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Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Abdallah, S. M., Bertarelli, L., Jacobs, A., Karekezi, S., Kimani, J., Mackenzie, G. A., Muzee, K., Nygaard, I., Olsen, K. H., & Shrestha, B. (2009). *Review of national frameworks for involvement of agro-industries in rural electrification*. Risø National Laboratory for Sustainable Energy.

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PACEAA

Poverty Alleviation through Cleaner Energy from Agro-industries in Africa

Review of national frameworks for involvement of agro-industries in rural electrification

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PACEAA Deliverable D1

April 2009

Title: Review of national frameworks for involvement of agro-industries in rural electrification
Division: Systems Analysis (SYS)

Contract no.:
EIE/06/247/SI2.448126

Group's own reg. no.:
1215166

Sponsorship:
European Commission
Intelligent Energy Europe
COOPENER Programme

Pages: 129

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Preface

Cleaner energy has great potential to contribute to sustainable agricultural growth, poverty reduction, and rural development. However, in practice, effective integration of energy and agricultural sectors to reduce poverty through cleaner energy systems is constrained by several barriers. PACEAA seeks to contribute to poverty reduction in Africa through improved agro-based cleaner energy planning and implementation. Specific objectives are: (a) to identify policy, commercial and regulatory barriers that are currently restricting the uptake of cogeneration and renewable energy systems from agro- industries in selected countries, and to propose ways of overcoming these barriers; (b) to develop detailed policy and regulatory guidelines and incentives for adoption of cleaner energy from agro-industries into rural electrification programmes as well as incorporate the packages into local rural electrification plans; and (c) to enhance local and regional capacity of public institutions, private sector (financial institutions, agro-industries, rural stakeholders) for the effective utilisation of cogeneration and other cleaner energy systems from agro-industries in the rural electrification process (d) to promote rural electrification packages for financing by rural electrification funds/ agencies and dedicated donors. PACEAA will accelerate the pace of integration of energy and agriculture sectors leading to poverty alleviation in Africa.

The actual potential for generating energy from renewable energy technologies (hydro, biomass) by agro-industries could potentially generate more than the industries' actual energy requirements and the excess energy could be used for Rural Electrification: the demand for power is high in rural areas of the 11 countries (Burundi, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Sudan, Swaziland, Tanzania, Uganda, Zambia) covered by PACEAA, as the average rural electrification rate does not exceed 5% of the total rural population.

The overall goal of the PACEAA project is to encourage and facilitate the involvement of rural African agro-industries in the process of rural electrification, in order to alleviate poverty and contribute to sustainable development. This requires understanding the energy needs and priorities of agro-based industries, the identification of best practice solutions to address these needs and the formulation of packages covering institutional, financial and technical issues ready for implementation and replication. It requires strengthening the capacity of agro-processing industries, local communities, planners and service suppliers to adopt such best practices, so that rural Africa will gain access to an improved choice of affordable, efficient and acceptable agro-industry-led and -induced energy services. The immediate objectives of the Project are threefold:

- To identify policy, commercial and regulatory barriers that are currently restricting the uptake of cogeneration and renewable energy systems from agro- industries in selected countries, and to propose ways of overcoming these barriers;

- To develop detailed policy and regulatory guidelines and incentives for adoption of cleaner energy from agro-industries into rural electrification programmes as well as incorporate the packages into local rural electrification plans.
- To enhance local and regional capacity of public institutions, private sector (financial institutions, agro-industries, rural stakeholders) for the effective utilisation of clean energy systems and cogeneration from agro-industries in the rural electrification process;

Four projects will be selected to develop full regulatory, organisational and financial packages that would facilitate the effective implementation of a rural electrification project in and around interested tea factories in parallel to their respective development of their small hydro projects. For these 4 projects, local rural electrification plans will be developed in association with local stakeholders in the vicinity of selected tea factories and used as case studies to validate the effectiveness of the regulatory, organisational and financial packages.

The output of these activities will be widely disseminated in Africa in order to set the foundation for an effective contribution of agro-industries to rural electrification. Training and capacity building activities will take place throughout the project duration.

PACEAA cooperates with two large initiatives from the agro-industries in East and South Africa, co-implemented by the United Nations Environment Programme (UNEP) and the African Development Bank (AfDB) through the Global Environmental Facility (GEF): “Greening the Tea Industry in East Africa (GTIEA)” executed by the East Africa Tea Trade Association (EATTA) and “Cogen for Africa” executed by AFREPREN/FWD. Both EATTA and AFREPREN/FWD are key subcontractors to the PACEAA project, with DTU (Denmark, Coordinator), IED (France) and UNEP (France) being the European partners. The project duration is 36 months.

1 Introduction

Engagement of the private sector and other non-state actors in developing countries' electric power provision is a fairly recent phenomenon, and started with the wave of energy sector reforms at the close of the 20th century. In the same vein, countries have embraced national power system decentralization and the use of renewable energy sources that are plentiful in rural areas. As part of the transformation process, rural electrification, which has traditionally been viewed as a government responsibility, has also been devolved to sub-national and private actors; and it is in this context that the involvement of agro-industries in rural electrification is being considered in the PACEAA project.

As governments have relinquished some aspects of their role in rural electrification, NGOs and other community development facilitators have on the other hand been active in promoting community based electrification. In some cases the electrification efforts preceded the formulation and implementation of legislation allowing communities to provide their own electricity supplies. Indeed, the community development supporters have in many cases taken part in lobbying for policy change leading to the laws granting rural people to produce and supply electric power. It has consequently and subsequently become easier for communities to join forces with other actors in public-private partnerships, with a view to undertaking rural electrification projects; and in the light of this communities can team up with agro-industries in their midst for electrification purposes.

Across the globe, a number of countries have had pioneering experiences relevant to the type of electrification under consideration. The countries are largely in South and East Asia, as well as in Latin America, and they include China, India, Nepal, Sri Lanka, the Philippines, Peru, and Chile. As literature indicates (e.g. Jiahua *et al*, 2006; and Khennas and Barnett, 2000) the earliest efforts to provide electricity supply in remote locations were made through development of small hydropower (SHP) schemes. From the early part of the 1990's, the SHPs in the pioneering nations were built up initially to cater for specific loads belonging to agricultural establishments, rural industries and institutions, and individuals. Later, they were used for supplying power to groups of rural consumers as grid-based electrification became increasingly unattainable, and use of the ubiquitous diesel generator started declining due to escalating fossil fuel prices.

Except in China, NGOs and electricity generation equipment suppliers played a key role as drivers of development of the SHP mode of power production and other renewable energy technologies (RETs). Secondly, the NGOs and suppliers facilitated inclusion of rural communities as participants and beneficiaries of RET based electrification schemes; and they together with international development trends also influenced government policies towards adoption of decentralized power supplies, use of RETs in electrification, independent power production, and non-utility power distribution. Similar driving forces had a major role in China's rural electrification development, but the influences came from within the government as a result of

pressure to electrify the country's vast rural areas and the existence of a high SHP potential.

From the beginning of 1990s the trail blazing countries undertook policy and regulatory reforms entrenching and further promoting RET-based and decentralized electrification. Important elements of planning, laws, and regulations were formulated and put into effect to actualize the emerging form of electrification. At the same time, tariff and non-tariff incentives were designed and used for facilitation of entry of new players into electrification development. The improvements in the enabling environment were attractive to the extent that they elicited considerable interest from financial institutions, industrial and institutional investors, and new public sector entrants. These players widely took up public-private partnership roles in electrification businesses, and as a result of their contributions rural electrification using locally available renewable energy sources picked up tremendously. Countries like China have an electrification level of nearly 100% (UNDP, 2008); and the attainment of this level can be attributed to the reforms that were made and the responses they received.

At another level, developing countries in sub-Saharan Africa have largely had very limited rural electrification based on SHP and RETs. Decentralized and individual power supplies from RET sources have also been sparsely built up, and have mainly consisted of *ad hoc* solar photovoltaic *(*PV) and wind systems. There has been strong dependence on grid based power for rural electrification, which has become more costly to provide as the deeper rural areas have been approached. Consequently, the level of access to electricity in most rural parts has remained at less than 5%.

Awareness of the need for systematic decentralization of rural electrification and use of RETs arose with the wave of energy sector reforms that took place from the beginning of 1990s. Some African countries, such as Uganda and Ethiopia, have been very dynamic in this respect, and these are also included in the eleven countries covered by the PACEAA Project. Other PACEAA countries in which similar efforts have been made comprise Kenya, Tanzania, Sudan, and Rwanda. Formulation of policies that brought in the required changes began as early as 1987. However, while a few countries like Ethiopia finalized the formulation process fairly quickly by the mid-1990s, others like Uganda did not complete the process until 2005.

To enable implementation of the policy reforms, laws were passed and new institutions were created. The two prominent types of institutions that were formed were regulatory and rural electrification (or energy) bodies. It was necessary to closely regulate the functions and activities of the increased number of players in the energy sectors and hence the introduction of new regulators. Equally important was the formation of bodies that would ensure accelerated growth of modern energy supply in rural areas, and hence the creation of bodies that would specifically handle rural energy or electrification matters. In sub-Saharan Africa generally and especially in the PACEAA countries the implementation measures are in progress or already completed.

This report examines the energy policies, the legal instruments and institutional setups for carrying out the policies, and the extent of implementation of the new enabling environments in the eleven PACEAA countries. Two other cases from West Africa are also included for the sake of comparison. However, detailed examination is done only for the four "Priority 1" countries, Tanzania, Kenya, Malawi, and Rwanda. These four countries are given greater attention as they have pilot hydro power sites and proposed rural electrification areas that are expected to form the basis for replication of rural electrification using power generated by agro-industries. Also included in the report are case studies of other developing countries that can provide useful lessons for the PACEAA project.

The report starts with a description of energy policy and related aspects for Tanzania, Kenya, Malawi, and Rwanda. This is followed by less detailed descriptions for the other seven PACEAA countries and two additional West African countries. For cases of relevance outside Africa and to provide an opportunity to learn from international experience, narratives of five other countries are presented. Finally, a needs assessment determines what the PACEAA countries need to do to make their policy environments conducive for rural electrification using power generated by agro-industries.

2 Review of policy, regulatory, and institutional frameworks: Priority 1 Countries

2.1 Kenya

2.1.1 Macro-economic and energy sector overview

Over the last ten years the economy in Kenya has experienced large fluctuations but it remains one of the largest in sub-Saharan Africa. Towards the end of the 1990s it experienced a large downturn to the extent of achieving a near zero growth in 2002. Thereafter, there was a steady rise up to 2007 as depicted in Fig. 2.1. This period of steady growth reflected the incoming of a reformist government which is largely in place up to the present. Importantly, the wavy nature of the economy was experienced late in 2007 when a political upheaval occurred. This was when a general election gave rise to ethnic fighting for a period of about two months. A quick intervention by the international community restored normalcy and the slight economic downturn was reversed as reflected by the country's balance of payment position shown in Fig. 2.2.

A major part of the national import bill goes towards purchase of petroleum as the country has no known oil resources. The country has however it's own oil refinery which processes crude not only for the country's use but also for export to land-locked neighbours that include Uganda, Rwanda, Burundi, and DR Congo. Imported refined products are also channelled through the Kenyan main port of Mombasa to these countries. Besides oil and its products, the only other fossil fuel resource that has been identified as a potential source of commercial energy is coal, traces of which have been discovered locally.

Other local sources of commercial energy are electrical power generated from hydro-electric stations, geothermal wells, and other renewable energy resources. Electricity generated from oil products is also used for supplementation of power from the local resources particularly during droughts. These electric power sources and their contributions to the total electricity capacity are indicated in Table 2.1.

For most rural people, who constitute about two-thirds of the national population (Nyoike, 2004), and many peri-urban dwellers the dominant source of energy is traditional biomass in the form of fuel wood and charcoal. The fuels are mainly used for cooking, and it is estimated that over 65% of the total national energy consumption is derived from this source. This fact is a cause for concern in view of the depletion of forests and consequent environmental degradation arising from cutting of trees for fuel wood and burning of charcoal (GoK, n.d.).

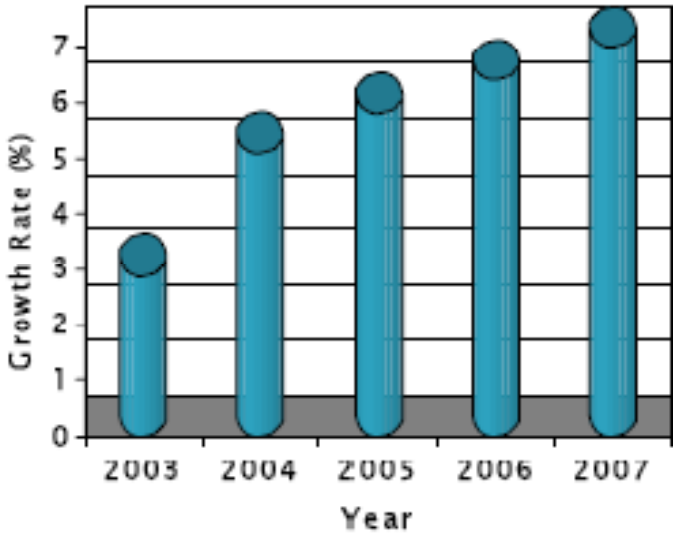

Fig 2.1: Kenya's economic growth (Source: GoK- MoPND, 2008)

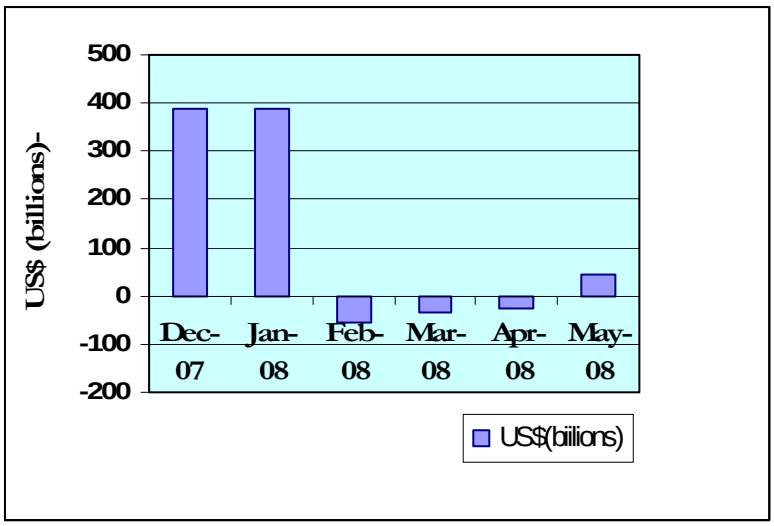

Fig 2.2: Kenya's balance of payments, Dec. 07 to May 08 (Source: GoK-MoF, 2008)

Table 2.1: Kenya's sources of electric power for national utilities and IPPs. (Source: KPLC, 2007)

	Thermal	Hydro	Geo-thermal	Wind	Biomass	Totals	(%)
KENGEN	134.6	657	115	0.4		907	(85.8)
KPLC	5.1					5.1	(0.48)
IPPs	130		13		2	145	(13.7)
Totals	269.7	657	128	0.4	2	1057.1	
(%)	(25.5)	(62.2)	(12.1)	(0.04)	(0.2)		

2.1.2 **Evolution of energy policy and legal framework**

Even as the economy has been going through a "seesaw" trend, the energy sector has been on a continuous change path in an effort to improve the sector's efficiency. Energy policy development was initiated in 1987 (AFREPREN/FWD & ENDA-TM, 2006), but momentum picked up in the power sub-sector when unbundling was done in 1997 to create separate national generation and T&D (Transmission and Distribution) utilities. In a study report (AfDB, 2007) it is further indicated that, as part of the unbundling, independent power producers along with KENGEN (the public power producer), were allowed to generate power for sale to the T&D utility (KPLC). Simultaneously, an Electricity Regulatory Board (ERB) was formed to regulate the newly constituted power industry. These changes were embodied in legislation by the Electricity Power Act, 1997.

Subsequently, a major policy change affecting the whole energy sector took place when the reform started in 1987, and culminated in the 2004 Energy Policy. The policy was tabled in parliament as Sessional Paper Number 4 of 2004. The paper led to the enactment of the Energy Act, 2006 giving legal force to the policy. The key features of the policy, which is being implemented up to now, include the conversion of the ERB into ERC (Energy Regulatory Commission) so that the body now regulates the whole energy sector. Rural electrification (RE) is given a new impetus by the policy through the formation of a rural electrification authority, to provide specific funding for RE, and promote development of RE by various actors including private sector developers. The policy also aims at accelerating the adoption of renewable energy as a means of improving energy security and access to modern energy (ibid).

2.1.3 **Regulatory provisions and tariffs**

The principal functions of the ERC are licensing of bodies and individuals interested in the provision of energy and energy services; tariff setting and approval; and protection of rights and privileges of energy providers, consumers, and all parties providing services for support of energy supply and utilization. Within the scope of these functions, the design and approval of power purchase agreements (PPAs) have taken a central position as the number of power producers and sellers is rapidly increasing. In this respect, the commission has had to create model PPAs for use by small operators who have limited financial means to obtain legal services for tailor-made PPAs.

As part of the ERC's mandate to ensure fair play and stimulate growth of certain aspects of the energy sector it has become critical to have the right tariffs planned and implemented.

2.1.4 **Rural electrification and renewable energy development**

According to discussions with officials of the Ministry of Energy and others within the energy sector (see UNEP Risoe, 2008), provision of electric power to rural areas, as a separate programme from the scheme of supply for urban and peri-urban locations, was started in 1973. The programme (REP) was originated and funded by the

government through its own finances and assistance from donors, but its implementer was KPLC. Up to this year, this arrangement has been in place, with power supply under the programme mostly provided from KPLC's large hydro-dominated national grid and diesel-powered isolated grids. The situation is now changing after the creation of the Rural Electrification Authority (REA), which takes over the mandate of running the programme. It is expected that under the REA the development of rural electrification will be enhanced, as the REA can give more attention to the REP than KPLC has done. As evident from Fig. 2.3, KPLC has been able to do much better in supplying urban and other non-rural areas.

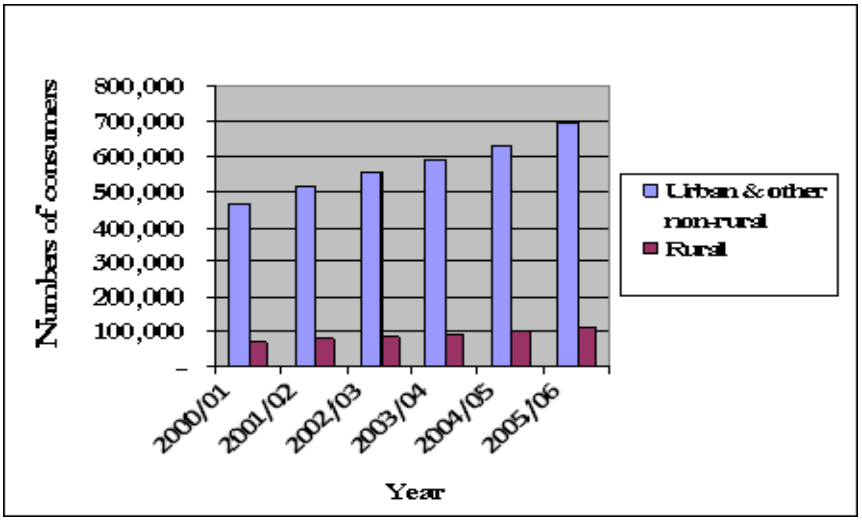

Fig 2.3: KPLC (public)electricity consumers
(Source: KPLC, 2007)

Separately from the REP, there has been a private form of rural electrification effort by entrepreneurs and individual groups. The most common type of electrification in this category is solar photovoltaic (PV) power supply that is aggressively marketed by solar power businesses. There has been little intervention from government in the industry apart from removal of import duty for solar panels. It is estimated that close to 200,000 PV power installations have so far been put up around the country (GoK, n.d.). Then there are a growing number of rural community groups that are undertaking projects to supply themselves with power from renewable energy sources, mainly small hydro. While NGOs and donor agencies have been supporting such groups financially and with technical assistance, there is significant contribution by the groups themselves. On the whole, the private form of rural electrification has been carried out with a bottom-up approach, and has manifested itself as the way forward for sustainably meeting the modern energy needs of rural people in the country. It provides useful lessons for initiatives like the PACEAA Project.

In the 2004 Energy Policy and the 2006 Energy Act, the importance of renewable energy other than from large hydro is recognized in respect of improving access to energy. This specific endorsement is key to the development of renewable energy resources, and to the provision of sustainable energy in rural areas.

2.1.5 **Key actors, roles, responsibilities, and regulatory status**

The main players in the Kenya energy sector with relevance to the PACEAA Project are indicated in Fig. 2.4. Referring also to the recent PACEAA fact finding mission (UNEP Risoe, 2008), it is observed that at the top of the hierarchy is the Ministry of Energy which has the role of policy making and oversight of the entire sector. Until the formation of the Rural Electrification Authority (REA) in 2007 the RE function was directly managed by the ministry, especially coordination of funding. Although REA has a direct link to the ministry it has assumed the funding and other key responsibilities of RE.

As explained above, the Energy Regulatory Commission (ERC) is a newly formed regulator for the energy sector, which unlike its predecessor (the ERB) has the electricity industry as just one of its main responsibilities. Under the ERC are KPLC, the main transmission and distribution utility, and KENGEN, the national and main power generating company. KPLC's role as a transmission company is however about to end since a new transmission company is in the process of being created.

Community level power generation and distribution is a new innovation in the country, and is especially relevant to the PACEAA Project. For the time being, a few rural communities that are far from a KPLC network, or are unable to afford extension of KPLC distribution to their areas, have .organized themselves to produce and distribute power within their localities. In the PACEAA Project it is envisaged that such communities can join hands with agro-industries to provide power for the communities as well as the industries. A wider scale of such projects is also contemplated along with support from commercial sources of financing

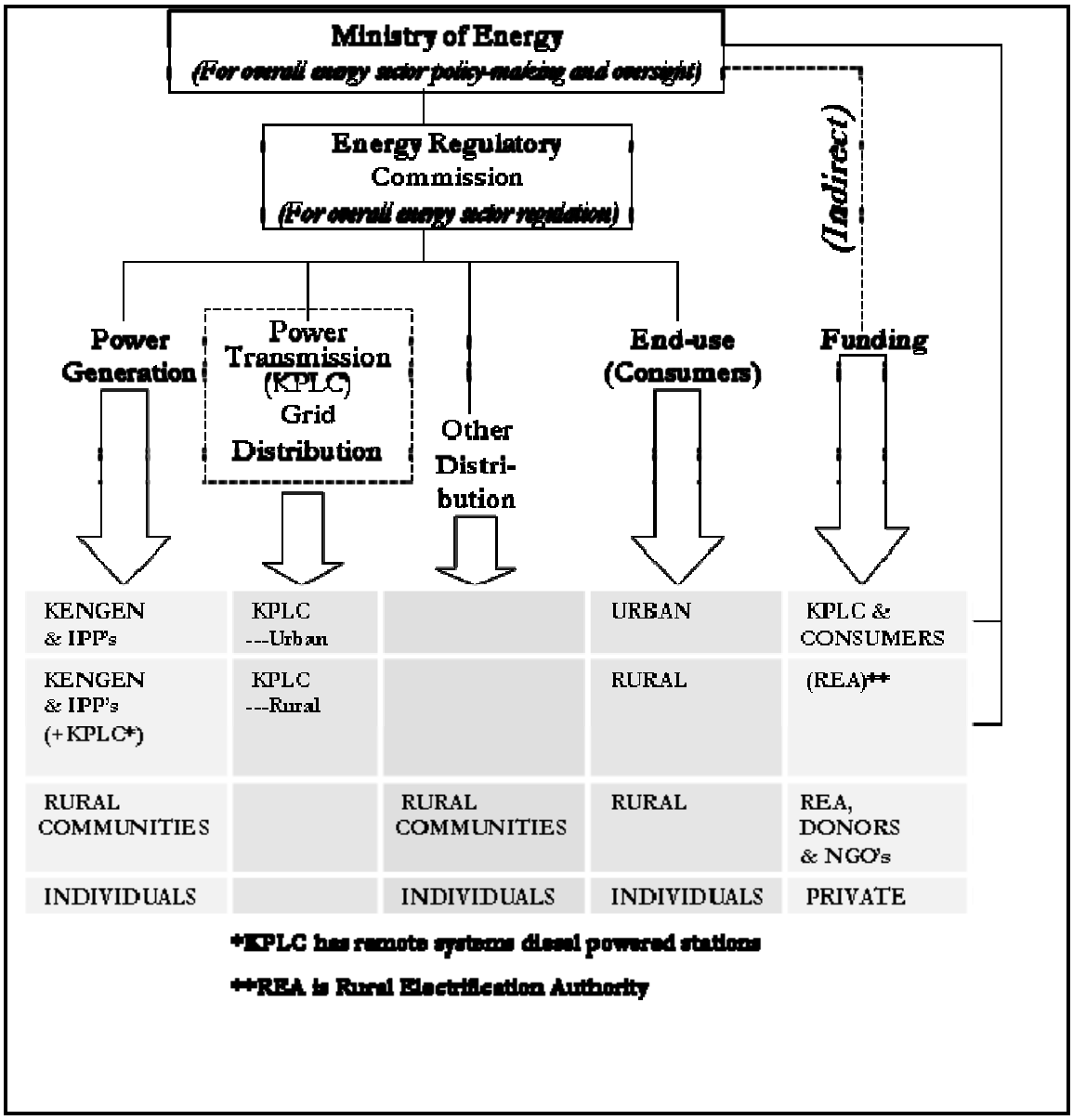

Fig. 2.4 Institutional setup in the Kenya energy sector

2.1.6 **Financing options and subsidy schemes**

In Kenya, as in most developing countries, it is generally recognized that costs of supplying potential rural consumers are too high for the consumers to afford. This is true for both capital and O&M costs; and is the reason why it is largely uneconomical to provide supplies under rural electrification. For the same reason commercial sources of financing are difficult to secure. Alternative sources of funding are therefore required to supplement what the consumers can afford plus any commercial finances that can be forthcoming. Government and donor funds are the normal alternative sources, and they come in the form of subsidies or grants, or combinations of these. As much as 100% of capital investment costs are financed through funding aid, but

generally O&M costs are charged through tariffs where very limited amounts of aid are given.

Information from the field (UNEP Risoe, 2008) indicates that the major part of donor funding assistance for rural electrification; consisting of multilateral, bilateral, and other forms of support; is channelled through the government. In turn, the government allocates the funds for the REP implementation after adding contributions from its own sources. The sources include a 5% levy charged on all existing KPLC consumers' electricity bills and KPLC's own contribution to rural electrification. The funding of all REP developments has been coordinated by the government. However, this function is expected to be taken over by the Rural Electrification Authority, and there is expectation that rural electrification outside the REP would benefit from its funding.

Non-utility projects, such as those considered by PACEAA which fall outside the scope of the REP could also be funded directly by bilateral donors e.g. AfDB and DFID; international technical and funding assistance programmes such as SGP of UNDP; and carbon finance facilities like the UNDP's MDG Carbon Facility and World Bank's BioCarbon Fund. Some NGOs can also assist in funding especially by leveraging donor support (ibid).

2.1.7 **Extent of framework implementation**

There is ample evidence of definitive steps being taken to implement reforms in the energy sector as noted in the first PACEAA mission (UNEP Risoe, 2008). The timely enactment of relevant laws and formation of necessary institutions is part of the manifestation, as is the encouragement of small scale power production, use of renewable energy sources, and rural communities' energy supply initiatives. A case in point is the recent introduction of tariffs for production of power by small IPPs based on renewable energy sources. The tariffs send a very clear signal of government intention to increase availability of power and promote sustainable sources of energy.

Recent surges in the prices of oil and the rapidly increasing demand for energy are some of the driving forces behind the push for reforms. Not only is energy for industrial and commercial development becoming a highly sought after product, but also energy requirements for socio-economic development are escalating. The latter requirements are rising in tandem with the expanding rural development growth. There is therefore cause for optimism with regard to maintaining the momentum of efforts to enhance energy development in the country using innovative and sustainable means.

2.2 Malawi

Information for Malawi given below is based on the findings of the PACEAA Mission to Malawi (Malawi Report, 2008) except where a different source is indicated.

2.2.1 **Macro-economic and energy sector overview**

Amongst the least developed countries Malawi stands out prominently with a low GDP income per capita of US$230 per annum, and a population of 23.6 million (World Bank, 2008; and Bekele, 2001). On the other hand, economic growth has recently been relatively high, with an average of 7.5% per annum since 2006. The economy is to a great extent reliant on agricultural production, and its population is mostly rural – 83% of the national population.

Local energy resources are limited and they include biomass, hydropower and coal. All petroleum requirements are met through importation; and the importation bill is quite high as most commercial energy needs are based on petroleum fuel.. Biomass energy provides for residential and other non-commercial uses. An analysis (SDNP (2008) shows that a whopping 93% of the national demand for energy is met by the biomass. The balance consisting largely of demand for commercial energy is met by petroleum (3.5%), electricity (2.5%), and coal plus miscellaneous sources (1%).

Over 95% of the national electric power capacity of 285 MW is contributed by hydropower, while the balance is provided by thermal power from petroleum sources. Due to underdevelopment of hydropower potential and power shortages, oil-fired electricity generation is generally employed by consumers utilizing standby diesel gensets. Additionally, inadequacy of power capacity in all parts of the power system from generation to distribution has kept the national access to electricity at a very low level of 7%. The situation is much worse in the rural areas where the level is about 1%.

2.2.2 **Evolution of energy policy and legal framework**

Compared to its northern neighbours that include Tanzania, Kenya, Uganda and Ethiopia, Malawi has not progressed much in areas of macro-economic and energy policy transformation. There is nevertheless a steady growth in the economy. The Malawian cabinet approved the Energy White paper in January 2003, defining the desired changes and intended reforms in the energy industry in Malawi including the drafting and finalisation of the Energy Regulation Bill, the Electricity Bill, the Rural Electrification Bill and other related bills. The proposal to establish the Malawi Energy Regulatory Authority (MERA) was also included in the White Paper. The energy policy currently in force was established in 2003, which gave rise to the following important legislations:

- The Energy Regulation Act, 2004
- The Electricity Act, 2004, and
- The Rural Electrification Act, 2004

These legislative instruments and the policy upon which they are based lay the foundations for non-conventional forms of electrification as conceptualized in the PACEAA Project. They also allow for independent power production and distribution. However, there are no specific stipulations for non-utility power generation and

distribution initiatives. Therefore, it would be necessary to obtain special dispensation to undertake such initiatives.

Implementation of the energy policy and legislation is in progress. However, unlike in the case of Kenya and Tanzania, Malawi has opted for a less aggressive pace of change, preferring to let the changes be dictated by the rate of growth of the energy sector. Thus institutional changes that have been carried out so far are small, particularly in the electricity subsector.

2.2.3 **Regulatory provisions and tariffs**

The establishment of MERA has taken sometime and formulation of regulations is in progress. Therefore, the working of energy subsectors is mostly as it was prior to the creation of the authority. For the power industry this implies regulatory powers are vested in both DoE and ESCOM. As an example, the applicable electricity tariffs nationally are as set by ESCOM. Any upcoming power supplier would have to use the tariffs until such time as individual applications for power tariffs can be determined by MERA. The good news for small power suppliers of less than 1 MW is that MERA has indicated its intention to apply light-handed regulations for such producers. The intention is expected to be a relief to RE suppliers envisioned in the PACEAA Project.

2.2.4 **Rural electrification and renewable energy development**

At present, RE efforts are chiefly in the domain of the DoE and are being made within the framework of MAREP (Malawi Rural Electrification Programme). The programme aims at achieving the widest coverage of RE using grid extensions. In some cases this means having long distribution lines without any drops to pick up potential consumers on the way. The rationale for this type of coverage is that the lines are being provided for future use by interested beneficiaries. However, as has been learned elsewhere pick-up of supply from such lines takes a long time, and improvement of the level of access to power is usually very slow.

Lines that are being constructed for RE mostly have terminal points at market centres and public facilities like schools and health institutions. At the centres or facilities transformers are installed to serve those who are in the vicinity. To get a connection from the transformer a potential consumer would be required to pay a connection charge just as would be the case for an urban consumer. However, this would not be much since there would be no transformer or high voltage (h.v.) line cost included. Those who are not lucky to get a transformer or h.v. line near them would have to pay for installation of these items if they need supply. It is for this reason that many rural people have remained without access to power as they cannot afford the latter costs. Furthermore, tariffs charged are the same whether power is supplied in an urban or a rural area.

Community-based RE has not started in Malawi, and only a few NGOs are contemplating initiating it on the basis of off-grid systems with renewable sources of energy. In this regard a few attempts have been made to start electrification by PV, but

the scale is very minimal. The PACEAA Project would therefore be a pioneering initiative augmenting the visions of the NGOs and others trying to promote renewables for rural power supplies.

2.2.5 **Key actors, roles, responsibilities, and regulatory status**

Overall, the energy sector is under the Ministry of Mines, Natural Resources, and Environmental Affairs; with the Department of Energy (DoE) being the executing arm of the ministry. On matters of regulation of the sector, responsibility lies with the Malawi Energy Regulatory Authority (MERA); while for electricity functions the mandate is mostly with the Electricity Supply Corporation of Malawi (ESCOM), which is the vertically integrated national power utility. The DoE took over RE aspects of the electricity industry from ESCOM and involves the power utility only in RE implementation aspects. This institutional arrangement is reflected diagrammatically in Fig. 2.10.

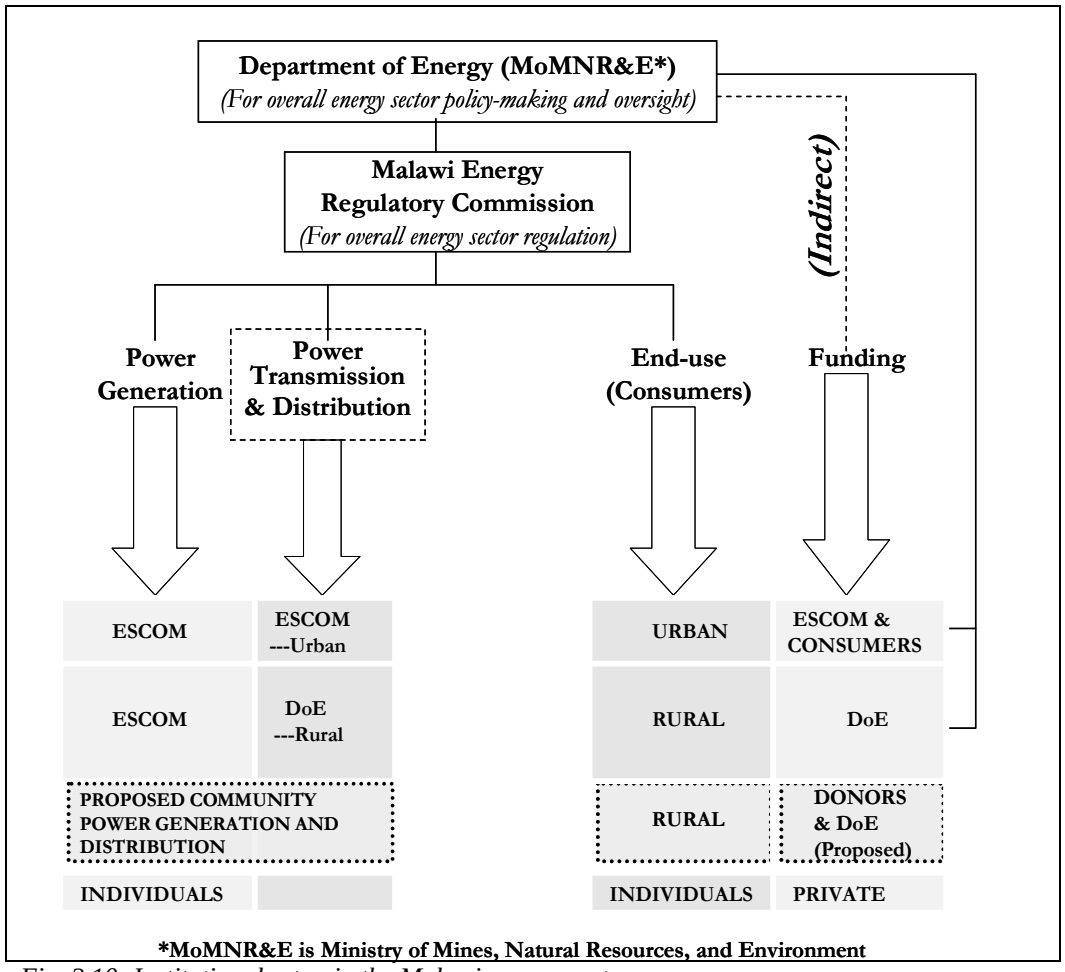

Fig. 2.10: Institutional setup in the Malawi energy sector

2.2.6 **Financing options and subsidy schemes**

The costs of RE under MAREP are unsubsidized currently except where a consumer is within reach of a transformer provided for a market centre or public facility. It would therefore not be expected that a supply under a rural community based scheme as envisaged by the PACEAA Project would receive any government subsidy. There is however likelihood of the regulatory authority (MERA) starting a subsidy arrangement for all RE schemes including community-based ones.

Other funding for community-based RE could possibly be obtained from UNDP (Small Grants Programme), and from the World Bank's Infrastructure Services Project for Malawi.

2.2.7 **Extent of frameworks implementation**

The policy and regulatory reforms that were started within the context of the 2003 Energy Policy are well underway, although the pace of implementation is slow. It is expected that with the full establishment of MERA substantive action on transformation of the energy sector would be taken. Innovative approaches to provision of rural electric power as proposed under the PACEAA Project would benefit immensely from full functionality of MERA.

2.3 Rwanda

2.3.1 **Macro-economic and energy sector overview**

The population in Rwanda is moving towards 8.5 million (2005) for only 26,338 sq km, which gives one of the highest population density in Africa. Return of refugees after the 1994 genocide has increased the pressure on the lands and local resources. 83% of the population now live in rural areas and most of them in extremely scattered dwellings making the supply of public services very difficult (water, electricity, roads, public institutions, etc.). Presently there are efforts by the Government to create centralized villages "umudugudu" so as to facilitate the access to essential services and maximize agricultural productivity of land. Despite economy improvement since the genocide, the average income level per inhabitant was US$220 in 2004, i.e. half of the African average (US$490) and many of the social indicators are still in the red. Agriculture remains the main employer and export earner (40% of the GDP). Coffee is the first export income (75%) followed by tea and pyrethrum. Other food crops are locally produced and consumed (IED, 2005). In recent years, the Rwandan economy has been growing at between 5.5% and 7% per annum, after a temporary slowdown in 2004.

A first Poverty Reduction Strategy Paper (PRSP) was adopted in mid-2002. Energy and water are among the 'priority sectors' under the World Bank's Poverty Reduction Support Credit (PRSC) programme. As described in this Document, there are three principal structural constraints in the economy: the country is landlocked, the quality of the roads network and transportation is low, and there is limited availability or

access to piped water and modem energy, which increases the cost of production for the manufacturing and service sectors (WB, 2004). This strategy paper has been updated recently with the new Economic Development and Poverty Reduction Strategy (EDPRS), which covers the period 2008-2012. Finally the long term goals are detailed in the 2015 Millennium Development Goals (MDGs), as well as the "Vision 2020".

Until recently, all the electricity supplies in Rwanda came from hydroelectric power; partly produced domestically by the national utility Electrogaz and partly imported from neighbouring countries.

As shown in the next table, a significant part of the national production comes from 4 hydropower plants (total available capacity: 26.74 MW_e) located in the North-West. However, since 2005, four diesel-based thermal power generators (total capacity: 26 MW_e) have been added to increase the national capacity.

The imported production is coming mainly from SINELAC – a jointly owned utility with Burundi, Rwanda and Congo managing Ruzizi II hydropower plant, but also in a lower extend from Ruzizi I - SNEL (RD Congo) and UEB (Uganda). Their cumulated operational capacity is now only 8.5-10.5 MW, due to a sharp decrease in water flows, partly as a consequence of overexploitation of surrounding marshlands.

Table 2.4 Data on power sector in Rwanda (2008)

Name	Type	Installed Capacity	Available Capacity		Production	
		MW	MWe		GWh	
			2005	2008	2005	2008
Mukungwa	Hydro	12	3.5	5-6	31.38	45.18
Ntaruka	Hydro	11.5	1.5	5	13.47	15.06
Gisenyi	Hydro	1	0.5	0.5-0.9	3.22	6.52
Gihira	Hydro	1.8	0.8	0.9	4.31	6.49
Total Hydro	Hydro	26.3	6.3	12.1	52.38	73.25
Total Import	Hydro	15.5	9	9.5	69.0	85.30
Total Diesel	Thermal	27.1	22.6	21	34.3	122.83
Total Solar	Solar	0.25	-	0.25	-	0.34
Total Methane	Methane	5	-	1	-	0.23
			37.9	42.6	155.68	279.80

Source: ELECTROGAZ

Today, the country is facing a real electricity crisis with on the one hand the increase of fuel cost (landlocked and mountainous country) and on the other hand the lack of investment during 15 years to adapt the power production capacity to the fast growing demand (8 to 12 %/year). Per capita, the consumption of electricity is among the lowest in the world, and low even by comparison to neighbouring countries, with

31.0kWh per capita per year (UNDP, 2008). Kigali alone accounts for about two thirds of the total number of customers and total demand of electricity and the electrification rate remains very low (6%), in particular in rural areas (< 1%).Rwanda faces electricity deficits of up to 40% due to reduced hydro power capacity. Growing electricity needs required to run the expanding industrial sector and general business environment are largely unmet (REEEP, 2007).

Moreover, severe shortages of river and lake water have affected the hydropower production during the last few years, further exacerbated by high transmission and distribution[1] losses and unreliability of Electrogaz's network. The result is an extremely overloaded network with extensive and lengthy power cuts beginning in early 2004. However, there are ongoing rehabilitation programmes for transmission and distribution lines, meters and hydro power plants.

Despite several attractive potential rivers for hydro development (Ruzizi, Nyabarango, Rukarara, Akanyau, Mukungwa, Rusumo) with an estimated potential of 214 MW, major investments in hydropower seem to be presently neglected[2] due to the perspective of generating power from natural gas stored in the Kivu lake (700 MW estimated capacity). Indeed, enormous amount of methane (22 billion m3) are expected to be economically extractable from the lake. A 5MW pilot plant has been recently commissioned and two larger projects are planned (totalling 250 MW).

In the mean time, Electrogaz tries to cover the increasing needs by implementing thermal power on an emergency basis. Electrogaz is currently buying thermal power from a local IPP running diesel gensets since Oct. 2005. An additional 20 MW Heavy Fuel Oil Thermal Power plant at Jabana is to be finalized in December 2008.

The national grid network is illustrated in the following map. The total length of the HV lines (70 and 110 kV) in the country is 394 km. About twenty substations are spread in the countries to distribute the power in 15 or 30 kV to the main cities. This MV network covers 1418 km of lines, whereas the LV lines (380/220 V) reaches over 2000 km.

[1] Technical and non-technical distribution losses are estimated to be around 18%

[2] It should be noted, however, that a feasibility study has been recently launched for an additional regional power plant on Ruzizi river (82MW).

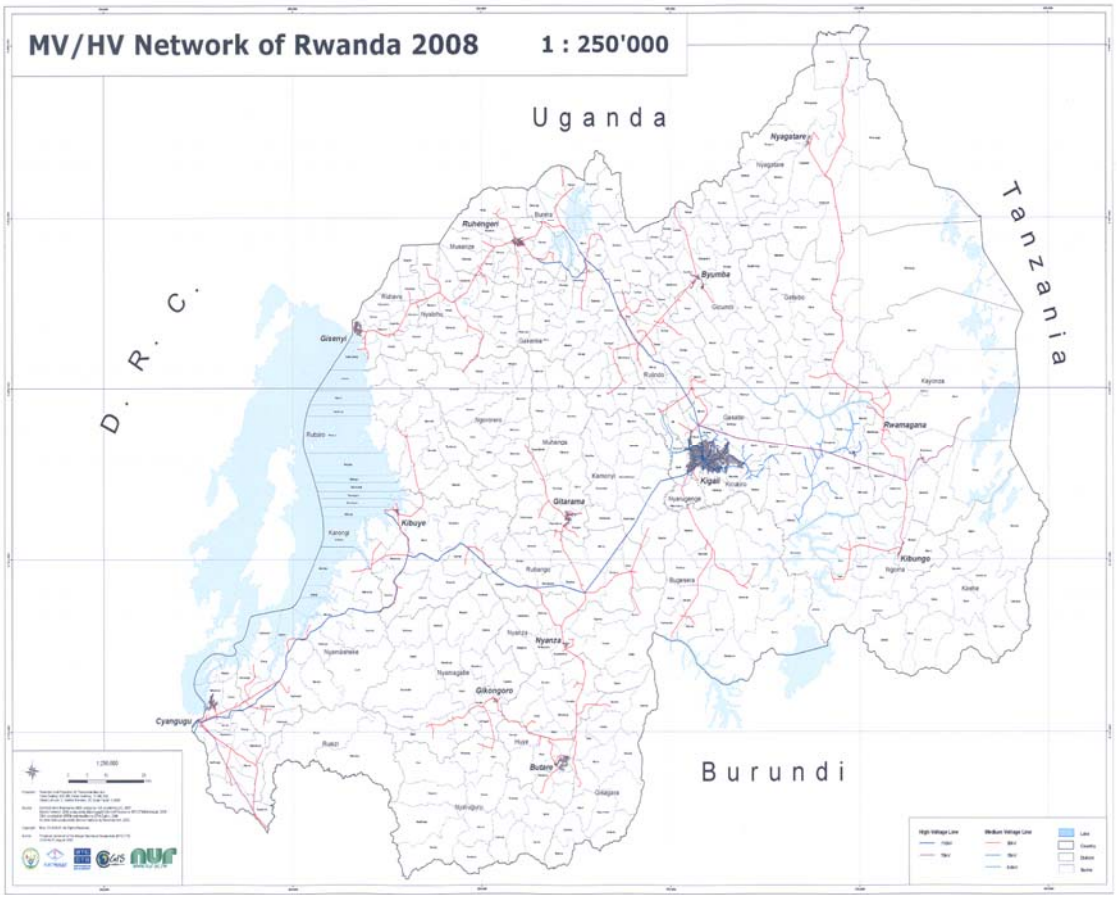

Figure 2.8: Electrical network in Rwanda (source: Electrogaz)

2.3.2 **Evolution of energy policy and legal framework**

There is a national energy policy formulated in 2004 that promotes the use of affordable and sustainable energy especially in the rural areas. There is an energy development programme instituted by the Rwanda government and partly funded by the Austrian government. The programme calls for the implementation of sustainable energy options.

The Government of Rwanda is in the process of reforming the power sector since 2000, and has already achieved the following tasks :

- Remove the monopoly of Electrogaz on electricity Generation, Transmission and Distribution (law no. 18/99 of 30 August 1999)
- Set up a management contract between a private entity (Lahmeyer International) and Electrogaz in an attempt to improve managerial and operational performance. The contract has been ended in 2005.
- Promote private sector involvement and introduce IPPs in the energy mix
- Create a multisector utility regulation agency, the Rwanda Utility Regulatory Agency, RURA (law no. 39/2001 of 13 September 2001)

The Government of Rwanda is also undertaking several actions in the power sector such as updating the master plan for the electricity sector, and promoting the development of hydro and electricity network (Vision 2020[3] and National Energy Policy and Strategy 2008-2012).

Finally, a Gas and Electricity Act is being drafted. The main objectives of the Electricity part are:

- To accelerate development and expansion of the electricity grid and rural electrification projects;
- To attract private investment into the electricity sector;
- To ensure a fair and competitive electricity marketplace, where consumer rights are protected; and
- To create the framework for transition to commercialisation of the National Power Utility in order to ensure that the company will operate as efficiently as possible, leaving open the question of whether all or a portion of the company should remain in State ownership.

This act should be gazetted around March 2009.

2.3.3 **Regulatory provisions and tariffs**

Policies and practices of PPAs between utilities and IPPs in the power sector

The law 39/2001, as well as the vision 2020, is promoting private and public participants in the power sector.

Since 2005, an IPP (Aggreko/Dalbit) has been licensed, as mentioned before, to run a thermal power genset and to sell power injected into the grid. Another IPP, LUDAN, has started generating power from a methane gas pilot plant (Kivu lake).

There is no specific law regarding the power purchase tariff yet but case-by-case power purchase agreement (PPA) is negotiated between IPPs and Electrogaz. Current buying tariff is set at about 185 RWF/kWh (US$0.335 per kWh) for diesel IPPs, while tariffs for hydro remain around 60-70 RWF/kWh.

Currently, there is no example of power wheeling agreements[4] in the country, but this scheme will be included in the upcoming Electricity Act.

Licences and authorisations for independent hydropower development and distribution

RURA is the main agency delivering licenses for IPPs for generation and distribution. Compensation mechanism exists for private properties crossed by power lines.

[3] Vision 2020: national policy document targeting an increase from 6% to 35% of the population to have access to electricity and a decrease of wood consumption from 98% to 50% by 2020.

[4] Power wheeling contracts allow an IPP to sell directly its power to an individual customer, while using the national grid network to transmit electricity. Power wheeling contracts include a wheeling fee, taking into account network costs as well as other factors (e.g. reliability of supply from the grid and the IPP). Such a contract will most probably be suggested by the GTIEA project for the Giciye hydro power plant.

Rwanda Environment Management Authority (REMA) is dealing with both water and land. It delivers licenses and rights for water usage (under Government decree) and controls environmental and social impacts. An ESMF (Environment and Social Management Framework) has been set up by the Government (Safeguard policy) to assess those impacts.

Table 1.5 Regulations on PPAs

Regulations	Requirements	Responsible authority
Licensing (generation)	For different capacity ranges	
	Required for captive use or only for sales to utility	RURA
	Fees	RURA
	Valid time period	
Licensing (distribution)	Allowed to distribute directly or must sell to utility	RURA
	Fees	GoR
	Subsidies available	GoR
	Valid time period	GoR
PPA	Standard offer or negotiation by project	GoR
Taxes and Levies	Customs on imported equipment	Customs services
	Taxes on construction contracts, income taxes	GoR
	Royalty fees for use of site	GoR
Environmental Regulations	EIA (water rights, public hearing)	REMA
	Ecological flow to be left in river after water diversion	REMA

Model documents for licenses are being drafted by RURA (RURA, 2007).

Customs, taxes, levies and royalties for hydropower development

The Law 14/98 is offering assistance and incentives for foreign investors in all sectors: exemption from import duties and sales tax, fiscal incentives, investment allowances, work permits, etc. The law has been revised in 2004 but no indication was obtained on the new content and the incentives for national investors.

A new "Eco-tax Regime" is being imposed to all users of water other than domestic and agricultural and as such, applies to SHP projects.

Tariffs

Until recently, a flat tariff was charged to all customers, irrespective of type of activity, supply voltage, consumption volumes. However, since 2007 tariffs are different for industrial customers, as shown in the following graph and table:

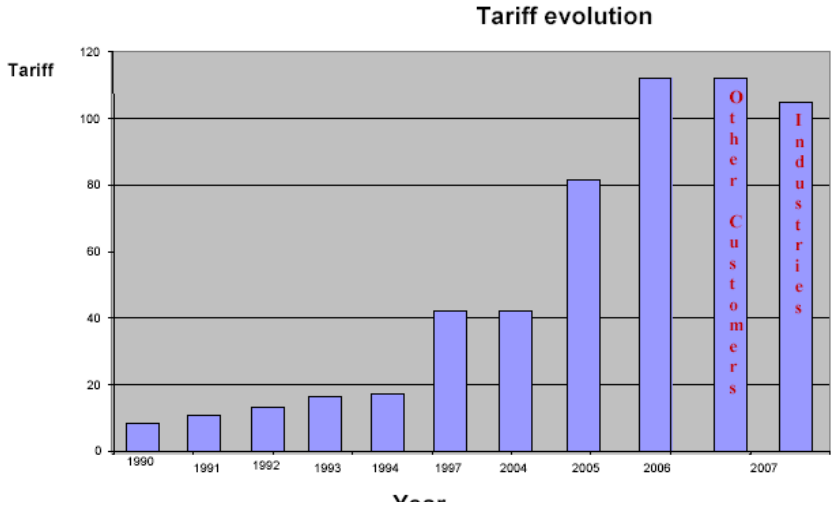

Figure 2.9: Electrogaz tariff evolution (in RwF, exclusive of VAT)
Source: RURA (2007)

Table 2.6 Electrogaz tariff evolution (in RwF, exclusive of VAT)

	1990	1991	1992	1993	1994	1997	2004	2005	2006	2007	
Rwf/kWh	8.5	10.8	13.0	16.5	17.0	42.0	42.0	81.26	112	112	105

Source: RURA (2007)

The financial imbalance between import prices (Sinelac, SNEL) and actual revenue collection rate and the increasing part of the costly diesel-based electricity production compared to the hydro-based power has led Electrogaz to increase drastically their electricity tariff since 2005, to reach 112 RwF/kWh (20 USc/kWh) and 105 RwF/kWh (19 USc/kWh) for industrial customers. However, this tariff is expected to again decrease substantially at around 80 RWF/kWh, as a consequence of methane exploitation and hydro projects, which would render current expensive diesel IPPs no longer necessary.

2.3.4 **Rural electrification and renewable energy development**

In its "Vision 2020" document, the government mentions the development of microhydro, solar and methane-based solutions to reach its objective of increasing electricity access from 6% to 35% of the population in the horizon 2020. The EDPRS targets an increase in access to electricity for enterprises and households from 92,000 in 2008 to 350,000 in 2012, including giving access to 100% of health and administrative centres and at least 50% of schools

Such high objectives are to be met with the help of all development actors and proper coordination. The Ministry of Infrastructure has thus signed in mid 2008 a Memorandum of Understanding (MOU) establishing a Sector-Wide Approach (SWAp), addressing in particular previous issues in bilateral and international donor programmes harmonisation.

There are indeed several financial institutions having recently re-engaged in the power sector in Rwanda, in particular through the following projects:

- As part of its Energy Facility, the European Union has signed in January 2008 for a 50% funding of a 20M€ 3-year programme aimed at energy access in rural areas: electrification of 25% of rural community institutions (schools, public buildings) and 3MW of micro-hydro projects supplying 70 villages through public-private-partnerships. The Belgian BTC is expected to implement this program, and modalities are being discussed.

- The "Urgent Electricity Rehabilitation" project (WB/IDA) aims to improve adequacy, efficiency and quality of power supply from Electrogaz network. It will implement in 2 phases between 2005 and 2010 investment in thermal generation, rehabilitation and expansion of transmission network, and rehabilitation of 2 MW small hydro units. The project also features technical assistance and capacity building.

- German decentralised cooperation has recently funded a 250kW solar power plant in Kigali and a total of 1MW is targeted.

- UNIDO has financed feasibility studies for several off-grid micro-hydro sites and is financing now the implementation of 3 micro-hydro electrical plants. The work is sub-contracted to a Sri Lanka company.

- The Government of Belgium (CTB) is financing identification studies, execution studies and execution works for 7 micro-hydro sites. 3 sites will be rehabilitated and 4 are new sites.

- The Government of Netherlands has initiated a "Micro Hydro Rural Electrification Project". During the first phase of the project, the Dutch government would provide a 50% grant on private micro hydro projects, channelled through the German GTZ as implementing agency. 4 projects are being developed in this first phase. 5 other projects are developed for the second phase of the program, featuring a soft loan instead of a direct grant, in collaboration with GroFin.

- The Dutch embassy also provides 50% grants (up to 1.5 M$) to innovative private initiatives, as part of its Private Sector Investment Program. However, the project requires to be co-financed by a foreign company.

- The Tunisian company STEG International Services has set up a pilot rural electrification project targeting 4000 households in Nyagatare, 160km north-east of Kigali, with lower distribution standards (single phase), bringing the average cost of MV lines from around 70,000 USD/km to 25,000 USD/km.

- The Arab Bank for Economic Development in Africa (BADEA) is planning to finance the rehabilitation of 3 hydro stations (US$10 million).

- The Rwandan “Institut de Recherches Scientifiques et Technologiques” (IRST) has launched several projects on biomass-based energy, including cogeneration from rice husk and biofuels (jatropha).

The Ministry of Infrastructure (MININFRA) has put in place an energy development plan which covers hydropower, energy saving and geothermal energy. MININFRA is also involved in planning of alternative energy supplies including the use of renewable energy technologies.

To ensure consistency of the rural electrification strategy, a least-cost Master Plan has been drafted for a “Roll-out Programme” to the year 2012. Estimated budget is around 215 million USD (116 billion RWF). Appropriate grid and off-grid technologies will be selected, with a focus on least cost electrification standards, inspired from the ongoing pilot project from STEG (cf. above). Distribution costs are a critical issue in Rwanda, with MV and LV lines costing up to 70-80,000 USD/km, caused by lack of competition, small market, landlocked country and other factors. The scale of the “Roll-out Programme” is expected to solve at least the first two issues.

2.3.5 **Key actors, roles, responsibilities, and regulatory status**

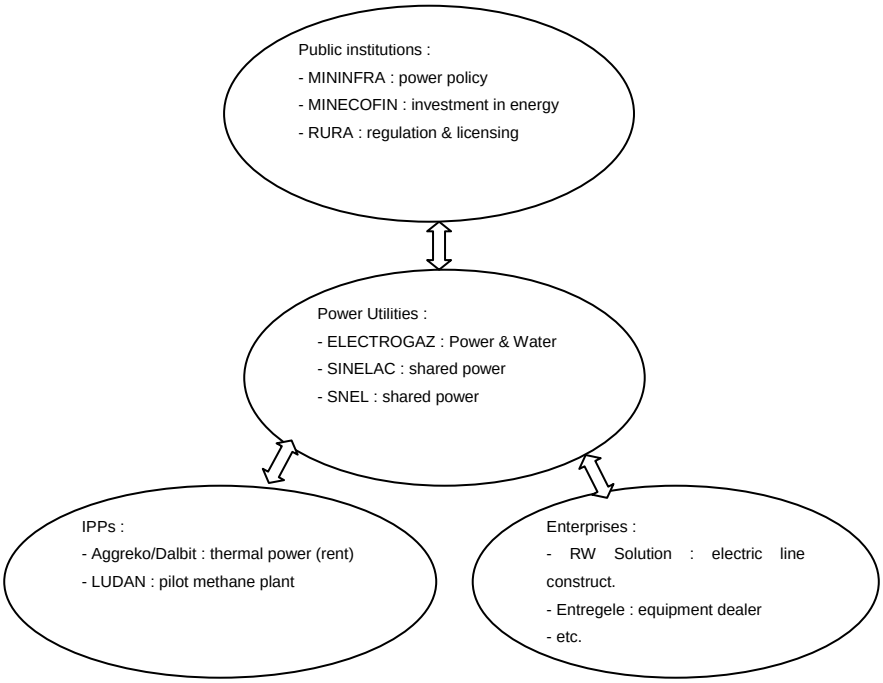

Figure 2.10: current organization of the power sector

MININFRA

The Ministry of Infrastructure host the Department of Energy and the Electricity sub-sector. MININFRA exerts regulatory powers over power and water sectors. It is in charge of the national power policy and deals with the national utility Electrogaz through its 3 different departments: production, transport, distribution. The Government strategy is to address first the power shortage and in the medium term to establish adequate policies, institutional frameworks and incentives to develop efficiently the energy sector with indigenous resources.

MINECOFIN

The Ministry of Finance is in charge of major investments in the electricity sub-sector through its CEPEX implementation agency if financing sources come from international donors and financial institutions (loan/donation). Electrogaz may also invest directly or through the MININFRA (bilateral aid).

ELECTROGAZ

ELECTROGAZ is the sole vertically integrated utility supplying electricity and water in Rwanda. It was created by Décret-Loi NO.18/76 of April 20th 1976. Until August

1999, Electrogaz enjoyed monopoly status with regard to generation, transmission and to distribution of water and electricity. The monopoly status had been granted for a period 99 years, but this disposition was abrogated by Law NO.18/99 of 30th /08/1999; paving way for private sector involvement in the energy sector.

ELECTROGAZ is also responsible for the imported power and shared power from SNEL and SINELAC.

RURA

Legal and regulatory framework in Rwanda is a relatively new concern. The Rwanda Utility Regulatory Agency (RURA) was established by Law NO.39/2001 to regulate enterprises in the Energy sectors and Water sectors (art.1 and art.5, point 20) and to ensure compliance with Government policy objectives. RURA is also the licensing authority in the electricity sub-sector. New sectoral laws and decrees will give effect to Law NO.39/2001 but they have not been passed at Parliament level.

RURA is responsible for promoting effective competition, advising government during formulation of energy policy, protecting consumers, educating stakeholders, approving contractual undertakings with regard to distribution and transmission of electricity and gas and assessing the tariff structure.

NTB

National Tender Board is involved in signing the implementation contracts.

Private Sector

Few private enterprises are involved in the electrical work as described previously. Electrogaz staff executes most of the implementation.

2.3.6 **Financing options and subsidy schemes**

As mentioned above, various financial institutions are contributing to the power sector: World Bank, EU-EF, ONUDI, GTZ, African Development Bank (AfDB), Nordic Development Fund (NDF), Swedish International Development Agency (SIDA).

Several donors have indicated a potential interest in energy sector engagement but have indicated that the lack of a policy-based strategic structure has inhibited significant support up to now.

The upcoming Gas and Electricity Act aims to expand the current Telecommunications Law Universal Access Fund to cover electrification needs, as well as streamlined license procedures for rural electrification projects, and waivers of license requirements for certain national energy agency funded projects.

The Universal Access Fund can be financed by multiple funding sources, including international donor funds and assessments on current electricity users. It may be used for multiple sector projects, such as electrification, telecommunications and internet access for high value educational or commercial clusters.

Main commercial loans are obtained from the Banque Rwandaise de Développement (BRD).

2.3.7 **Extent of framework implementation**

Sector reforms have accelerated, though much remains to be done: The Government began sector reforms under the Energy Sector Rehabilitation and Urban Waste Management Project, which have been continued under the ongoing Competitiveness and Enterprise Development Project (CEDP). A significant milestone in the reform process was achieved when the Electrogaz management contract with Lahmeyer International (LI) became effective in October, 2003 but the contract ended prematurely in 2005.

Electricity and Gas laws as well as utility regulation still have to be prepared, as well as secondary legislation to enable RURA to approve Electrogaz' submissions and issue licenses for new electricity and gas businesses.

Despite official liberalisation of the power sector (both generation and distribution), there are only few IPPs operating currently. Given that the National Power Utility will probably continue operations as a state-owned vertically integrated, legacy provider, it is not likely that market opening will proceed beyond an early stage wholesale market, with large consumers purchasing from independent power producers, in those areas served by the National Power Utility.

2.4 Tanzania

2.4.1 **Macro-economic and energy sector overview**

Tanzania, with a population of 39,500,000 (World Bank, 2006), has been one of the African countries that have experienced significant economic growth over the last decade. Between 1993 and 2006 growth rates rose from 0.4% to 6.7% per annum as indicated in Fig 2.5. The substantial rise has been in spite of the country remaining one of the poorest, with Income per Capita of US$350 in 2006 (World Bank, 2006). It has been possible to achieve increased prosperity on account of a stable political leadership and commitment to sound macro-economic and fiscal policies. Poverty reduction has also been given a high priority, as spelled out in the country's Poverty Reduction Strategy, referred to as MKUKUTA in Swahili (World Bank, 2006). Economic performance from a poverty reduction perspective is further indicated by improvements in employment levels on Table 2.2.

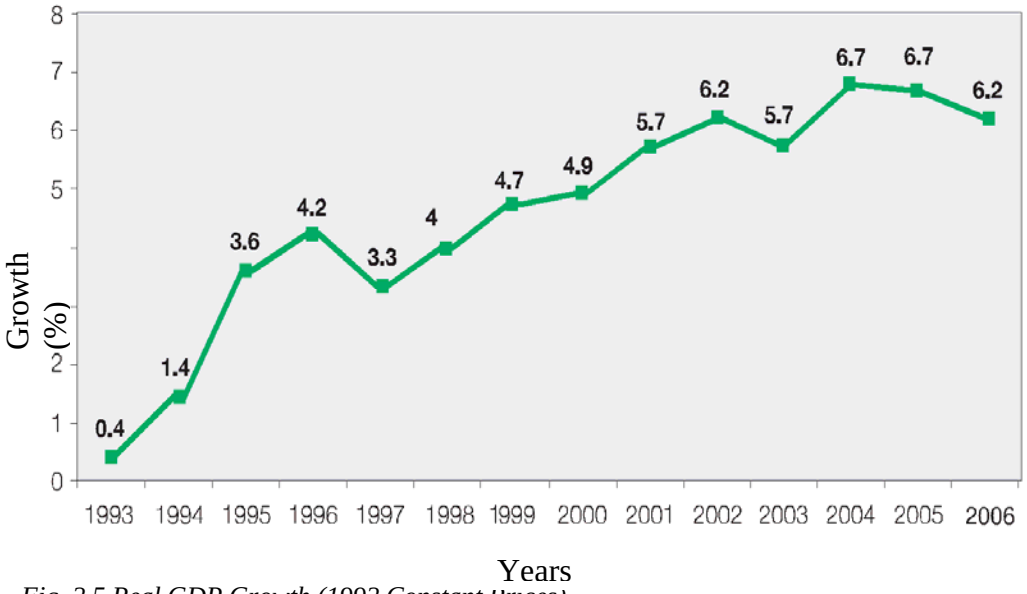

Fig. 2.5 Real GDP Growth (1992 Constant Prices)
(Source: MoPE&E, 2007)

Table 2.2: Employment by Sector (Source: MoPE&E, 2007)

Sector	2000/01 %	2005/06 %
Central/Local Government	2.2	2.4
Parastatal Organisations	0.5	0.4
Informal Sector	5.7	9.3
Other Private*	4.4	8.0
Agriculture	84.2	76.5
Housework Duties	3.1	3.5

For support of the country's growth, supply of energy has been a key pursuit. By various accounts, e.g. GoT (2008) and Mbendi (2008), the country has limited energy resources and relies to a great extent on imported oil for commercial energy supply. That scarcity of commercial energy is a bottleneck to industrial and general advancement is amply evident, as proved by hindrances arising from recent power shortages. More than 90% of non-commercial energy comes from traditional biomass resources, and this is the main source of energy for rural areas where more than 70% live. However, there is a high potential for hydro-power, natural gas and coal energy. Recently, efforts have centred on exploitation of the natural gas along the coast line.

Renewable energy sources apart from large hydro are also being promoted, as a means of supplying power to rural areas lying far from the national grid.

2.4.2 **Evolution of energy policy and legal framework**

A notable milestone in the policy making process of the Tanzania energy sector was the 1992 energy policy formulation, that led to the 2003 policy currently in force. Since then many energy policy and regulatory framework developments have taken place as indicated in various studies (e.g.UNECA & UNEP (2007), SEI (2006), and AFREPREN/FWD & ENDA-TM (2006). Key pillars of the policy include:

- Pursuit of cost-effective energy solutions optimizing on local resources
- Enhancement of energy stability and security
- Promotion of commercial practices and private sector involvement
- Curtailment of unsustainable use of forest resources
- Application of alternative and modern energy technologies particularly for rural energy development
- Improvement of the accessibility and affordability of energy to the rural population

The legal force of the reforms entailing electric power is expected to take effect through the new Electricity Act, 2008, which is replacing the Electricity Ordinance of 1931. The act paves the way for further reforms that are expected to break up the monopoly of TANESCO, the vertically integrated national power utility. Other laws that have been enacted in the wake of the 2003 energy policy, and which have a bearing on the supply and use of electricity, are the EWURA Act of 2001, and the Rural Energy Act of 2005.

2.4.3 **Regulatory provisions and tariffs**

As transformation of the energy sector has progressed, the increased complexity of functions and actors in the sector has made it necessary to have a well coordinated regulatory system. For example, the fairly rapid expansion of the body of independent power producers selling power to the national grid has necessitated a greater number and sophistication of power purchase agreements. Tariff issues have also increased as the sale of power has been taken up by not only power producers but also independent distributors. The regulatory system that was created by the EWURA Act, 2001 has therefore had to rise up to the challenge of licensing the entities emerging in the energy sector, and also protect the interests of all the suppliers and consumers alike.

An important regulatory aspect relating to the PACEAA Project is the design of power purchase agreements for small IPPs and rural communities wishing to be involved in electrification businesses. Since the producers and communities do not have sufficient capacity to make individual agreements it is prudent to make standard agreements for them. This sort of assistance is precisely what EWURA is providing. At the same time, EWURA is facilitating tariffs that would enable the communities afford and get access to electric power, and for IPPs to undertake viable electricity businesses.

It is worth noting that the regulatory system has taken time to form and as such many of its functionalities have not started in earnest. A talk with EWURA representatives indicated that efforts are being made to get the system running in full within a few months (UNEP Risoe, 2008).

2.4.4 **Rural electrification and renewable energy development**

Like in other sub-Saharan Africa countries availability of electricity in rural areas is very low despite the fact that close to 75% of the countries' populations live in the areas. Rural locations of Tanzania have an electrification level of around 2%, while the national overall level is about 11% (Mwihava, 2009). Need has therefore been identified for giving a higher priority to rural electrification than has hitherto been the case. The *Rural Energy Act, 2005* was designed to *inter alia* support faster growth of the level of rural electrification, and for this purpose it provides for creation of a *Rural Electrification Agency* responsible for a *Rural Electrification Fund*. Both the agency and fund were set up and have been running for about a year. Rural electricity producers and distributors can apply to the fund for grants towards capital costs of developing rural electrification systems. This being the case, the fund would be a very useful source of funding for initiatives like those envisaged by the *PACEAA Project*.

The bulk of the very limited supply of power that has been made available to rural areas of Tanzania so far has been obtained through extensions of the national grid. However, the cost of the extensions has been increasingly prohibitive as attempts have been made to reach the more remote locations. Decentralization has therefore been seen as the main solution for further rural electrification. Community and other locally based electrification ventures are therefore being encouraged. Although the energy policy and laws are not specific on use of renewable energy sources there is a clear reference to intentions to institute measures for increased use of indigenous resources. Given that in rural areas the most abundant energy resources are renewable ones it is clear that decentralized supplies for rural areas would have to be from renewables.

2.4.5 **Key actors, roles, responsibilities, and regulatory status**

The setup of relevant institutions in the Tanzanian energy sector is similar to the one in Kenya as depicted in Fig. 2.7. Some of the differences include the fact that the regulator, EWURA, is a multi-sector institution having not only energy but also water in its scope. TANESCO is, unlike KPLC, very partially unbundled and only a limited amount of generation business is in the hands of IPPs. Although there are plans to reduce its monopolistic status, the utility remains largely vertically integrated with IPPs selling power to it. Another small difference in comparison with the Kenya energy sector is the fact that the Rural Energy Agency encompasses all forms of energy and not electricity alone.

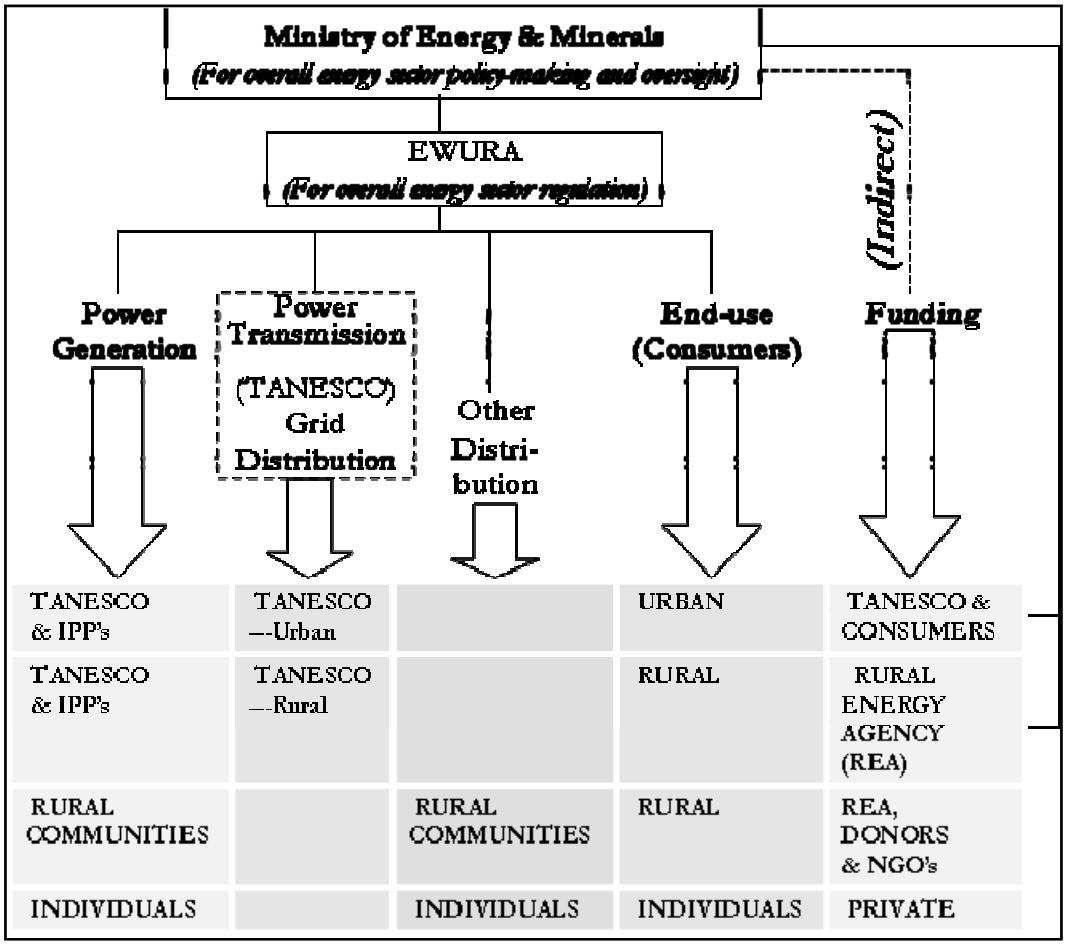

Fig. 2.7: Institutional setup in the Tanzania energy sector

2.4.6 **Financing options and subsidy schemes**

In Tanzania, the sources of funding for rural electrification include national budgetary allocations for rural development, levies on the costs of energy products like petroleum fuels, and interest charges on government accounts (Uisso *et al*, 2005). Prior to the setting up of the Rural Electrification Agency (REA) the government directly disbursed the funds for implementation of electrification projects by TANESCO. However, the REA took over this function on behalf of government, and is free to provide financing and technical assistance not only to TANESCO but also to any rural electrification developer. This has important implications for potential non-utility power developers like rural communities and independent power suppliers, and is likely to provide a source of funding for agro-industries and other potential developers in the scope of the PACEAA project.

Other potential funding sources for PACEAA-type rural electrification initiatives are bilateral donors, e.g. SIDA and NORAD; international technical and funding assistance programs like the SGP of UNDP; and carbon finance facilities, e.g. UNDP's MDG Carbon Facility and World Bank's BioCarbon Fund. Some NGOs can also assist in funding especially by leveraging donor support (UNEP Risoe, 2008).

2.4.7 **Extent of frameworks implementation**

It is manifestly clear that there is a dedication towards implementation of recent energy policy reforms in Tanzania, particularly the aspirations of the 2003 policy. With regard to electric power, the timely enactment of laws like the Rural Energy Act 2005 which promote rural electrification, and the fairly rapid setting up of electricity related functions of REA and EWURA, are steps that augur well for the energy sector. Further key changes are expected to take place when the implementation of the Electricity Act 2008 starts, possibly by the end of this year. Introduction of competition for electricity business that has been solely carried out by TANESCO is bound to improve efficiency in the whole power industry. Provision of affordable power and other improvements are expected to considerably raise the level of electrification and quality of electricity services in the country.

3 Review of policy, regulatory, and institutional frameworks: Priority 2 Countries

3.1 Burundi

3.1.1 **Country economy and energy sector brief**

The Republic of Burundi is a small country land-locked in central Africa on the eastern shore of Lake Tanganyika, bordering with Rwanda, Tanzania and DRC. The economy is almost entirely agricultural, with most engaged in subsistence farming, growing corn, sorghum, sweet potatoes, bananas, and manioc. Coffee, Burundi's chief export, accounts for 80% of its foreign exchange income. Cotton, tea, sugar, and hides are also exported.

Its poor transportation system and its distance from the sea have tended to limit economic growth. Burundi is a resource-poor country with an underdeveloped manufacturing sector. The industrial sector is still in an embryonic stage. Food, medicine, and electricity remain in short supply. Despite economy improvement since the 1993 crisis, the average income level per inhabitant is extremely low and the human development index (HDI) is one of the worst, in 2007, Burundi ranked 167 over 177 countries making it one of the poorest countries in the world.

The population in Burundi is about 7.5 million (2007) for only 27,834 sq km, which gives one of the highest population density in Africa (257 inhab./km²) and leads to high pressure on the lands and local resources. The majority of the population is still living in rural areas (90% in 2002) and most of them in extremely scattered dwellings making the supply of public services very difficult (water, electricity, roads, public institutions, etc.).

The global energy balance in Burundi is largely dominated by the firewood 96% compared to oil products 1.65% and electricity 2.2%. Access to electricity concerns only 1.8% of the population (25 000 customers) and 95% of the electricity is consumed in the capital Bujumbura. Bujumbura and Gitega are the only two cities in Burundi that have municipal electricity service. The national average electricity consumption per capita is only 20 kWh per year.

Burundi relies on hydro power for 95% of its power production, with 24 national and regional micro hydropower plants (MHP) and 2 foreign SHPPs on the border. Nine of the MHP belong to REGIDESO (public utility), 5 to Direction Générale de l'Hydraulique et des Energies Rurales (DGHER), 1 to OTB and other to private and religious organisations. The largest hydropower station has a nominal power of 18 MW. Until recently, only four SHPP were connected to the national grid but today most of the SHPPs are interconnected. The total installed MHP power capacity amounts to 32 MW (representing only 10% of the hydropower potential in the country) and producing about 104 GWh (2003).

Besides hydropower, REGIDESO operates also one diesel-based power plant of 5.5 MW near Bujumbura since 1996, only when hydropower is faulty. Other alternative electricity sources (biomass, solar, wind) remain extremely marginal.

The country's electrical power sector is traditionally state owned. Structural adjustment and privatisation for the power sector was initially commenced in 1989, but civil and political conflict has curtailed the process. Electricity generation and supply in Burundi is managed and administered by two primary organisations. The first organisation, Régie de Production et de Distribution d'Eau et d'Électricité (Regideso), operates and controls all of Burundi's thermal power stations, and is also responsible for power distribution in urban areas, the majority of which are located in the country's capital Bujumbura and the surrounding areas, and a small amount of hydro capacity (in the form of small units in rural areas).

The second organisation, Société Internationale des Pays des Grand Lacs (Sinelac), is responsible for developing international electricity projects, which include the 28 MW Rusizi hydro plant situated in Burundi. SINELAC is a jointly owned utility with Burundi, Rwanda and Congo – managing Ruzizi I and II hydropower plants. Sinelac has initiated several other large hydro projects which are presently under construction.

The third organization is the Direction Générale de l'Hydraulique et des Energies Rurales (DGHER) who is responsible for the production, transport, distribution and marketing of power and drinking water in rural areas in the country. The average consumption per customer amounts to 24 kWh/month. The DGHER has limited funds hence the rate of electrification in rural areas still remains negligible, in addition connection costs still remain out of reach for many rural people.

The Government vision is to reduce the reliance on traditional forms of wood energy use from the present 96% to 70%, to increase national capacity from today's 32 MW to 150 MW, to increase the access to power from the present 2% to 20% and to

electrify at least 80% of health centres, secondary schools in off-grid areas through PV.

3.1.2 **Energy policy and regulatory instruments**

The privatisation of the REGIDESO was officially initiated in 1994 to put an end to the monopolistic situation and to open the sub-sector to private investors and operators. The regulatory framework was reformed in August 2000 (Law no.1/014) with the adoption of a new law on liberalisation of the water and electricity supply sector allowing the private sector to play a role. The first step which is still underway is to invite private sector for the management and financing of several activities of REGIDESO.

The decree no.100/107 of 17 November 2005 describes the re-organization of the services provided by the Ministry of Energy and Mines and defines the roles and responsibilities of each partner.

The market is liberalised but IPPs are not allowed yet to inject power into the grid. IPP permit should come soon. Nevertheless IPPs can produce electricity for their own consumption only. There are several small stand-alone independent producers through the religious communities.

The electricity sub-sector in Burundi is state-controlled by the Ministry of Energy and Mines (MEM) through the state-owned company REGIDESO. The company is responsible for the national electricity production, basically from 9 hydro power plants spread all over the country and from importation, as well as for the distribution and commercialisation to urban areas.

REGIDESO is also responsible for the distribution of electricity through a HV/MV/LV network interconnecting most of the hydropower stations and supplying all the provincial administrative centres and most of the secondary centres.

The Direction Générale de l'Hydraulique et des Energies Rurales (DGHER) is responsible for the production, transport, distribution and marketing of power and drinking water in rural areas in the country.

Burundi has not yet a separate regulatory body, it is under the Ministry of Energy & Mines, but when it will be in force it will regulate the following aspects of the power sector's legal and regulatory framework:

- Tariff setting: Tariffs are now set by the REGIDESO General Director, approved by the REGIDESO Board and ratified by the Ministre de l'Énergie et des Mines;
- The export and import of electricity;
- The use of natural resources, including licensing, water management plans and water quality standards;
- The supply of electricity to outlying areas; and

- The delivery of subsidies to vulnerable and low-income groups.

3.1.3 **Institutional setups**

In Burundi, the Ministry of Energy and Mines (MEM) is responsible for the development and implementation of energy policies, sectoral planning and programme coordination, as well as for the management of the energy sector.

Under this ministry there is the DGEE (Direction Générale de l'Eau et de l'Energie) which is divided into 2 departments : the Energy department and the Hydraulic Resources Department. The DGEE is responsible for the coordination of sectorial activities, project planning, hydroelectric development studies, preparation of energy balance, control of services to the public, and renewable energy programme implementation through the Burundi Centre for Alternative Energy Studies (CEBEA), etc.

The electricity sub-sector in Burundi is under the supervision of 2 different ministries : MEM and MDCA (Ministère du Développement Communal et de l'Artisanat).

For the production, transportation and distribution in urban centres, the sub-sector is in the hand of a state-owned company REGIDESO since 1963[5], under the supervision of MEM.

The rural electrification activity is managed separately by the DGHER, Direction Générale de l'Hydraulique et des Energies Rurales, which supply electricity to small rural cities from both several micro hydropower plants (< 300 kW) and from connections to the MV lines from REGIDESO network. The DGHER is under the MDCA.

The IGEBU (Institut Géographique du Burundi) centralizes all the information regarding the water resources and meteorological data relevant for SHPP feasibility studies.

There is no regulation authority in Burundi yet. The enabling decree (art. 35) creating the Regulating Agency is being drafted.

3.1.4 **Financing options**

There are limited funds for rural electrification through government channels.

[5] REGIDESO Rwanda-Burundi was created in 1939

3.2 Ethiopia

3.2.1 **Country economy and energy sector brief**

Ethiopia encompasses an area of 1.1 million square kilometres, of which about 45 % is arable (National Bank of Ethiopia). About eighty-five percent of its population of 70.7 million people (estimate for 2006) resides in rural areas and derives its livelihood from subsistence agriculture and livestock. In Ethiopia the GDP per capita amounts to US$111 [6], incomes are the second lowest in sub-Saharan Africa, some 81 % of the population are living below US$2 per day, and 45 % of these live below the absolute poverty line.

The Ethiopian economy is dominated by subsistence agriculture. The Ethiopian highlands are very fertile, and are criss-crossed by large rivers with enormous untapped potential. The growing of coffee occupies 25 % of the population[7] and coffee accounts for 55 % of Ethiopia's exports[8].

Ethiopia is rich in mineral deposits and ores but little commercial exploitation has occurred.

About 22% of the population residing in about 1,752 towns and settlements benefit directly or indirectly from an electricity service[9]. There are over 700 000 customers on the public supply system, a high proportion of these consumers are concentrated in the main urban areas and their surroundings. According to the CSA 1994 census report, only 61,000 households or less than 1 % of rural population have access to electricity. The majority of these are low level customers who consume electricity only to meet basic lighting needs. The average Ethiopian Electric Power Corporation (EEPCO) electricity consumption amounts to 35 kWh/month per connection. Growth in electricity sales has been at a rate of 7 % per year for the past two decades.

Unofficial electricity service providers in rural areas are also not uncommon, these usually tend to be small activities wherein a few households are connected to a diesel generator. The tariffs tend to reflect the true cost of operating the system.

The configuration of generation system under the public utility, EEPCO was as follows:

- Total installed capacity of 814 MW (2008) of which 98% is from hydropower.
- 30 MW capacity in several small diesel stations and three small hydro stations supplying off-grid demand in rural towns

[6] Data for 2004 from the Department of Foreign Affairs, Canada.

[7] Conservation and use of coffee genetic resources in Ethiopia: challenges and opportunities in the context current global situations. Tadesse Woldemariam Gole (2002).

[8] Mugged Poverty in Your Coffee Cup. Oxfam, 2002.

[9] This figures are obtained from EEPCO – they are significantly different to the World Bank figure which states that only 6% of the population has access to power.

- A total of 9,395 km (2007[10]) of high voltage transmission network (230 kV and 132 kV) and 62 788 km of distribution infrastructure (33 kV, 15 kV & 380/220V lines)
- In total there are 108 transmission substations and substations in hydro power stations supplying the distribution system
- 1752 towns are electrified with more than 1 396 000 customers
- Total electricity sales to customers is 2,408 GWh

The national energy balance indicates that biomass fuels (wood, charcoal, agricultural residue and animal waste) meet 94 percent of total energy supplied and that the household sector accounts for 90 % of total energy consumed in the country. Domestic energy requirements are primarily for cooking fuels where they account for 98 percent of energy consumed in the sector.

The modern energy infrastructure in Ethiopia consists of 814 MW electricity generation capacity and about 500 petroleum distribution stations. The population that has physical access to these services is less than 10 percent (the proportion within this group that has financial capability to use services would be lower). The contribution of petroleum fuels (5.1%) and electricity (0.9%) to the national energy balance even if low play critical roles in the transport, industrial and commercial sectors of the economy and the overall development of the country.

In Ethiopia energy resource endowment as well as use is mostly based on renewable resources. The most accessible (physically and economically) have been biomass resources, which for the past few decades have been exploited in the traditional inefficient and unsustainable ways. The energy resource base of the country include hydro power (30 GW), geothermal (700 MW), biomass (80 million tons annual yields), solar energy (5.2 kWh/m^2.day), wind (3 - 6m/s), coal (70 million tons), and natural gas (2.7 TCF).

Under the government's strategic goal for 2010, the installed generating capacity is estimated to be 3028 MW by the year 2010 with an energy production of 10,907 GWh/yr. By 2015, a capacity of 6588 MW is planned. Currently the demand for electricity stands at more than 622 MW.

Over the previous years the rate of electrification by EEPCO has been between 30 and 40 settlements per year. In an effort to reduce poverty and give way to rapid socio-economic development the Government is trying to expand access to power in rural areas through the "Universal Energy Access Project" wherein a total of 6 000 settlements are being identified for electrification in the next 5 years using least cost options.

The Government's strategic goal relies on two pillars:

[10] EEPCO estimate for 2007, based on 2006 data and forecasted projections

- An ambitious grid extension Programme to be implemented by EEPCO, the utility, foresees the electrification of 6 000 settlements by 2010 and 50% of the population will have access to power.
- The implementation and operation of electricity supply systems in rural areas (off-grid) by the private sector or community-based organizations. This is overseen by the Rural Electrification Executive Secretariat (REES) and financed through the Rural Electrification Fund (REF). Project champions can obtain a loan from the fund, which finances up to 70 % of the investment cost. The loan carries an interest rate of 7.5 % per year and has to be fully repaid not later than six years after disbursement. The remaining 30 % have to be financed by the project champion in the form of equity or in-kind contributions.

3.2.2 **Energy policy and regulatory instruments**

Until the liberalization of the power sector in 1997, generation, transmission, distribution and sale of electricity was a monopoly of EEPCo, a public enterprise. Prior to 1997, there was no legislative framework that allowed for private sector participation in the industry. Electricity Proclamation N0.86/1997 seeks to promote domestic, foreign private investment in power generation from all sources. Today independent power producers (IPPs) may generate and sell electric power to EEPCo or establish independent distribution systems in areas not served by the grid. Generation licenses are available for the life of project up to 40 years and transmission, distribution, power sale licenses are available for up to 50 years.

Having recognized the importance of electricity for rural development and the limitations of previous strategies to electrify the country's vast and isolated rural population, the federal government formulated a triple-track rural electrification strategy, which comprises (i) grid extension by EEPCo, (ii) "private sector-led rural electrification" in isolated rural areas (i.e. isolated grids and stand alone units covered under the REF), and (iii) promotion of cost-effective and renewable energy technologies (RETs).

In March 1994 the Transitional Government of Ethiopia (TGE) released its energy policy, the first of its kind. This is still in force as the policy of the Government of Ethiopia (GoE). The policy document states the government's intentions in each of the sub sectors. Thus it aims to address household energy problems by promoting agro-forestry, increasing the efficiency with which biomass fuels are utilized, and facilitating the shift to greater use of modem fuels. Furthermore, the policy paper states that the country will rely mainly on hydropower to increase its electricity supply but also take advantage of Ethiopia's geothermal, solar, wind and other renewable energy resources where appropriate. In addition it aims to further explore and develop oil and gas reserves. It also refers to the need to encourage energy conservation in industry, transport and other major energy-consuming sectors, to ensure that energy development is environmentally sustainable and, to provide appropriate incentives to the private sector.

The general objectives of the energy policy are:

- To ensure a reliable supply of energy at the right time and at affordable prices, particularly to support the country's agricultural and industrial development strategies adopted by the government.
- To ensure and encourage a gradual shift from traditional energy sources use to modern energy sources.
- To streamline and remove bottlenecks encountered in the development and utilization of energy resources and to give priority to the development of indigenous energy resources with a goal toward attaining self-sufficiency.
- To set general guidelines and strategies for the development and supply of energy resources;
- To increase energy utilization efficiency and reduce energy wastage; and,
- To ensure that the development and utilization of energy is benign to the environment.

3.2.3 **Institutional setups**

Until change of government in 1991, there were neither energy sector policies nor institutional arrangements that separate policy making organs from those of operations. Since the mid 1990s, in a bid to enhance efficiency and harmonize operations in the energy sector, policy making organ is separated from operation organs. According to various proclamations enacted to restructure institutions in the energy sector, the two organs are restructured with their own respective roles, mandates and responsibilities as follows:

The Policy Making Organ:

The Federal Ministry of Mines and Energy (MME) is the energy policy making organ of the government. Based on studies and recommendations of one of its departments, Energy Policy Implementation Follow up and Supervision, the MME formulates various energy sector policies and supervise their implementation when approved.

Operation or Implementation Organs:

- Petroleum Works Department: Prospecting and exploration of petroleum.
- Ethiopian Electric Agency (EEA): Regulates operations in the electricity supply sector including licensing and ensuring safety and quality standards.
- Rural Energy Promotions: Ethiopian Rural Energy development and Promotion Center (EREDPC): Conducts research and studies including development and promotion of rural energy efficient supplies and technologies such as improved stoves, PV solar, and biogas.
- Ethiopian Electric Power Corporation (EEPCo): EEPCo is the national electricity utility engaged in the generation, transmission, distribution and sales of electricity in Ethiopia.
- Ethiopian Petroleum Enterprise (EPE): EPE is an operational wing of government entrusted with the responsibility of exclusively importing petroleum products in to the country. The petroleum products market, with the

exception of LPG, is still regulated in Ethiopia and importation is the monopoly of EPE.

- Ministry of Trade and Industry (MoTI): The MoTI fix/adjust retail prices and regulates the distribution of petroleum products by oil distribution companies.
- National Strategic Petroleum Reserve Administration: This is an arm of government that manages and administers strategic reserve depots located throughout the country to ensure sustained supply at times of sudden shocks.
- Rural Electrification Executive Secretariat (REES): Under the auspices of the EREDPC, REES is entrusted with the responsibility of supporting and promoting off-grid rural electrification projects by cooperatives and private sector operators operating outside the national grid.

EEA

The Electricity Proclamation No. 86/1997 of June 1997 gave way to the establishment of the Ethiopian Electricity Agency (EEA) as an autonomous federal government organ.

EEA has become fully operational since the beginning of 2000. EEA is accountable to the Ministry of Infrastructure. The Agency is striving to fulfil the expansion of efficient, reliable, safe, high quality, economical electricity supply and equitable distribution through the Regulation No° 49/1999 issued by the Council of Ministers, the directives prepared by the Ministry and procedures of the Agency itself so as to play a key role in contributing to the efforts of bring about a rapid socio-economic development in the country.

The vision of the Agency is to become a regulatory institution influencing the country's electricity services to achieve world standard. The objectives are:

- Make sure the prevalence of safety, reliability and high quality in electricity supply and services.
- Ensure the prevalence of competition and righteousness in the supply and services of electricity;
- Encourage the promotion of investment in the electricity sector;

Ethiopian Rural Electrification Secretariat

The Ethiopian Rural Electrification Executive Secretariat (EREES) has developed an indicative Off-Grid Rural Electrification Master Plan. REES manages a rural electrification fund.

In the Ethiopian context, Off-Grid is that area that will not be covered by Ethiopian Electric Power Corporation (EEPCo) ten year system expansion plan.

- 240 Off-Grid Projects are in the pipe line
- 12 Projects are implemented (as of 2006)
- Projects are under implementation
- MHP Projects under Tendering Stage
- 300 PV Systems for Health Posts and Primary Schools under Tendering Stage

EEPCo

The Ethiopian Electric Power Corporation (EEPCo) is a company responsible for power Generation, Transmission, Distribution and Sales of electricity all over the nation. EEPCo manages and operates power-generating facilities, the national transmission and distribution grids, and is also responsible for the supply of electricity to more than 1,396,000 customers.

Ministry of Mining & Energy

The Department of Mining and Energy was first established in 1978 under the name of natural Resources Sub-council and it functioned as Department of Natural Resources from 1990-1994. It got its current name during the restructuring of the Commission in 1994. The Department is one of the five departments organized under the Commission and it comprises three teams; namely:

- Earth Sciences Team
- Water Team and
- Energy Team
- The main objective of the MWED is to guide and coordinate the efforts to build and strengthen science and technology capability in the mines, water, energy and geo-information sector that would assist to achieve the socio-economic development goals of the country.

3.2.4 **Financing options**

Rural Electrification Fund

The Electrification Fund was established by Proclamation No.317/2003 to provide loans and technical services for Rural Electrification Projects so as to encourage utilization of electricity for productive uses and on improving energy availability and quality of rural energy service sectors.

The Fund has the following objectives:
To provide loan and technical services for Rural Electrification Projects carried out by private operators, cooperatives and local communities and more specifically for those projects operating on renewable energy sources;
To encourage the utilization of electricity for production and social welfare purposes in rural areas.

- The sources of the Fund:
- Budget allocated by the Government;
- Loans and grants from other Governments;
- Loans and grants form International Financial Institutions;
- Grants from non-Governmental Organizations;
- Income from other different sources.

3.3 Mozambique

3.3.1 Country economy and energy sector brief

Mozambique covers an area of 779,400 km2. The population is currently estimated to be about 21.4 million, with an annual growth rate of 1.9-2.1 %. Mozambique's political and economic development in the past has been remarkable.**Error! Bookmark not defined.** At independence in 1975, Mozambique was among the poorest countries in the world, and the civil war between 1977 and 1992 worsened the situation, destroying much of the rural infrastructure and productive base. Macro-economic reforms in 1986/7 aimed at stabilizing the economy and promote economic development, while political reforms in 1992 resulted in increasing donor aid flowing into the country (KPMG 2008). This in combination with economic stability and other economic measures has resulted in strong growth from the early 1990s, arriving at annual growth rates in 2005-2007 of 7.0-8.4 %. In 2007 the per capita income (GNI PPP) was US$ 690. In 2006, official development assistance and aid was 1,611 Million US$ [11]

According to the KPMG (2008), there is however, a concern over the sustainability of the growth path. This concern is mainly funded on the poor linkages between the capital-intensive export sector (dominated by mega-projects) and the rest of the economy, as well as other factors, such as business environment, transactional costs, bureaucracy, labour market, poor access to credit and labour market regulations.

The power sector

The stateowned national utility Electricidade de Moçambique (EDM), is in principle a 100 % vertically integrated national power company, but due to the large share of electricity provided by the large hydro power station at Cahora Basso, it is largely a transmission and distribution utility.

Mozambique generates far more electricity than it consumes and the majority of electricity from Cahora Bassa is exported to South Africa and Zimbabwe via the Southern African Power Pool (SAPP). However, due to lacking transmission line between Cahora Bassa situated in the central part of Mozambique and the southern part, some of the electricity exported are re-imported from SAPP to the southern part of Mozambique, hosting the capital, Maputo, and a large aluminium smelter situated close to Maputo. This import is facilitated by Mozambique Transmission Company (MOTRACO), which has been formed jointly by South Africa's electric Utility, ESCOM, EDM and the Swaziland Electricity Board to supply electricity from South Africa to Swaziland and Maputo. Until 2007, when the Mozambique state took over 100 % of the shares, the private company *Hidroelectrica de Cahora Bassa*, was partly owned by Portugal (82%) and Mozambique (18%) (KPMG 2008).

Its peak load in the EDM system recently reached 270 MW, which is small when compared with Cahora Bassa's generation capacity of 2,075 MW, and MOTRACO's transmission capacity of 850 MW. Besides Cahora Bassa, EDMs has production capacity of 393MW at various small power plants across the country. Hydro power

[11] World Development Indicators database, September 2008, http://ddp-ext.worldbank.org/

capacity comprises Chicamba: 38.4MW, Mavuzi: 52MW, Corrumana: 16.6MW, Cuamba: 1.1MW, Lichinga: 0.75MW (KPMG 2008).

Hydro potential is substantial in Mozambique, originally estimated to be 12000-14000 MW, most of it in the Zambezi valley. For a list of major sites see e.g. (KPMG 2008, p. 87). Potential for small scale hydro is currently being investigated. Besides the hydropower resources, Mozambique has significant reserves of natural gas at Pande, Temane and Buzi. Pande (240kVA) and Temane (1890kW) gas are used for local generation of electricity in Nova Mambone, Vilankulo and Inhassoro. The gas fields of Temane are primarily producing gas for export to South Africa and there are plans for using the gas in Mozambique including steel production. Mozambique also has three relatively large known deposits of coal at Moatize-Minjova, Senangoe and Mucanha-Vuzi, all of them in the province of Tete. Total coal reserves are estimated at about three billion tonnes. The 2 bn tonne Moatize coal mine is being developed by the Brazilian company CVRD to produce 14 m tonnes of coal per year. Most of this is for exports but CVRD is seeking a partner to build a thermal power station at the mine. There is a huge regional demand for Mozambican power, particularly from South Africa. Therefore, there is shortage of power for local industry development; several major industrial projects (e.g. MOZAL III) are held up for this reason (Risø 2008)

3.3.2 **Energy policy and regulatory instruments**

The Electricity Act approved in 1997 still provides the general legal framework for electrical energy generation, transmission and sale of electricity and for import of export of electricity (Electricity act). An Energy strategy aiming at unbundling the EDM was approved in 2000, and since the restructuring of energy sector is an ongoing process in Mozambique as a part of the overall restructuring of the country's economy. The World Bank and GEF supported power sector reform project, *Mozambique Energy Reform and Access Program (ERAP)* was initiated in 2003, with a total cost of 81.5 million dollars. The programme comprises: (i) reforms necessary for improved performance of the energy sector (in particular electricity) and accelerated access to electricity, in rural and peri-urban communities, and (ii) investments in electricity supply infrastructure (including renewables).

However with respect to ERAP, implementation is significantly behind schedule and this is reflected in the very low disbursements. This is in part due to a rethinking of the approach to sector reform which has culminated in the Ministry of Energy's new approach communicated to the donors in November 2005. EDM is currently undergoing a more restricted restructuring process through the separation of accounts and the creation of business units. As a result EDM operates under a three-year performance contract with the GOM (Risø 2008, p. 56).

In 2004 EDM prepared a Master Plan for the expansion of the country's national power grid and distribution networks with the goal of reaching 15-20% of the population by grid electricity by the year 2020, from the present 5% (Meier and Disch 2005, p. 11). To complement EDMs master plan, a low cost rural electrification plan (LCREP) has recently been developed by EDM/FUNAE/DANIDA (KPMG 2008, p. 116). Further a Policy for Renewable Energy and Master Plan for Off-Grid Energy is

currently being prepared by an international consultant PKMG. The draft document has been made available by the Ministry of Energy (KPMG 2008).

Mozambique's privately operated concession to generate, distribute, and sell electricity was tested in a rural area of Inhambane Province isolated from the country's main transmission grid. The winning consortium of ElectroTec (Mozambique) and Rural Maintenance and Siemens (South Africa) bid an average tariff of 18¢ per kWh. Although this tariff is higher than the previous tariffs (much higher than the EDM tariff of 7¢ per kWh), community members agreed that they were willing to accept higher charges in return for much better service. The household dependent on diesel generated power pay similar or more rates. The contract was won through competitive bidding and leaves the private operator free to develop the power system in the concession area in the way most cost-effective. Subsidies have been provided to keep cost low. The subsidies are output based contingent on physical verification of households being connected. The approach was highly praised by the Output Based Aid (OBA) initiative (Cockburn and Low 2005), but according to Meyer & Disch (2005, p. 21) it turned out to be costly and difficult to manage in the current 'skills context', here referring to the low level of practical experiences with complicated tendering procedures as in this case. The concession was taken over by EDM in late 2007, with claims of bad performance. According to an analysis from KPMG (2008) there was a number of problems, especially related to the roles and responsibilities of government and external partners with respect to delivery of gas, high voltage lines etc. and according to the same source, this experience is likely to negatively impact on future concessions in Mozambique.

The National Electricity Council (CNELEC) was established on the basis of the Electricity Act of 1997 with the intension it should become a regulatory body. Today 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 really is not required yet. There is a serious question whether the establishment of CNELEC is premature, and that its establishment may fragment the very limited resources the public sector has for managing the energy sector (Meier and Disch 2005).

3.3.3 **Institutional setup**

The Ministry of Energy (ME), formerly part of the Ministry of Mineral Resources and Energy, was established in 2005. It plans, promotes and controls the inventory and use of energy resources, and the development and expansion of the supplying and distributing network of power, natural gas and oil products.

EDM is responsible for grid connected rural electrification in the coherent grid area. Except for the above mentioned private concession model tried out in the Inhambane Province non-grid electrification in rural areas is left to public and private investors and supported by FUNEA.

EDMs efforts during the last five years has increased the national electrification rate from 6.8 % in 2001 to 8.2 % in 2006 (KPMG 2008, p. 115). For a comprehensive analysis of the advantages of rural electrification see Muldera & Tembev (2006).

Fundo de Energia (FUNAE) was established as an independent fund by decree in 1997. The vision of FUNAE is to provide access to economic and sustainable energy solutions for a major part of the rural population, and manage the natural resources which contribute to the national development. The objectives of FUNAE are:

- Provide funding for financing sustainable energy projects in rural areas;
- Manage funds for on-lending;
- Promote opportunities for the private sector;
- Promote the use of renewable energy.

The intention was that FUNAE should use a number of financing mechanisms to attain these objectives: loans with a maximum repayment period of 10 years; grants; and mixed financing and subsidy, depending on the project type and its viability. Private sector competition should be fostered through public tendering (chapter about FUNAE from (Risø 2008, p. 56).

So far the results obtained by FUNEA have been very limited compared to the intentions. A limited number of villages have been supplied with small scale diesel, and about 50 villages with solar PV or with solar lanterns, and in all cases, FUNAE holds the ownership of the installation and is through local management groups responsible for maintenance and collecting consumer fees. In this sense FUNAE works according to the same principles as the national utility. [12]

According to the information from Meier and Disch (2005) and according to interview with FUNAE it has been very difficult to attract the private sector in rural electrification, due to limited interest and capacity by national enterprises. This approach, however, is still pursued and there is an ongoing study on options for private concessions on solar service in 4 provinces, which is supported by the World Bank. **Error! Bookmark not defined.**

There are no examples of existing mini-hydro projects set up by FUNAE, but according to KPMG (2008, p. 111) the Provincial Government of Manica with support from GTZ has in 2005 implemented a 75 kW hydro-scheme for electrifying 200 villagers, and feasibility studies for rural electrification based on mini-hydro in Manica and Tete provinces are currently carried out based on a 3 MEUR grand by the EU. [12]

3.3.4 **Financing options**

EDM is applying a uniform tariff structure throughout the country, which means that the rural electrification activities are based on cross-subsidisation on a large scale. 30 MUSD was used for this purpose in 2003 (Meier and Disch 2005, p. 11).

[12] Interview with President of the Administrative Board of FUNAE, Miquelina Menezes, 10 October 2008.

FUNAE is not supported by any sustainable funding mechanism, such as e.g. a levy on electricity sales as seen applied in other countries. This means that FUNAE is fully dependent on donor funding (Meier and Disch 2005, p. 23). While there is a vision for moving towards a programmatic approach to rural electrification, for the time being FUNAE seems to be operating on a project to projects basis searching funding for individual projects. **Error! Bookmark not defined.**

Other financing possibilities:
There are a number of donors and development banks active in the energy sector in Mozambique.

The major interest of donors has been to expand the national electricity grid beyond urban towns and to assist in reforms to the energy sector. This support has to a large extent been channelled through EDM and FUNAE and the Ministry of Energy. It has been supported both by donors providing grant funding and international development banks, mainly providing concessionary loans for larger infrastructure projects. Besides the World Bank the following banks have recently been active in energy sector in Mozambique: African Development Bank (AfDB), Arab Development Bank for Africa (BADEA), Islamic Development Bank (IDB), Nordic Development Fund (NDF), OPEC Fund, Kuwait Fund.

Donors mainly providing grants which has recently been active in Mozambique include DANIDA (Denmark), NORAD (Norway), SIDA, (Sweden), Agence Française pour le Développement (AFD, France), Kreditanstalt für Wiederaufbau (KfW, Germany), Spain and Japan. Finally UNIDO and EU have also provided some grants.

DANIDA closed its sector programme in Mozambique in 2007, but has been funding EdM Southern Region Control Center, rural electrification and system improvement in Maputo, as well as providing institutional support to the Ministry of Energy in terms of advisers and training of officials. The Danish Government also supports the program for dissemination of solar systems and cooking stoves to conserve biomass in Sofala province.

Norway is extending support for transmission line development and rural electrification.

AFD has supported Mozambique-Zimbabwe interconnection, EdM billing system and a loan for development of Pande and Temane gas fields.

Swedish International Development Agency is expected to fund the rehabilitation of hydropower plants and provide institutional support to the Ministry of Energy.

Spain is providing assistance for expansion of Solar PV.

KFW/GTZ has provided funding for a village electrification project based on microhydro in Manica Province (KPMG 2008, p. 111)

EU is supporting feasibility studies of small scale hydro power in Manica and Tete provinces **Error! Bookmark not defined.**

Islamic Development Bank is funding the electrification of Cabo Delgado.

United Nations Industrial Development Organization (UNIDO) is setting up three pilot community Development Centres (CDC) in Kazula, Rotanda, and Sembezeia in central region in Mozambique. The CDCs will be powered by renewable energy hybrid systems. The objective is also to build local capacities at the CDCs to operate, maintain and also fabricate these units in the rural context. The project will provide decentralized power to run the community centres with common facilities, namely to local enterprises, schools, training centres and health centres, leading to a range of social and economic benefits that will help alleviate poverty and improve the standard of living along with other benefits. Upon completion and successful operation; the pilots can be replicated in other villages in the regions (Risø 2008, p. 58).

3.4 Sudan

3.4.1 **Country economy and energy sector brief**

Sudan, the largest country in Africa, is an agricultural country with fertile land, plenty of water resources, livestock, forestry resources and agricultural residues. 80% of the population resides in rural areas.

Traditional uses of biomass remain today the principle energy use in Sudan. In 2004, Sudan's energy consumption mix (excluding traditional biomass uses) was dominated by oil (93%) and the remainder hydroelectricity (7%).

The electricity sector is plagued by poor infrastructure, frequent outages and a small customer base. Presently electricity only accounts for 2% of the total energy use in the country and only half a million households, or less than 10% of the 37,8 million people (2005) are connected to an electric network, the local and secondary networks provide power to a further 5% of the population. Currently, the total installed capacity operated by NEC in Sudan was 1138.8 MW in 2006 – the total in isolated areas amounts to 142 MW. The country's main generating facility is the 280-MW Roseires dam located on the Blue Nile river basin. Projects are presently underway to add both fossil-fuelled and hydropower generating capacity.

Sudan is developing its significant hydrocarbon resources, in 2006, crude oil production averaged 414,000 barrels per day (bbl/d). The country's oil exports, which have increased sharply since the completion of a major oil-export pipeline in 1999, account for 70% of total export revenues.

According to Oil and Gas Journal (OGJ), Sudan contained proven oil reserves of five billion barrels as of January 2007 up from an estimated 563 million barrels of proven oil reserves in 2006. Sudan's licensed acreage is currently dominated by Asian

national oil companies, most importantly China National Petroleum Corporation (CNPC). The government expects that the revenue from oil export will provide investment for development.

As the micro hydro potential in the country is negligible, a full assessment of the country's regulatory and policy framework here is not deemed necessary.

3.4.2 **Energy policy and regulatory instruments**

The Government formulates its energy policies by using a participatory process between relevant ministries and relevant stakeholders for each policy field e.g. oil, electricity. The national energy policy sets the direction for the development of the energy sector in order to meet national development goals in a sustainable manner. The strategy of the Government is to provide access to electricity to 75% of the population by 2025.

Through its National Energy Affairs Directorate, the Ministry of Energy and Mining is responsible for:

- Formulating & implementing the strategic national energy planning issues.
- Promoting and disseminating renewable energy technologies and
- Conducting studies for conservation and environmental impacts issues.

The Sudan National Petroleum Corporation (Sudapet) is active in Sudan's oil exploration and production. However, due to its limited technical and financial resources, Sudapet often develops joint ventures with foreign companies in oil projects. Foreign companies involved in Sudan's oil sector are primarily from Asia. They are led by the China National Petroleum Corporation (CNPC), India's Oil and Natural Gas Corporation (ONGC) and Malaysia's Petronas.

The Ministry is composed of several institutions which are responsible for:
Formulating and reviewing processes, plans and to incorporate views of energy suppliers i.e. market actors and representatives of consumers in addressing the complex nature of the sector.

Sudan's energy sector has 3 main regulatory bodies dealing with (electricity, petroleum and mining):

- Electricity : Electricity Regulatory Authority.
- Petroleum : Sudanese Petroleum Cooperation.
- Mining : Public Geological Research Authority.

3.5 Swaziland

3.5.1 **Country economy and energy sector brief**

Swaziland is a land-locked country covering an area 17,400 km^2 and bordering Mozambique and South Africa. Swaziland's climate ranges from sub-humid and

temperate in the Highveld to semi-arid in the Lowveld. Average rainfall varies from 500 mm in the eastern lowland to 1500 in the Highveld. Swaziland has seven river basins (Mwendera 2006).

Swaziland is a middle income country whose economy is closely linked to and largely dependent on South Africa. Most imports, about 80 %, are from South Africa, including fossil fuels and most of the electricity, and 60 % of export is also destined there. In the 1980s and early 1990s, Swaziland experienced a high economic growth rate, mainly because Swaziland had one of the most attractive investment climates in the region at the time. However, political changes in South Africa and Mozambique in the 1990s have attracted capital to these emerging markets. This coupled with the effects of HIV/AIDS in the country have had a significant negative impact on economic growth in the last decade For more information see e.g. (MEPD 2005; Khumalo and Francis 2007; WB 2006).

The population is currently estimated to be about 1.14 million, with an annual growth rate of 2.4-2.8 %. In 2007 the per capita income (GNI PPP) was US$ 4930. In 2006, official development assistance and aid was US$ 35 million[13]

The power sector

The commercial supply through the national grid is the responsibility of Swaziland Electricity Board (SEB), which controls all generation, transmission and distribution of electricity and which delivers about 70 % of electricity consumed in Swaziland. The remaining 30 % is generated by autoproducers in industry, agriculture and service sectors for their requirements.

Swaziland is a member of the Southern African Power Pool (SAPP). The SAPP enables SEB to trade freely within the Power Pool with respect to purchase of bulk power and energy (GoS 2002). SEB electricity production in 2004 was generated from four hydropower plants, Edwaleni (15 MW), Ezulwini (20 MW), Magnuduza (5.6 MW) and Mbabane (0.5 MW) and from two diesel plants with a total capacity of 9.5 MW. The consumption in the SEB grid in 2004 was 868.7 GWh of which 88 % was imported from South Africa (Mwendera 2006, p. 954).

The private manufacturing firms, mostly in sugar, pulp & paper and forestry industries, have an installed capacity of 50 MW, which produces power for both their factories and their associated company towns (WB 2003b, p. 2). According to Mwendera (2006, pp. 956, 957) the technical exploitable potential of hydropower is about 61 MW. Out of this potential, 41 MW was exploited in 2004 and a 19 MW hydropower plant at Maguga on the Komati River was planned to be in operation by 2006. There seems to be some discussion on the real unexploited potential, but for the PACEAA project it is of specific interest that there is an untapped potential of micro (< 0.1 MW) and mini- (0.1-0.2 MW) hydropower of about 8 MW at 34 specified sites.

[13] World Development Indicators database, September 2008, http://ddp-ext.worldbank.org/

According to the World Bank (2003b, p. 2) there is an unexploited potential for cogeneration based on biomass waste, which is explained by the lack of enabling environment for sale to the grid, and the low import price (US$ 0.02/kWh) of electricity from South Africa. The Annual Report from the Ministry of Energy (2004, p. 6) mentions two potential project for cogeneration, which most likely is expanding existing production at Ubombo Sugar Mill and Simunye Sugar Estate, which are used as examples of co-generation options in Boldt & Christensen (2002). According to this source, the two units could contribute with additional 241 GWh and 162 GWh respectively, if new high pressure steam turbines (54 MW & 65 MW) were installed instead of the existing. This should be compared to the aforementioned annual electricity consumption in the national grid of 869 GWh in 2004

3.5.2 **Energy policy and regulatory instruments**

In the last ten years various policy documents and strategies relating to the energy sector have been developed in Swaziland. Of specific interest are the Utilisation of Renewable Energy Action Plan 1997 and the National Energy Policy in 2003.

The Renewable Energy Action Plan identified a number of actions, which were deemed appropriate to the country, such as electrification of homesteads using solar PV systems, distribution of commercial cooking fuel, and dissemination of improved cooking stoves. According to Khumalo (2007) implementation of these actions has been compromised by lack of funding, and many of the actions have therefore been incorporated into the National Energy Policy. See e.g. (ESMAP 2001; ESMAP 1997)(Lasschuit, Westra and van Roekel 2002)

In 1998, the Cabinet made a decision to privatize the SEB and to establish an independent regulatory authority. The aim was to facilitate the commercialization of the energy production and to allow private participation, third party access and transparency in pricing. This decision was reiterated in the National Energy Policy adopted by Parliament in 2003 (2004), and while in 2006 the acts relating to privatizing the utility had been passed by parliament, but not yet signed by the Kings Office (Khumalo and Francis 2007), the privatization of the utility was achieved in 2007. [14] It has not been possible to throw more light on the status of implementing the independent regulatory authority.

3.5.3 **Institutional setup**

In Swaziland, energy is the responsibility of the Ministry of Natural Resources and Energy. The Energy Department of the Ministry is subdivided into 5 sections, covering Petroleum Industry, Conventional Fuels, Energy Planning, Renewable Energy and Rural Electrification.[15]

[14] New year's statement by the Prime Minister's Office 31/12/2007: http://www.polity.org.za/article.php?a_id=126009

The Renewable Energy unit is responsible for the development, monitoring and evaluation of pilot and research projects and of market developments programmes, while the Rural Electrification unit is responsible for projects undertaken in rural electrification, which targets schools, health care facilities and other government institutions as a priority.[15] In contrast to a number of other countries there is no specific agency responsible for rural electrification.

According to Khumalo (2007) a rural electrification programme, mainly funded by the Government of Taiwan, has been carried out since 2001. The main focus of the programme has been installation of 11 kV high voltage lines to reach rural schools and government institutions. The programme has connected about 170 institutions, mainly schools, but very few households have been connected. According to the same source, high connection costs have been identified as the main barrier, and consequently subsidies and provision of 'smart boxes' have been introduced by SEB to increase the connection rate.

3.5.4 **Financing options**

Major donors in Swaziland are the Republic of China (Taiwan) and the EU. Other donors include Japan, United Kingdom, Italy, Germany, Denmark and the various agencies under the United Nations. Aid has decreased in recent years with donors changing their strategies and focusing on Least Developed Countries and countries in transition.

Rural electrification

The Republic of China (Taiwan) has supported SEB with a total of E 45 million (US$ 4.5 Million) for the rural electrification programme, including subsidies to connections of households located less than 1 km from the grid. A micro project scheme supported by the EU and development funds from the DPMs office will be used to add on to the Taiwanese funding. A project concept document from the WB/GEF describes a project for Energizing Rural Transformation with a total budget of US$ 118 million, to start in 2005, but apparently the project never got off the ground (WB 2003a; WB 2003b)

The Community targeted micro-project programme supported by the EU since 1988 has facilitated more than 700 micro-projects of various types. According to the Swaziland Government webpage consulted January 2009, the last programme ran from 2003-2007.[16] It has not been verified if the programme continues, but with the long lasting cooperation it seems likely. The programme seems to be of interest for supporting rural electrifications schemes in connection with small scale hydro power or co-generation plants.

A general clause is a minimum local community (beneficiary) contribution of 25% of the investment cost. This can be a contribution in kind or in cash by the beneficiaries.

[15] http://www.gov.sz/home.asp?pid=1122; http://www.gov.sz/home.asp?pid=1124

Any contributions from other donors, NGOs, Missions, Government or agencies are not allowed to count towards this 25%.

It is explicitly mentioned that charges for connection towards SEB or community micro power system can be covered by 75 % in order to promote small industry domestic consumption and wood fuel savings. There seem to be options for more general support to rural electrification or micro power systems, within the maximum contribution to a project which is E 1 million or about US$ 100,000.[16]

3.6 Uganda

3.6.1 Country economy and energy sector brief

Uganda covers an area of 241,000 km2, of which 18 % is covered by lakes and rivers. It hosts the Lake Victoria, which is the second largest freshwater lake in the world and the upper part of the River Nile. The population is currently estimated to be about 30.9 million, with an annual growth rate of 3.2-3.4 %. Uganda's political and economic development in the past has been remarkable. From a time with internal war and severe economic conditions in the 1970s to 1980s, it has become a dynamic economy, with an annual growth rate of 5.1-5.7 % in 2005-2007. In 2007 the per capita income (GNI PPP) was US$ 920, which is higher than most countries in the region. In 2006, official development assistance and aid was 1,551 Million US$ [17]

Uganda has since 1986 embraced fundamental institutional and economic reforms. The government strategy has been to modernise the economy by relying on the private sector on the one hand and on a decentralised administrative policy on the other (Francis and James 2003).
Both the privatisation and decentralisation strategies have had important influence on the energy sector.

The power sector

Hydropower provides the majority of Uganda's electricity supply. It consists of two larger stations at Lake Victoria, Nalubale and Kiira, with a total output of 380 MW. In addition, by 2007 there was about 17 MW of grid connected independent generation from a number of small hydro power plants. Currently three factories in Uganda, namely; Kakira Sugar Works Ltd, Kinyara Sugar Works Ltd and Sugar Corporation of Uganda Ltd, are doing cogeneration with a total electricity generation of over 10 MW (MEMD 2007, p. 40). Further there is a total of 200 MW reserve diesel capacity.[18]

There are estimated potential for 2000 MW large scale hydro projects in Uganda, including six potential major hydropower sites: Bujagali 250 MW, Kalagala 450 MW, Karuma (Kamdini) 150 MW, Ayago North 300 MW, Ayago South 250 MW and

[16] http://www.gov.sz/home.asp?pid=732
[17] World Development Indicators database, September 2008, http://ddp-ext.worldbank.org/ext/ddpreports/ViewSharedReport?&CF=&REPORT_ID=9147&REQUEST_TYPE=VIEWADVANCED&HF=N/CPProfile.asp&WSP=N
[18] Personal communication with James Baanabe, Ministry of Energy and Mineral Development

Murchison Falls 600 MW. Bujagali and Karuma sites have been significantly studied and are being developed on a Public Private Partnership (PPP) basis to generate electricity in the medium term (MEMD 2007, p. 41)

All resources, however, are not practically exploitable due to environmental concerns. As an example of this is the Bujagali hydropower plant (250 MW), which was stalled for some years due to protests from environmentalists (Nape 2008). It was taken over by a new investor, the Bujagali Energy Limited, a company jointly owned by affiliates of Sithe Global Power, LLC and the Aga Khan Fund for Economic Development, and the project is expected to be commissioned early 2011. [19] The private consortium has received loans from IFC and is backed by guaranties from IDA and Multilateral Investment Guarantee Agency (MIGA)[20].

More than 60 mini hydropower sites with a total potential of about 210 MW have been identified through different studies in Uganda. Some of the sites can be developed for isolated grids; others as energy supply to the grid and the reminder of the sites were assessed to be less relevant to the energy supply for environmental and power market reasons. A complete list of potential sites for small and large scale hydro is provided in the renewable energy policy document (MEMD 2007, pp. 112-120)

Electricity demand is strongly increasing. In the years from 2001 to 2006 the max load increased from 270 to 380 MW. According to the transmission company, UIETC, this increase it expected to continue with about 7 % per annum in the years to come. Accordingly the maximum load will increase to 500 MW in 2010 and to 700 MW in 2015 (MEMD 2007, p. 29). Before 2005 about 20 % of retail sales was sold to neighbouring countries, especially to Kenya, but the increasing demand and reduced hydropower output due to low rainfall led to a power shortage and consequently export have come to a halt (ECON 2006, p. 4).

Total electrification rate was 5.9 % in 2000; 2.1 % in rural areas and 21 % in urban. The rural electrification plan from 2001 estimates rates to increase to 13% total, 10 % rural and 23 % urban in 2011 (MEMD 2001).[21]

3.6.2 **Energy policy and regulatory instruments**

Privatisation of the Uganda power sector started in 1999 with government publishing the Power Sector Restructuring and Privatization Strategy and promulgation of the new electricity act, which provided the institutional framework for reforming the electricity sector. It permitted privatisation of the former state owned utility, Uganda Electricity Board (EEB) and established the Electricity Regulatory Authority (ERA) and the Rural Electrification Board, Agency and Fund.

[19] (http://www.bujagali-energy.com/default.htm)

[20] http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTPROJECTSPROGRAMS/EXTBUJHYDPOWPRO/0,,contentMDK:21452006~menuPK:3323746~pagePK:64168445~piPK:64168309~theSitePK:3323560,00.html

[21] Figures from World Energy Council from 2005 were 8.9 total, 2,4 rural and 24,6 urban (IEA 2007)

In 2001, a single buyer model was chosen and UAB was unbundled into three state owned entities for generation (UEGCL), transmission (UETCL) and distribution (UEDCL). Following the unbundling, the government privatized the generation and distribution through long-term leases. Hydropower generation assets were leased to ESKOM Uganda Limited and the distribution network was leased to Umeme Limited (ECON 2006, p. 17).

As part of the World Bank engagement in the energy sector in Uganda, a rural electrification strategy study was carried out by ESMAP and published in 1999 (ESMAP 1999). Following this an ambitious Energy for Rural Transformation project (ERT) financed by the World Bank and covering a ten year period was launched in 2001. The ERT aimed at increasing rural electrification through a privatised approach integrating all sectors (WB 2001). In 2001 a rural electrification plan was launched covering the period from 2001 to 2010. The rural electrification plan aimed at increasing the rural electrification rates from 2.1 % in 2001 to 10 % in 2011 (MEMD 2001). Information on progress has been available through the ERT Bulletins, issued in 2006 and 2007 (ERT 2006; ERT 2007). However, while a number of projects are mentioned to be initiated and in progress, only few have been finalised by 2007, and there is no detailed information available of achievements compared to initial goals. Observers, were already in 2004 sceptical towards the likely achievements of these goals (Karekezi, Kimani, Mutiga and Amenya 2004, pp. 49-50), and a recent non published study on renewable energy agencies in African countries claims that by 2007 initial goals were far from being achieved (Mostert 2008)

A general energy plan for Uganda, which had among its objectives to increase use of modern renewable energy, was launched in 2002 (MEMD 2002). Power shortages and increasing oil prices paved the way for further pursuing these objectives through a renewable energy policy for Uganda which was approved by cabinet in Marts 2007. This ambitious policy goal for renewable energy is to increase the use of modern renewable energy from the current 4% to 61% of the total energy consumption by the year 2017 (MEMD 2007). Details from the plan regarding electricity are shown in Table 3.1:

Table 3.1: Actual and planned capacity from renewable energy and targets for rural access to electricity. Source (MEMD 2007, p. 64)

PROGRAMMES	**BASELINE**	**CUMULATIVE TARGETS**	
1) *Power Generation (MW installed)*	**2007**	**2012**	**2017**
Hydropower plants (large)	380	830	1200
Hydropower plants (mini and micro)	17	50	85
Cogeneration	15	35	60
Geothermal	0	25	45
Municipal Waste	0	15	30
2) Rural Electrification and Urban Access	**2007**	**2012**	**2017**
Electrified households through PREPS/LIREPS and CIREPS	250,000	375,000	625,000

The implementation of the renewable energy policy will be of paramount importance for achieving the objectives in the PACEEA project, as it addresses the main barriers for deployment of cogeneration and small scale hydro, as shown in the following quote:

> Basic studies of the various resources and sites will be carried out followed by promotion and tendering to the private sector, followed by their development. This will cover mini hydropower schemes, biomass cogeneration, wind power, peat, geothermal and solar thermal electric and limited to 20 MW installed capacity per plant. The feed-in- tariffs, for renewable electricity are presented in Annex 2. These will be reviewed periodically (MEMD 2007, p. 21).

It envisages among other incentives standard power purchase agreements (PPAs) and feed in tariffs for renewable energy. Part of the policy document is a proposed feed in tariffs shown in Table 3.2.

Table 3.2: Proposed feed-in tariffs for hydropower and cogeneration with bagasse in US cents/kWh.

	Hydropower		
	Years 1 - 6	**Years 7 - 20**	**Simple Weighted Average**
Peak	12	9	9,9
Shoulder	6,4	5,4	5,7
Off-peak	4	1,5	2,25
Average	7,2	5,33	5,89
	Cogeneration with Bagasse		
	Years 1 - 6	**Years 6 - 15**	**Simple Weighted Average**
Peak	12	8	9,6
Shoulder	6	4,5	5,1
Off-peak	4,1	4	4,04
Average	7,03	5,25	5,96

Source: (MEMD 2007, p. 113)

In line with the objective of the PACEEA project, the plan also envisages to provide special support to independent grids supplied by biomass or small scale hydro:

> Electricity access to rural populations and the urban poor require special packages to make connections and services affordable. The programme will enhance the on-going procedures for community schemes, where the cost of connection to the community is subsidized. **It will also support the development of independent grids supplied by micro and pico hydros and biomass gasifiers to be managed by communities and solar PV systems in dispersed remote settlements.** The programme will prioritize supporting electrification for productive uses and key social services (MEMD 2007, p. 22)

The more precise conditions being the results, however, have so far not been available.

3.6.3 **Institutional setup**

The electricity act from 1999 envisaged the creation of the Uganda Electricity Board (EEB), the Electricity Regulatory Authority (ERA) and the Rural Electrification Board, Agency and Fund, which will be further described below.

The Electricity Regulatory Authority (ERA) has authority of all electricity undertakings in Uganda. This involves awards of licences for production, distribution and transmission and in the case of isolated grids, a licence for mini-grid. Licences are not required for generation below 500 kW (ECON 2006, p. 23)

The Rural Electrification Agency (REA) and a Rural Electrification Fund (REF) were set up in 2001 to be responsible for development and promotion and funding rural electrification and renewable energy projects. The relationship between the different institutions is shown in the Figure 3.1 below.

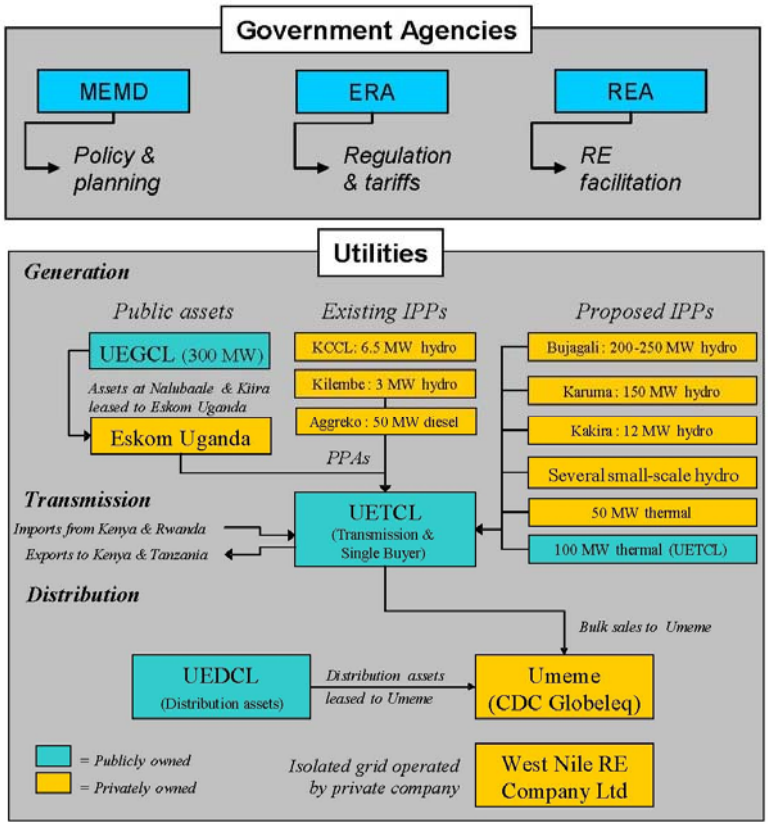

Figure 3.1: Institutional framework in the energy sector. Source: (ECON 2006)

The rural electrification board (REB) was inaugurated in 2002, but REA, which serves as the secretariat for REF was not operational until 2003. The REB consists of seven members: 4 from ministries, 1 from private sector, 1 from banking sector and 1 from NGO. The board defines the policies for subsidy level, project eligibility criteria, application processing and other procedures based on proposal from the REA. The Board approve grants to be offered for new projects and approve the annual operating budget of the Fund (MEMD 2001, p. 4.3.2$4.5.3).

The REF is financed by a levy of 5 % of transmission bulk purchases of electricity form generation stations, and is further supported by Donors. In 2006, World Bank,

SIDA and NORAD were supporting the REF, and more funds were expected from the European Investment Bank and the EU (ECON 2006, p. 22).

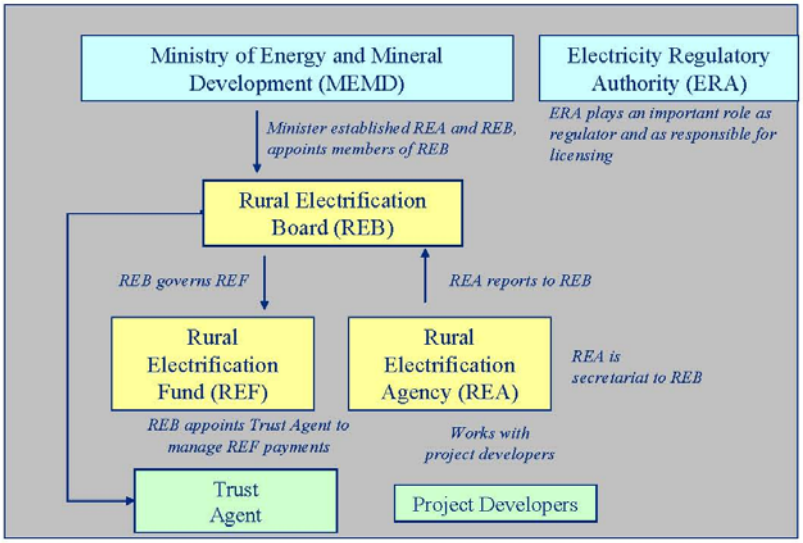

Figure 3.2: Roles of different players in rural electrification. Source (ECON 2006)

The REA is in charge of - in cooperation with the system operator - preparing and updating the RE master plan for rural grid connection, and for initiating feasibility studies and coordination of plans for off-grid regional projects (MEMD 2001, p. 4.3.1).

3.6.4 **Financing options**

Rural electrification projects based on cogeneration and small hydropower projects can be subsidised and financed, either through the rural electrification fund and agency or via independent donor projects. The institutional framework recently put in place is however strongly supported by major donors, which means that most subsidy and financing is channelled through REA and REF.

Rural electricity fund and agency

The REF deals with grants and subsidies to three types of rural electrification: 1) expansion of the grid, 2) development of isolated mini-grids in concentrated settlements far from existing grid 3) renewable energy power generation for sale to grid or mini-grid (ECON 2006, p. 22)

REF provides subsidies for utilities, for private operators and for community cooperatives. Projects can be initiated from either top down or bottom up. Priority rural electrification projects (PREPs) should be identified through the REA/MEMDs rural electrification master plan (IREMP) and tendered out each year, but this approach has seriously been hampered as the plan has not yet been finalised in 2008 (Mostert 2008, p. 40). So-called Locally Initiated Rural Electrification Projects (LIREPs) constitute an alternative option for private investors, as LIREPs can be

developed by a project developer in cooperation with the local community (Mostert 2008, p. 39). In this case developers interested in a specific project must submit a notice of intent to the regulatory authority before study a specific site, and after the private operator's application for a licence, ERA must advertise the application in order to allow for competing developers. ERA both approves tariffs and monitors performance (ECON 2006, p. 23)

REF may co-finance feasibility studies to the three eligible types of electrification (MEMD 2001), and BUDS-ERT – a private arm of the Private Sector Foundation (PSF), provides a 50 % grant fro market development (max. US$ per project) carried out by private enterprises.

Most important however, is investment subsidies which are given to grid based system both in terms of grid extension and isolated grids in order to make end-user prices more affordable. Apparently, subsidies are based on cost estimates, allowing private capital a return on equity. So far no subsidy criteria have been publically available, although by 2006 the REA was said to be 'working on the subsidy policy, which will present the subsidy award criteria and procedures in a clear and transparent way' (ECON 2006, p. 21). Subsidies for solar PV systems for isolated settlements are handled exclusively by BUDS-ERT, There are special schemes for PV-based community packages for schools, clinics, water supply etc, and for individual Solar Home Systems (SHS) (ECON 2006, pp. 21-22).

No exact figures of achievements of the REA/REF approach is available, but according to Mostert (2008, pp. 33,34,39) the REA/REF approach has far from achieved its intended goals, mainly because: i) the development of institutions have taken longer than anticipated ii) application of a concession wide single tariff in the UMEME distribution area has blocked grid extensions, as they are not feasible within the uniform tariff scheme and iii) the rural electrification master plan providing priorities and information to private investors has not been finalised and made available to investors.

Other donor projects
World Bank, BMZ, SIDA, NORAD, European Investment Bank and the EU are present in the Energy Sector.

3.7 Zambia

3.7.1 Country economy and energy sector brief

Zambia covers an area of 752,614 square kilometers, with a terrain which is mostly plateau savanna and a climate which is dry and temperate. The population is currently estimated to be about 11.9 million, with an annual growth rate of 1.9 %.[22]

[22] World Development Indicators database, September 2008, http://ddp-ext.worldbank.org/

The country is endowed with abundant natural resources, which include copper, cobalt, zinc, lead, coal, emeralds, gold, silver, uranium, water and fertile land. The main industries are mining, transport, construction, manufacturing and agriculture (GoZ 2006). In 1969, Zambia was the world's fourth largest copper producer. However, falling production, due to low market prices and a lack of investment, have reduced Zambia's copper output to about half of this 1969 level meaning that Zambia is now the 11th largest producer. This decline was very serious for the Zambian economy, which has suffered for a number of years. However, recent record high copper prices and international debt relief (HIPC) have improved the Zambian economy, and in spite of high inflation (~18% in 2004) and a number of adverse supply shocks (e.g. drought, high world oil prices, and fuel shortages due to oil refinery production interruptions) the Zambian economy now performing well (GEF 2006), with annual growth rates of 5.2-6.2 % in 2005-2007. In 2007 the per capita income (GNI PPP) was US$ 1220, which is higher than most countries in the region. In 2006, official development assistance and aid was 1,425 Million US$.[22]

The power sector

The power sector is dominated by ZESCO, the vertically integrated state-owned utility. It owns most of the generation, transmission and distribution infrastructure in Zambia, including the small hydro and most of the isolated diesel plants. The Kariba Northern Bank Company is a public utility, which owns the Kariba North Bank Power station with an installed capacity of 600 MW. The Mulungushi and Lunsemfwa Hydropower Company is a privately owned independent power producer (IPP), which runs two hydro power stations with a combined capacity of 38 MW. The Copperbelt Energy Corporation (CEC) is a private company that purchases bulk power from ZESCO and supplies to the copper mines (CORE 2004, p. 10).

Zambia has six mini-hydro and micro-hydro stations with capacities from 750 kW to 20 MW. SESCO owns the 4 of them, while two as mentioned above is owned by Lunsemfwa Hydropower Company (GEF 2004, p. 14)

In 2005, the total installed capacity reached 1,732 MW, mostly hydro generation, while the peak demand was 1,330 MW. The total generation in 2005 was 8,884 GWh; with a net export of 69 GWh. Evolution of electricity generation by fuel is shown in Figure 3.3 below.

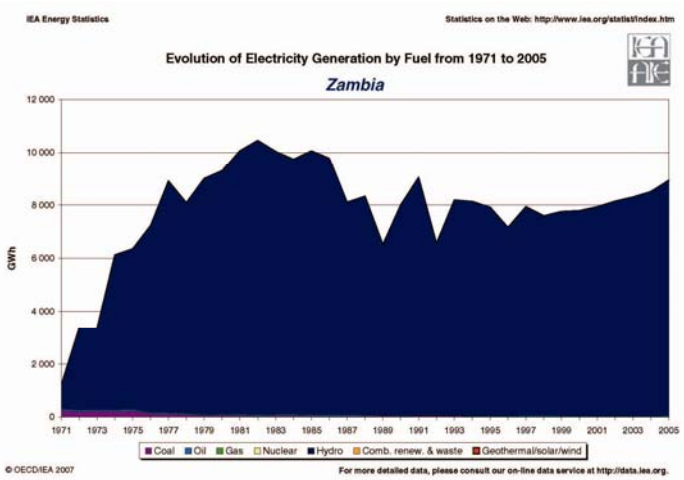

Figure 3.3: Evolution of electricity generation by fuel from 1971 to 2005. Source: IEA statistics

In Zambia, no major new generating station for power has been developed since the 1970s. However, electricity demand on the power system has increased steadily since then and accelerated in the late 1990s, but without a corresponding expansion of the supply infrastructure. With the rapid development of new mines and industries, and rapidly growing household electricity needs, the country is experiencing load shedding.

To address the power crisis, ZESCO is implementing power rehabilitation projects, which will increase availability and reliability of existing plants, and can add an additional 210 MW by 2009. ZESCO also plans to construct three new large generation plants at Itezhi Tezhi (120 MW), Kariba North Extension (360 MW), and Kafue Gorge Lower (750 MW), with an estimated cost of about US$1.5 billion in the next five years to meet domestic demand and for export. Institutional setup (WB 2008)

3.7.2 **Energy policy and regulatory instruments**

The government promulgated an National Energy Plan in 1994, which laid the ground for a) the Energy Regulation Act (1995) under which the Electricity Regulatory Board (ERB) was established; b) an Electricity Act (1995) which permits private investment in the power sector, and which sat up the Rural Electrification Fund (1995) further described below. The Energy Regulation Board (ERB) was established in 1995 with a mandate to oversee the entire energy sector, including electricity, petroleum, coal, and solar. ERB reviews and approves ZESCO tariff submissions (Haanyika 2008).

In May 1999, the Government published the Framework and Package of Incentives for private Sector Participation in Hydropower Generation and Transmission Development." An Office for Promoting Private Power Investment (OPPPI) has been set up under the MEWD to implement the framework, but this initiative has yet to be made operational (WB 2008).

Following the 1994 plan, a draft revised National Energy Policy was developed in 2005, but not yet approved by the Cabinet. The World Bank is currently financing

development of the Implementation Strategy of the National Energy Policy, and USAID and JICA is financing a Rural Electrification Master Plan, which is not yet finalized (CORE 2005; WB 2008) [23]

3.7.3 Institutional setup

Rural Electrification Fund

The REF was set up in 1995 in order to finance rural electrification through a levy of 3% of all electricity. Since its start this levy has been the main funding for the REF. (Haanyika 2008, p. 1050). Until 2003 it was managed by a Rural Electrification Unit, set up under the Rural Electrification Fund Committee. The REU was responsible for selecting projects, which were thereafter implemented by ZESCO. According to Haanyika (2008, p. 1051) various difficulties were experienced with this institutional setup, forcing the government to establish the Rural Electrification Agency.

Rural Electrification Agency.

The government established the REA, under the Rural Electrification Act in December 2003 (Haanyika 2008, p. 1051). REA is responsible for (i) administering and managing the REF to rural electrification project developers (including ZESCO) on a competitive basis; (ii) developing rural electrification plans to provide a level playing field for grid and off-grid electrification; and (iii) provide technical assistance and promoting rural electrification. (WB 2008)

According to Haanyika (2008) establishment of the REA was a slow process with the consequence that the new REA still had limited capacity in 2007. Accordingly, a SIDA-supported consultancy is assisting REA in becoming operational. This will include developing transparent and effective capital subsidy schemes, project selection criteria based on economic and financial principles, eligibility criteria and principles for the REF, appraisal of project proposals, etc. in the REF Operational Manual (WB 2008).

The REF will provide capital subsidies to project developers to extend the grid in rural areas, while ZESCO will increase connections within its grid networks in peri-urban areas.

3.7.4 Financing options

Rural electrification projects based on cogeneration and small hydropower projects can be subsidised and financed, either through the rural electrification fund and agency or via independent donor projects. The institutional framework recently put in place is

[23] http://www.lusakatimes.com/?p=3773 9 September 2008. Government says the full implementation of the Rural Electrification master plan will commence next year and will require US$50 million.

however strongly supported by major donors, which means that most subsidy and financing is channelled through REA and REF

Rural electrification agency and fund

Currently there is a levy of 5 % on all electricity consumption of which 3 % is earmarked to for REA and REF to provide capital subsidies for rural electrification projects (about 2.5 M USD/year). According to Haanyika (2008) results, have been limited, and further fundraising would be necessary to reach the goals. In May 2008, the multi-donor project, *Increased access to electricity services project'* was finally approved. According to the project document the project aims at providing electricity services to 70,000 new customers including households, public facilities (schools, clinics, church, etc.), and commercial establishments (farm blocks, agriculture processing mills, water pumping, shops, etc). The electricity access rate is expected to increase from 20 percent to 25 percent as a result of the project (WB 2008, p. 6).

The total project cost is estimated to be $80.5 million, of which IDA $30 million[24] equivalent, GEF $4.5 million, EU Energy Facility $14 million equivalent, government $12 million, and equity and debt from ZESCO, private developers, and consumers $20 million. The WB is mainly playing a 'catalytic' role. All the grant funds are channeled through REF and managed by REA, in order to ensure a level playing field between grid and off-grid options to multiple service providers for grid, mini-grid, and solar PV options (WB 2008, p. 5).

According to the World Bank project document, cooperatives and private sector companies will be the service providers, responsible for procurement, construction and operation of the projects financed under REA. They will operate on a commercial basis, with tariff revenue covering the cost of service. To ensure financial viability of the projects, REA in turn, should provide a partial capital subsidy from the REF. In the project document, it is emphasized that support should follow transparent, competitive selection criteria; when evaluating proposals for potential service providers (WB 2008, p. 7).

Ongoing Donor Programmes

SIDA, a major donor to Zambia's energy sector, is already supporting REA in the design and operation of the RE Fund, providing technical assistance to REA and ERB, and demonstrating a Renewable Energy Service Company (RESCO) approach to deliver solar home systems on a fee-for-service basis. It is expected that SIDA will continue its active role in the sector, including additional support for REA and the RE Fund. (For further information, see e.g.CEEEZ 2006; Ellegård and Nordström 2001; Ellegard, Arvidson, Nordstrom, Kalumiana and Mwanza 2004)

Other Solar PV experiences include a project undertaken by the Ministry of Health (MOH) with funding from the European Union, UNICEF and JICA to provide medical

[24] USD 33 Million is IDA credit, with a maturity of 40 years and a grace period of 10 years. www.wordlbank.org

refrigeration and lighting to about 200 rural health centres and a project by Ministry of Education (MOE) under the World Bank funding (through Zambia Social Investment Fund, ZAMSIF) to provide electricity for teachers houses in 80 schools.

UNIDO is undertaking two GEF activities – assisting MEWD to pilot renewable energy mini-grid projects and assisting the Ministry of Education to conduct feasibility studies of solar PV for ICT applications in rural schools (see e.g. GEF 2004). The first mentioned UNIDO project focuses on building demonstration projects on renewable energy mini-grids, while the 'Increased access to electricity services project' focus on putting in place policy and financing frameworks for grid-connected and isolated grid renewable energy systems, and developing markets for solar PV systems (GEF 2006)

According to the WB project document (2008) there are some potential of additional funding for the Energy Sector in Zambia from Japan Bank for International Cooperation (JBIC), SIDA, and an additional EU grant. These options are listed as follows:

- **The Japanese government and JBIC** are interested in providing Japanese ODA loan following the on-going JICA Rural Electrification Master Plan Study. The GoZ submitted a request of JBIC loan for (i) intensification in peri-urban areas (US$ 17.9 million), (ii) grid extension to rural areas (US$ 136.6 million), (iii) isolated grid in rural areas (US$ 48.3 million) and (iv) consulting services. The GoZ also indicated its intention to appoint ZESCO as the project implementation agency, who will own, operate and maintain the infrastructure, and will be responsible for carrying out JBIC procurement procedures and guidelines. JBIC plans to review the request from GoZ and narrow down the project scope for Japanese ODA loan by the end of 2007. The decision of Japanese ODA loan as well as of it size and scope are expected to be made in the first quarter of 2008.

- **SIDA** plans to fund $20-30 million to REF and an additional $4-6 million for capacity building and institutional strengthening to MEWD, REA, ERB, and ZESCO in the energy sector.

- **EU Energy Facility**: REA has applied for an additional 10 million Euro from the EU Energy Facility for access expansion. If materialized, this larger access expansion program, including the IAES project, could assist the government in achieving the target of 30 percent access rate (WB 2008, p. 6).

There has been no information available of to which extent these expectations have been fulfilled.

4 Other African Experience with Village Level Cooperatives

4.1 Burkina Faso

4.1.1 National and geographic situation

Burkina Faso is landlocked nation, surrounded by six countries: Mali to the north, Niger to the east, Benin to the south east, Togo and Ghana to the south, and Côte d'Ivoire to the south west. The population is estimated at approximately 15 million in 2008, of which 83% lives in rural areas.

Burkina Faso faces severe constraints. It has limited natural resources, an economy that is strongly dependent on cotton exports, and a vulnerability to both natural disasters and fallout from civil strife in the nearby West African countries. Nonetheless, Burkina Faso has maintained a real GDP growth rate averaging over 5 percent per year since 1994, and has driven poverty incidence down from 54 percent in 1998 to around 42 percent today (WB, 2008).

Table 2.1 Socio-economic indicators

Country Indicators	1995	2005
Real GDP growth (%)	6.3	7.1
Atlas GNI per capita (US$)	240	400
External debt (% of GNI)	51.95	40.8 (2004)
Debt service ratio (exports/debt service)	23	24.7
Poverty incidence (%, national threshold)	54.6 (1998)	42 (2006)[e]
Gross primary school enrolment rate (%)	39.6	56.8
Gross secondary school enrolment rate (%)	7.2 (1990)	15.5
Under-five child mortality (per 1,000)	204	184 (2003)
Total fertility rate (births per woman)	7	6.5 (2004)
Population (millions)	9.8	13.2

Sources: World Bank World Development Indicators and surveys (e : staff estimate).

4.1.2 Energy Sector

Power generation in Burkina comes mostly from thermal power plants, only 18% of installed capacity of the national utility SONABEL consists of hydro power (estimated potential is 150 MW). As of 2007, installed capacity consisted of:

- SONABEL (249 kVA)
- Thermal: 217 kVA
- Hydro: 32 kVA
- Autoproducers (16 kVA)

- Thermal: 8 kVA
- Steam turbines: 8 kVA

Since 2001, Burkina also imports electricity from Ivory Coast and Ghana (124 GWh in 2007). Energy consumption amounted to 607GWh in 2007, which represents about 2% of total energy end-uses. Only 1% of settlements are electrified, accounting for 13% of the population.

A total of 460 kW_p of PV systems have been installed mostly for telecommunication, health, water and lighting services in remote areas.

4.1.3 **Historical development of policy and regulation**

A sector reform has been launched with the Energy Sector Development Policy Paper ("Lettre de politique de développement du secteur de l'énergie") of 30 December 30 2000.

Following this new policy strategy, a first measure has been the opening of national power and hydrocarbon companies (SONABEL and SONABHY) to private participation (law no. 15-2001/AN).

The next steps occurred in 2004-2005 with the 060/98/AN law revision project, which promoted further institutional changes :

- Power sector would be split in two segments: the first one consists of centres already exploited by SONABEL, and the rest is the responsibility of the rural electrification fund ("Fond de Développement de l'Electrification" – FDE)
- SONABEL would become a concessionaire and has the sole responsibility of exploiting and maintaining the existing infrastructure, while the ownership is transferred to a dedicated entity
- Funding and supervising of rural electrification would be led by the FDE through concessions to natural persons or legal entities.
- A regulation entity would also be created

While the FDE has been created in February 2003 (in collaboration with Danish cooperation) and is effectively operational since November 2004, the regulator and the infrastructure management entity are not yet created. Besides, the privatisation process of SONABEL is still ongoing.

A privatisation process has been officially launched for SONABEL but until now the private sector has shown no interest.

The main players of rural electrification and their respective roles are described below:

The Ministry in Charge of Energy defines, implements and follows the energy policy of the Government. The Fonds de Développement de l'Electrification (FDE) finances and supervises rural electrification. As such the FDE is actually a hybrid entity,

sharing characteristics with both rural electrification funds and rural electrification agencies. Danish cooperation is currently the main financial partner of the fund (3.7 billion FCFA have been injected for the 2004-2006 period). Local authorities are responsible for public lighting and can influence electrification projects in their area.
The private sector is involved in feasibility and design studies. They are also sometimes contracted to operate supply systems. Associative and cooperative groups can be granted concessions in rural areas (cf. chapter below).

4.1.4 **Experience with community electrification**

Community-based electrification is being promoted in Burkina with the inception of the COOPEL concept (electricity cooperative).

During the setting-up of a COOPEL, several actors are involved (in addition to the COOPEL itself):

- The rural electrification fund (FDE)
- Two design offices
- A contractor

The FDE is responsible for:

- Financing: 60% of investment costs for distribution, 100% for HTA transmission
- Providing soft loans: 40% of investment costs for distribution over 10 years with a first refund after 3 years
- Recruiting design offices
- Assisting COOPELs in recruiting the contractor and obtaining the concession
- Supervises actions of design offices and the contractor

The first design office realises feasibility studies while the second one ("MOOD/ACA") assists the COOPEL in supervising construction works, obtaining the concession and monitors accounts of the COOPEL.

The contractor builds and maintains the power system, manages billing and collection, and advises the COOPEL on grid extension. He is supervised by the FDE, the second design office and the COOPEL.

The COOPEL itself is in charge of the following tasks:

- Works supervision
- Recruitment and payment of the private contractor (5 year contract)
- Add new members to the cooperative

The organizational set-up is summarized in the following diagram:

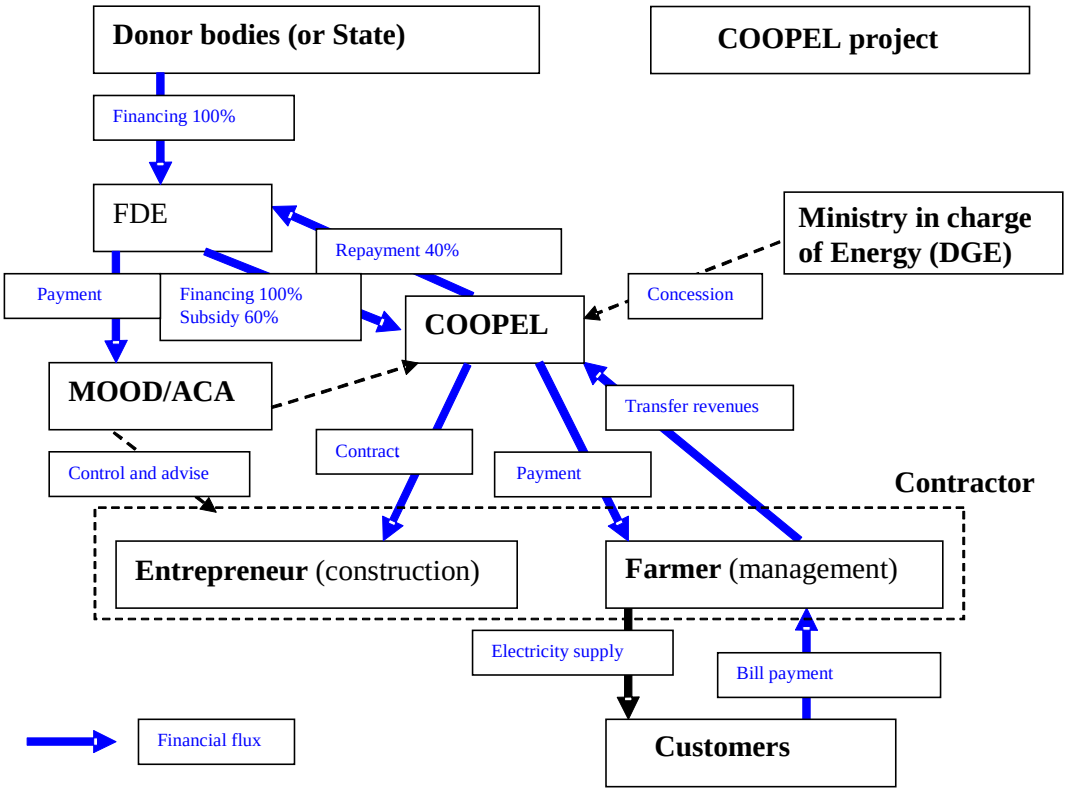

Figure 4.2 Organizational set-up of electricity cooperatives. Source: J.P. Laude (2008)

Each customer of the cooperative is also a member of the cooperative and is thus responsible for its proper technical and financial operation. The cooperative is led by a bureau of members elected at a general meeting.

This scheme requires a significant amount of self-discipline and solidarity among members, as payment faults must be compensated by other members. Financial reserves are indeed very limited, as opposed to large utilities, especially during the first year of operation as shown in Figure 4.3.

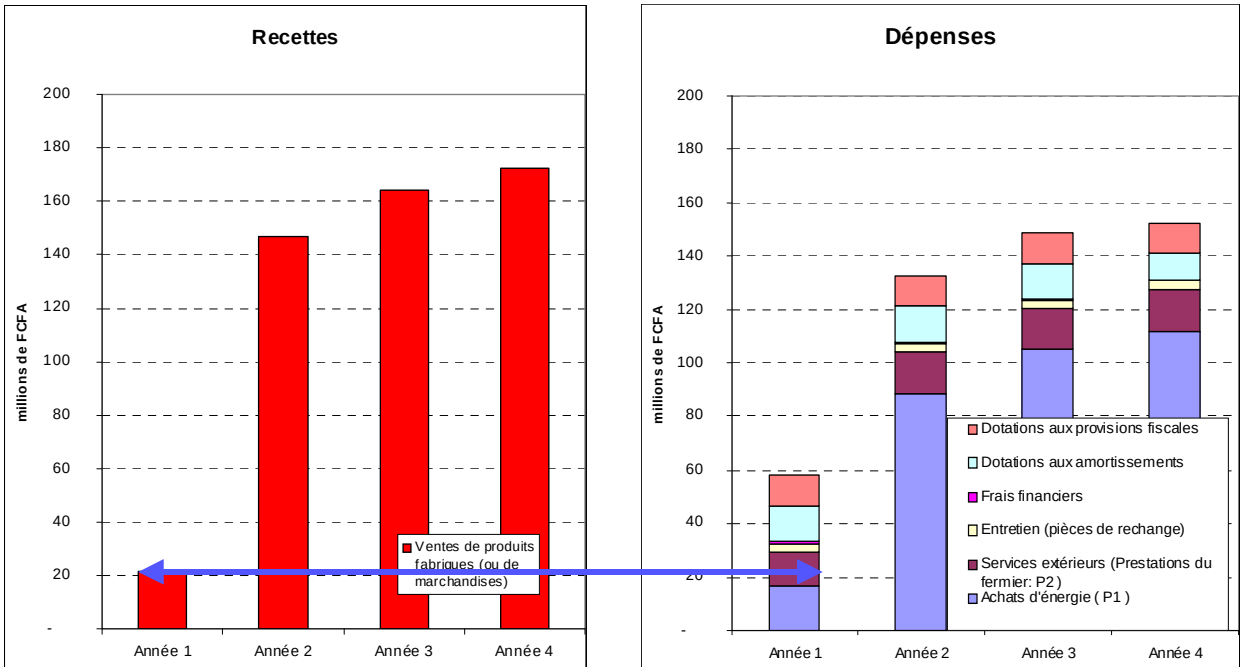

Figure 4.3 Gap between revenue (on the left) and expenditure for the first years of operation Source: FDE

It should be noted that tariffs are defined according to real costs, and thus vary from one COOPEL to another. The maximum allowed tariff is 250 FCFA/kWh. Costs include:

- Fuel expenditure in the case of diesel gensets, or power bought from SONABEL. Other supply options are not currently considered (hydropower is constrained by the lack of water throughout the country).
- Payment of the contractor
- Maintenance
- Capital depreciation over 10 years (100% of genset, 1/3 of distribution and 1/4 of connection costs)

Small consumers (1A) have a fixed price per month and low connection costs, while consumers above 3A (single and three phase) have a more detailed tariff structure.

Main obstacles until now have been the low financial capability of local communities (even with subsidies and loans) combined with a lack of experience of local banks in commercial loans for rural electrification, low technical capability of all actors (contractors, design offices, COOPELs) and low demand for power. Besides, the COOPEL bears almost all of the financial risks (the contractor has very limited involvement, being contracted for a period of 5 years only) and has limited capacity to deal with it, therefore banks are reluctant to provide loans at reasonable rates.

Finally, a large UNOPS-backed programme is installing multifunctional platforms[25] throughout the country (the "Programme National Plates-formes Multifonctionnelle pour la Lutte contre la Pauvreté"). These platforms, usually managed by women groups, consist of diesel engines operated several hours per day and powering various tools for income generating activities (e.g. milling, hulling). Sometimes they also include an alternator for battery charging, welding, lighting and other basic community needs. The programme plans to install 400 systems, targeting 500,000 people.

4.2 Mali

4.2.1 National and geographic situation

Mali is a vast country located at the heart of West Africa. It lies between latitude 10° and 25° North, and longitude 12° West and 4° East, and has an area of 1.241.231 km², making it the seventh largest country in Africa. In 2003, the population of Mali was estimated to be 12 millions with more than 80% of this population living in rural areas, resulting in a low population density of about 10 inhabitants per km². It is bordering Algeria on the north, Niger on the east, Burkina Faso and the Côte d'Ivoire on the south, Guinea on the south-west, and Senegal and Mauritania on the west.

Table 4.4 Socio-economic indicators Source: World Bank, 2008

Indicator	2005	2006	2007
GDP (current million US$)	5305	5866	6863
GNI per capita, PPP (current international $)	960	1000	1040
Population, total	11611090	11968376	12334168

4.2.2 Energy Sector

Mali's energy sector is mostly based on traditional fuels, with a low per capita consumption (0.3 tons oil equivalent). 90% of energy consumed comes from the unsustainable use of fuel-wood. Biomass producing surface has been disappearing at a rate of 9,000ha per year, leading to soil erosion and desertification, and making this the predominant environmental issue linked to energy consumption[26].

A number of RET programmes, mostly photovoltaic (PV), have been deployed in the country to date. Current efforts focus on promoting promising PV applications whilst continuing development of other technologies such as solar dryers, micro hydro, wind power, small scale gasifiers and biogas digesters. Meanwhile, the government is encouraging private enterprises to take the lead on renewable energy

[25] www.ptfm.net
[26] United Nations Environment Programme's Rural Energy Enterprise Development (REED). Country Info. http://www.areed.org/country/index.htm#mali

commercialization issues such as distribution, installation, and maintenance of installed systems[27].

Electricity supply in Mali is limited to around 20% of the urban population and less than 7% of the rural population. To address this contrast, the Government elaborated a rural electrification strategy backed by a financing mechanism so as to providing a conducive environment for public-private partnerships. The reform detailed in Article 14 of the law no. 00-019 of 15 march 2000 gives rural electrification an important profile for the country's economic development, and defines the role of the Ministry of Energy with this regard. The Ministry is obliged to keep an up-to-date "Rural Electrification Development Plan" and provide support for emerging private sector investments.

This reform has opened the market to private operators thereby providing an opportunity for local cooperatives to engage in the rural electrification business. This reform already is bearing fruits in that the rate of rural electrification has already increased from 1% in 2003 to 7% in 2008.

Moreover, the following three axis of action are also envisaged to increase access to modern forms of energy in rural area:

- Spontaneous Candidates (PCASER) proposing small scale rural electrification projects at village or district level. The project is put forward to AMADER by either public or private actors such as local cooperatives, associations grouping the villages and private operators. The concession period is of 15 years and renewable for a project which does not concern an areas larger than a local authority. Prior to acceptance, the AMADER waits for 60 days for counter bids.

- Call for Candidates for disadvantaged settlements. It refers to settlements which have not proposed a rural electrification project. If the settlement falls within an already assigned concession area and the settlement in question is not envisaged to be electrified in the next three years. Each call for Candidates will be proposed with a subsidy and a concession provided for 15 years.

- Call for proposals targeting areas called "Zones of Multi-sectoral electrification" (ZEM). There are 8 large ZEM's, each can include up to 5 000 consumers, and 10 small ZEM's which group together some isolated rural communities with less than 1 000 consumers. The call for proposals is based on the results of specific studies conducted in the ZEM, allowing defining the Terms of Reference which will be attached in the call for proposals. The concession period is provided for 15 years for a project that includes a number of local authorities.

[27] Ibid.

The concession of the first two large ZEM's (Mopti et Ségou) plan to electrify in 2009, 13 settlements in the Mopti ZEM and 7 settlements in the Ségou ZEM with the following technologies:

- Isolated diesel generators
- Mini-MV decentralized networks, supplied by diesel gensets
- Grid extension interconnected to the MV network or decentralized network

In addition pre-electrification modes are also considered for households which are too far from existing LV lines. Multifunctional platforms and Solar Home systems are being considered. A total of 1200 Solar Home Systems (SHS) will be installed.

4.2.3 **Historical developments of policy and regulation**

After a stagnant period in Mali's efforts to integrate renewable energy technologies into the energy sector, the government undertook a series of reforms to create a more favourable climate for growth.

The energy sector in Mali is governed by the following policy reforms:

- The adjustment of the Government's functions in relation to the sectoral policies;
- The creation of a regulatory body;
- The transfer of operational activities to the private sector, through the creation of a conducive environment so as the transfer is rendered possible and attractive
- The implementation of the Rural Electrification Programme and drinking water supply in rural areas

In 1999:
In February 1999, Mali established the National Energy Directorate, an energy board within the DNHE that was designed to strengthen coherence and rationality of national energy policy.

In 2000:
Law 00 19/P-RM of 15 march 2000 opening up the electricity sector to private players and competition;

Creation of the regulatory body « Commission de Régulation de l'Électricité et de l'Eau » (CREE) which guarantees the regulation of the two sectors (power & water) in urban centres

In 2003:
Continuation of the reforms with the creation of the « Agence Malienne pour le développement de l'Énergie Domestique et de l'Electrification Rurale » (domestic energy & rural electrification agency) AMADER, ensuring also the regulation in rural areas

The National Water and Energy Directorate (DNHE) is Mali's primary governmental institution for implementing national energy policy, regulating the energy sector and the planning of large energy and water projects. It oversees various projects such as the National Program for the Promotion of Butane Gas, the Special Energy Program (PSE)and the Domestic Energy Project, and supervises the operations of a number of entities, included some of those listed in the following table (regional or national research and development organizations are listed in the organizations section).

4.2.4 **Experience with community electrification**

As explained above, village-scale electrification is taken into account in the institutional framework with PCASER projects. According to recent communication with AMADER, the rural electrification agency has received 206 applications for PCASER concessions to date. Detailed breakdown is given in the following table:

Table 4.5 Status of current PCASER applications. Source: AMADER, 2008

PCASER	206
Preliminary permit being published	02
Business plan being created	83
Business plan being reviewed by AMADER	50
Business plan validated and waiting for financing	30
Financing done	41

Among financed PCASERs, energy supply is effective for 23 of them, covering 58 settlements and 21,692 customers. Breakdown of generation technologies is:

- Diesel gensets (60% of settlements)
- Hybrid diesel/wind (2%)
- Hybrid diesel/PV (19%)
- PV only (19%)

Works are in progress for 18 projects covering 52 settlements, with significant delays caused by lack of funds from AMADER. This issue should be solved before June 2009, as additional resources are expected to be provided by the World Bank. Performance indicator of AMADER since 2004 until 30th November 2008 are shown in the table below:

Table 4.6: Performance indicators of AMADER. Source: AMADER, 2008

Activities	FORECAST		REALISATION		% REALISATION	
	2008	PEDASB	2008	PEDASB	2008	PEDASB
Total number of connections	10.400	40.000	5,066	29.666	49%	74%
Public institutions	540	1.080	450	690	83%	64%
Schools in rural and peri-urban areas	75	125	65	104	87%	83,2%
Health centres in rural and peri-urban areas	52	107	50	94	96%	87,85%
Community PV systems	400	500	421	582	105%	116,4%
Solar home systems	755	9.650	300	2.645	40%	27,41%

Achievements

Electrified areas have seen and overall improvement in living conditions through lighting, access to modern information and communication technologies (ICT) and income generating activities with:

- Irrigation, pumping and water quality improvement
- Conservation and transformation of agricultural products
- Craftsmanship and commerce

PCASER in particular have been rather popular among the private sector, thus justifying the public-private partnership approach promoted throughout Mali. In fact, more than 40 private companies have been created for this purpose, accounting for more than 200 permanent jobs.

Among the 23 running projects, some of them have really demonstrated professionalism according to AMADER.

Obstacles

However, some obstacles have been encountered at different levels, while setting-up new PCASERs:

- AMADER: lack of financial resources have constrained the ability of the agency to meet the rising demand for PCASERs and even projects under construction (18). Delays in payment from the State have also delayed works supervision activities on ongoing projects. Tax deductions of fossil fuels have suffered delays as well.
- Private operators: lack of professionalism is sometimes witnessed regarding:
- Technical, administrative and financial management
- Recruitment and organisation of personnel

Some of the 23 realised projects are also facing serious challenges:

- Lack of clients (some projects are not running because of this)
- Some operators have not respected the Convention
- Projects are delayed because of conflicts between the operator and its suppliers
- Projects have started on the funds of the operator, but have been stopped until funds from AMADER are unlocked

- Technical issues: some wind turbine projects are not working properly because of irregular and slow winds in the area

A few suggested solutions:

- New financing from international donor organisations has been sought for AMADER
- Capacity building is planned for AMADER
- Awareness raising campaigns towards entrepreneurs to promote renewable energy (including biofuels) and proper maintenance of systems
- Transition from community-managed projects to private-managed projects will be promoted

4.3 Senegal

4.3.1 **National and geographic situation**

The Republic of Senegal is a country south of the Sénégal River in western Africa. Senegal is bounded by the Atlantic Ocean to the west, Mauritania to the north, Mali to the east, and Guinea and Guinea-Bissau to the south. The Gambia lies almost entirely within Senegal, surrounded on the north, east and south. From its western coast, Gambia's territory follows the Gambia River more than 300 kilometres (186 miles) inland. The local climate is tropical with well-defined dry and humid seasons that result from northeast winter winds and southwest summer winds.

In January 1994 Senegal undertook a bold and ambitious economic reform programme with the support of the international donor community. This reform began with a 50 percent devaluation of Senegal's currency, the CFA franc, which was linked at a fixed rate to the former French franc and now to the euro. Government price controls and subsidies have been steadily dismantled. After seeing its economy retract by 2.1 percent in 1993, Senegal made an important turnaround, thanks to the reform program, with real growth in GDP averaging 5 percent annually during the years 1995–2001. Annual inflation was reduced to less than 1 percent, but rose again to an estimated 3.3 percent in 2001. Investment increased steadily from 13.8 percent of GDP in 1993 to 16.5 percent in 1997.

However, despite this good performance, Senegal still has a significant portion of its reform agenda to meet. The economic growth after the devaluation had only a small impact on poverty especially in rural areas. Income inequality is high. Social indicators—primary education, infant and maternal mortality, access to clean water—still lag behind income indicators. The lack of key infrastructure—water, electricity, and transport—handicaps development and poverty reduction. Public policies, notably in the areas of taxation and investment, do not provide sufficient incentives and handicap growth by slowing down private-sector development. As a result, close to 60 percent of the national Senegalese population is considered to be below the absolute

poverty level[28], and this number can go up to 90 percent in some rural areas. (ESMAP, 2008).

A new push toward poverty reduction was started in 2002 with the creation of the Senegal Poverty Reduction Strategy Paper (PRSP, or DSRP in French). The pillars of Senegal's PRSP are: (i) wealth creation; (ii) capacity building and social services; (iii) assistance to vulnerable groups; and (iv) implementation of the PRSP strategy and monitoring of its outcomes.

4.3.2 **Energy Sector**

Total installed capacity of the Senegalese power sector is 694.9 MW, but different constraints such as aging equipment bring the operational capacity down to 508.7 MW in 2008. This capacity is available mostly on the interconnected grid network (572.1 MW), of which 354 MW are provided by the national electricity company SENELEC (76 MW of steam turbines, 227.8 MW of diesel generators and 50 MW of gas turbines), while the rest is supplied by private operators (40.8 MW rental diesel, 60 MW Mantali hydro power plant, 67.5 MW Kounoune heavy fuel power plant, 50 MW GTI gas turbine). The share of power bought from IPPs has increased recently, to cope with heavy fuel supply issues of SENELEC (heavy fuel accounts for 80% of its fuel inputs).

The self-sufficiency in terms of primary energy is 42%, but the figure drops to 2% if traditional uses of biomass are included.

There has been a steady increase in capacity of the power sector (from 340 MW in 2000), and it is expected to continue, as a consequence of the PRSP project and an energy sector reform programme funded by the World Bank (80 M$) and the French AFD (50 M€), which will span from September 2008 to June 2010.

This programme aims at improving the financial situation of SENELEC, which is facing serious challenges with a deficit amounting to 63 billion FCFA in 2008. Series of blackouts have been experienced recently and triggered protests in Dakar. This situation is naturally worsened by the recent increase in fuel prices, as all generation equipments owned by SENELEC are fossil fuel fired.

As part of this programme, a first measure has been a 17% increase in tariffs starting from August 2008. This follows a 6% increase in 2007, but is still considered insufficient to cope with soaring costs according to SENELEC mangers. Current low voltage tariffs are indicated in Table 4.6.

[28] In 2001, the last year when the poverty levels were effectively measured for the PRSP, 57 percent of the population nationwide was below the absolute poverty threshold at which an adult cannot meet the minimum nutrition levels of 2,400 calories per day.

Table 4.7: Tariffs as of August 2008 (without VAT)

Tariff categories	Price of energy (FCFA/kWh)			Fixed rate (FCFA/kW)
	1st block	*2nd block*	*3rd block*	
Domestic				
Low power domestic user	112.00	116.18	119.49	
Medium power domestic user	118.86	121.11	122.78	
Professional				
Low power professional user	159.50	160.41	161.86	
Medium power professional user	160.69	161.41	163.57	
High power	***Peak hours***	***Normal hours***		
High power domestic user	100.45	140.63		1 011.74
High power professional user	120.31	192.50		3 035.23
Prepaid	***Price of energy (FCFA/kWh)***			
Low power domestic user	116.18			
Medium power domestic user	121.11			
Low power professional user	160.41			
Medium power professional user	161.41			
Public lighting	138.14			3515.72

Several large scale regional interconnection projects have been launched, as part of a master plan on the 2005-2020 period and following the creation of the « West Africa Power Pool ». These projects are mostly hydroelectric projects on the Sénégal (as part of the OMVS, featuring Mali, Mauritania and Senegal) and Gambia rivers (as part of the OMVG, featuring Gambia, Guinea, Guinea-Bissau and Senegal). Other regional bodies (ECOWAS, UEMOA…) are also involved in the process.

4.3.3 **Historical developments of policy and regulation**

In 1998, the Government of Senegal (GoS) has led a deep reform of the power sector, so as to secure low cost energy supply and expand access to electricity in rural areas. Major changes have been brought by law no.98-29 of April 14th 1998 and its associated decrees: the role of existing institutions have been changed and new institutions have been created, such as a regulator, the "Commission de Régulation du Secteur de l'Electricité" (CRSE) and the rural electrification agency, the Agence Sénégalaise d'Electrification Rurale (ASER) with an associated rural electrification fund (FER). The Construction–Exploitation–Transfer (CET) law and the law creating the "Conseil des infrastructures" (voted in 2004), aimed at creating suitable conditions and a clear regulatory framework for public-private partnerships, have incurred further institutional changes.

As part of this reform, SENELEC has been privatised in 1999 and partially bought by the Hydro Quebec-Elyo consortium. However, the consortium got dismantled in January 2001 as initial performance objectives were not met. Failure of this privatisation attempt has led GoS to enact the following changes:

- Rural electrification activities, structurally not profitable, are no longer the responsibility of SENELEC.
- Independent generation is introduced, [29] with SENELEC being the only buyer
- Distribution is also opened to competition, on the basis of concessions (cf. next paragraph) SENELEC becomes a state controlled company, with 51% shares owned by GoS, 34% by strategic partners, 10% by local operators and the rest open to the public.

A new privatisation process is now initiated, with the "Energy sector development policy paper" ("Lettre de politique de développement du secteur de l'énergie" – Lpdse) drafted in February 2008. This new policy aims at unbundling generation, transmission and distribution activities of the national company, and bind them in a Holding company. National and international private sector participation will be sought, especially in the distribution and generation activities, while ownership of transmission will remain mostly public. This reform is due to be finished by the end of 2009.

Nine main actors are now involved in rural electrification:

- Minister in charge of Energy ("Ministre chargé de l'Energie")
- Energy Department ("Direction de l'Energie")
- Power Sector Regulation Commission ("Commission de Régulation du Secteur de l'Electricité" - CRSE)
- Tender Commission ("Commission d'appel d'offre" - CAO)
- Infrastructure Council ("Conseil des infrastructures")
- Senegalese Rural Electrification Agency ("Agence Sénégalaise d'Electrification Rurale" - ASER)
- Multisectoral Committee for Poverty Alleviation (« Comité Intersectoriel de Mise en œuvre des synergies entre le secteur de l'Energie et les autres Secteurs Stratégiques pour la réduction de la pauvreté » – CIMES)
- SENELEC
- Concessionaires

Their respective role is as follows:

The **Minister in charge of Energy**, defines sectorial policy and applicable norms, and supervises ASER. He is responsible for awarding PPER and ERIL concessions (see next paragraph for a detailed explanation of these schemes). The new CET law also grants him the management of the prequalification phase, and the first phase of the two-phase tender procedure. The Minister is due to follow advice from the CRSE (or CAO when relevant) on concession awards.

The **Energy Department** has the following responsibilities:

- Draft and follow implementation of energy planning

[29] There are currently four IPPs in Senegal: GTI, ESKOM-Manantali, Kounoune Power and Aggreko (rental diesel power).

- Liaise and collaborate with subregional organisations working in the energy sector
- Plan and follow implementation of rural and urban electrification, in collaboration with relevant organisations and structures
- Develop and promote renewable energy technologies and energy conservation
- Provide statistics and energy accounting
- Assist the CRSE on the supervision of works within concessions
- Supervise companies and other autonomous agencies working in the energy sector (ASER, SENELEC, CNH)

The **Power Sector Regulation Commission (CRSE)** evaluates applications for concessions (excluding requests for subsidy). After awarding, the CRSE monitors concessions to ensure that the Terms of Reference are properly followed, especially quality and continuity of service and technical norms. It also defines tariffs in association with the Minister in charge of Energy. Finally, it acts as a consultative body, allowed to submit law proposals to the Minister on all aspects of concessions.

The **Tender Commission (CAO)** collects and evaluates proposals from would be concessionaires.

The **Infrastructure Council** is a consultative body dealing with public-private partnership matters in all infrastructure sectors. It provides advice at the beginning of the concession awarding process, and at the end to prevent lawsuits and ease their solving.

The **Agence Sénégalaise d'Électrification Rurale (ASER)** provides technical and financial assistance to rural electrification initiatives, within the energy policy defined by the Minister in charge of Energy. Its mandate is to:

- Inform population on development of rural electrification in Senegal
- Bring technical assistance to rural electrification projects
- Provide subsidies (through the national rural electrification fund, Fonds d'Electrification Rurale –FER) or financial insurance to ease commercial loans
- Award electrification concessions on behalf of other entities
- Promote social and productive uses of electricity : education, health, rearing, water supply, telecommunication, craftsmanship.

The rural electrification fund is supplied by taxes on revenues of all concessionaires, direct funding from the government, and international donors. The investment plan for the 2005-2016 period spreads 163.65 billion FCFA over 3 phases:

- 35.87 billion FCFA from 2005 to 2008
- 64.11 billion FCFA from 2009 to 2012
- 63.67 billion FCFA from 2013 to 2016

The Multisectorial Committee for Poverty Alleviation (CIMES) is a new structure dedicated to improvement of synergies and coordination between different sectors of rural development. Its main tasks are to:

- Help poverty alleviation projects in assessing their energy component and ease their access to energy services
- Monitor ongoing development projects for a better integration with rural electrification strategies
- Identify best practices and failures of past synergy experiences
- Promote diffusion of mature technologies for poverty alleviation
- Define impact indicators and set up a monitoring and evaluation process

SENELEC is the historical power utility. As a concessionaire in rural areas, SENELEC operations are limited to settlements which were already electrified or in the process of electrification at the time of the concession contract. It cannot apply for other concessions. However, SENELEC is the sole operator allowed to buy, transmit and sell wholesale power on the national grid, which formally belongs to the Senegalese State. Concessionaires will thus have to buy power from SENELEC if interconnected with the main grid network.

Concessionaires will be private companies, most probably regional (such as the Moroccan ONE, the first concessionaire) or international ones.

4.3.4 **Rural electrification and renewable energy**

Electrification rate in rural areas is still relatively low but has risen significantly over the past years, since the reform of the power sector: from 5% in 2000 to 15% in 2006, with a target of 30% in 2015. However, it is estimated that less than 30% of the population of electrified villages are effectively connected.

First attempts of GoS at improving access to modern forms of energy in rural areas have consisted in small-scale decentralised pilot projects, which proved successful but hardly up-scalable without massive involvement of the private sector. Besides, coordination of electrification with other sectors of rural development was poor, resulting in lower efficiencies of all sectors (ESMAP, 2008).
The GoS is now aiming to solve these two issues with a comprehensive new policy, based on the following core principles:

- Recognise specificities of rural electrification, which is both a commercial activity and a strategic sector of rural development. This statement is behind the creation of the dedicated rural electrification agency (ASER)
- View rural electrification from the perspective of long term economic and social development, and thus pay particular attention to technical and economic viability of all projects
- Involve private sector, NGOs and local communities in rural electrification

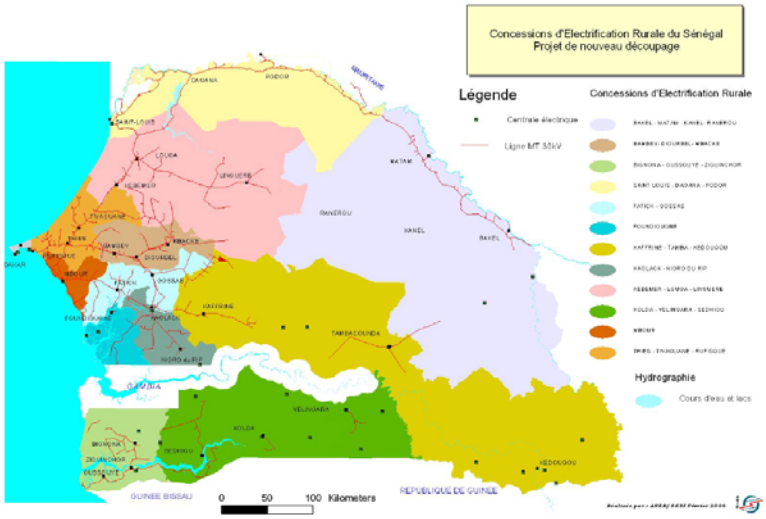

Figure 4.6: Map of PPER concessions. Source: CRSE 2006

As part of this strategy, and following a policy paper of 2004 (LPDER), the "Programme Prioritaire d'Electrification Rurale" (PPER) project has divided the whole territory in 12 concessions, to be handed down to private operators for a duration of 25 years. One of the concessions has already been granted to Morocco's Office National de l'Energie (ONE), and several local rural electrification plans are being drafted in other concessions. While the concession strategy is officially technology neutral, a GEF subsidy aims to foster the use of renewable energy technologies by concessionaires, as a complement to the base subsidy from GoS and other international donor bodies.

As a complement to this "top-down" approach, smaller demand-driven concessions ("Electrification Rurale d'Initiative Locale" - ERIL) are also studied. These are meant to provide room for electrification projects in remote areas of concessions, and in concessions which will not be awarded soon. These projects would be implemented on a small area or village, and would be financially supported by local stakeholders (local authorities, consumer associations, migrant associations, villagers groups, local entrepreneurs, other community associations), up to 80% of initial costs.

In the meantime, multisectoral projects (« Projets Énergétiques Multisectoriels » - PREMs), focused on income generating activities, are identified and validated by a new multisectoral entity (the « Comité Intersectoriel de Mise en œuvre des synergies entre le secteur de l'Energie et les autres Secteurs Stratégiques pour la réduction de la pauvreté » – CIMES).

However, it should be noted that this framework is being implemented at a rather slow pace since its inception in 2004. That is why the number of PPER concessions has been reduced from 18 to 12.

Until now, the steady increase in electrification rate has been supported by 4 large projects totalling 42 billion FCFA, which electrified 500 villages. Spanish cooperation in particular has financed two large PV projects:

ATERSA connected in 2004-2005, 2648 street lights and 662 community centres (dispensary, school, women houses, worship centres…) with 10.7M €
ISOFOTON installed in 2003-2004, 10000 solar home systems in 287 villages with 20M $

In terms of renewable energy, Senegal enjoys significant potential in all main renewable energy families (small hydro, wind power, solar PV, biomass and bioenergy), but only a fraction of it is currently exploited, with the Manantali hydro power plant (60 MW) and more than 2 MW_p of cumulated PV capacity. However, several large projects are being implemented (solar public lighting, wind farms in Potou and Lompoul, 7.2 MW solar PV power plant in Zinguinchor and 15 MW wind farm in Gandon).

Historically, renewable energy, and PV in particular, has played a significant role in project-based decentralised electrification. While this has been slightly tempered with the energy sector reform in 1999, the two recent PV projects mentioned above and the technological neutrality of concessions enforced with GEF subsidies indicate that renewable energy is to continue its role as a significant player in off-grid electrification. In fact, a nation-wide study has been recently launched to assess the potential of renewable energy for both grid and off-grid systems.

4.3.5 **Organization and financing of community electrification**

Starting with the sector reform of 1998, Senegal has operated a shift from villager associations to rural energy service companies, grouped under the FOPEN ("Fédération des Organisations Paysannes pour la Promotion des Energies renouvelables"), which had the responsibility of disseminate, install and monitor PV systems in Senegal.

This liberal approach to rural electrification has been supported by the African Rural Energy Enterprise Development (AREED) of PNUE, also implemented in Mali, Ghana, Zambia and Tanzania. An NGO (ENDA) has been responsible for the implementation of the programme in Senegal, and supported the creation of 9 energy companies, of which 2 are dedicated to rural electricity supply.

5 Other international experience

5.1 Cambodia

5.1.1 National and geographic situation

Cambodia is located in South East Asia lying between Thailand to the west and north and Vietnam to the east. Cambodia shares also a land border with Laos in the northeast and it has a sea coast on the Gulf of Thailand. Cambodia's climate is tropical monsoonal with a pronounced wet and dry season. During the wet season from May until early October, rainfall is largely derived from the southwest monsoon drawn landward from the Indian Ocean. The average annual rainfall varies across the country from between 1,000 to 2,500 mm.

In general, Cambodia's mineral resources appear to be limited. The country's hydroelectric generating potential is considerable (about 10000 MW), especially from the swift current of the middle Mekong River where it flows through Stoeng Treng and Kracheh provinces. Another natural resource is the forests, which cover approximately 70 percent of the country and which potentially constitute a second pillar of the economy in addition to the primary one, agriculture.

Table 4.2: Selected key socio-economic indicators, year 2006. Source: ASEAN secretariat.

Total land area	thousand km^2	181,035
Total population	thousand	13,996
Population density	persons per km^2	77
Annual population growth	percent	2.5
GDP product (at current prices)	US$ million	6,105.2
Gross domestic product/capita	US$	436.2
	US$ PPP	2,406.4
Growth rate of GDP, constant prices	percent per year	5

Cambodia has a population of 14 million people with annual growth rate of 2.5% (data 2006). Its GDP per capita is 436 US$/y. The agriculture, mostly subsistence rice farming dominates the economy, employing an estimated 85% of the population and producing of 50% GDP, while the industry and services share 25% of GDP each.

The Cambodian economy continues economic boom during last years, most from tourism sector. The tourism is one of the main economic sectors in Cambodia with more than 1.5 million tourists per year, US$ 1 billion revenue, and growth rate about 15-20%/y (Cambodian statistical office 2006). This increase creates a pressure on infrastructure development in Cambodia, particularly on electricity and water demand.

In following up on the Millennium Declaration, Cambodia has launched several initiatives to meet its global and national commitment to fight extreme poverty, including several institutional reforms. The *Rectangular Strategy* and the *National Poverty Reduction Strategy* build upon a policy stance of economic growth and poverty reduction. The reform agenda essentially focuses on a deepening of economic reforms and macroeconomic stability, including fiscal and monetary reforms, trade and investment promotion, administrative reforms, military demobilization, and improved fishery and forestry management.

5.1.2 **Energy Sector**

Electric power system in Cambodia was reconstructed from the ruins since the 80'. It consists of isolated systems with the biggest systems in Phnom Penh capital (140 MW peak demand) and several non-interconnected grid in provincial towns under the national utility "Electricité du Cambodge" (EDC) and many mini-grid systems provided by scattered rural electrification enterprises (REE, private energy providers). These systems can be grouped into three categories

- EDC supply systems (18 not interconnected supply areas in Phnom Penh and provinces);
- Licensed private Rural Energy Enterprises (REE) power supply systems (around 142 generation, distribution and/or retail REE, mostly mini-grid with diesel systems);
- Non-licensed REE power supply system (estimated number between 400 – 600).

About 18% of household have access to electricity, mostly concentrated in Phnom Penh and big cities (Sihanouk ville, Xiem riep, Battambong). Per capita consumption is about 78 kWh/y. Also rechargeable automotive batteries are commonly used in rural areas where are without existing grid for basic lighting and powering radio.

At the end of 2005, the total installed capacity in Cambodia was 231.33 MW which was distributed between EDC (83.86 MW), IPP (127.97) and small consolidated licensee (REE, 19.5 MW) and generated 879.37 GWh. Most of the generation capacity is Diesel (158.82 MW), one steam turbine (18 MW), two small hydropower plants and about 0.1 MW of wood & biomass power plants. There are two HV lines of 115 KV: a peripheral line around Phnom Penh of 22.71 km and Kirirom 1 – Phnom Penh of 111.24 km. The total distribution systems is about 1200 km of 22/15/10/6.6 kV.

Recently, a 200 MW coal-fired power plant project has been signed in Sihanoukville. Completion is expected for 2010.

Interconnection of isolated systems and import of electricity from Vietnam and Thailand are considered as an appropriate short and mid-term strategy to meet surging demand and keep tariff at reasonable levels. In fact, with more than 90% of electric generation coming from diesel gensets, the electricity prices in Cambodia are currently the highest in the ASEAN region (12-25 US cents/kWh, and up to 1$/kWh for isolated

private systems). That is why rechargeable car batteries are commonly used throughout the country, even among electrified households.

5.1.3 **Historic developments of policy and regulation**

The basic law that governs the energy sector in Cambodia is the electricity law which was promulgate on 02 February 2001. The Electricity Law of the Kingdom of Cambodia governs and establishes a framework for the electric power supply and services throughout the Kingdom of Cambodia. This law covers all activities related to the supply, the provision of services and use of electricity and other associated activities of power sector. This law aims to establish:

- the principles for operations in the electric power industry,
- the favourable condition for the investments in and the commercial operation of the electric power industry
- the principles for the protection of the rights of consumers,
- the principles for the promotion of private ownership of the facilities for providing electric power services and
- the principles for establishment of competition wherever feasible within the electric power sector.

Article 3 of electricity law defines the responsibility between two main institutions: Ministry of Industry, Mines and Energy (MIME) and Electricity Authority of Cambodia (EAC), in power sector. The roles of two organisations as well as other institutional arrangements are shown in the following picture.

EDC is a state owned corporation under MIME, which owns and operates the Phnom Penh main generation, transmission and distribution assets, as well as in several provincial towns and accounts for approximately 90% of total electricity consumption of the country (including IPP generation selling to EDC). The remaining electricity consumption is supplied through rural electrification enterprises (REE) and small generators.

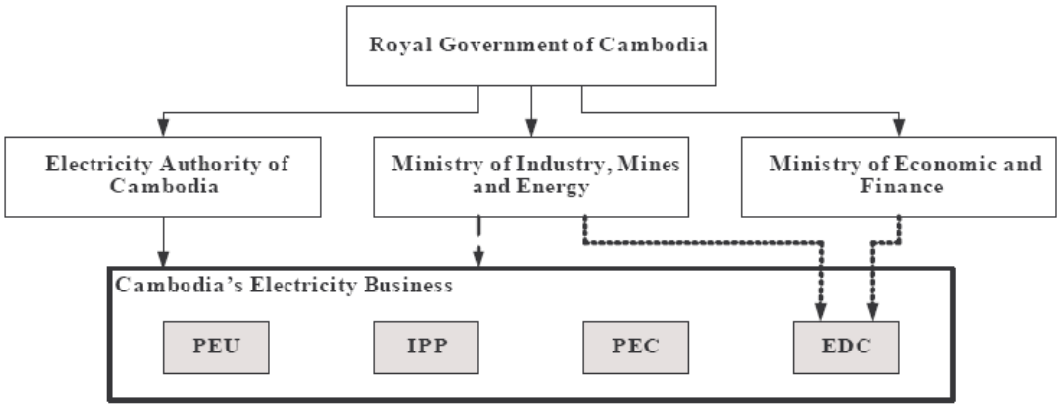

Figure 4.4: Institutional structure of Cambodia energy sector

Note : PEU – public electricity utility; IPP – Independent power producer; PEC – Private electricity company; EDC – Electricité du Cambodge;

⋯⋯▶ *Ownership control of EDC*

– – ▶ *Policy, strategies planning, development, technical, safety and environmental standards*

——▶ *Regulations, issue licences, review the planned investments, finance & performance, enforce regulation, rules and standards*

At provincial level, the Departments of Industry, Mines and Energy (DIME) which depends on MIME and on Provincial authority, plays a key role in implementation of rural electrification programs, but not very actively participate in the formulation of policy and measures.

5.1.4 **Rural electrification and renewable energy**

Rural electrification

Main components of the Rural Electrification Strategy in Cambodia:

- Grid expansion from the existing network
- Diesel stand-alone, Mini-Utility Systems
- Cross-border Power Supply from neighbouring countries (Thailand, Vietnam and Lao PDR)
- Renewable Energy (Solar, Wind, Mini-micro hydro, Biomass, Biogas, Bio-fuel, etc…)
- Rural Entrepreneurs, NGOs and woman's groups shall be encouraged to participate in the management at the local level
- Goals: by 2020, all villages will have access to electricity of different forms; The target of the government is to provide 24-hours services to 70% of rural households by 2030 at acceptable price level and with minimum subsidy from the government.

The challenge of Rural Electrification in Cambodia is substantial, requiring a private and public up scaling in investments, implementation rate and human resource

development. To achieve the RE target of 70% in 2030, it is estimated that an investment of more than US$ 1 billion would be required.

A World Bank initiative, The Rural Electrification Fund (REF), is to be the principle instrument to facilitate financial support and technical assistance to expand electricity supplies in rural and remote communities. Its main features are :

- Credit from the World Bank to RGC with Low Interest Rate
- Grant from Global Environmental Facility
- Counterpart funding from RGC
- Future funding may include funds from other sources and/or countries.
- For the 1st year the subsidies are as follows:
- Diesel REEs – US$ 45 per new Household Connected
- Solar Home System: US$ 100/set of 40 W_p
- Mini and Micro Hydro – US$ 400/kW Capacity

Table 4.3: Rural electrification plan and financing requirements

Type of Electrification	No. of Candidate Villages	No. of h.h. to be electrified by year 2020	Total Cost	Total Cost per h.h.	Fund Source of Capital Costs		
			($1,000)	($/h.h.)	Subsidy	Equity	Loan
Electrified as of 2005	2,062	(350,345)	-	-	-	-	-
Newly Electrified by Grid	6,411	**600,000**	**280,140**	467	70,035	42,021	168,084
MHP/Hybrid	137	9,000	11,064	1,229	5,532	1,106	4,426
Biomass	3,071	168,000	99,498	592	24,875	14,925	59,699
Diesel	392	23,000	9,760	424	2,440	2,440	4,880
Sub-total of Mini-grid	**3,600**	**200,000**	**120,322**	**602**	**32,847**	**18,471**	**69,004**
Solar BCS	1,720	60,000	21,045	351	19,993	1,052	0
SHS(World Bank)		12,000	5,520	460	1,380	1,380	2,760
Sub-total of off-grid area	5,320	**272,000**	**146,887**	540	54,219	20,903	71,764
Village data unknown	121	-	-	-	-	-	-
Total	13,914	**872,000**	**427,027**	490	124,254	62,924	239,848

Renewable energy

No concrete incentives for renewable energy have been applied, although the governments have announced several policies for renewable energy development.

Hydro

Potential of hydropower in Cambodia is very high (Technical potential is more than 10000 MW for large hydropower and 300MW for small, mini and micro hydropower) but the development of these sources has not been implemented due to lack of technical studies and investment capital. Besides, significant drop in the dry season flow and power output make them not very attractive option for off-grid rural electrification.

As of 2006, there are 10 hydropower plants in operation in Cambodia with total capacity of 13189 kW, 4 hydropower plants with a total capacity of 180.44 MW are under study and/or construction, and about 65 small and minihydro sites have been identified.

Biomass

Biomass resources such as wood (rubber trees, acacia, eucalyptus…) and agricultural residues (rice husk, cashew nut shells, peanut shells, palm oil residues) are abundant in Cambodia.

Biomass-fired generation is expanding quickly, especially gasification of agricultural residues, either spontaneously or through international cooperation. A few examples of biomass fuelled electricity generation in Cambodia:

- NEDO PV and biogas hybrid power generation project which consists of PV (50 kW) and 2x35 kW duel fuel biogas engine near Sihanouk ville. The biogas is extracted from cattle excrements from farms. The system is operating but for demonstration and research purpose and would not be economically viable
- A 200kW rice husk gasification project has been implemented in Battambang province, in a relatively large rice mill (2t rice processed per hour). Investment costs amounted to US$75,000 and the payback period was 3 years.
- Anlong Ta Mei community energy project – Battambang : This is a 9 kW biomass gasification electricity generation project running on commercial basis from Leucaena tree. Cost of the gasifier was about US$15,000.
-

Figure 4.5 Biomass gasifier in Anlong Tamey. Source: JICA study of rural electrification by Renewable energy in Cambodia

Solar

The data from the JICA master study of rural electrification by Renewable energy in 2006 have show an average radiation of 5.1 kWh/m²/day or equivalent of 1860 kWh/m²/y over the country. According to MIME, as of 2004, more than 204 kW_p of PV modules has been installed in the country. They are used to supply power for household lighting and small electric equipment of public and telecommunication facilities. These installations were mostly donation and/or demonstration research projects.

Wind

There are few reliable records of wind speed data for Cambodia. Observations and extrapolation from neighbouring Thailand and Vietnam tend to indicate that mean wind speeds are low, in the order of 2m/s for much of the country.

The southern part of the great lake Tonle Sap, the mountainous districts in the southwest and the coastal regions have an annual average wind speed of 5m/s or greater; thus the introduction of wind power generation system in these areas is promising.

5.1.5 **Organization and financing of community electrification**

As indicated above, private involvement in rural electrification and community based schemes in particular are mentioned in the national policy. However, at present there are few community based grid systems under commercial operation.

The Anlong Ta Mei pilot biomass project mentioned above is an example of such organisational set-up, its main features are:

- Electricity is supplied 9h a day to 70 customers
- 81 households, 20 streetlights and 7 small businesses served
- Technical and supervisory inputs were provided by a NGO at the onset of the project, from 2003 to 2005 (Small and Medium Entreprise Cambodia – SMEC)
- Initial investment costs (US$35,000) are supported by Canadian funds (CIDA)
- Community energy cooperative owns, operates, maintains and manages the system on a non-subsidized basis. It also provided free labour to construct the electricity system.
- 100% fuelled with locally grown Leucaena tree (tropical fast growing legume tree). Grown and sold by 53 farmers on 5ha.
- Current tariff: 1500 Riel/kWh (0.37 US$/kWh), covering O&M costs and depreciation (provision for equipment replacement, accounting for 38% of the tariff). Tariff is high but still 50% lower than similar neighbouring villages.
- Without the grant on investment costs, tariff would have been close to 0.60 US$/kWh.
- Financial sustainability is dramatically increased by businesses operating during the day (e.g. battery charging station)

The existing private energy entrepreneurs have obtained financing from local banks, in particular ACLEDA and AMRET banks. These loans are primarily for diesel fuelled generators supplying mini-grids or battery charging operations. In December 2004, ACLEDA had financed 79 mini-grid projects with the loan outstanding amount of $205,436, and 134 battery charging projects with the loan outstanding amount of $ 263,495. Loan conditions are not disclosed, but the bank usually lends for less than one or two years at 18 to 30% annual interests. This short-term financing is possible for diesel gensets because the initial capital costs are relatively low (most gensets are

second-handed) and cost recovery is quick due to high tariff setting. Obviously, this is more difficult for renewable energy technologies, being more capital intensive.

5.2 China

5.2.1 **National and geographic situation**

The fast pace of industrialization being experienced by China today is rooted in a long history of reforms, and a strong determination to make full use of its enormous resources. As indicated by various sources (e.g. World Bank(2008) and Enerdata (2008a), included in the resources is the large mass of population numbering about 1.320 billion, this being the largest concentration of humanity. Slightly over half of the population still lives in rural areas as there has been a tight control on rural-urban migration. A high level of penetration of industrialization into rural areas has also played a role in stemming the migration. It is also worth noting that there is an uneven regional distribution of urbanity which may be equated with the level of industrialization and development. The western, northern, and north-eastern regions that are generally mountainous have a lower level of urbanity than the rest of the country. The highest level of industrialization is in the southeast.

Statistics (ibid) show that the country's GDP, with a per capita level of US$2400 in 2007, grew by an average of about 11% per annum between 2005 and 2007. Although the level of poverty has dropped dramatically on account of industrialization, there is still a sizeable portion of the rural population in the northern half of the country where people live on less than US$1 per day – the World Bank's measure of poverty. The situation faced by this section of the population is similar to that experienced by many people in poor developing countries, meaning that much more than industrialization is required for eradication of poverty.

5.2.2 **Energy Sector**

The fast-paced economic growth taking place in China has brought with it an insatiable demand for energy, and while the country was an exporter of oil about two decades ago now it is a net importer. This is documented by various studies (e.g. Enerdata (2008a), World Bank (2007), and World Bank (2008), which also indicate that coal continues to be the leading energy resource due to its abundance locally. It is used for commercial and household purposes.

Considering the total national energy supply in 2007 the total contributions from coal, oil (local and imported), biomass, primary electricity, and natural gas (local and imported) were 65%, 18%, 11%, 3% and 3% respectively. Unlike in many developing countries, the share of household energy contributed by biomass is reducing while that of coal and electricity is increasing. For example the biomass contribution dropped from about 85% in 1980 to 56% in 2004, while the share of coal and electricity rose from 14% and 1% to 34% and 6% respectively within the same period. Statistics

provided by Jiahua *et al* (2006) show that access to electricity in rural areas within the period rose appreciably (e.g. from 93.0% in 1993 to 98.7% in 2002).

For the country as a whole, the current installed capacity for electricity is given by Enerdata (2008a) as 722 GW, which is constituted by generation from coal (69%), hydropower (20%), oil and gas (9%), nuclear energy (1%), and wind and other renewables (1%). Jihua *et* al report that in rural areas there are both on-grid and off-grid supplies with 51% of off-grid supply coming from small hydropower (SHP) sources. Other sources for off-grid supply are coal (36%), diesel (12%), and other renewables (1%).Overall, the rural power generation sources had an installed capacity of 52 GW in 2002, and between 1975 and 1979 a total of 40,000 SHP plants were installed (Khennas *et al*, 2000).With this huge potential for SHP capacity China has become a leader in SHP development and has established an international training centre on this form of generation at Hangzhou.

The institutional setup in the energy sector has been very dynamic and has been following the trend of overall reforms in the country. At present, energy institutions are spread over the State Council and several ministries (Enerdata, 2008a; and Zhao, 2001), but the overall jurisdiction of the electricity sub-sector lies with the State Council. At central government level, the council is responsible for policy and regulation through the State Electricity Regulatory Commission, and coordination of the national electricity corporations (enterprises) such as the National State Power Corporation, the National Grid Company, and the International Water and Electricity Corporation. At the local government and rural level the ministries responsible for electricity functions are: Ministry of Water Resources (hydropower and rural grids), Ministry of Agriculture (renewable technologies except hydropower), and the Ministry of Science and Technology (Research, development, and demonstration of energy supply and use with specific focus on renewable technologies).

5.2.3 **Historical developments of policy and regulation**

The trend of energy policy and regulation has been as varied as the national reforms that have taken place over the last fifty years. The general trend of the reforms can be summarized as in this chronology (Zhao, 2001; and Jiahua *et al*, 2006):

1949-1979
Started with a centrally planned economy and ended up with decentralization, with communism as the guiding ideology.

1980-1992
Chinese economy opened up to the world and adopted market principles: Modified form of communism emerged. During this time local governments and communities were allowed to start power generation and supply with off-grid networks and commercial arrangements

1993-1998
Due to tensions between the central and local governments and weakening of central authority central planning was partially restored. Reorganization of energy sector institutions at the apex was carried out, but no major changes were made in power supply arrangements at the rural level

1999 onwards
Involvement of central government in both policy making and regulation on one hand and commercial activities on the other was identified as a weakness. This was addressed by allowing national corporations to take over commercial businesses, leaving central government to focus on policy and regulation matters. Various ministries and commissions were given different energy sector functions to manage

Changes were made to suit prevailing political visions but increasingly the following pursuits were emphasized in the energy policy arena:

- Provision of adequate energy to meet the growing needs of industrialization and economic development
- Self-sufficiency in energy production by maximum use of indigenous resources, where energy equipment manufacturing is included as part of the local industry
- Prioritization of energy efficiency and conservation to ensure optimum use of available energy
- Strategic partnerships with foreign sources that can facilitate importation of energy for meeting shortfalls in local energy supplies
- Decentralization of power supplies so that local governments and rural people can make full use of local resources to provide power and engage in industrialization commercially
- Commercial orientation of energy supply businesses at all levels with a view to ensuring sustainability
- Environmental protection and emissions reduction through use of cleaner energy, implementation of mitigation measures, and development of renewable energy sources

Several policies were made to encapsulate the indicated aspirations, and laws such as the Electric Power Law and the Energy Conservation Law were established to enforce their implementation.

5.2.4 **Rural electrification and renewable energy**

RE was promoted by the Chinese government both through the central grid and off-grid supplies, with a view to catering for the growing urbanization and industrialization in rural areas. An analysis by Jiahua *et al* (2006) further notes that in some cases the two supply sources were interconnected to improve reliability and provide off-grid suppliers with the opportunity for selling their extra power to central

grid authorities. In this way, financial viability for the small grid suppliers was increased; and similarly the central grid suppliers were able to expand their businesses into rural areas through the interconnections. The expansion however turned into encroachment when the larger grid threatened to swallow the smaller ones. Regulatory protection had therefore to be sought to ensure the survival of the small grid operators, and relief was obtained when among other things prices charged by the central grid suppliers were raised to be in harmony with those of small suppliers.

Although availability of coal throughout China made power production from this type of fuel viable in rural areas, abundance of SHP sources in the areas made it equally attractive to use SHP. On account of the emission-free nature of the SHP, power producers were encouraged to take up more of this renewable energy source, and by 2000 nearly 51% of power generated in rural locations was SHP based. In addition, wind power and other renewable energy sources have been employed, especially in the remote western lowlands, where hydropower potential is low.

The competition between local or rural power suppliers and central grid utilities, rural power sources exploitation, and policy-related measures taken by the government are among the key drivers of RE in China. Through efforts of the government and others the electricity access level in rural areas has been raised considerably, as illustrated by the increase of the level from 61% in 1978 to the present level of close to 100% (ibid). The success achieved has been such that there is no longer need for a separate initiative to electrify rural areas. The current electrification programme is a unified one for the whole country, and is aimed at meeting the ever rising demand for power from especially the industrial sector, and also targets improvement of the efficiency of supply and utilization.

5.2.5 **Organization and financing of community electrification**

Various studies (e.g. Zhao, 2001; and Jiahua *et al*, 2006) indicate that the majority of RE projects undertaken by rural people themselves are administered by local governments with villagers' participation. Only a few are initiated and fully run by community groups. In each case there are experts provided by the central government to give training for development and operation of generation plant and distribution systems. The government also provides limited financial assistance for both types of projects. In the case of projects administered by local authorities benefitting communities contribute investment capital as well as labour. The authorities secure financing from banks in the form of low interest loans or foreign direct investments, and deploy capital ploughed back from profits. The infrastructure put up during the projects is owned and maintained by the authorities, and the communities participating in the projects are expected to share in the proceeds of power sales.

On the other hand, communities undertaking projects on their own are expected to raise investment capital, secure financing from banks and central government aid, and assume ownership and O&M tasks for their systems. As far as possible, the central government supports such community groups and particularly provides protection against the threats of takeovers.

5.2.6 **Performance of electricity businesses**

In recent years it has been found necessary to reorganize the running of the local government RE projects so as to avert some losses. Initially, counties and units below the counties were responsible for the projects, but there was mismanagement where among other things profits from the projects were used on expenses unrelated to RE. Jurisdiction for the projects was therefore transferred to provincial administration and commercial orientation for the projects was strengthened. Efficiency has since improved at technical and financial levels.

Community projects have continued to perform well especially due to assistance they get from the central government. However, the long-run sustainability of the projects is uncertain due to the dependence on government support. Should the support cease it is very possible that their survival would be threatened.

5.3 Nepal

5.3.1 **National and geographic situation**

Located in the mountainous Himalayan region and to the north of the economically diverse countries of India and Bangladesh, Nepal is a passageway for much of the water that flows from the Himalayas into the two neighbours. There are also many historic, cultural, and economic ties with these countries, and in terms of income level Nepal lies somewhere in the middle of the two.

From World Bank (2007) data, Nepal had a population of 28.1 million in 2007, and economic growth averaged 5.2 and 3.6 in the periods 1987-1997 and 1997-2007 respectively. It is significant to note that in the latter period the country underwent a Maoist insurgency that resulted into the abolishment of a monarchy and emergence of a democratically elected government that took over power this year. During the period of strife foreign investments inflows including aid were very low. Like in many developing countries, most of the country's population is rural (84% of the total) and is dependent on agricultural production (CRTN, 2005). The most abundant natural resource is water and it is extensively used for agriculture, hydropower production, and fisheries among other applications.

5.3.2 **Energy sector**

By various accounts (e.g. CRTN, 2005; MOWR, 2008; AEPC, 2008; NEA, 2008; and Khennas & Barnett, 2000) traditional biomass is the largest source of energy as is the case in most poor developing countries, with its contribution to overall energy amounting to 86%. This source mainly provides energy for household use in rural areas. Other contributors to the national energy are imported petroleum oil (9%), coal (2%), and electricity (2%); these three sources being the main supply for commercial energy requirements. Alternative energy (small hydro and other renewables) contributes the last 1% of the national energy supply.

The sector as a whole is governed by the Ministry of Water Resources (MOWR) except for the development of alternative (renewable) energy sources including efficient fuel wood use. The latter responsibility lies with the Ministry of Environment, Science and Technology under the Alternative Energy Promotion Centre (AEPC). The electricity industry is largely within the jurisdiction of the national power utility, namely Nepal Electricity Authority or NEA. While NEA is responsible for conventional power grid-based supply and use, the AEPC is concerned with electricity from renewable energy sources and off-grid systems, as well as administration of a rural electrification fund. Supplies from IPPs are for the time being available only for feeding into the grid, with NEA as their single buyer. Regulation takes place through two bodies: The Department of Electricity Development or DOED (previously the Electricity Development Centre) which is under the MOWR, and the Electricity Tariff Commission (ETC). While DOED was created to promote private sector participation in electricity development and licensing, ETC was established to regulate electricity tariffs specifically.

Electricity is obtained from generation sources available locally, and due to underdevelopment of local power resources some electric power is imported from India. The largest source of power is hydroelectricity generation by NEA which taps only about 1% of the available potential of 42,000 MW. Some of the hydropower is obtained from small-scale sources in the range of a few megawatts, but NEA leaves development of sources below 1 MW to other developers. To meet the peak demand, which stands at 720 MW, NEA's hydropower is complemented by local hydropower IPPs (30%), importation (13%), and NEA's thermal plants (0.3%).

On the demand-side of the electricity supply industry, about 37% of the total population has access to electricity with urban and rural levels of access at about 67% and 27% respectively. Rural electrification is carried out both by NEA and villagers. The latter act through Village Development Committees (VDCs), and either have their own off-grid supplies or lease portions of the grid. Small hydropower and PV forms of power generation are employed by the VDCs, and distribution is done by the same committees. In some cases the VDCs work in partnership with private organizations and this makes the Nepal case study very relevant to the PACEAA project.

5.3.3 **Historical developments of policy and regulation**

An analysis by Dr. G. Nepal (n.d.) observes that significant policy and legal reforms in the energy sector started alongside democratic transformation of government in early 1990s. Among the important instruments that emerged include the Electricity Act 2049 of 1992, Electricity Regulation 2050 of 1993, and the Hydropower Development Policy of 2001. These instruments resulted into the breakup of the monopoly held by NEA in electricity generation, whereby IPPs emerged as suppliers of power to the grid. Regulation was also introduced to among other things license power generation for capacities exceeding 1 MW, and approve electricity tariffs. Leasing and construction of distribution networks by non-utility bodies were also provided for, whether the networks are on-grid or off-grid. The latter provision paved the way for NGOs, private sector parties, and communities to take part in rural electrification as

envisaged by the PACEAA project. Furthermore, support for non-utility electrification initiatives was indirectly provided by the absence of licensing requirements for power projects with capacities of 1 MW or less.

However, there were many inconsistencies in the electricity governance elements of the early 1990s. Subsequently, therefore, it became necessary to create two new acts, the Electricity Act 2007 (draft) to replace the old electric power legislation, and the Electricity Regulatory Commission Act 2007 (draft); an additional aim of both the acts being to give legal backing for the Hydropower Development Policy 2001. The acts are nevertheless still awaiting parliamentary approval and are therefore still in draft form.

5.3.4 **Rural electrification and renewable energy**

Besides the facilitative policy and regulatory environment indicated above, the other key factors that have enhanced RE through renewable energy resources in Nepal are the measures taken and promotional activities by the AEPC, NEA, NGOs, and private bodies or individuals. This is as noted in a study by Scanteam (2003), which further supplies details appearing in this and the next subsection. AEPC has the mandate of developing an array of renewable energy technologies in the process of rural energy provision; the technologies involved being biogas plants, energy-efficient cookstoves, small hydro plants, and PV among others. The Centre (AEPC) differs from NEA in terms of the range of RETs covered and the fact that NEA and AEPC are responsible for on-grid and off-grid RE supplies respectively.

Both the NEA and AEPC are required by law to develop community based electrification as well as support NGOs and private companies or individuals participating in or undertaking RE. As a consequence, community based organizations such as electricity users groups are increasingly taking over low voltage sections of rural distribution systems owned by NEA. The groups are also being motivated to take up more small-scale hydropower schemes that have been a tradition in Nepal, and are thus able to raise the level of RE coverage. To ensure sustainability of the community ownership the two agencies work closely with NGOs to enhance the rural people's capacity to manage their power systems and organizations. In this regard it should be understood that the people do not necessarily own the physical assets but the intangible aspects, this being particularly the case with NEA supported or owned systems.

At the rural community level there are also private enterprises that develop their own power especially from small hydropower sources. They then use the power for meeting electricity needs of their own businesses and where possible for sale to NEA. In some cases the entrepreneurs work in partnership with community groups to supply the groups with their power requirements. Apart from securing equity and debt financing, the companies or private organizations are able to get financial assistance from donors or other funding sources. On the basis of the latter source of finance the bodies can extend supply to community groups at subsidized fees, with part of the groups' contributions being in kind. An example of the enterprises is the Butwal

Power Company, which was started by the United Mission to Nepal, and support for it comes from Winrock International of USA, and from USAID.

It is important to note that RE system expansion has suffered the impacts of insurgency activities in Nepal especially in the more remote areas. For this reason, investors and facilitators have kept away from many war ravaged parts of the country, and the growth of RE has not been as high as would otherwise have been expected.

5.3.5 **Organization and financing of community electrification**

Among the entities considered above, the community and private organizations undertaking RE are of particular interest to the PACEAA Project. The community groups have appreciated the value of electric power in raising their socio-economic standards and poverty reduction. Through various forms of stimulation, the groups have established cooperatives and other types of associations, with a view to developing and in many cases owning RE systems for supplying their power needs. In a few cases the groups have acted on their own, but for the majority of cases partnerships have been formed between the groups and NEA, NGOs, and private companies. It has been possible for the groups to set up and run RE projects through their own efforts and the partnerships, but more importantly they have managed to develop the projects with support from government and donors. A small fraction of the groups have in addition managed to obtain commercial financing from local development banks, the principal one being the Agricultural Development Bank of Nepal.

The main type of government and donor support given to community groups is investment subsidy, and subsidized tariffs. The standard investment subsidy is 80% of capital costs for support received from government through NEA or AECP. Subsidies from donors range from about 50% to 85%; but whether support is from donors or government the community groups are expected to make in-kind contributions principally in terms of labour. To enable the groups meet O&M costs tariffs have generally been kept low through regulation, but this works well only where the groups are purchasing power from NEA or other suppliers. Where the communities produce their own power RE businesses tend to perform badly as a result of low tariffs, and there are moves towards having the tariffs raised or cost-efficiency improved, or having both measures implemented.

While communities rely largely on financial assistance to meet their investment costs, private organizations involved in RE have to seek commercial funding. Subsidies that the entrepreneurs can get from the government and donors are limited, and are only given where there would be RE benefitting the societies around the entrepreneurial businesses.

5.3.6 **Performance of rural electricity businesses**

As noted by Dr Vaidya (n.d.) among others, small hydropower systems in Nepal, the performances of rural electricity businesses have been mixed. Generally, the

businesses located in easily accessible parts of rural areas have done well; and similarly, those businesses that are supported and have power systems owned by NEA have performed satisfactorily. On the other hand, the businesses that are in remote areas and those that are not backed by established authorities or programs have tended to perform poorly.

There are two important reasons for unsatisfactory performance by the remote businesses. Firstly, although the businesses are involved in productive activities like grain milling and charging of batteries, it is difficult for customers and suppliers to access the locations of the businesses especially due to problems of transportation. Secondly, retention of trained technicians who operate and maintain the power systems is a major task as the technicians are more attracted to the better opportunities in better parts of rural area and urban centres.

In general, there are also businesses that perform badly due to low tariffs and bad management. As indicated above, regulation has kept tariffs too low and this has resulted into inability to recover costs sufficiently, with the consequence that businesses have suffered. Poor book-keeping and non-metering of supplies have also played part in the low level of business performance.

5.4 Peru

5.4.1 National and geographic situation

After overcoming the political and military upheavals of periods before 1990, Peru's economy has had a steady upward growth that has increased from 2.9% in 2000 to 6.4% in 2005. For 2006 there was a slight drop to 6%. This is documented by Enerdata (2008b) and World Bank (2006), which further gives the population by 2006 as 28.4 million and an income per capita of GDP amounting to US$2953. About 6 million people live in rural areas which is an indicator of the high level of urban population -- a characteristic feature of many Latin American countries, and reverse of the situation in many developing countries of Africa and Asia. The rural population is largely found in the mountainous areas and jungle covered parts of the country, where the level of poverty is highest.

5.4.2 Energy Sector

Although Peru is an oil and natural gas producing country it is a net importer of the same types of energy. According to Enerdata (2008b) and World Bank (2006), the order of level of consumption of energy from various sources is petroleum (49%), biomass (18%), gas including LPG (13%), electricity (11%), and coal (9%). The relatively lower level of biomass consumption is another reflection of the contrast with developing countries in other regions. Electricity which is supplied from sources with a total capacity of 6.4 GW (in 2006) comes from hydropower (52%), oil (36%), gas (11%), and coal (1%). The share of electricity from water sources has occasionally

declined and was worst affected by impacts of El Nino and La Nina phenomena. The reduced share has been largely taken up by increased generation from gas.

Overall responsibility for the sector is with the Ministry of Energy and Mines (MEM). Regulatory functions for the electricity sub-sector are included in the Supervisory Body for Investment (ONSINERG), which was recently restructured and renamed Adjunct Office for Tariff Regulation (GART). Other important institutions dealing with electricity functions within the ministry are the DGE (National Electricity Office) and DGER (National Rural Electrification Office).

While MEM is more concerned with policy and regulation, commercial development and operations of the electricity sub-sector are mostly in the hands of the private sector. Generation and distribution businesses are largely run by private companies, and transmission business is wholly held by private entities on an open-access platform. However, the state is entirely responsible for rural electrification through the DGER.

5.4.3 **Historical developments of policy and regulation**

The new regime that took over political leadership in Peru in 1990 brought with it a wave of policy change in the energy sector, where government involvement in energy businesses was drastically reduced. This is as noted by Enerdata (2008b) and World Bank (2006) among others, where further information points out that the Electricity Concessions Law was passed in 1992, and revised in 2005, transferring most national electricity businesses to the private sector. As a result of the law, the vertically integrated power subsector was unbundled passing over generation, transmission, and distribution functions to different private companies. This change had a very positive effect on the performance of the power industry, especially with regard to power supply to the majority of Peruvians, who live in urban centres. Overall access to electricity in the country improved from 57% in 1993 to 76% in 2004, and the quality of electricity services improved remarkably.

However, RE did not benefit much from the policy and legislative changes that were made. This was because no measures were taken to promote RE among private sector or other non-state bodies, and instead the government continued its limited endeavours to electrify rural areas. There were efforts made towards enacting new legislation for improvement of RE, the first one being the introduction in 2002 of a Law for Electrification of Rural and Isolated or Frontier Areas. The second attempt was the tabling before parliament of a Law to Regulate the Promotion of Private Investment in Rural Electrification in 2004. In both cases the proposed laws could not be implemented due to deficiencies in the proposals.

Another issue that has not been well addressed by the RE policy and regulatory framework is the need for off-grid power supplies, where renewable energy sources available in rural areas would be utilized. In this regard it is worth taking into account that rural settlements in Peru are highly dispersed, and the terrain that the central grid would have to cover to reach them is quite difficult. It therefore makes off-grid

supplies using hydropower, wind, and PV resources that are found in the rural areas an economic and eco-friendly proposition. The fact that renewable energy can contribute to improvement of energy supply was recognized by government authorities. This is as evidenced by the introduction of Law No. 28546 of 2005, and the conduct of a study on use of renewable energy for electric power generation. However, there has been no commitment yet towards implementation of the law or study, and particularly application of renewable energy to development of RE has not been given adequate attention.

In view of the indicated lack of a suitable framework for development of RE there are plans being made between the World Bank and the government of Peru to undertake an IDA funded programme of activities for establishing an enabling environment for RE. It is proposed that the programme will facilitate off-grid RE using renewable energy, and participation of rural community groups and the private sector in RE development. Funding for implementation of the proposals has been allocated and implementation is expected to start soon.
Organization and financing for RE with renewable energy

Although the Peruvian government has been active in trying to develop RE and it has incurred large expenditures on the initiative achievement has been low. Statistics by World Bank (2006) show that between 1993 and 2004 access to electricity in rural areas has only risen from 5% to 32%, making the country's rural access to power the second lowest in the whole of Latin America. The government efforts have generally been through the extension of the central grid and for very remote places the establishment of distribution networks around diesel powered generation plant. Evidently, the option of extending the grid is being exhausted as further expansion gets more costly.

Involvement of non-government parties in RE has been very minimal. Some examples, as studied by Khennas (2000) include initiatives by ITDG or Practical action who have been actively promoting development of small-scale hydropower generation and electrification for isolated communities. ITDG has through capacity building of the communities and facilitation of various forms of support enabled rural people to engage in electrification and income generating projects. The initiatives serve as good examples for the Peruvian government, and the proposed World Bank RE project is expected to use them in developing suitable models for RE in remote location of Peru.

5.5 Philippines

5.5.1 **National and geographic situation**

Being an archipelago of more than 7000 islands and a terrain that is to a large extent mountainous the country has rather unique features as observed by BEAPA (2008), Enerdata (2008c), and GOPH (2003) among others. The features include a bulging population which by current estimates stands at 90 million, with about 48% of the

population living in urban centres that are scattered around the republic. Furthermore, about 30% of the population lives on less than US$2 per day.

The country has had a varied history of economic prosperity, which has been swinging from low to high. Nevertheless, since 2000 the economy has grown steadily with a growth rate ranging between 4 and 7%, and by 2006 the GDP per capita stood at US$1500. The economy is mostly dependent on agriculture, industrial production, mining, and remittances from its large population (about 11% of national total) living outside the country.

5.5.2 **Energy Sector**

There are fossil fuel resources in the country including petroleum, natural gas, and coal; and significant production of energy from these resources is done except for petroleum which yields negligible amounts and sometimes ceases altogether. Further, various accounts (e.g. Enerdata (2008c); and BEAPA (2008) indicate that the other substantive local energy resource is geothermal steam which is used for electricity production. Including imports, the main sources of energy in the national energy mix are: oil (34%), biomass (25%), primary electricity (22%), coal (14%), and gas (5%). Electricity is produced from oil (24%), coal (24%), large and small hydropower (19%), gas (16%), geothermal steam and wind (11%), and biomass (6%); the percentages being on a capacity basis. In total the electric power capacity is 17.6 GW (2006 data).

The institutions in the energy sector are steered by the Department of Energy (DoE), which is the energy policy making body reporting directly to the country's president. Among the important institutions working with DOE is the Energy Regulatory Commission (ERC), which is mandated with the regulation of the whole energy sector. On matters of electricity, functions are handled by *inter alia* the National Power Corporation (NPC) and the National Electrification Administration (NEA). Prior to reforms that were started in 2001, NPC was a vertically integrated national utility. Currently, the corporation is in the process of privatization and it is involved in power generation along with IPPs. Its former transmission functions were taken over by TRANSCO, a private company; and distribution functions are entrusted to 17 private companies. RE is carried out by NEA through rural electricity cooperatives (RECs) and SPUG (Small Power Utility Group) of NPC.

5.5.3 **Historical developments of policy and regulation**

By accounts of GOPH (2008) and World Bank (2003), energy sector reforms have been progressively taking place for almost two decades, with adoption of renewable energy having been promoted by early laws like the Mini Hydroelectric Power Incentive Act of 1991 (Republic Act No. 7156). There has however been a slow pace in strengthening renewable energy legislation, as a comprehensive law on this form of energy was only passed this month (December 2008). The reforms that have received considerable attention are those that came with the Electric Power Industry Reforms Act or EPIRA of 2001 (Republic Act No. 9136).

EPIRA came into force with the main aims of increasing private sector participation in the power industry so as to accelerate improvements in service delivery, and meeting the challenges of escalating energy demands and resource limitations. To facilitate implementation of the legislation the Energy Regulatory Commission was set up in 2002 to replace the Energy Regulatory Board. It is under the direction of ERC that the unbundling of NPC took place as described above. Under the EPIRA reforms, a target was also set for all areas of the country to attain 100% access to power by 2008.

However, although the privatization goal was widely achieved, there has been no buy-down of electricity prices as expected. In addition, as the year 2008 is coming to an end, the 100% target for electrification has not been achieved; this is because a few regions particularly in the south have currently an electricity access level of about 95%. There is therefore an outcry calling for repeal or substantive revision of EPIRA. At the same time support has been obtained from the World Bank to search for more innovative approaches to providing power to the areas that have received no electricity to-date. The World Bank initiative is funded by IDA credit and is currently ongoing.

5.5.4 **Rural electrification and renewable energy**

Studies, by for example WJEC (2007), point out that RE in the Philippines is substantially based on fossil fuel energy as it mostly obtained from the central grid, the supply for which has a nearly 70% contribution from a combination of oil, coal, and natural gas sources. There is also a part of RE in very remote areas that is provided by SPUG through heavily subsidized diesel powered generation. This is why innovative approaches are being considered under the World Bank initiative indicated above, and one of the approaches is greater use of off-grid renewable energy sources that are available in rural areas. It is estimated that up to 30% of rural areas can be electrified via off-grid systems.

5.5.5 **Organization and financing of community electrification**

The 119 rural electric cooperatives or RECs work under the direction of NEA to develop and run RE in their areas. In addition, according to documents by World Bank (2003) and others, there are RECs that carry out RE in areas under SPUG. Altogether, the RECs are responsible for RE at the local level throughout the country; and they generally conduct the electrification as profit-making organizations.

NEA not only manages RECs but is also the provider of loans and conduit of government subsidies to the cooperatives. REC's survival is therefore substantially dependent on NEA Partly due to this dependence, and a lack of businesslike approach that arises from the subjectivity, the RECs are not sufficiently credit-worthy to attract financing from commercial institutions.

5.5.6 **Performance of electricity businesses**

By 2003 NEA had serious financial challenges and the difficulties faced were reflected in the performance of the RECs. As a result, out of all the RECs only 25% were able to make a profit. Drawing from the World Bank (2003), this was taken into account when the rural power project was mooted in 2003; and one aim of the project was to make the proportion of RECs that are financially viable at least 90% of the total number.

5.6 Sri Lanka

5.6.1 **National and geographic situation**

A perpetual struggle to contain internal conflict has been the hallmark of Sri Lanka; but, as the World Bank (2008) and Ananda (2006) observe, in spite of this economic development has largely been positive. The economy of about 20 million people has grown by an average of 4% to 5% per annum annually over the last 30 years; and it has maintained a middle low income status with a 2007 GDP per capita level of US$1540. The country has low and mountainous terrains on which tea growing takes place. Together with other plantation crops tea is farmed on a large scale and a major portion of the country's earnings depend on the crops.

By assessments made by the World Bank (2007) and others, a high proportion of the country's population is spread in all regions of Sri Lanka except the urbanized western region, where Colombo lies. About 80% of the total population, and 88% of the country's poor people, are to be found in these regions, which are essentially rural. Furthermore, the civil conflict that has been taking place mostly affects the north and eastern regions, while the countries' plantations are concentrated in the central and southern regions.

5.6.2 **Energy Sector**

The government of Sri Lanka (GOSL) has formulated a national energy policy and strategy (GOSL, 2006) which together with ADB (2007) give a comprehensive overview of the energy sector in the country. According to these documents national energy supplies are obtained from biomass or traditional energy sources (48.2%), petroleum (44.2%), and hydropower plus other renewable energy so (7.6%). All petroleum supplies including its derivatives are imported as there are no local oil resources.

In the electricity subsector, the total capacity was 2.4 MW in 2005, with the largest contribution being from thermal sources (60.6%). Hydropower has until recently been the largest source of electricity, but due to rainfall shortages and other challenges the contribution from this source dropped from 99.7% in 1986 to 39.4% in 2005. Small hydropower sources have been well exploited and a huge number of IPPs (with power capacities of less than 10 MW) use these sources to generate power for sale to the grid; and relatively few small-scale hydropower plants are community based and provide

off-grid power for RE purposes. Overall, the power subsector has been facing many delays in the expansion of capacity and as a result supply lags demand and power rationing has had to be carried out. This is despite the high level of access to electricity in urban areas, which by 2005 had reached 77%. In rural areas only 30% to 50% have access.

The sector governance is headed by the Ministry of Power and Energy, which is in charge of policy making and overall administration. The Public Utilities Commission of Sri Lanka (PUCSL) is the regulatory authority that covers within its mandate all the sectors responsible for physical infrastructure. Currently, only three industries are included under PUCSL, namely electricity, petroleum, and water. Further down the hierarchy the electricity sub-sector has the Ceylon Electricity Board (CEB) and Lanka Electricity Company (PVT) Ltd. (LECO) as the two state-owned power utilities. CEB carries out power generation along with IPPs, the entire transmission, and 89% distribution. LECO does the balance of distribution with a concentration in the western region.

5.6.3 **Historical developments of policy and regulation**

The current energy policy as given in GOSL (2006) replaced the one of 1997, and aims at among other things enhancing energy security where indigenous sources of supply would be utilized optimally, minimizing adverse environmental impacts, and maximizing the level of energy efficiency and conservation. Some of the targets set by the policy include preparation of a long-term RE plan and creation of an RE fund, increasing the level of RE with more off-grid power supplies, and provision of capital subsidies for investments in off-grid supplies, greater use of non-conventional forms of energy from renewable sources, electricity pricing that would ensure cost-effectiveness, and raising of power delivery efficiency on the supply-side and demand-side.

The 2006 policy carried on with reforms started in 1997, but although the reform proposals have been comprehensive the pace of implementation has been slow, as observed by ADB (2007) among others. For example, although the Electricity Reforms Act that emanated from the earlier policy set out a transformation of CEB there has been little progress made. The transformation involves unbundling CEB, which is vertically integrated, and privatization of some aspects of the board. CEB was established through the existing electricity law enacted in the 1950's, and a new bill has been created to replace the law as part of the transformation process. However, the bill is being opposed by politicians for fear of loss of public sector jobs and loss of other privileges that would arise following partial privatization of CEB. Similar barriers have caused very slow progress in the implementation of an RE policy that was created in 2002 to streamline the development and operation of RE.

5.6.4 **Rural electrification and renewable energy**

Assessments of the RE developments in Sri Lanka (e.g. by Perera, 2003; Ananda, 2006, and Nagendran, 2001) point out the divergent directions taken by grid-based RE

on one hand, and off-grid RE on the other. The former is entirely administered and driven by CEB and is fully supported by the government and the regulatory framework; with grants and cross-subsidization of tariffs being some of the elements of support provided by government. Since the grid is fed from a mixture of fossil-fuel fired and renewable energy plants, the grid-based RE is only partially supplied from clean energy sources (mostly large hydropower). Conversely, off-grid RE is largely driven by NGOs, the private sector, donors, and rural communities; and both the regulatory framework and new electricity bill do not fully cater for them. The prevalent generation technologies for schemes outside the central grid are small hydropower, solar, wind, and other renewables.

From the trend of the slow progress being made towards energy policy and regulation in general, and RE policy specifically, it is bound to take a long time for the level of rural power access to be improved. This is particularly true of grid-based electrification that depends to a large extent on the government and political system. The chances of off-grid RE progressing faster are, however, higher since the non-governmental forces that are supporting this form of RE are gaining strength. Some of the drivers of the off-grid RE are worldwide agencies advocating for use of renewable energy technologies for sustainable development, e.g. UN bodies and international NGOs.

The growth of the advocacy for decentralized RE in Sri Lanka is attested by recent and ongoing programmes and projects for off-grid electrification through renewables, including: the Energy Services Delivery (ESD) Project, the Renewable Energy for Rural Economic Development (RERED) Project, and the Renewable Energy Promotion towards Rural Economic Development through Public Private Partnership Initiative (PPPI). Some Provincial Councils have also been motivated to support decentralized RE and are particularly adopting electrification through small hydropower production. As an example non-governmental initiatives towards improving off-grid RE, about 350 village hydropower schemes have been developed between 1992 and 2006, and for five years (1998 – 2003) the numbers rose dramatically from 56 to 255 (Ananda, 2006).

5.6.5 **Organization and financing of community electrification**

As documented by Perera (2003), Ananda (2006), and Nagendran (2001), the setup for provision of grid-based rural power is structured according to CEB's utility model. This is where CEB is responsible for construction, operation, and maintenance of the power system all the way to the customer's meter, and carrying out billing and collection of revenue. Customers are then obliged to install and carry out O&M activities in respect of their internal installations (beyond the meter), and pay power bills submitted by the utility. The customer is thus a passive receiver of electricity and gets a connection only at the discretion of the utility upon payment of required connection charges. Since the government has the mandate for grid-based RE and fully owns CEB, it channels through the utility finances for grid-based RE and subsidies designed for the customers' benefit.

In the case of off-grid RE the customers are independent of national utilities, and they have to do their own power development and management. The most common type of customer is a member of an Electricity Consumers Society (ECS) which has under it a Village Hydro Scheme (VHS), or a PV Power Scheme. The societies were initially facilitated by an NGO, Practical Action (or ITDG as it was known previously), and involve the customers as owners and users of power systems that serve them -- from generation to internal installations. The organizations are registered and have a legal status, and therefore the customers can and do get loans for their power supplies' financial requirements.

The ECS secures the investment capital needed for construction of a power generation plant and the entire power system including distribution lines and internal installations. It then organizes for the necessary development through contractors and members of the society. The members are free to provide labour or other in-kind contributions, and may also contribute cash; and whatever they give entitles them to a share of power supply. For O&M the society engages technicians who may be specially trained members or employees. Revenue obtained from fees payable by members is based on tariffs set by the society, and in general cost-recovery is targeted as a minimum. Sale of power is not done either internally within the membership or to non-members as non-utility power sale is not allowed by law; as a result no metering is done for those who are connected. An important note here is that the tariffs are outside the jurisdiction of PUCSL, and customers may suffer where tariffs are set without regard to fair practice.

Normal sources of investment finance for an ECS include:

Members' contributions	- 30%
Loans (from banks or Micro-finance)	- 30%
Donors' grants (e.g. from RERED)	- 20%
Local government	- 20%

To increase the affordability of power by members costs are minimized by using low-cost supplies and technologies at the generation plant construction stage, through the distribution system, and to the internal installations. Equipment used includes whatever can be manufactured locally in the members' locality; and materials could, for example, be poles supplied by members from their trees. Again, due to exclusion from the regulatory scope technical standards could be below expectation, and consequently quality of service could be compromised if an ECS is lax.

5.6.6 **Performance of electricity businesses**

Khennas and Barnett (2000) have analyzed a few examples of ECS businesses and found that in addition to providing power for households the supplies made available by the societies are used for milling grains, condiment making, carpentry work, battery charging, hair salons, etc. The productive uses enable the ECS members to make enough income for among other things paying fees for electricity. The ECS businesses are therefore able to get enough payment from members and they are performing

satisfactorily. It has also been noted that for businesses that have not relied on investment grants and were capitalized mostly by commercial financing the rate of performance is much higher.

6 Needs assessment

At the core of the PACEAA Project is the aim of facilitating reduction of the level of poverty of rural communities with the assistance of agro-industry based electricity provision. With this in mind, and taking into account the circumstances of the communities in the countries reviewed above, it is clear that for all the countries there are common needs to be met in order to satisfy objectives of the project. The needs exist not only within the ranks of the communities but within the entire group of stakeholders of the project. It is therefore imperative that all the stakeholders' needs elaborated below get adequate attention for the project to be productive and lead to targeted benefits.

a) Rural Communities (RE beneficiaries)
The specific communities taken into account are those living around and providing inputs like raw products and labour for agro-industries. Many such communities are closely associated with the industries as suppliers or shareholders, or both. They also have no power supplies and can benefit substantially from the proposed electricity production by the industries. However, for the community members to get the power and use it for effective and sustainable livelihood improvement, they require capacity building and other forms of facilitation as indicated here:

(i) Awareness Raising
Findings from field investigations indicate that most community members know the benefits of electricity, and many of them have made attempts at getting access to electricity through government RE programmes. High costs and other barriers have however frustrated their efforts and as a result the members have despaired. What they are generally not aware of is the possibility of getting the power they need through community-based or local initiatives, and the higher level of effectiveness and sustainability of such initiatives. In most cases, they are also not aware that use of the power sources that are within their reach can be more sustainable, due to substantially lower environmental and social downsides. It is therefore necessary to close or reduce the communities' knowledge gaps. Information dissemination tasks of the PACEAA Project should aim at addressing the awareness raising needs.

(ii) Linkage to Capacity Building Agencies
Due to the limitations of the PACEAA Project, it will not be possible under the project to undertake capacity building that is required by the rural communities. Linkage of the communities to agencies or Development Organizations (DO's) that can carry out the task is therefore necessary. The DO's that are envisioned are for example NGO's, community-based organizations (CBO's), or other institutions responsible for rural community development. The linkage may be carried out by recommending to the communities suitable DO's, and leaving the communities to follow-up with the DO's. Alternatively, the DO's can be identified under the PACEAA Project, and recommendations be made to the DO's to take up the capacity building

initiative. However, regardless of the approach taken, the DOs' involvement will be contingent on acquisition of necessary support by the DO's; this being due to usual limitations of funding and other resources of the DO's. With commitment from the DO's, it should be possible for them to make proposals to donors for support towards capacity building assistance.

(iii) Organization, Training, and Project Funding

Once rural communities start working with DO's the initial tasks would be to organize and train the communities. Possible organization types could be cooperatives, associations, or private companies, all with legal status. Training would be necessary to ensure that community members are equipped with the skills of running the organizations sustainably, project development including preparations of funding or financing proposals, and most importantly to carry out businesses cost-effectively. It is expected that one of the outputs of the PACEAA Project will be identification of suitable funding sources for the project development. The DO's and communities would then follow-up with these sources for acquisition of the required funds or finances.

(iv) Suitable Policy and Regulatory Framework

As pointed out in other sections of this report, an appropriate policy and regulatory environment is a crucial requirement for the PACEAA project objectives to be met, and consequently for rural communities to realize the intended benefits. In this regard, it is noted that most countries included within the scope of PACEAA have the right environments, and those that do not have are on the way to creating them. Through sensitization of policy makers through information dissemination activities of the PACEAA Project it is expected that there would be acceleration of the efforts towards establishing the environments.

(v) Involvement in PACEAA Project

Through awareness creation activities indicated above, and getting rural community members to participate in meetings of stakeholders of the PACEAA Project, it is expected that the communities would develop a sense of ownership for the project.

b) Agro-industries

While agro-industries are very likely to be aware of the possibility of production and their own use of locally produced renewable energy, it is unlikely that the industries would engage in initiatives to supply communities around them with the energy. The normal expectation is that the communities would be considered for electrification through government programmes. Furthermore, the industries would most probably not know the benefits of participating in RE, such as leveraging local power production funds from rural and clean energy development institutions; and they would not envision the benefits to themselves of higher community productivity resulting from community RE. Therefore, attention is required to meet needs the satisfaction of which would get agro-industries to contribute towards the RE of

communities around the industries, and in return experience better performance. The main needs in this respect are:

(i) Awareness raising and Involvement in PACEAA Project
Through information dissemination activities and participation in stakeholder meetings the necessary awareness would be created. Commitment and action by the industries towards implementation of the PACEAA Project would be sought after underscoring the project's benefits to the industries.

(ii) Assistance in Identification of Funding for Small Hydropower Projects

Under the GTIEA Project, which is the power generation counterpart to the PACEAA initiative, agro-industries would be seeking funds or finances for generation of power. Since this power would be partially for the benefit of RE under PACEAA it would be mutually beneficial to have efforts made within the PACEAA Project to identify funding sources for the agro-industries (GTIEA). Therefore, although the scope of PACEAA is limited, wherever possible information regarding the sources should be obtained and passed on to the industries.

c) NGO's and Similar Development Organizations (DO's)
As pointed out under the discussion of rural communities ((a) above), the DO's are critical for required capacity building of rural communities. The DO's would most importantly need support to carry out the task. Therefore, like agro-industries the DO's could be greatly assisted by identification of possible support for their participation in the PACEAA Project and beyond. Accordingly, the needs of DO's would mainly be:

(i) Awareness raising and Involvement in PACEAA Project

(ii) Assistance in Identification of Funding

d) Other Stakeholders
The other key stakeholders include government departments, funding and technical assistance agencies, financial institutions, and consultants. The needs of these stakeholders so as to facilitate their contributions to the mission of the PACEAA Project are largely creation of their awareness and getting them involved in the project. Information dissemination, participation in meetings, and other forms of engagement should address the needs of the stakeholders.

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Annex I: Carbon finance in support of rural electrification in Africa

By Karen Holm Olsen, UNEP Risø Centre

1. Introduction

The Clean Development Mechanism (CDM) is part of the global carbon market developing rapidly as part of the Kyoto response towards the mitigation of global warming. The double aim of the CDM is to assist developing countries listed as non-Annex 1 Parties in promoting sustainable development and to facilitate developed countries listed as Annex 1 Parties in complying with their emission commitments in a cost effective manner.

The global carbon market currently consists of a number of non-integrated greenhouse gas (GHG) trading schemes. A fully global carbon market would be more efficient, as it would provide market players and policy makers with information thus far absent from decision making: the global cost of GHG mitigation. Briefly outlined the existing trading schemes are: the European Union Emission Trading Scheme (EU-ETS), which is the largest by far, the CDM being project based as opposed to allowance based, national and regional trading schemes such as the Chicago Climate Exchange, New South Wales Certificates, the United Kingdom trading scheme and the voluntary market offsetting e.g. air transport. Furthermore, a number of trading schemes are in the making in Australia, New Zealand, Canada and possibly the US and China. A workable global emissions trading scheme is likely to evolve slowly through a patchwork of linked national and regional schemes.

2. Carbon Finance in Africa: The Clean Development Mechanism

There are now 4364 projects in the CDM Pipeline. After the first CDM projects entered the UNFCCC pipeline in 2004, the number of new projects increased from 39 projects in 2005 to 70, 119 and 130 per month in 2006, 2007 and 2008. So, although the end of the first commitment period in 2012 is getting closer, the number of new projects is not falling.

The CDM has been successful in generating emission reductions in many developing countries, however Africa accounts for only 2.1 % of the projects. See table 1.

Table 1: Geographical distribution of CDM projects

Region	Number		2012 kCERs	
Latin America	837	19.20%	427801	14.90%
Asia & Pacific	3339	76.50%	2299604	79.90%
Europe and Central Asia	43	1.00%	18992	0.70%
Africa	90	2.10%	92511	3.20%
Middle-East	55	1.30%	38003	1.30%
Less developed World	4364	100%	2876911	100%

Source: UNEP Risø CDM Pipeline, 1 January 2009

The geographical spread of CDM projects is very unequal but some improvement is seen as the fraction of projects hosted by China, India, Brazil and Mexico has decreased from 85% in mid 2006 to 73% in the last quarter of 2008. Meanwhile the number of projects in Africa has increased to 90 compared to 52 projects a year ago, which may indicate the Nairobi Framework (reference) for capacity development in Africa has played a role. It is also interesting that 30% of the afforestation/reforestation projects and three of the seven programmatic projects are hosted by African countries.

In Table 2 projects are ranked by type. The most common project types are landfill gas projects with a total of 14 projects. Biomass energy projects come second with 12 projects followed by hydro power projects with 11 projects. In total 40% of the projects are renewable energy projects (biomass, hydro, wind, biogas, geothermal and solar) making up only 16% of the Certified Emission Reductions (CERs) by 2012. Landfill gas projects, fugitive, cement and coal bed mine/methane projects produce 53% of the CERS but only constitute 23% of the total number of projects.

Table 2: CDM projects in Africa by type

Africa	**Number**	**%**	kCER2012
Landfill gas	14	15.6%	20.7%
Biomass energy	12	13.3%	6.5%
Hydro	11	12.2%	3.8%
Reforestation	9	10.0%	1.4%
Fossil fuel switch	7	7.8%	4.5%
Wind	5	5.6%	4.2%
N2O	5	5.6%	18.2%
Biogas	5	5.6%	1.0%
Fugitive	4	4.4%	22.3%
EE OwnGeneration	4	4.4%	3.9%
EE households	4	4.4%	0.9%
Solar	2	2.2%	0.3%
EE supply side	2	2.2%	0.3%
Coal bed/mine methane	2	2.2%	3.4%
Geothermal	1	1.1%	0.7%
EE industry	1	1.1%	0.4%
Cement	1	1.1%	5.7%
Afforestation	1	1.1%	1.8%
Transport	0	0.0%	0.0%
Tidal	0	0.0%	0.0%
PFCs	0	0.0%	0.0%
HFCs	0	0.0%	0.0%
Energy distribution	0	0.0%	0.0%
EE service	0	0.0%	0.0%
CO2 capture	0	0.0%	0.0%
Agriculture	0	0.0%	0.0%
Renewables	21	23%	10%
Landfill etc	20	22%	21%
Fuel switch	0	0%	0%
HFC & N2O reduction	6	7%	7%
Supply-side EE	22	24%	26%
Afforestation & Reforestation	6	7%	10%
Demand-side EE	15	17%	26%
Total	90	100%	100%

Source: UNEP Risø CDM Pipeline, 1 January 2009

3. Experience with CDM projects in the PACEAA countries

Out of the eleven countries included in the PACEAA project eight host a total of 22 CDM projects. See table 3. Kenya, Tanzania and Uganda host 17 projects, respectively 7, 3 and 7. Of relevance to the PACEAA project are experiences with biomass energy and small hydro power projects in Kenya, Swaziland and Uganda.

Table 3: Overview of CDM projects in PACEAA countries

Table 3: Overview of CDM projects in PACEAA countries

Host country	Title	Type	Sub-type	Status	MW	1st period ktCO2e/yr	Credit buyer
Ethiopia	Humbo Ethiopia Assisted Natural Regeneration Project	Reforestation		At Validation		29	Canada (IBRD)
Kenya	"35 MW Bagasse Based Cogeneration Project" by Mumias Sugar Company Limited (MSCL)	Biomass energy	Bagasse power	Registered	35.0	130	Japan (Japan Carbon Finance)
Kenya	Sondu Miriu Hydro Power Project	Hydro	Run of river	At Validation	60.0	211	Denmark (IBRD)
Kenya	Olkaria II Geothermal Expansion Project	Geothermal	Geothemal electricity	At Validation	35.0	171	Spain (IBRD)
Kenya	Conversion of the Kipevu Open Cycle Gas Turbine to a Combined Cycle Operation Project	EE supply side		At Validation	35.0	45	Denmark (IBRD)
Kenya	Redevelopment of Tana Hydro Power Station Project	Hydro	Existing dam	At Validation	19.6	42	Denmark (IBRD)
Kenya	Optimisation of Kiambere Hydro Power Project	Hydro	Existing dam	At Validation	20.0	38	Spain (IBRD)
Kenya	6 MW Bagasse Based Cogeneration Project by Muhoroni Sugar Company Limited	Biomass energy	Bagasse power	At Validation	6.0	17	United K.
Mozambique	Cimentos do Mozambique – Matola Gas Company Fuel Switch Project	Fossil fuel switch		At Validation		46	n.a.
Rwanda	Rwanda Electrogaz Compact Fluorescent Lamp (CFL) distribution project	EE Households		At Validation		19	Netherlands (IBRD)
Swaziland	RSSC (Royal Swaziland Sugar Corporation) Fuel Switching Project	Biomass energy	Bagasse power	At Validation		64	n.a.
Tanzania	Landfill gas recovery and electricity generation at "Mtoni Dumpsite", Dar Es Salaam	Landfill gas	Landfill flaring	Registered	0.0	202	n.a.
Tanzania	Afforestation in grassland areas of Uchindile, Kilombero, Tanzania & Mapanda, Mufindi, Tanzania	Afforestation		At Validation		318	Norway
Tanzania	Mtwara Energy Project	Fossil fuel switch		At Validation	18.0	29	Netherlands (VROM)
Uganda	Uganda Nile Basin Reforestation Project No.3	Reforestation		At validation	0.0	5.6	n.a.
Uganda	Kakira Sugar Works (1985) Ltd. (KSW) Cogeneration Project	Biomass energy	Bagasse power	At Validation	12.0	54	IBRD
Uganda	Bugoye 13.0 MW run-of-river Hydropower project	Hydro	Run of river	At Validation	13.0	54	n.a.
Uganda	Uganda Nile Basin Reforestation Project No 1	Reforestation		At Validation		7	Italy (BioCarbon Fund)
Uganda	Uganda Nile Basin Reforestation Project No 4	Reforestation		At Validation		6	Italy (BioCarbon Fund)
Uganda	Uganda Nile Basin Reforestation Project No 2	Reforestation		At Validation		6	Italy (BioCarbon Fund)
Uganda	Uganda Nile Basin Reforestation Project No 5	Reforestation		At Validation		8	Italy (BioCarbon Fund)
Zambia	CDM LUSAKA SUSTAINABLE ENERGY PROJECT 1	EE Households		At Validation		150	Germany (Climate InterChange)

Source: Modified from the UNEP Risø CDM Pipeline, 1 January 2009

An equally important objective of CDM projects in addition to emission reductions is to contribute to sustainable development as defined by the host country. This typically means that the project must demonstrate social, economic and environmental co-benefits for local communities in order to be approved by the Designated National

Authority (DNA) for CDM. Such sustainable development benefits could be access to electricity by local residents, schools or businesses meaning new opportunities for economic and social development.

To show how carbon finance from CDM projects can contribute to rural electrification through the PACEAA project two examples are chosen: The Kenyan 6 MW Bagasse Based Cogeneration Project by Muhoroni Sugar Company and Masca Small Hydro Programme in Honduras. An example of a programmatic approach from Honduras is chosen as the hydro power potential in relation to tea production is typically very small in the order of 0.5 to 1 MW. This is too small for a single project to carry the transactions costs of project development. However, with a programmatic approach many micro hydropower projects can be developed using the same methodology[30] and share the transaction costs.

4. Examples of hydro power and cogeneration CDM projects

Both the examples are based on the renewable electricity being grid connected, which means emission reductions are calculated based on the emission factor of the national grid as the baseline.

4.1 Kenya: Muhoroni Sugar Company 6 MW Bagasse Based Cogeneration Project

Established in 1966 Muhoroni Sugar Company is Kenya's first post-independent sugar factory with a cane crushing capacity of 2200 ton per day. Outgrower companies supply 80% of the cane crushed and 10% come from its own estate. The company has sufficient stocks of bagasse to run the cogeneration plant throughout the year. In 2000 the company was placed under receivership. It is now a quasi government institution with Kenya Government holding 82% of the shares.

The production of clean electricity is the key objective of the project. It will generate 6MW of electricity with 3.5 MW for internal consumption in the sugar company and 2.5 MW for export to the national grid.

The CDM component of the project is a power expansion project based on unused bagasse, which hitherto was stockpiled to decompose emitting methane to the atmosphere. The technology used is a conventional steam and power plant (cogeneration) and activities undertaken are installation of economisers in existing boilers as well as a turbo generator to generate electricity from the steam. The CDM methodologies applied for baseline calculation and monitoring of GHG emission reductions are the Approved Consolidated Methodology for grid connected electricity generation from biomass residues (ACM0006 version 6) and the Approved

[30] As part of the decision on further guidance relating to the CDM at the meeting of the Parties to the Kyoto Protocol (CMP 4) in Poznan, 2008, the Executive Board was encouraged to allow a combination of small scale methodologies under a programmatic approach rather than only one methodology allowed currently.

Consolidated Baseline Methodology for Grid-connected Electricity generation from Renewable Sources (ACM0002). The GHG reductions derive from the following sources: 1) displacing grid electricity: 15.8 $ktCO_2$/year, 2) methane abatement: 0.9 $ktCO_2$/year and 3) avoiding diesel generators: 0.2 $ktCO_2$/year. GHGs emitted from the project activity stem from combustion of bagasse: 0.18 $ktCO_2$/year. In total the emission reductions are 16.7 $ktCO_2$/year over a ten year period from 2008-18.

Though the project applies the Gold Standard for assessment of its contribution to sustainable development, there will be no immediate improvement in access to electricity for surrounding consumers. The 2.5 MW excess electricity production will go to the grid managed by Kenya Power and Lighting Company (KPLC), which will distribute the electricity through its existing rural electrification programme.

4.2 Honduras: Masca Small Hydro Programme – a programmatic approach

The objective of a programmatic approach to small hydro power development is to overcome institutional, financial and structural hurdles for development of seven hydro power plants with an installed capacity between 0.7 and 2.3 MW. All projects are run-of- river plants and connected to the grid at remote points, which will help to stabilize voltage and electricity supply in the surroundings. In addition to electricity generation the projects are accompanied by reforestation programs in the basins of the rivers.

In spite of a huge potential the share of renewable energy in the Honduran grid has decreased from 91% to 36% in the period 1993 to 2006. In 1993 the country slid into an energy crisis due to a severe drought that coincided with insufficient energy reserves. The government response was to privatise the energy market to mobilise private funding for expanded generation capacity. To meet an increase in energy demand of 6.2% per year new fossil fuel based power plants have been constructed under emergency conditions. These conditions – such as fossil fuel price adjustment compensation reducing financial risks significantly - favour fossil fuel power over renewable power. Hence, carbon financing has become a crucial element for development of small hydro power projects over the last three years in order to meet banks internal selection criteria for providing loans.

The programme of small hydro power activities is managed by a central coordinating unit Hidromasca, a group of entrepreneurs joining forces to develop seven small hydro power plants. One of the seven programme activities is Matarras I, a small run-of-river hydro power plant of 1 MW. The technology applied is simple with a penstock diverting water from the intake to the power house consisting of one or more turbines and generators and a discharge channel returning the water to the river. The plant connects to a sub-station on the grid through a new or modified power line. The methodology chosen to calculate emission reductions is the Approved Small Scale Methodology AMS-I.D for grid connected renewable electricity generation. Emission reductions stem from the supply of electricity to the Honduran grid and are thus based on the emission factor of the grid. In total GHG reductions are estimated at 3.3 $ktCO_2$/year over a 7 year period from 2009-16.

The project implementers for Matarras I have involved representatives of the local communities to discuss potential problems such as gates denying access to the river as well as opportunities for the project to assist with local employment and reforestation.

5. Summary

The selling price of primary CERs is unknown and depends on project risks but in late 2008 it was generally in the range of Euros 8-12. Assuming a price of 10 Euro/tCO_2 carbon finance could contribute with annual cash flows of respectively 167 000 Euros from the 6 MW cogeneration project in Kenya (1.67 mio Euros over the ten year life time) and 33 000 Euros from the 1 MW hydro power project in Honduras (231 000 Euros over the seven year life time).