production and use are widespread in small urban settlements and district capitals, and around larger towns and cities.

Only around 10.5 percent of households have access to electricity, with over half of them situated in Maputo and its surrounding areas. All the provincial capitals and most of the municipal areas are also supplied with electricity. Most of these urban centres are connected to the main national electrical grid, which is owned and operated by the Mozambican power utility Electricidade de Moçambique (EDM).

Mozambique is now recording a yearly growth in electricity demand of 7 percent. The government's objective is to reach an electrification rate of 15 percent by 2019 and 20 percent by 2020.

EDM's existing installed capacity is approximately 240 MW (109 MW hydropower and 130 MW diesel and gas generated). Nevertheless, most of EDM's available supply capacity—about 136 MW (61 MW of hydropower and 75 MW of thermal power)—is generated by ageing plants that will soon require refurbishment.

In 2005 total energy consumption was 1,707 Gwh and peak demand was 284.6 MW. Total power generating capacity, including the share from Cahora Bassa, is in excess of what is needed in the country. However, due to lack of power transmission lines and distribution networks, the availability of hydroelectricity for the time being is largely restricted to urban areas. In other areas electricity is simply not available, and where it is available, it is supplied by diesel generators.

By 2020 Mozambique should have a total energy need of 5.4 Gwh and electricity demand close to 900 MW, based on an annual demand growth of 7–8 percent.

The main source of electricity supplied to the national grid comes from hydropower plants. The remaining centres have diesel or gas generators that supply electricity distributed through mini grids that are independent of the main national grid system. All except a few of these independent systems are

owned by the state and operated by district administrations, municipalities or other government institutions. Many district capitals and other rural localities with relatively high population concentrations are still either not currently supplied with electricity or have old generation and distribution systems that are no longer functioning.

In low-demand rural centres, electricity development, connection and operation costs per customer are higher than those in larger towns and cities. Revenues from consumers rarely cover costs. Most consumers fall within the domestic consumer category and very little electricity is used for economic purposes. There are very few large consumers. Under the current regime of uniform tariffs throughout the country, there is an implicit cross-subsidy of consumers in these low-demand centres by consumers in the larger cities and towns.

Thus, it can be concluded that the government is facing three primary challenges, namely: (1) increasing access to modern energy, in particular electricity, and mitigating adverse environmental, livelihood and health impacts of traditional biofuels; (2) increasing the production and use of electricity; and (3) promoting and prudently managing export-oriented energy projects (MoE, 2009).

The government must be prepared to face these challenges and turn them into positives tools to strength the country's development initiatives. It is important to bear in mind that the government's vision is to ensure energy availability in order to sustainably meet the requirements of national socioeconomic development.

5. Mozambique's energy potential

The energy from the main grid covers only about 6 percent of the approximately 21 million inhabitants of the country. People not on the grid are mainly those living in rural and peri-urban areas.

Mozambique is rich in modern energy resources. More than 80 percent of the hydropower potential is located in the Zambezi Valley, including the existing Cahora Bassa dam. The above estimates do not include estimates for solar and wind power or other renewables.

All of Cahora Bassa's capacity, except for Mozambique's entitlement of around 300 MW, is committed to supplying South Africa, Zimbabwe and Malawi. On the Zambezi River there are plans to construct another hydropower unit on the northern side of Cahora Bassa, the Cahora Bassa North Bank, with a capacity of 850 MW. There are also plans to install another hydropower plant about 100 km from Cahora Bassa known as the Mpandha Nkuwa Hydro Scheme, with a capacity of 1,300 MW in the first phase and 2,400–2,600 MW in the second phase. For both schemes, feasibility studies have been undertaken.

The study on medium-sized and large plants reveals that the potential is very high in the central (Sofala, Manica and Zambézia provinces) and northern (Nampula, Cabo Delgado and Niassa provinces) parts of the country. The south (Maputo, Gaza and Inhambane provinces) is relatively poor in hydro resources for energy generation. The tea-producing areas, which are concentrated in the districts of Gurue, Ile, Milange and Lugela in Zambézia Province, also have very good hydro energy resources, according to an energy survey undertaken by the National Energy Fund (FUNAE) in 2004.

An ITDG (2000) publication gives an overview of micro hydro potential in Mozambique, especially in Manica Province. A scoping study for micro hydro investments in the provinces of Manica, Niassa and Tete has been undertaken by the World Bank (2004).

Apart from hydro resources, Mozambique has large sedimentary basins of gas. Three accumulations of gas have been discovered onshore at Pande and Temane in Inhambane Province and Buzi in Sofala Province. Total gas reserves might be as high as 3.5 trillion cubic feet. Pande gas is now being exported to South Africa through a pipeline linking the locality of Temane to Secunda in Gauteng Province in South Africa, a distance of 865 km, of which 340 km lies in South Africa. The project was launched in 2002. Pande gas is to be used domestically both in rural and industrial activities. Currently some industries in the cities of Maputo and Matola are already using natural gas.

Regarding coal resources, Mozambique has three relatively large known deposits at Moatize-Minjova, Senangoe and Mucanha-Vuzi, all of them in Tete Province. Total coal reserves are estimated at about three billion tons. Coal has been produced since 1940 from Moatize underground mines, both for in-country use and export. Operations were suspended in 1981 due to the civil war, but preparations are now being made to restart mining activities. The Brazilian Company Vale do Rio Doce has won the bid for exploitation of the Moatize coal mine, including the installation of a local power station.

Oil has been explored for in different parts of the country, but so far there are no good indications of the availability of oil reserves in quantities that would justify economic exploitation.

Biomass, micro hydro, wind, solar and geothermal resources constitute some of the country's renewable energy resources. At the moment, most of Mozambique's primary energy consumption is met by traditional biofuels such as wood, charcoal and agro/animal wastes. In rural institutions that operate at night (e.g. health centres), kerosene is the main lighting fuel. Over the last few years PV solar energy has been gradually adopted in schools and health centres in rural areas, telecommunications businesses, etc.

This reflects the fact that the country has substantial solar energy resources. Therefore, what is required is the government to undertake the necessary actions to increase access to diversified energy sources in a sustainable way, thus contributing to the welfare of the population and the country's socioeconomic development.

An example of this is the work of FUNAE, which is promoting the use of wind energy for water pumping in areas along the coast, in the highlands of the interior and in the vicinity of water bodies where there are substantial wind energy resources. The same has yet to happen with the country's geothermal and tidal energy resources.

6. Energy supply and demand

Areas of demand for electricity produced by Mozambique (much of which is distributed through South Africa) can be broadly divided into three categories:

- local residential and business markets (low-voltage consumers);
- Mozambican industrial markets, which are served by both EDM and the Mozambique Transmission Company (MoTraCo) (medium- and high-voltage consumers); and
- Southern Africa Power Pool (SAPP) and South African markets.

A fourth demand category—off-grid electricity demand—is handled by a separate organization, FUNAE, and does not feature in overall electricity grid planning.

The major players in the supply of electricity in Mozambique are EDM, Hidroelectrica de Cahora Bassa (HCB) and MoTraCo (Hankins, 2009).

- *EDM*, which is the national power utility, is wholly owned by the government. It participates in all parts of the electricity supply chain, including some generation (although it is not the primary generator in the country); transmission; distribution; and consumer connection, supply and billing.
- *HCB* manages and operates the Cahora Bassa hydroelectric power stations and their associated transmission networks that supply power to SAPP. The installed capacity of 2,075 MW at the Cahora Bassa dam makes this the primary electricity source for both Mozambique and Southern Africa as a whole.
- *MoTraCo* is the third major supplier of electricity in Mozambique and is a joint venture company formed by the state power companies in Mozambique, South Africa and Swaziland to transmit power from South Africa to the Maputo-based Mozambique Aluminum Smelter (Mozal) plant. The company manages transmission lines in these three countries and was created in 1998 through an equity debt arrangement worth USD 120 million.

The national energy supply in Mozambique falls into three distinct categories: the national grid, mini grids and independent systems. Responsibility for the national grid network rests with the EDM power utility, under the supervision of the MoE. Mini grids are the responsibility of the MoE through the provincial directorates and/or donor-specific initiatives. Management is undertaken privately, typically led by the relevant district administrations.

The provincial directorates of energy are responsible for the design, installation and quality management of the mini grid systems. These systems are typically found at district headquarters level and feed commercial centres and local services. Households are eligible to sign up, but few do so, due to affordability constraints. Below the mini grid level, responsibility for electricity access or energy services to institutional facilities falls to individual ministries (e.g. health, education) for providing essential services. These comprise the independent systems.

The EDM transmission system comprises three regions, namely northern, central and southern. The northern region has a 220 kV transmission system extending some 1,000 km from Songo substation to Nampula, thereafter continuing at 110 kV to the town of Nacala. A separate 220 kV (operated at 110 kV) system extends from Tete to link with the central region at Chibata. The central region has a 110 kV system linking the hydroelectric power stations at Chicamba and Mavuzi with the load centres within the Beira–Manica corridor. The southern region of the EDM system comprises a 110 kV network extending from Maputo to Xai-Xai, Chokwe and Inhambane, together with a 275 km single circuit line from Maputo to the Eskom¹ system at Komatipoort in South Africa.

EDM has an installed capacity of about 393 MW. Eighty-five percent of the electricity generated by EDM in 2002 was from hydroelectric sources, with the remaining 15 percent coming from thermal sources.

Electricity coverage in the country is still very low in all categories. For instance, average domestic access to electricity is only about 6 percent, one of the lowest in Africa, and varies from province to province.

1 Eskom is the state-owned South African power utility.

Table 1 presents the level of access by province for 2003–04, from which it can be seen that Cabo Delgado and Zambézia (the only tea-producing areas in the country) have levels of access of less than 2 percent. The province of Maputo, where the capital of the country is located, has a level of access of 24.5 percent.

Table 1: Mozambique's electricity supply, 2003–04

Region and province	EDM domestic customers	Other customers	Total domestic customers	Population	Access 2003	Access 2004
Cabo Delgado	4,679	1,513	6,192	1,584,584	1.6%	1.8%
Niassa	5,727	977	6,704	972,391	2.8%	2.9%
Nampula	27,557	800	28,357	3,588,348	3.2%	3.3%
Zambézia	15,556	583	16,139	3,626,739	1.7%	1.9%
Tete	9,200	2,230	11,430	1,472,728	3.2%	3.3%
Manica	10,809	1,586	12,405	1,281,317	2.9%	4.1%
Sofala	20,431	3,642	24,073	1,600,581	5.3%	6.3%
Inhambane	7,086	1,761	8,847	1,350,372	2.4%	2.8%
Gaza	20,473	470	20,943	1,277,307	5.0%	6.9%
Maputo	128,828	-	128,828	2,207,136	23.1%	24.5%
Total	250,346	13,572	263,918	18,961,503	Average: 5.3%	Average: 5.8%

Source: EDM (2006)

One of the main problems of energy and electricity access in Mozambique is its high cost relative to local incomes and, thus, consumers' need to balance expenditure on energy/electricity with their other expenditures. The low rate of national and mini grid subscribers is due in large part to the inability of users to pay for these services. In generator-served centres, mainly commercial institutions, administration buildings, and local health and education facilities are connected.

EDM's 2004 Master Plan discusses the development of the electricity sector in the country and gives a demand/supply forecast for the next years. Table 2 presents this forecast for the period 2006–10.

Table 2: Demand/supply forecast for Mozambique, 2006–10

Forecast	Capacity in MW				
	2006	2007	2008	2009	2010
Peak demand (low-growth scenario)	302.2	317.7	333.8	350.7	368.3
Peak demand (medium-growth scenario)	396.3	438.9	482.9	518.9	556.6
Peak demand (high-growth scenario)	427.9	484.2	543.6	597.0	654.0
Energy source					
Fuel oil					
Diesel					
Coal					
Natural gas			60	120	120
Geothermal					
Hydropower	466	511	516	516	551
Other renewable					
Reserve capacity (maintenance, largest unit)	64	67	72	105	108

Source: EDM (2004)

6.1 On-grid electrification approaches

Current electrification access rates are about 12 percent of the country, with the vast majority of these connections in urban and peri-urban areas. EDM is primarily involved in grid-based transmission and distribution, levy collection and, to a lesser extent, power generation. At present, its involvement in power generation is confined to five hydropower sites and the numerous off-grid and back-up generators it operates in regional capitals. EDM tariffs are unified and rural electrification activities are cross-subsidized.

EDM has one of the most ambitious rural electrification roll-out programs in Africa. Over the past three years it has aggressively expanded its electrification network by over 260,000 connections. An estimated 100,000 connections were made in 2008 at an estimated cost of USD 800 per connection. Grid-based rural electrification in Mozambique is mainly funded by grants and soft loans. About USD 80 million was spent on rural and peri-urban electrification activities in 2008. USD 60 million of this came from the Swedish International Development Cooperation Agency (SIDA,) the Norwegian Agency for Development Cooperation (NORAD), the Danish International Development Agency (DANIDA), the World Bank and the African Development Bank.

All regional capitals are connected, and 83 out of 123 district capitals are now on the grid. This number is expected to rise to 106 in 2011/12. There is one isolated mini grid (in Villanculus).

With Development Bank of South Africa funding, EDM is rolling out connections in low-income areas of Maputo. The program expects to connect 12,000 households (10 MW at 200 W per household) and is conducting 'backbone strengthening'. EDM has standardized low-income connections and is using low-income appropriate ready boards and meter cupboards for many of the connections.

EDM has been gradually reducing its generating capacity from thermal sources by purchasing more power from the independent power producer HCB for its network. EDM customers are classified into the categories of residential, commercial, industrial and agricultural.

6.2 Off-grid electricity demand and electrification approaches

More than 80 percent of Mozambique's population is not connected to the grid, and this is explained by the inadequate basic infrastructure, lack of investment, lack of market network and huge cost of installing an energy grid, among other factors. The large majority of people rely on traditional wood and charcoal biomass resources for all of their energy needs. Members of this group have little access to conventional electricity or modern fuels. In fact, they pay much more per kWh of energy for the little electricity they get than those who have access in urban areas.

To solve the special problem of off-grid energy demand, the government set up FUNAE in 1997, mandating it to tackle the unique problems faced by rural populations. FUNAE is responsible for off-grid energy and electrification efforts. Its organizational objectives are:

- to develop, produce and use different forms of low-cost power; and
- to promote the rational and sustainable management and conservation of power resources.

FUNAE provides financial aid and financial guarantees for economically and financially viable projects that are in tune with its stated objectives. Its off-grid activities include:

- the provision of financial assistance/guarantees and loans to enterprises that have as their objective the production, dissemination of production techniques, distribution and conservation of power in its diverse forms;
- the provision of financial assistance for the installation of power production equipment or the distribution of power;
- acquiring, financing or supplying financial guarantees for the purchase of equipment and machinery destined for the production and distribution of power, with particular focus on the use of new and renewable power sources;
- the promotion of distribution networks for petroleum products in rural areas;
- the provision of financial assistance for the transport of petroleum products to supply rural areas;
- the provision of support and consulting services and technical assistance for rural energy projects;
- financing the preparation of studies and investigative papers on technologies for the production, distribution and conservation of power products or renewable power, including their publication; and
- the promotion of the development and planting of forests for biomass production.

With support from the government and various donors such as the European Union, NORAD, DANIDA, the World Bank/Global Environmental Facility and others, FUNAE has managed the installation of PV systems, the development of micro hydro projects, the installation of wind pumps and the promotion of fuel-efficient stoves in the country. However, given FUNAE's small size and modest budget and the huge size of the off-grid population of the country, the impact of its work is relatively small.

A recent review of energy programs in Mozambique put it this way:

FUNAE has a huge task—in scope and in scale—in rural energy. Despite being a young, eight year old organization, FUNAE is involved in:

- all forms of energy supply: traditional and modern fuels, decentralized grid, stand-alone energy systems;
- all forms of uses: household energy, productive use promotion, energy savings;
- all forms of finance: loans, subsidized loans, subsidies, guarantees;
- all forms of investments: project preparation, project implementation, project rehabilitation (Hankins, 2009: 30).

Whether any such relatively inexperienced institution is capable of handling such a range of activities effectively is doubtful.

7. Renewable energy projects and resources in Mozambique

This section provides an introduction to the renewable energy resources that are available in Mozambique, as well as projects currently planned or under way.

As is the case with renewable energies in many African countries, renewable energy projects in Mozambique have historically been confined to traditional uses (i.e. wood and charcoal for cooking) and off-grid power supply sources (PV cells and wind-driven pumps). There is increasing government and private sector interest, but investment lags behind this interest and official government policy.

7.1 Key renewable energy resources in Mozambique

Table 3 presents an overview of the key renewable energy sources available to Mozambique.

Table 3: Key renewable energy sources available to Mozambique

Resource	Availability	Comments
Biomass/cogeneration	<ul style="list-style-type: none"> • 100s of MW from various fuel sources; potential bagasse availability of 433 thousand tons (dry weight, 2006) 	<ul style="list-style-type: none"> • 5 sugar plantations located in Maputo and Sofala provinces
Wind	<ul style="list-style-type: none"> • Encouraging wind resources exist along coast in Niassa Province • Tests show >6 m/second average wind speed in some areas 	<ul style="list-style-type: none"> • 4 sites studied (but using 10- and 20-metre masts will probably reveal greater resources) • Resource mapping needed
Solar	<ul style="list-style-type: none"> • High: 4.5–7 kWh/m²/day • Assuming average insolation of 5.2 kWh/m²/day, 1.49 million Gwh of annual radiation is incident on Mozambique's land surfaces 	<ul style="list-style-type: none"> • Estimated 1 MW of off-grid PV systems installed • FUNAE study on PV potential under way
Small-scale hydro (up to 10 MW)	<ul style="list-style-type: none"> • >1,000 MW 	<ul style="list-style-type: none"> • 60 potential projects
Geothermal	<ul style="list-style-type: none"> • Possible resources, but no studies completed yet • Conservative estimates of at least 25 MW in Tete, Manica and Niassa provinces 	<ul style="list-style-type: none"> • No realistic plans or resource assessments
Tidal	Ample resources, but no studies completed yet	No realistic plans or resource assessments

Source: Hankins (2009)

The production of renewable energy was estimated at about 300,000 TJ in 2005, with an average annual growth of 2 percent. Almost all of this is traditional biomass used for domestic consumption.

About 90 percent of renewable production consists of fuel wood. However, over the last few years new renewable technologies, such as solar power technology, are being introduced, accounting for about 12,000 TJ in 2005, which was about 3 percent of total renewable energy production.

In most provinces the vast majority of the population uses fuel wood for cooking. In the bigger cities, people use mainly charcoal for cooking, as is most notably reflected in the data for the provinces of Sofala (Beira City) and Maputo (Maputo City). In Maputo City about 25 percent of the population use other energy sources for cooking, mainly liquid petroleum gas (LPG).

In most provinces the majority of the population uses kerosene for lighting, followed by fuel wood. The other energy source for lighting is mainly electricity and, as such, reflects the electrification pattern of the country, with Maputo City having by far the highest electricity consumption.

7.2 Priority planned projects

Mozambique's current planned power projects include a number of 'traditional' large-scale hydro, coal and gas power generation projects, which are summarized in Table 4.

Table 4: Planned power projects in Mozambique

Project name	Type of project	Size	Comments
Cahora Bassa North Bank	Hydropower expansion	850–1,200 additional MW	Detailed feasibility study under way
Mphanda Nkuwa	Hydropower	2,500 MW	Developed by Camargo Correia, Brazil
Massingir	Hydropower	40 MW	Managed by EDM
Lúrio	Hydropower	120 MW	
Majawa	Hydropower	25 MW	
Malema	Hydropower	60 MW	
Moatize	Coal-fired power plant	1,500 MW	Developed by IES
Temane	Combined-cycle natural-gas-fired power plant	300–400 MW	On the Sasol gas pipeline, 2010

Source: Hankins (2009); Vattenfall (2008)

Two additional dams are proposed downstream from Mphanda Nkuwa on the Zambezi: Boroma (400 MW) and Lupata (650 MW).

Mphanda Nkuwa is a preferred project for the government because of the 'firm energy' it can supply to the grid and because of its potential for exporting power. The government has:

- identified a developer (Camargo Correia of Brazil);
- conducted a pre-feasibility study; and
- conducted a preliminary EIA.

In March 2009 a final EIA study was in its initial stages. The project design has been re-engineered, increasing the estimated rated capacity from 1,300 MW to 1,500 MW. The 2008–10 global financial crisis has, however, affected the financing of the dam.

There is a project to enlarge the spillway at Cahora Bassa. This retrofit, which would greatly increase HCB's capacity, was considered the 'preferred option' in an earlier EIA for Mphanda Nkuwa. The project would likely reduce the need for Mphanda Nkuwa and also help with the restoration of downstream flows.

8. Tariffs and the fiscal regime

Tariffs and the fiscal regime are two very important matters that require a cautious approach by the Mozambican government. However, it has been already decided in the 2008–12 Energy Strategy (MoE, 2008) that the energy tariff must be formulated on the basis of the following principles:

- Tariffs should reflect the real costs of energy.

- Incentives will be provided for energy savings and the rational use of energy.
- Policies for the minimization and mitigation of the environmental impact of energy production will be incorporated into any plans.
- Tariffs should reflect social challenges and will aim to support less-favoured segments of the population by providing increased access to more-efficient and less-polluting sources of energy.
- National cohesion should be promoted.
- Fair profits for investors should be ensured.

On the other hand, fiscal benefits are also relevant for the promotion of the energy sector. And for this purpose the government has decided that the energy strategy should include the following strategic initiatives:

- ISO standards 14040 and 14043 dealing with life cycle analyses should be introduced and disseminated. These standards quantify the environmental impact of the use of raw materials in the manufacturing of goods and equipment; the provision of services; and the transportation and distribution of goods after use.
- Together with the Ministry of Finance, fiscal regimes for equipment destined for rural electrification that consider the social character of these programs should be defined.
- Inter-ministerial commissions of key ministries should be established that will be responsible for the different groups within the country with higher energy consumption levels and their direct agents in order to produce recommendations for ensuring the sustainable and efficient use of energy.
- A White Paper recommending fiscal regimes for the transition of the economy, together with a timetable for their implementation, should be prepared.

It is in the context of a new model of economic development for the electricity, liquid fuels, and new and renewable energies sectors that the country's Energy Strategy recognizes the implementation of measures to:

- expand energy coverage and the access of rural areas to modern forms of energy;
- expand and modernize electrical networks for households; and
- expand infrastructures to propel economic activities in a sustainable and environmentally friendly manner for the country.

Specifically in terms of electricity, the Energy Strategy has established that the National Energy Council (CNELEC) will undertake a strategic initiative to appoint an independent commission composed of people of recognized merit representing economic activities and municipalities to examine the present functioning of EDM in terms of its organization, structure, resource management, present internal procedures, outsourcing and human resources management in order to determine possibilities for streamlining, improving and reducing costs without affecting the quality of services provided. Findings will be presented in a White Book on the management of EDM.

The White Book will enumerate detailed recommendations that suggest timetables and quantify impacts on the company's cost structures. Based on the findings and recommendations presented in the White Book, a detailed study of tariff structures and the pros and cons of establishing a bi-hourly tariff

will follow. The study will indicate ways of penalizing energy waste and providing incentives for the rational management of consumption, and assess the feasibility of introducing the category of consumer/producer and independent producers.

In order to guarantee the effective and smooth implementation of projects aimed at expanding electricity networks and connecting a larger number of families while ensuring financial sustainability, the following strategic initiatives will be taken:

1. Tax exemptions on electrical equipment imports are to be applied to rural electrification and expansion projects and new connections.
2. VAT exemptions are to be given for all rural electrification and expansion projects and new connections.
3. Foreign companies contracted to implement rural electrification and expansion projects and new connections are to be exempted from corporate profit tax.

In addition, the following strategic initiatives will be taken:

- All donations for rural electrification received by EDM and other agencies executing such projects will be converted into social capital.
- A mechanism will be established within the entity responsible for operating the national grid that will convert 25 percent of the costs of new connections into amortization of the debt to the Treasury.

In the liquid fuels subsector, the following strategic initiatives will be undertaken:

- The cost of liquid fuels supplied to public consumers will be aligned with real market prices to make it clear that such fuels are a scarce resource that need to be used efficiently, thus avoiding inflationary situations.
- Subsidies to enable reasonable tariffs to be applied to semi-public transportation for poorer members of the population will be compensated for by taxation applied to energy-wasteful goods, services and equipment.

Finally, in the areas of new and renewable energy, it has been stated that in rural and peri-urban areas fixed payment amounts will be given priority. These fixed amounts will be calculated in terms of the amount of traditional energy that will be replaced by renewable sources.

Other strategic initiatives will be taken to:

- promote community involvement in order to reduce implementation costs;
- establish simple and common tariffs that are easy to administer;
- establish a tariff structure that reflects costs and incorporates an element of subsidy only when necessary and for limited periods; and
- implement a detailed study on tariffs for these systems and formulate a manual of procedures for the determination of fixed tariffs.

All measures taken by the government, whether in terms of tariffs or a tax regime aimed at boosting the energy sector, are aimed at ensuring the population's access to energy and its use in a sustainable manner.

9. Institutional and regulatory framework

Mozambique has put in place a modern legislative framework for the energy sector in general and the power sector in particular. But some aspects are still unclear, particularly the contribution that the energy sector is to make to poverty reduction. While the legislative framework is considered to be largely in place, implementation and enforcement appear to lag behind considerably.

Since the 1990s a program of energy sector reform has eliminated the state's monopoly rights in the sector (with the exception of electricity transmission). The reform program has also entailed wide-ranging organizational initiatives to help public companies operate on a more commercial basis. In 1997 various pieces of legislation altered the status and competencies of the two main state companies in the energy sector, *Petróleos de Moçambique (PETROMOC)*, which distributes oil products, and EDM (electricity). The first became a limited liability company and the second a public company with the obligation of signing multi-year program contracts with the government, while the performance objectives of both companies were outlined.

A Council of Ministers decree established new conditions for the importation and distribution of petroleum products and a market-based pricing system, while another introduced management contracts for district electricity facilities. The 1997 Electricity Act no. 21/97 of 1 October 1997 opened up all aspects of electricity production, distribution and sale to private operators through concession contracts. Decree no. 8/2000 of 20 April 2000 determined the legal and financial autonomy of public companies and stipulated that they should function on a commercial basis and be financially viable. But responsibility for the management of the high-voltage transmission system is reserved for a public entity.

While the role of private actors in the petrol distribution sector has increased substantially, EDM still dominates the electricity sector. Regarding EDM, important aspects of the reforms include the unbundling of the company and the separation of accounts. Although the reform program envisages considerable private sector participation, particularly at district level, this has not occurred. Mozambique's nascent private sector is still small and fragile and other fields of endeavour offer more secure promises of return.

The MoE has prime responsibility for the energy sector. The all-important forestry resources are under the responsibility of the Ministry of Agriculture (MINAG). The Ministry for the Coordination of Environmental Affairs (MICOA) has an important potential role in documenting and monitoring the effects of both the extraction and end use of energy resources. Moreover, some of the most important international programs and projects with strong energy and environmental components have been promoted with the support of the UN Environment Program and the World Bank's Global Environmental Facility.

Two potentially significant new institutions have been created under the reform program and are subordinated to the MoE. The CNELEC, established by the 1997 Electricity Law, has as its main responsibilities the carrying out of mediation and arbitration in differences arising from aspects of energy supply and pronouncing on policies, projects, concession requests and new technologies. It also supervises tenders. Its broad-based membership includes government representatives, producers, consumer associations, research institutions, the manager of the national grid and concessionaires. The CNELEC's functions are regulated by Decree no. 25/2000 of 3 October 2000. The Energy Reform and Access Project (ERAP) is aiming to transform the CNELEC into a regulatory body.

FUNAE was also created in 1997 by Decree no. 24/97 of 22 July 1997. FUNAE is a public institution with a legal personality and administrative and financial autonomy aimed at supplying financial aid and financial guarantees for economically and financially viable projects in the energy sector (see above). Its focus is to promote rural electrification and the use of 23 renewable energy technologies. Any entity can have access to FUNAE funds. Finance can cover installation; equipment; biomass production, including reforestation and forest management; the distribution of petroleum products; studies on energy resources and technologies; and the dissemination of information on energy technologies. It can also install and manage systems. During the period 2003–04 FUNAE funded the activities of energy surveys in Sofala, Zambézia and Nampula provinces in order to assist the private sector and non-governmental organizations with information useful for their interventions in these provinces' energy sectors. Another institution subordinated to the MoE is the Technical Unit for the Implementation of Hydroelectric Projects (UTIP). Although not created within the framework of the reforms, its tasks are being adjusted accordingly.

Following the approval of the Electricity Law, MoTraCo was established and received a concession from the government to provide power to the Maputo-based smelting company Mozal in 2001. MoTraCo gets energy from the South African power utility Eskom. Currently it provides around 900 MW to Mozal. It is foreseen that MoTraCo will get a concession to provide power to the Limpopo Sands Project to be established at Chibuto in Gaza Province.

Another company, Energia de Moçambique, received a concession from the government for the production, transmission, distribution and commercialization of energy in the northern part of Inhambane Province. Currently the company has installed thermal stations using natural gas from Pande in the towns of Vilanculos, Inhassoro and Nova Mambone. A larger gas-powered thermal plant is to be constructed by the company in Temane to provide power to the whole of northern Inhambane. Other smaller initiatives are taking place following the approval of the Electricity Law.

The impacts of the reforms initiated in 1997 have been very positive so far. In the fuels sector, for example, before 1997 there were only two operators, i.e. the state-owned PETROMOC and the privately owned BP. As a result of the reforms 12 companies are now active in the sector, which has brought more efficiency and stability to the services provided. Developments in the electricity sector are slower due to its complexities. Nonetheless, in the last few years concessions have been granted for the private sector to produce, transmit and distribute electricity, specially via hydropower schemes. The CNELEC has not done very much so far, but with the most recent developments it is clear that it will start to play its role in regulating the electricity sector.

The new and renewable energy resources sector has benefitted significantly from the reforms, as the establishment of FUNAE helped expand the use of PV, micro hydro and wind (for water pumping) systems. Currently the private sector is also interested in undertaking wind parks projects. Thus it can be said that rural electrification is gaining momentum, both through grid extension and also through independent power producers and the use of renewable energy systems.

9.1 Current policies and developments

9.1.1 Energy Policy

This policy was formulated in 1997. The main objectives are:

- to ensure reliable energy supply at the lowest possible cost so as to satisfy current levels of consumption and the needs of economic development;
- to increase the availability of energy for the domestic sector, particularly coal, kerosene, gas and electricity;
- to promote reforestation in order to increase the availability of firewood and charcoal;
- to strengthen the institutional capacity of the main agencies that supply energy in order to improve their performance;
- to promote economically viable investment programs with a view to the development of energy resources (hydroelectricity, forests, coal and natural gas);
- to increase exports of energy products;
- to increase efficiency in the use of energy;
- to promote the development of conversion technologies and environmentally benign energy uses (solar power, wind power and biomass); and
- to promote a more efficient, dynamic and competitive business sector.

9.1.2 Ministerial Decree no. 20/97

This provides the organic legal basis for the National Directorate for Energy (DNE), establishing its duties, areas of activity, levels of administration and structure, including the services to be rendered by the various departments defined in the structure.

9.1.3 Electricity Act no. 21/97

In August 1997 this new electricity law was approved by parliament to define:

- the general policy for the organization of the electrical energy sector and the administration of the supply of electrical energy; and
- the general legal framework for electrical energy generation, transmission, distribution and sale within the country, as well as its export to and importation from outside of the national territory, and the granting of concessions for such activities.

9.1.4 Municipal legislation

New municipal legislation was enacted in 1997 giving municipalities certain functions in investment planning and the operation of electricity services. A study of the possible reform and regulation of the electricity sector was initiated by the government in the same year. The objective was to fulfil the intentions of the Electricity Act reforms through the granting of concessions and the presentation of proposals for tariff regulation.

9.1.5 Decree no. 42/2005 of 29 of November 2005

This decree approves the regulation that establishes the rules relating to the planning, financing, construction, ownership, maintenance and operation of the production, transportation, distribution and marketing of electricity, as well as the rules and procedures for the management, operation and overall development of the national transmission of electricity.

9.1.6 Decree no. 43/2005 of 29 November 2005

The decree designates EDM as the public company that manages national electricity transmission and its dispatch centre.

9.1.7 Decree no. 45/98 of 25 of September 1998

This decree approves regulations for the management of electrical installations built or rehabilitated with a particular district's own funds, if such management is not assigned to a public company.

9.1.8 Ministerial Decree no. 31/85 of 31 of July 1985

This defines the powers of the technicians responsible for project preparation, and the implementation and operation of electrical installations for private service.

9.1.9 Decree no. 46847 of 24 September 1968

This approves the regulations dealing with the safety of the high-voltage power lines and distribution networks.

9.2 PARPA and the Performance Assessment Framework

Mozambique's poverty reduction strategy, PARPA, has poverty reduction as one of the six main aims of the energy supply system. However, the perceived role of energy in poverty reduction is unclear and poorly defined.

In order to monitor the performance of the government's efforts to reduce the country's poverty, the Performance Assessment Framework for PARPA has been elaborated. It contains annual and tri-annual targets in the areas covered by PARPA. These targets are then to be assessed on an annual basis.

The first PARPA review was carried out in April 2004. Working groups were established in all the sectors covered by PARPA, including energy. This process brought donors and government officials together to look at the operationalization of PARPA goals, to assess performance during the previous year and to set targets for the period to come.

During this exercise, it became clear that for the energy sector, the goals remained vague and the poverty-impact analysis incomplete. The discussions led to a series of clarifications of these issues, however, and thus constituted an important step forward both at the conceptual level and also in terms of defining more-monitorable targets. But this debate needs to be continued, at least along two lines that are of relevance to the discussion between government and donors.

The first one concerns the overarching question of what a poverty-focused energy policy should look like. While the policy emphasizes increasing the availability of energy to the domestic sector, including firewood and charcoal, the operationalization of this goal in terms of concrete plans remains poor. This, of course, has to do with the difficulty in finding the right balance between promoting access to more modern and improved forms of energy and the capacity and willingness of poor households to pay for this. Energy is a commodity on which households are willing to spend an increased share of their income, but for this to work, it requires that the average income levels of the poor increase—something that is a function of the general economic development of the country. At the same time, more modern sources of energy can contribute to income generation, although one should be careful not to exaggerate this link.

Energy by itself is of little value as a production input—it typically becomes a factor in terms of the sort of machinery to be employed in production, etc. This means—one again—that the capital/access costs of being able to take advantage of more modern forms of energy often constitute an insurmountable barrier to entry into a particular industry. So a pro-poor energy policy needs to find solutions to the contradiction that the poor have problems accessing sources of income that can help them work their way out of the poverty trap.

This links with the second challenge: that of clarifying the exact role of electrification in poverty reduction in Mozambique. It is clear that the overwhelming share of resources for the energy sector is provided to the electricity subsector for transmission/national grid extension and local distribution hook-ups. A number of project documents for donor-funded projects contain a lot of intellectual gymnastics to prove the benefits of electrification for the poor. However, it is clear that the first-order effects of electrification are primarily experienced by the non-poor. While improved health and educational facilities due to electrification benefit the poor, it is nonetheless a fact that middle- and higher-income groups benefit considerably more because these groups' consumption of electrified services is much higher.

So even in terms of social sectors, the pro-poor argument seems to be on weak grounds. On the other hand, it is impossible to conceive of any longer-term poverty reduction activities that are not based on the improved production capacity of society as a whole, and modern and cost-efficient forms of energy are an indispensable factor in this process. In the case of Mozambique, the long-term comparative advantage of stable and locally generated energy supplies, primarily hydropower, is beyond doubt. Electrification is thus fundamental to the country's future.

The challenge is once again to find the balance between supporting short- to medium-term answers to the poor's energy needs—which by and large will not be based on electricity—and the longer-term accelerated economic growth that is required for the poor to have sustainable higher incomes that will permit their use of more efficient and environmentally friendly energy, where electricity distribution represents the key element.

While the answers to these problems are not obvious, what is clear is that the dialogue among the various stakeholders in the energy sector has so far been incomplete and that a more permanent and continuous arena for addressing the questions, finding more and better information to inform future decisions, etc., is needed. The annual meeting for assessing PARPA and its Performance Assessment Framework is thus a step in the right direction.

However, the issue is much more complicated than this. Efficient energy use requires not only access to operating and investment capital, but also skills, market access, more complete information, etc.—all

the constraints that poor households, who tend to live on the outer fringes of society's various transaction networks, face when trying to move into better-paying income streams.

One thing that can be done in the run-up to the next PARPA review is to look more critically at the kinds of indicators that can be developed to track the impact of electrification on poverty. These could include:

- the number of new electricity connections per province, subdivided according to tariff categories;
- the percentage of households connected per province;
- the number of clinics and schools electrified (PV) in each province;
- the percentage increase in electricity consumption in each province, partly as a proxy for economic growth;
- the number of improved cooking stoves installed and used; and
- the percentage increase in kerosene and LPG sales in each province.

These kinds of indicators need to be combined with more careful household surveys so that the socioeconomic profile of low-consumption households is clear, because the assumption that these households are 'poor' in the Mozambican context may be fallacious. Studies like the baseline study in Sofala funded by DANIDA are therefore very useful to 'calibrate' these indicators against the overall poverty profile of the country.

10. Harmonization and coordination: The public sector

Mozambique's energy sector is undergoing rapid changes, in part as a result of the restructuring of the country's overall economy, which places more emphasis on market-based solutions. Other forces at work include closer integration into regional power markets and the rapid growth in large-scale energy projects with important private sector participation.

In addition to the regular ministry departments, Mozambique has established several new institutions to promote new activities, regulate traditional ones, and participate more actively in regional networks (Scanteam, 2005). These are discussed below.

10.1 Ministry of Agriculture

MINAG manages traditional forest-based fuels. The National Directorate of Land and Forestry is responsible for ensuring the sustainability of supply through its provincial offices. A system of licensing exists for charcoal production and sale, but it does not appear to function well. Overexploitation is common near urban centres, while resources are underutilized due to lack of access.

10.2 Ministry of Energy

The MoE is responsible for energy in Mozambique and was created in 2000. Of relevance for energy are three directorates and several technical units: the DNE, the Directorate for Economics (DoE) and the National Directorate for Renewable Energy.

Other important entities are the CNELEC, the corporatized but state-owned electric utility (EDM) and FUNAE, which has been set up to fund new energy projects. As we have seen, UTIP is responsible for large-scale hydropower development.

10.2.1 National Directorate for Energy

The DNE is a central technical body within the MoE that is responsible for the analysis, preparation and elaboration of energy policies. Its main tasks are to:

- study, propose changes to and administer the country's energy policy;
- promote the diversification of energy use and optimize the use of various energy sources;
- determine environmental issues and provide the plans and programs for the development of the sector, based on the development of the economic perspectives of the country;
- promote and maximize the rational use of national energy sources with relevance to the installed capacity by encouraging investment; and
- promote cooperation between public and private institutions, whether national or foreign, in achieving the maximum potential in the technical development and regulation of the sector.

A certain degree of overlap appears to exist with MINAG in the tasks assigned to the DNE's fuel department to:

- prepare development and management proposals, in coordination with other entities, concerning forest resources and wastes in order to produce energy;
- promote the development and use of technologies that will improve the production of charcoal; and
- guarantee wood fuels supplies to urban areas.

10.2.2 Directorate for Economics

The DoE is one of the core units in the MoE and is the central unit for planning and monitoring the ministry's own activities. The DoE puts together the ministry's annual budget and work plans based on the inputs coming from the technical directorates and the ministry's other units. The DoE is thus the MoE's dialogue partner with the Ministry of Planning and Finance and is responsible not only for the annual budget proposal, but also for delivering the inputs to the government's annual Social and Economic Plan, which is supposed to reflect the annual operationalization of the government's poverty reduction strategy.

As part of the DoE's budget responsibilities, it should therefore also have an overview of the external funding made available to the sector. Its ability to take on this task has been limited—one of the key issues that will be addressed below regarding the challenges facing donor coordination in the sector.

10.2.3 National Electricity Council

The CNELEC was established on the basis of the 1997 Electricity Act and in principle is to become a regulatory body. Currently it has an advisory and arbitration role that is not very clear, but it also remains organizationally weak, with few staff in place. More important is that the power sector still has a structure where the regulatory function is not required yet. There is thus a serious question over whether

the establishment of the CNELEC is premature and that its establishment may fragment the very limited resources the public sector has for managing the energy sector.

10.2.4 Technical Unit for the Implementation of Hydroelectric Projects

UTIP was established largely to develop and promote large-scale power projects on the Zambezi River. Its main activity so far has been the design and appraisal of the large Mphanda Nkuwa power project below the Cahora Bassa dam. It has been suggested that UTIP should be a more general development and promotion entity for power projects in Mozambique, including looking into the north bank potential at Cahora Bassa and possibly other medium-scale power projects. The government is currently looking into this proposal.

10.2.5 Electricidade de Moçambique

As we have seen, EDM is the national power utility of Mozambique. It used to be a state entity, but in 1977 was converted into a government-owned public company. It is largely a transmission and distribution utility with a current peak load capacity of 270 MW. This should be compared with Cahora Bassa's generation capacity of 2,075 MW; MoTraCo's transmission capacity of 850 MW; and the peak capacity of the neighbouring South African giant utility, Eskom, of around 35,000 MW.

EDM is undergoing a restructuring process through the separation of accounts and the creation of business units. Today, EDM operates in terms of a three-year performance contract with the government and is one of the very few business entities in Mozambique that has a structure, management and measurable output delivery that permits the kind of performance monitoring required by this contract.

EDM has prepared a Master Plan for the expansion of the country's national power grid and distribution networks with the goal of reaching 15 percent of the population by the year 2020 from the present 6 percent, at a cost of more than USD 800 million.

EDM applies cross-subsidization on a large scale. This can now be tracked thanks to the creation of appropriate business units and the separation of accounts. This process has been made automatic by the application of a uniform tariff structure throughout the country. Thus, in poor and remote regions (in the central parts of the country and especially the north), where electricity supply and distribution are more expensive than the tariff charged due to long distances and low customer density, combined with low consumption per customer, cross-subsidy takes place from the much more lucrative southern region.

Furthermore, the tariff structure across user categories is progressive and therefore pro-poor: the greater the domestic consumption—indicating greater income and hence higher affordability—the higher the unit rate.

This policy thus promotes national equity in two ways: it shifts resources from the wealthy south to the lower-income regions in the centre and north, and charges the wealthy more in order to subsidize low-income consumers in general.

10.2.6 National Energy Fund

FUNAE was established as an independent fund by decree in 1997 to raise and administer funds to support public and private energy production and distribution. Its function and activities have been discussed in detail in section 6.2.

10.3 Ministry for the Coordination of Environmental Affairs

MICOA has legislative power regarding the environment, and one of its key functions is to coordinate with line ministries on such matters. Strong links to both MINAG and the MoE are thus required, as MICOA is responsible for EIA approvals, but also Kyoto Protocol reporting and for any future Clean Development Mechanism application, all of which are relevant to the energy sector.

11. Harmonization and coordination: Private sector participation and other stakeholders

The private sector and other relevant actors play a very important role in the energy sector (Scanteam, 2005).

11.1 HCB

HCB is privately owned by Portugal (82 percent) and Mozambique (18 percent). Cahora Bassa is the largest single power plant in the Southern Africa region. Originally, about 90 percent of the energy produced was exported to South Africa at a very favourable price to the South Africans. As the region in general, but South Africa in particular, is expected to face power shortages over the next few years, the terms of these power exports are being changed, generating more benefits for Mozambique. On the other hand, HCB is heavily in debt and therefore needs to be restructured. Estimates are that the enterprise—with accumulated debt and interest payments—owes around USD 2 billion. Negotiations among the various parties concerned have been going on for some time and their outcome will not only determine the new benefits streams that Mozambique may be entitled to, but will also impact on the commercial viability of power projects and will thus affect the interest of private investors in investing in new large-scale power generation in Mozambique—notably Mphanda Nkuwa and Cahora Bassa North Bank.

11.2 MoTraCo

MoTraCo was formed by Eskom, South Africa's power utility; Mozambique's EDM; and the Swaziland Electricity Board to supply electricity from South Africa to Swaziland and Maputo. In Mozambique the power supply is primarily for the Mozal aluminum smelter, to which MoTraCo has built transmission lines with a capacity of 850 MW. But some of this power is in fact also being provided to the southern grid, which has helped stabilize power supplies in the south and improve the quality of the power supplied. MoTraCo is a commercial undertaking with, among other things, a secured loan from the European Investment Bank.

11.3 Southern African Power Pool

Mozambique is part of SAPP, an organization established on 8 December 1995, when the representatives of the power utilities of Botswana, Mozambique, Angola, Malawi, South Africa, Swaziland, the Democratic Republic of Congo, Namibia, Tanzania and Zimbabwe signed the Inter Utility Memorandum of Understanding. All imports and exports of power among these SADC countries lie within the rules and confines of SAPP.

SAPP aims at creating one single interconnected grid in Southern Africa. Mozambique has the second-largest generating capacity after South Africa. A key issue in SAPP is the dominant size of South Africa's Eskom, which accounts for more than 82 percent of generating capacity and over 85 percent of peak demand.

This near-monopoly purchasing role has been a contributing factor allowing Eskom to buy Cahora Bassa power at very low rates (HCB originally had no alternative buyer). The South African authorities have also made it clear that for the time being they have no intention of breaking up or unbundling Eskom to make the regional power market more competitive. The integrated behemoth in the south will therefore continue to dominate the regional power market, which is a key factor when assessing possible alternative structures for the power market in Mozambique.

11.4 External funding agencies

The development of the power supply sector depends largely on donor funding. There are broadly two categories of funding agencies, based on the kinds of funding provided:

- *Lending institutions providing credits (loans)*: This category includes the African Development Bank, Arab Development Bank for Africa, Islamic Development Bank, Nordic Development Fund, Agence Française pour le Développement (France), Kreditanstalt für Wiederaufbau (Germany), OPEC Fund, Kuwait Fund and World Bank.

Loan funding is concessionary and is commonly intended for infrastructure investments, with some exceptions, e.g. the African Development Bank has funded technical assistance for EDM's Master Plan study, while the World Bank's ERAP includes several non-infrastructure components. It is noted that not all these institutions have ongoing activities at present.

- *Grants donors*: This category includes DANIDA (Denmark), Norway, SIDA (Sweden), Spain and Japan; however, the latter two are not considered regular donors with a long-term commitment.

12. Conclusion

Mozambique has substantial energy resources, ranging from fossil fuels (natural gas and coal) to renewables (solar, hydro, wind, geothermal and tidal sources of power). However, the exploitation of these resources for national use is limited. In fact, most of Mozambique's primary energy demand is met by traditional biofuels such as wood, charcoal and agro/animal waste. The tea-producing areas, concentrated in Zambézia Province, have plenty of hydro resources that could be used for the development of the tea industry. In fact, most tea factories have been equipped with micro hydro schemes since their establishment prior to the 1970s and such schemes have been the driving force of the tea industry. Tea processing is being reinitiated after the long interruption resulting from the civil war. Currently, tea factories are operating in the districts of Gurue and Ile in Zambézia.

Major difficulties are associated with the fact that most hydro plants were destroyed during the civil war. There is an urgent need to rehabilitate these plants and also identify new potential in order to foster the tea industry. Even in places where electricity is available from the grid, micro hydro plants can be attractive if they can produce electricity at lower cost than that provided by the national utility.

The current situation in the Southern African region shows a deficit of 4,000 MW, which, combined with estimated socioeconomic growth, indicates the need for an additional 1,200–2,000 MW per year. This suggests that there are good opportunities for power exports from Mozambique.

The Master Plan for the production of electricity has to meet growing domestic needs and promote exports to the regional market, in particular in the context of SAPP. In this context, strategic initiatives will be undertaken to:

- encourage private sector participation in projects to generate power;
- observe and follow the increasing worldwide tendency to liberalize power generation, including the participation of consumers as micro energy producers;
- prepare a Generation Master Plan focused on meeting domestic needs and privileging the use of indigenous and renewable energy sources like hydro, wind and solar power, as well as biomass;
- incorporate into this plan an electricity substitution plan for water heating using solar energy;
- formulate a policy and establish mechanisms to create adequate reserves in the national electricity supply system;
- establish reliability criteria for energy supply to different types of load centres (capital cities and ports, and special loads like water supply, hospitals, cold storage facilities, etc.);
- determine the ‘economic price’ to be agreed when special tariffs are requested for special projects, in particular those requiring intensive electricity consumption;
- proceed with a thorough evaluation of export dynamics to maintain options for redirecting electricity to the domestic market for national development; and
- negotiate pricing for supplying Mozal with energy in its third phase of expansion.

An analysis of Mozambique’s institutional and regulation framework reveals that the reforms in the energy sector have created the necessary enabling environment for private investments in the sector. Particularly the 1997 Electricity Act foresees the granting of concessions for private energy production, distribution and sales.

The strong involvement of the public sector, enforcement of the regulatory regime, the participation of the private sector, the move towards corporate responsibility and the strong mobilization of civil society should make it possible to reverse the current situation in the energy sector.

The private sector can operate its own generating system, provide electricity to surrounding communities and also sell its energy surplus to the state power utility, while buying energy from the utility when it is required. Furthermore, FUNAE, with its focus on rural electrification using renewable energy technologies, will provide good support for the East African Tea Trade Association project, as some of the resources needed for the rehabilitation and/or construction of new hydro schemes can be mobilized locally.

However, it is important that government actively encourages private sector investment in renewable energy projects in Mozambique and creates clear incentives for investors, manufacturers and developers to utilize and promote renewable energies when making investments in the country. Renewable energy support should not be targeted exclusively at off-grid initiatives and poverty alleviation, and renewables should be encouraged in economically active sectors, including tourism, telecommunications and commercial enterprises, as well as among middle-class households.

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