



Southern African Development Community

SADC Regional Energy Access Strategy and Action Plan

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Abbreviations and acronyms

AFUR	African Forum for Utility Regulation
ANRE	National Agency for Renewable Energy (Tunisia)
AsgiSA	Accelerated Growth Initiative (South Africa)
BEDP	Bagasse Energy Development Program (Mauritius)
BIG	Basic Income Grant
BNM	Basa Njengo Magogo (meaning ‘Light up, grandmother’) method of coal fire lighting (South Africa)
BPC	Botswana Power Corporation
CCF	Cheetah Conservation Fund (Namibia)
CDM	Clean Development Mechanism
CEB	Central Electricity Board (Mauritius)
CFL	compact florescent lamp
CNELEC	Conselho Nacional de Electricidade (Mozambican electricity regulator)
CNER	National Rural Electrification Commission
CSO	Central Statistics Office
CTBV	Compagne Thermique de Belle Vue Limitee (IPP in Mauritius)
CTDS	Compagne Thermique du Sud Limitee (IPP in Mauritius)
CTSav	Compagne Thermique de Savannah Limitee (IPP in Mauritius)
DBSA	Development Bank of Southern Africa
DEAT	Department of Environmental Affairs and Tourism (South Africa)
DME	Department of Minerals and Energy (South Africa)
DRC	Democratic Republic of the Congo
DRF	Desert Research Foundation (Namibia)
EAI	Energy Access Index

ECA	Economic Consulting Associates
ECB	Electricity Control Board of Namibia
EDM	Electricidade de Moçambique – Mozambique electricity utility
EIA	environmental impact assessment
ENE	Empresa Nacional de Electricidade – Angola’s electricity utility
EPWP	Expanded Public Works Programme
EPWP	Expanded Public Works Programme (South Africa)
ERB	Energy Regulation Board of Zambia
ERC	Energy Research Centre (at UCT)
ESCOM	Electricity Supply Commission of Malawi
ESKOM	South African electricity utility
ESMAP	Energy Management Assistance Program
EU	European Union
EUEI	European Union Energy Initiative
EWURA	Energy & Water Utilities Regulatory Authority of Tanzania
FBAE	Free Basic Alternative Electricity
FBE	Free Basic Electricity
GWh	giga watt-hour (measure of electrical energy = 10 ⁹ watt-hours)
HCB	Hidroeléctrica de Cahora Bassa (company operating the Cahora Bassa complex)
HDI	Human Development Index
ICT	information and communications technology
INEP	Integrated National Electrification Programme (South Africa)
IPP	Independent Power Producer
IRR	internal rate of return
IRSE	Institute for Electricity Regulation of Angola

ktoe	kilo tonnes of oil equivalent
kVA	kilo volt-amps
kWh	kilo watt-hour
LEA	Lesotho Electricity Authority
LEC	Lesotho Electricity Corporation
LED	light emitting diode
LPG	liquefied petroleum gas
LRMC	long run marginal cost
MDE	Ministry of Economic Development (Tunisia)
MDG	millennium development goal
MFC	microbial fuel cells
MFP	multifunction platforms
MI	Ministry of Industry (Tunisia)
MRPU	Ministry of Renewable Energy and Public Utilities (Mauritius)
MSE	medium and small enterprises
MTEF	medium term expenditure framework
MW	megawatt (unit of electrical power = 10^6 watts)
NAD	Namibian Dollar (on par with the Rand)
NamCor	National Petroleum Corporation (Namibia)
NamPower	Namibian electricity utility
NECO	National Electricity Council of Malawi
NERSA	National Energy Regulator of South Africa
NORAD	Norwegian Agency for Development Cooperation
NREP	Namibia Rural Electrification Programme
NUST	National Universities of Science and Technology (Zimbabwe)
O&M	operations and maintenance

ODA	Overseas Development Institute
OGEMP	Off-Grid Energisation Master Plan (Namibia)
PIESA	Power Institute for East and Southern Africa
PLED	Polymer LED
PPA	Power Purchase Agreement
PPIAF	Public Private Infrastructure Advisory Facility
PRSP	Poverty Reduction Strategy Paper
PSP	private sector participation
PV	photovoltaic
R	Rand (South Africa)
RDP	National Reconstruction and Development Programme (South Africa)
REB	Rural Electrification Board (Bangladesh)
REC	Rural Electrification Collective Scheme (Botswana)
RED	Regional Electricity Distributor (Namibia)
REEI	Renewable Energy and Efficiency Institute (Namibia)
RERA	Regional Electricity Regulators Association of Southern Africa
Rs	Rupees (Mauritius)
SABS	South African Bureau of Standards
SACCOS	Savings and Credit Cooperative Societies (Tanzania)
SADC	Southern Africa Development Community
SAPP	Southern African Power Pool
SEB	Swaziland Electricity Board
SEI	Swedish Environment Institute
SHS	solar home system
SIRDC	Scientific, Industrial Research and Development Centre (Zimbabwe)

SME	small to medium scale enterprise
SNEL	Societe Nationale d'Electricite - electricity utility of the DRC
SPPA	Standardised PPA
SPV	special purpose vehicle
STC	State Trading Corporation (Mauritius)
STEG	Tunisian electricity utility
STM	Standardised Tariff Methodology
SWER	single wire earth return
SWH	solar water heater
SWS	shield wire system
TanESCO	Tanzania Electricity Supply Company Ltd
TaTEDO	Tanzania Traditional Energy Development and Environment Organisation
TSh	Tanzania Shilling
UCT	University of Cape Town
UEM	Eduardo Mondlane University (Mozambique)
UNDP	United Nations Development Program
URA	Utility Regulatory Authority (Mauritius)
USc	United States dollar-cents
WTP	willingness to pay
ZERC	Zimbabwe Electricity Regulatory Commission
ZESA	Zimbabwe Electricity Supply Authority (now ZESA Holdings)
ZESCO	Zambia Electricity Supply Company (later registered under the Companies' Act as ZESCO Limited)

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Important milestones in the execution of this study were the submission of the draft Strategy and the high level workshop held in Maseru, Lesotho, on 4 November. The consultants wish to record their appreciation for the detailed comments received on the draft, particularly from the SADC Energy Programme and the EUEI Secretariat and the stimulating discussions held at the workshop.

Part A - Executive Summary

1 SADC Regional Energy Access Strategy

1.1 Goal and Objectives

Improving energy access is a major goal of energy policy in all SADC Member States. Everyone in SADC has some degree of access to energy, but this is often restricted and inadequate. People aspire to use more energy and to do so in a way that involves high quality fuels which are readily available, are affordable and attractive enough for people to be willing to pay for them. Increasing access to such ‘superior’ forms of energy on a reliable basis is a basic requirement both for sustaining the national level of economic development, for reducing poverty and allowing people to improve their standard of living.

Within SADC, improving energy access is fundamentally a national rather than a regional responsibility. Efforts made at the regional level must largely be supportive of and complementary to endeavours at the level of Member States.

At the high level SADC Regional Energy Access workshop held in Maseru on November 4, 2009, the following SADC Energy Access goals were agreed:

- Member States have as a **strategic goal** the harnessing of regional energy resources to ensure, through national and regional action, that all the people of the SADC Region have access to adequate, reliable, least cost, environmentally sustainable energy services.
- The **operational goal** is to endeavour to halve the proportion of people without such access within 10 years for each end use and halve again in successive 5 year periods until there is universal access for all end uses.

It is noted that for some countries 10 years will be too generous for a halving of the access deficit, while for others 10 years may be too difficult, but the 10 year target nonetheless is a useful reference point for discussion of national and regional energy access improvements.

Taking account of the existing situation in the region and the aspirations of stakeholders, these goals are further elaborated into specific **strategic objectives** of the SADC Regional Energy Strategy in Section 1.4 and these then become the foundation of the Action Plan that is presented in Sections 2.1 and 2.2. First, however, in the following two sections, definitions and the principles for a twenty-first century energy access strategy for SADC are provided.

1.2 Definitions

When moving between the national and the regional level, and particularly when cross-country comparisons are to be made, it is important to ensure that there is a clear and shared understanding of the key issues and concepts. The key definitions presented and agreed at the Maseru workshop for 'energy' and 'energy access' are as follows:

- ❏ **Energy:** refers to the traditional and modern resources and technology used to provide light, power and heat. Based on cost, efficiency and convenience, current energy end-uses can be classified into three broad areas:
 - ❏ *lighting and small power*, usually provided by biomass and petroleum based products (candles, paraffin lamps, etc), or grid and off-grid electricity (rechargeable and non-rechargeable batteries, solar PV, small hydro, wind and small diesel/petrol generators);
 - ❏ *heavy power*, usually provided by animal draught power for non-mechanical ploughing or machinery connected to grid and off-grid electricity or that uses petroleum products for other end uses; it should be noted that cooling needs such as air conditioning and refrigeration are some of the applications that require heavy power.
 - ❏ *heat*, usually provided by biomass (wood, charcoal, crop residues, cow dung etc), coal and coke, plus grid and off-grid electricity and petroleum products.

The versatility of electricity in meeting all the different end-uses makes this an energy source of special interest and attention.

- ❏ **Energy access:** the preferred definition of access is the actual *use* of the form of energy¹.

This definition is particularly well suited to electricity, where for households access to electricity is best considered as the actual use of electricity by a household through connection to the grid or some form of off-grid electricity. 'Access' is often used in a wider sense of a household being located in a centre where electricity is available, but this concept is more accurately labelled as an electricity 'penetration rate'.

¹ Alternative definitions of 'energy access' are usefully explored in Abeeku Brew-Hammond (2007) *Challenges to Increasing Access to Modern Energy Services in Africa*, background paper prepared for FEMA Conference on Energy Security and Sustainability, Maputo.

Access in this usage definition can be usefully disaggregated into the 3 A's - **availability**, **affordability** and **acceptability** (this reflecting both cultural acceptability and the consumers' willingness to pay - WTP). The 3 A's indicate why a household which has electricity access will certainly use electricity for lighting but may choose to continue to use, say, charcoal or wood for cooking because electricity for cooking would be unaffordable or perceived to be too expensive relative to other forms of energy for cooking, or may lack other, more subtle, attributes such as the cultural aspects of families congregating around cooking fires. The economic aspects (affordability and WTP) relate both to the capital costs of appliances to use a particular form of high quality energy as well as the recurrent costs of buying the energy that is needed on a regular basis.

Interactions between the 3 A's make for considerable complexity in energy choices, particularly those made by households for cooking and heating. This makes it difficult to neatly carry over the 'usage' concept of access to forms of energy other than electricity. Rich households who can easily afford say LPG for cooking and electrical heaters for space heating may choose instead to use charcoal braziers for most of their cooking and open fires for heating. It is common for there to be a mix of energy sources used by households on different occasions and in different seasons. Even poor households may use a range of energy sources, but the range from which poor families choose is much smaller.

From this viewpoint, the ideal measure of access would be 'ability to choose' a high quality form of energy for a particular end use, whether or not the high quality energy actually chosen. Empirically, it is difficult to define a measure to capture 'ability to choose' and in practice actual usage is most usefully taken as the measure of access. In the sort of instances described above, access in the sense of ability to choose energy sources will likely be higher than access measured by actual usage.

It has been agreed that the usage concept of energy access will be universally adopted in SADC, thereby paving the way for meaningful cross-country comparisons to be made.

The practical implication of these definitions is to focus the formulation of policies on enabling people to meet specific energy end-use needs. The emphasis therefore is on applications rather than technologies, which is the more typical emphasis in energy access studies and strategies. This is not to suggest that technologies are irrelevant or unimportant: ultimately access strategies come down to rolling out certain technologies. Some of the important access-oriented innovations which are being widely deployed throughout Africa (such as, in the electricity sector, ready boards and modernisation of pre-payment meters) have their origins in SADC.

1.3 Principles

The change in focus from ‘technologies’ to ‘applications’ and the emphasis on energy access that goes beyond availability to embrace affordability and acceptability, requires that a number of what can be characterised as ‘common concepts’ be re-interpreted and reformulated. This is done in Table 1, which identifies key principles relevant for a SADC energy strategy in the twenty-first century.

Table 1 Principles for a 21st century energy access strategy

Common concepts	Observations and new interpretations	Principles to promote energy access
Electricity access and energy access are often considered as one and the same thing	Disproportionate allocation of resources towards electrification at the expense of other energy types that may be more appropriate. The agenda for meetings of SADC Energy Ministers’ is mostly devoted to electrification and yet a large though hopefully declining proportion of SADC citizens will continue to be dependent on non-electrical energy options for the foreseeable future.	Although the goal of universal electrification is desirable, for most SADC countries it is a challenge for the very long-term because of the massive investment resources which would be required and which are beyond reach. The focus should thus be on developing a ‘portfolio’ of least-cost energy options to fulfil lighting, power and heating needs.
Energy requirements need to be subsidised to cater for the poor	The ‘poverty argument’ has been exploited by politically influential urban elites, resulting in consumption subsidies for the rich which leave no resources to extend access to the poor, who often end up paying more for inferior energy services. In practice the poor end up subsidizing the rich.	While subsidies have an important role to play in extending access, subsidy programmes need to be carefully designed and targeted. Subsidies, especially for consumption, are not always needed: there is a large, willing-to-pay market for energy products and services which is not yet quantified. As a rule of thumb, countries with less than universal access should prioritise access over consumption subsidies.
Biomass is an inferior form of energy	Although biomass is acknowledged as the main energy source for the majority of SADC households and perhaps even increasing size of the population in absolute terms, there are hardly	Accept the reality that biomass is here to stay and can be a carbon-neutral energy resource if well-used. In the developed world, far from being ‘inferior’, wood has become an energy carrier of choice. There is need

Common concepts	Observations and new interpretations	Principles to promote energy access
	any resources devoted to improved production and consumption of this resource. With one or two exceptions, there are no official quantitative statistics of biomass energy production and use.	to 'modernise' biomass, that is: <ul style="list-style-type: none"> change perceptions of policy makers give users truly appropriate and more sustainable ways to use biomass energy resources, for example through mass produced cooking, heating and lighting products from reputable companies with better quality control, technological and marketing skills than current artisanal approaches.
People need to be assisted to climb the 'energy ladder' to eventually attain access to 'modern' energy services such as electricity and petroleum products	Energy choices are more complex than the energy ladder approach implies. Well-off households with access to electricity typically continue to have a 'portfolio' of energy sources for cultural or other non-income related reasons. In particular, in many electrified households, non-electrical and traditional forms of energy often continue to be used for cooking and heating.	Policy makers need to fully incorporate the energy portfolio concept into energy access strategies. Focussing on applications rather than technologies will help to sharpen this approach.
Electrification and other high quality energy services stimulate economic production and improve quality of life	Experience shows that economic and social development is only enhanced where the economic activities already existed based on inferior energy resources, or where productive uses of energy were concurrently developed.	The development of electricity and other energy services has to be integrated with productive uses to create the income base needed to pay for the energy investments. Quality of life applications, e.g. for improved domestic, health and education services, are more sustainably developed on the back of productive use applications
Cost-reflective energy pricing promotes investment viability	In practice most governments only pay lip service to the concept of cost-reflective prices and are more concerned with the political consequences of energy prices than the viability of energy companies, hence the limited private sector involvement and continued public ownership of major energy service	Cost reflective but competitive prices (including well designed subsidies) will result in viable and affordable energy products and services and will permit the entry of the private sector. The addition of private sector finance would significantly reduce the period within which

Common concepts	Observations and new interpretations	Principles to promote energy access
	delivery companies.	universal access can be achieved. Striking the right balance in energy prices is achieved through independent regulatory systems that remove the conflict of interest inherent in politically influenced decision making.
Capacity building involves institutional and individual skills development	In practice well-designed institutions with highly skilled people often fail to deliver due to lack of commitment. Sustained lack of commitment leads to the loss of the developed skills to 'greener pastures'.	Commitment is the missing ingredient in capacity building. It is essential not to assume commitment but to build commitment as part of capacity building and to have explicit performance measures for commitment.

1.4 Strategic framework

As recorded in Section 1.1, the goals of the SADC Energy Access Strategy are at the strategic level to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC Region have access to adequate, reliable, least cost, environmentally sustainable energy services, and at the operational level that the proportion of people without such access is halved within 10 years for each end use and halved again in successive 5 year periods until there is universal access for all end uses.

Drawing on the analysis of the current energy access strengths and weaknesses in the region (documented as technical annexes and country studies in the main report) and guided by the expectations of the different stakeholders, the framework for achieving the above goals consists of the following 7 elements:

- ❏ **Statistics:** improved systems of providing accurate information, especially quantitative data, on energy access.
- ❏ **Applications:** focus on energy end-uses rather than technologies
- ❏ **Biomass:** recognition of the dominant role of biomass in the present and projected energy balance of most SADC countries.
- ❏ **Prices:** cost-reflective but competitive prices

- ❏ **Subsidies:** prioritise access over consumption subsidies
- ❏ **Development:** focus on use of energy to enhance economic productivity for poverty reduction and enhanced quality of life
- ❏ **Capacity:** ability and willingness to implement, operate and maintain energy access projects and programs

In Table 2 below, each of these elements is associated with a corresponding strategic objective and key principles. In Section 2.1, the elements of the Action Plan are laid out first in terms of the responsibilities of the executing agency and then subsequently (Table 4, Section 2.2) in terms of the ways in which the action plan activities address the strategic objectives. Table 4 completes the logical flow from Strategy to Action Plan by laying out the Measureable Outputs and the Expected Outcomes for each of the strategic elements.

Table 2 SADC Regional Energy Access Strategy

The strategic goal is to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC Region have access to adequate, reliable, least-cost, environmentally sustainable energy services

The operational goal is to endeavour to halve the proportion of people without such access within 10 years for each end use and halve again in successive 5 year periods until there is universal access for all end uses.

Strategic element	Strategic Objective	Principles
Statistics: improved systems of providing accurate information, especially quantitative data, on energy access.	To improve the quality of planning and measurement of performance of energy access strategies and plans	<ul style="list-style-type: none"> • Statistics must be based on agreed definition of access • Information and data to focus on availability, affordability and acceptability of energy services • Spatial data should be collected using a common GIS approach
Applications: focus on energy end-uses rather than technologies	To fulfil light, heat and power needs using the least-cost socially acceptable energy service for each end use.	<ul style="list-style-type: none"> • Promote balanced portfolio of energy options for the different end-uses because there is no single technology that can fulfil all energy uses at least-cost in a socially acceptable way for all consumer groups and markets. • Energy access strategies that are focused on end-uses ensure that all the needs of the people are catered for.

Strategic element	Strategic Objective	Principles
Biomass: recognition of the dominant role of biomass in the present and projected energy balance of most SADC countries.	To attract resources that ensure the efficient production and utilisation of biomass energy resources	<ul style="list-style-type: none"> • ‘Modernisation’ of biomass helps to raise its status and enhances the range of applications for biomass users • Promote inexpensive stand-alone biomass energy technologies that really are ‘appropriate’ for and are willingly adopted by the intended beneficiaries.
Prices: cost-reflective but competitive prices	To balance the interests of energy investors and consumers	<ul style="list-style-type: none"> • Independent, professional and transparent energy regulation • Regulators must insist on least-cost development and operation as well as socially-acceptable rates of return in order to have greater efficiency and competitiveness in the energy industry. • Share regulatory experience at the regional level and harmonise regulatory approaches
Subsidies: prioritise access over consumption subsidies	To promote more carefully justified and targeted subsidies for the less privileged	<ul style="list-style-type: none"> • Focus of subsidies to be on creating access, rather than to promote consumption – capital subsidies (often on a per connection basis) rather than recurrent subsidies • Careful, adaptive implementation of subsidies, based on accurate quantitative data, to ensure that the rich are not subsidised by the poor
Development: focus on use of energy to enhance economic productivity for poverty reduction and enhanced quality of life	To improve the coordinated development and implementation of energy, social and economic strategies and plans.	<ul style="list-style-type: none"> • Greater efforts at the national level to integrate economic, social and energy planning • Quality of life applications, e.g. for improved domestic, health and education services, are more sustainably developed on the back of productive use applications

Strategic element	Strategic Objective	Principles
Capacity: ability and willingness to implement, operate and maintain energy access projects and programs	To develop and sustain long-term commitment to energy access goals and objectives	<ul style="list-style-type: none"> • Capacity building must include the development of a constituency for the intended objectives, as well as the institutional and individual skills and resources needed to ensure successful implementation. • Improve enabling environment and organisational structures at the national level • Enhance professional development frameworks for energy officials

2 SADC Regional Energy Access Action Plan

2.1 Action Plan implementers, activities and scheduling

Energy access is primarily a national responsibility, rather than a regional one, and the **Member States** are responsible for a number of primary activities in the Action Plan that is laid out in this section. The first activity is for the Department of Energy to publicise the adoption of the SADC Energy Strategy and Action Plan, seeking to involve other actors (including energy research and training institutions, community groups, NGOs and the private sector) in implementation.

At the regional level, the main roles of the **SADC Energy Programme** are to mobilise resources for energy access activities and to be a catalyst or facilitator of exchange of information on best practice within the region. However, the SADC Energy Programme is already extremely overstretched and the implementation of the Action Plan is premised on the first step being the recruitment of a full-time Energy Access Adviser to work within the Programme on a contract of at least 3 years.

The financial resources which are to be raised are for 4 main purposes:

- ❏ Recruitment and employment of a full-time Energy Access Adviser for an initial period of 3 years
- ❏ Hiring of Consultants to execute a 1 year project during which they will produce Guidelines on National Energy Access Strategies and Energy Access Reporting Guidelines, as well as producing the baseline SADC Energy Access Yearbook
- ❏ Support for establishing and maintaining a SADC Energy website
- ❏ A Drawdown Facility to support two streams of activity:
 - ❏ Regional exchange of experience
 - ❏ Commercially viable pilot projects to enhance access for light, heat and/or power delivery

Once recruited, the **Energy Access Adviser** and the team of **Consultants** will be two other actors assisting the Member States and the SADC Secretariat in the implementation of the Energy Access Strategy and Action Plan. In Table 3 below the activities of the Action Plan are allocated to the four implementing parties.

It is envisaged that the Action Plan will be implemented over a period of 3 years. The overlapping scheduling of the activities and the timing of the delivery of the main tangible outputs are given in Figure 1. It is assumed that the Energy Adviser

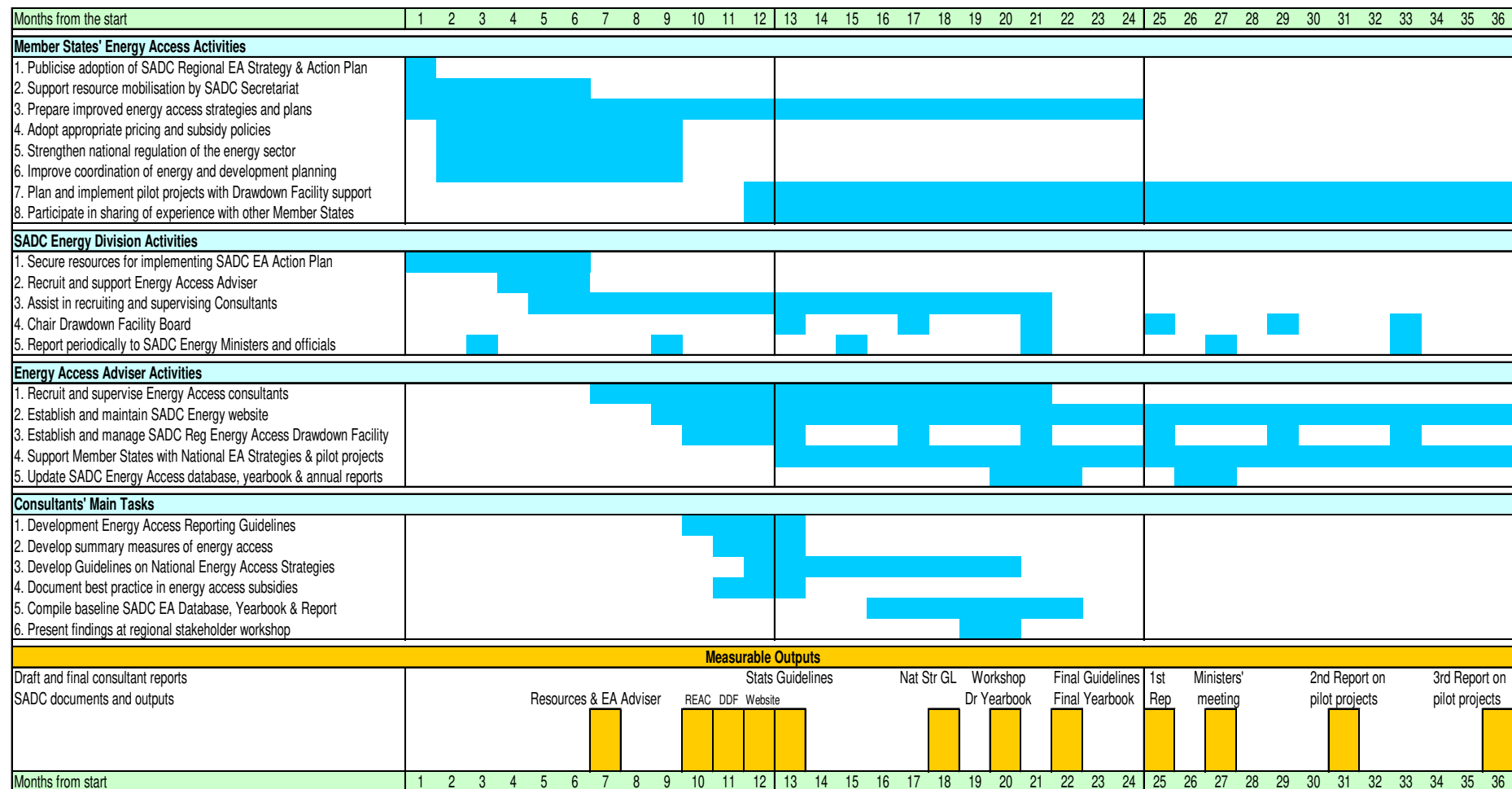
will be recruited by mid 2010, with the Action Plan elements being implemented immediately thereafter.

Table 3 SADC Regional Energy Access Action Plan

Implementer	Activities
Member States	<ol style="list-style-type: none"> 1. Publicise adoption of SADC Regional EA Strategy & Action Plan 2. Support resource mobilisation by SADC Secretariat 3. Prepare improved national energy access strategies and masterplans using GIS-based information on access 4. Adopt appropriate pricing and subsidy policies 5. Strengthen national regulation of the energy sector 6. Improve coordination of energy and development planning 7. Plan & implement pilot projects with Drawdown Facility support 8. Participate in sharing of experience with other Member States
SADC Energy Programme	<ol style="list-style-type: none"> 1. Secure resources for implementing SADC EA Action Plan 2. Recruit and support Energy Access Adviser 3. Assist in recruiting and supervising Consultants 4. Chair Drawdown Facility Board 5. Report periodically to SADC Energy Ministers and officials
Energy Access Adviser	<ol style="list-style-type: none"> 1. Recruit and supervise the energy access consultants 2. Establish and maintain SADC Energy website 3. Establish and manage the SADC Regional Energy Access Drawdown Facility 4. Support Member States to develop National Energy Access Strategies and pilot projects 5. Update SADC Energy Access Database, Yearbook and annual SADC Regional Energy Access Reports
Consultants	<ol style="list-style-type: none"> 1. Develop Energy Access Reporting Guidelines 2. Develop summary measure(s) of energy access 3. Develop Guidelines for National Energy Access Strategies 4. Document best practice in energy access subsidies

	<p>5. Compile the SADC Energy Access Database, Yearbook and first annual SADC Regional Energy Access Report</p> <p>6. Present findings at a regional stakeholder workshop</p>
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Figure 1 SADC Energy Access Action Plan Implementation Schedule



2.2 Implementation Commitment

Energy access strategies and action plans are essential but not sufficient to ensure that energy is delivered to the people. The effectiveness of strategies and plans is largely a function of the level of determination that stakeholders, especially those in leadership positions, have towards achievement of the strategic goals and objectives. Commitment is what makes for a conducive enabling environment which facilitates the individual and organisational capacity needed to develop and implement energy access strategies and plans. A common factor among all countries which have achieved high levels of energy access is the strong and consistent commitment by political and other stakeholders. **Commitment by key stakeholders to the strategic framework laid out in this report is the principal outcome that this study hopes to achieve.**

Commitment to the Regional Energy Access Strategy and Action Plan needs to be shown first and foremost by the Member States. They need to publicly express their support and to back the SADC Secretariat in its resource mobilisation efforts. They need to work with the consultants developing the Energy Access Reporting Guidelines and the National Energy Access Strategy Guidelines, but more importantly they need to actually collate and make available their data on energy access, to improve their own policy and strategic frameworks and formulate and implement pilot energy access projects.

Commitment from Member States will also be critical to the success of the Action Plan as seen from the SADC Energy Programme perspective. The SADC Secretariat's inputs will be delivered primarily by the Energy Access Adviser, who will in the first few months be working on establishing the Drawdown Facility and the SADC Energy website. Subsequently, most of the time of the Adviser will be spent working with the Member States on their national strategies and pilot projects.

2.3 Outputs and Outcomes of the Action Plan

It is important in developing a strategy and action plan to ensure that the activities and associated deliverables or *outputs* are likely to lead to the desired but not directly controllable *outcomes*. Table 4 below completes the elaboration of the SADC Energy Access Strategy and Action Plan by linking the Action Plan activities to the strategic objectives, noting the measurable outputs (as discussed and scheduled in the previous section) and relating these to the expected outcomes.

Table 4 From Strategic Objectives to Outputs and Outcomes

Strategic objectives	Activities	Measurable Outputs	Expected Outcomes
Statistics: To improve the quality of planning and measurement of performance of energy access strategies and plans	<ol style="list-style-type: none"> 1) SADC Energy Programme to source funding and recruit consultants and an energy access adviser 2) Consultants to establish energy access measures including an energy access index 3) Consultants to develop Energy Access Reporting Guidelines 4) Consultants to compile baseline SADC Energy Access Yearbook 5) Adviser to assist SADC Energy Programme to prepare and present first annual energy access report for SADC Energy Ministers (next meeting after report) 	<ol style="list-style-type: none"> 1) Energy Access Index and other access measures 2) Energy Access Reporting Guidelines 3) Baseline SADC Statistics Yearbook, with energy access data provided on a uniform basis 4) Workshop for presentation, discussion and adoption of baseline yearbook and planning guidelines 5) First annual report on SADC Energy Access 	<ul style="list-style-type: none"> • Better understanding of current status, hence better policies • More meaningful performance monitoring and inter-country comparisons
Applications: To fulfil light, heat and power needs using the least-cost socially acceptable energy service for each end use.	<ol style="list-style-type: none"> 1) Member states to prepare improved national energy access strategies and plans 2) Adviser to establish a SADC Energy Website for dissemination of energy information, giving special focus to replicable lighting, heating and power projects 3) In consultation with public and private energy service agencies and companies, adviser to work with Member States to design and pilot commercially 	<ol style="list-style-type: none"> 1) SADC Energy Website 2) Replicable commercially-viable pilot projects in as many SADC countries as possible for increasing energy access for lighting and/or heating and/or power. 	<ul style="list-style-type: none"> • Energy rather than technology access • Greater awareness of energy access experience and hence more rapid uptake of productive new approaches suitable for the SADC region

Strategic objectives	Activities	Measurable Outputs	Expected Outcomes
	viable light, heat and power delivery models		
Biomass: To attract resources that ensure the efficient production and utilisation of biomass energy resources	1) 'Probec' project to concentrate on energy technologies that are demonstrably 'appropriate' for and willingly adopted by the intended beneficiaries 2) Adviser to market the SADC region for pilot projects of multinationals working on modernising biomass	1) Replicable and commercially viable pilot projects	<ul style="list-style-type: none"> • Biomass no longer regarded as inferior • Prominence to biomass in national energy policies and strategies
Prices: To balance the interests of energy investors and consumers	1) Each country to strengthen the independence and professionalism with which energy prices are regulated 2) SADC to propose the expansion of RERA's mandate to cover all forms of energy	1) Cost reflective and competitive prices	<ul style="list-style-type: none"> • Balance between the interests of consumers and producers of energy • Greater efficiency and competitiveness in the energy industry • Internally generated resources to expand energy access
Subsidies: To promote more carefully justified and targeted subsidies for the less privileged	1) Consultant recommendations for improved targeting to be presented and discussed at stakeholder workshop and included in Guidelines for National Energy Access Strategies 2) Energy adviser to publish best practice subsidy lesson on the website	1) Effectively targeted subsidy programmes	<ul style="list-style-type: none"> • Subsidies which reach intended beneficiaries • Acceleration in energy access • Avoidance of the poor subsidising the rich

Strategic objectives	Activities	Measurable Outputs	Expected Outcomes
Development: To improve the coordinated development and implementation of energy, social and economic strategies and plans.	1) Countries to improve multi-sector coordination of development 2) Energy adviser to publish on the website an inventory of innovative and successful experiences of productive use of energy for poverty reduction	1) Formal structures at national level to improve the integration of economic and energy planning	<ul style="list-style-type: none"> • Prioritisation of productive use of energy • Expanded sources of funding for energy programmes
Capacity: To develop and sustain long-term commitment to energy access goals and objectives.	1) SADC Energy Programme to source funding and establish drawdown facility for pilot projects and regional exchange of experience 2) Energy adviser to assist SADC Energy Programme to help build national commitment to energy access by promoting the adoption of access statistics as the formal measure of effectiveness of SADC Energy activities	1) Sharing of national energy access experience within the region through a variety of mechanisms including exchange visits, website etc 2) Formal approval of energy access as performance measure for effectiveness of SADC Energy activities	<ul style="list-style-type: none"> • Much higher degree of implementation of planned energy activities • Improved institutional and individual performance in policy making, regulatory oversight and energy delivery

Part B – Elaboration of the SADC Energy Access Strategy

3 Energy Access Statistics

The importance of statistics is reflected in the old adage - what gets measured is what gets done. The questionnaires that were sent out as part of the research for this Strategy were designed to get statistics that would help assess which energy subsectors were the focus of current policies, strategies and plans. It was not surprising that amongst the replies which were received the most easily available statistics were for electricity and petroleum products – these are also the most active energy sub-sectors at regional and member country level.

In most countries, the acknowledged largest energy sector, biomass, has the least reliable or no statistics, demonstrating the fact that current energy access projects and programmes are not addressing the needs of the vast majority of the people. The amount of wood or charcoal produced from natural forests or plantations is unknown. The amount of wood or charcoal purchased or freely collected is unknown.

The productive use of energy is an important area where statistics would be very useful for development of appropriate policies and plans. An assessment of energy use statistics for rural businesses would establish where energy investments would be economically and financially viable to avoid the wasted investments that often follow politically-determined project site selection.

Where there are available statistics, they are more reliable from the supply side but not from the demand or end-use side. There are statistics on the generation, transmission and distribution plant installed, number of customer connections, power and energy generated and consumed, quantity of fuel imported or produced, quantity sold and amount of money spent or earned. However, reliable statistics on end uses and even the number of potential end users are often very difficult to find.

With a few exceptions, most countries have statistics on technologies but not on end uses. For example the number of electricity connections is available but the number of those using the electricity for light, power or heat is often unknown.

There are no agreed definitions or types of data to be collected which makes it difficult for inter-country comparisons. For example some countries define access in terms of proximity to the energy source, which is misleading because affordability constraints are not taken into account. Only actual usage would confirm energy access. Reliable numbers of households, businesses, education and health institutions are not readily available. Without these numbers it is not possible to verify the percentages of the population and of these institutions with energy access.

Many countries have subsidies but there are few statistics on the actual subsidies or that support the level and types of subsidies given. Although some countries have

statistics on the amount that households and businesses spend on energy services as a percentage of their budgets, there are no agreed definitions of what constitutes affordability. The result is that high income households which spend less than 5% of their budgets on energy get the same or higher subsidies than poor households that spend 10% or more for energy.

Without model policy documents or energy laws, actual energy policies and laws in different countries do not always address the same issues. The institutions that administer the policies and laws are also different as a result, which creates challenges for regional cooperation and coordination. In particular, the institutions responsible for regulatory oversight are very different. Some countries have energy sector regulators, others have sub-sector regulators and yet others have multi-sector regulators with energy or electricity as a component. The degree to which the regulatory agencies conform to the ideal of being professionally competent and independent of political pressures also varies considerably. In countries without dedicated energy regulatory agencies, regulatory functions are carried out by various ministries and are not necessarily the preserve of the ministry responsible for the energy sector.

It is appreciated that local circumstances will always dictate the policies, laws and institutions in member countries, and harmonisation is **not** therefore being advocated in these areas. What **is** being recommended is the development of a common approach to the collection and analysis of statistical information and data pertaining to energy, based on agreed definitions and reporting periods.

The SADC Energy Programme will be taking the lead on this, commissioning consultants to Develop Energy Access Reporting Guidelines, Compiling the SADC Energy Access Database, baseline Yearbook and the first annual SADC Regional Energy Access Report for presentation to the Ministers of Energy. Thereafter, these instruments will be maintained and used by officials in the SADC Energy Programme to produce updates of the SADC Energy Access Yearbook and annual reports. The information will be used by Member States to monitor and improve their national energy access strategies.

4 Portfolio of Energy to meet End Use Applications

In most of the SADC countries, there is a clear divide in energy access. There are a relatively small number of high income citizens, located mainly in urban areas, who are using high quality energy sources, notably grid-supplied electricity, which serves a wide range of end-uses, and petroleum products, which are used for transportation and also in some settings for cooking (e.g. LPG). At the other end of the spectrum, the majority of SADC citizens live in rural areas and use a variety of inefficient, low intensity and often health-compromising energy sources, notably wood or charcoal for cooking and space heating, candles or paraffin/kerosene for lighting and small amounts of electricity for low power end uses, such as radios or televisions, cellphone charging and also for lighting. Women bear the bulk of the

burden of collecting and using biomass, and this in many parts of SADC seriously compromises their time and capacity to undertake other activities.

As the focus of much of the discussion of energy access is on the household sector, Table 5 below provides a typology of the way different energy end-uses are met by people in different income strata. These categories are not clear cut. What is clear is that as people's income rise, they switch to using different forms of energy, although this switching tends to be partial. The energy access strategy which is developed in this document is thus one based on the recognition of a 'portfolio' of multiple energy types that people have in the past used and will continue to use in the future to satisfy different end-uses.

Table 5 Energy types and end-uses in SADC households

Income strata	Energy Types				Strategic approach
	Lighting	Small power	Cooking	Space water heating	
Poor - rural	Wood	Dry cell batteries	Wood	Wood	Modernising traditional energy
Poor - peri-urban/urban	Candles	Rechargeable penlight batteries	Charcoal	Charcoal	
			Coal	Coal	
	Paraffin lamps	Dry-cell batteries	Wood/Other biomass	Wood/Other biomass	
	LEDs	Car batteries	Subsidised Electricity		
Middle - rural	Electricity	Electricity	Paraffin		Facilitating energy transition
		Car batteries	Wood	Wood	
		Electricity	Charcoal	Charcoal	
			Coal	Coal	
	Small PV devices	Small PV devices	Paraffin		
	Solar PV	Solar PV	Solar thermal	SWH	

Income strata	Energy Types				Strategic approach
	Lighting	Small power	Cooking	Space water heating &	
Middle - urban	Electricity	Electricity	LPG	Electricity	Access achieved – modify mix for efficiency and environmental reasons
			Electricity	Low tech SWH	
Upper – urban/rural	Electricity	Electricity	Electricity	Electricity	
			LPG	LPG	
			Paraffin	High tech SWH	
			Coal	Coal	
	CFLs replacing incandescent lamps	Solar PV	Solar thermal	SWH	

The above are quality of life applications that are also applicable to social institutions such as schools and health centres. Productive use applications are different and require special study and policy support because of their potential for poverty alleviation. Rural high schools and large hospitals with boarding facilities can be classified as productive uses that require heavy power and heating as well as lighting. Statistics on these applications, as well as information on appropriate least-cost environmentally friendly energy services would help raise awareness and resource allocation by the developers of these institutions.

The most common businesses in rural areas are trading, building, transport, farming, agro-processing and craftwork or cottage industry. The number of businesses and the energy types used in these businesses depends on the availability or absence of high quality energy services. Depending on the level of business activity, small-scale trading businesses tend to have the same energy use patterns as middle to upper income households. The large scale businesses are likely to be non-existent or to have grid or off-grid electricity depending on the relative cost of either.

5 The Continued Importance of Biomass

There is little doubt that biomass will continue to play a dominant role in the present and projected energy balance of most SADC countries. Although statistics on use are woefully absent for SADC, this continued dominance can be proxied by the most recent International Energy Agency World Energy Outlook, which expects the number of people depending on biomass for cooking to rise to approximately 2.7 billion by 2020, with nearly a third residing in Africa. Although the number stabilises thereafter, no significant drop is envisioned through to 2030.

Given biomass' expected prevalence for the foreseeable future, it is time resources were properly attracted to improving its production and utilisation. Historically, attention has been in the form of small-scale, donor driven programmes aimed at improving the use of non-modern fuels for cooking via the introduction of "improved" biomass technologies, the main one being improved cookstoves. Few government policies or strategies devote space or funding to improving biomass energy. It is time this trend was reversed through governments acknowledging that the use of biomass will play a considerable role in the energy balance of their countries and, as such, that its use and production need to be "modernised" to minimise the environmental damage and to attract the necessary capital.

Specifically, the range of applications for biomass users needs to be enhanced with inexpensive stand-alone biomass energy technologies that are 'appropriate' for and willingly adopted by the intended beneficiaries being developed and promoted. Fortunately, Governments need not start from ground zero as a number of high-quality, clean, sophisticated, energy efficient, and mass-produced technologies that are well-packaged and marketed are currently under development. Described in more detail in Annex A3.5, these new devices include modern stoves from Philips, Bosch and Siemens Home Appliances Group as well as large-scale funding from the likes of RWE and Shell.

SADC governments should piggy-back on the work of these projects not only by supporting these efforts, but by incorporating them into their energy strategies and policies. For example, countries such as Botswana, Namibia and South Africa are currently setting up one-stop-shops, or "Energy Stores", as part of official policy in recognition that energy consumers use a portfolio of fuels, and want them to all be readily available. In Namibia, these shops are based around Recommended Energy Baskets, which are made up of a wide range of affordable and appropriate energy technologies, compatible fuels, and compatible appliances, with the final basket consisting of a total energy solution. Critically, these baskets include efficient options for biomass utilisation.

Promoting the efficiency and acceptance of biomass by Governments is also important on the supply side. With biomass playing such a large role, the mainstreaming and enhancement of production will help ensure that biomass is utilised as sustainably as possible. Likewise, the government needs to regularise and legalise the sector and discontinue regulations and policies which seek to stop its existence. For example, in Tanzania, charcoals is estimated to contribute

approximately US\$ 650 million per annum to the economy in terms of employment, rural livelihoods and other areas, providing income to several hundred thousand people in both urban and rural areas. Often, those receiving income from the sector are members of poorer households working as small scale producers and traders. These individuals often have limited alternatives for earning a living. Likewise, national and local governments are estimated to lose about US \$ 100 million per year due to failure to effectively regulate charcoal sector. Government efforts to end use of biomass are not only fighting a losing battle, but doing harm to their economies in the process.

6 Economics of Energy Access: Prices and Subsidies

Approaches to the supply of modern forms of energy in SADC, as in many other parts of the world, have historically been supply-oriented, with emphasis on publicly owned energy companies being able to supply enough energy to satisfy the requirements of a growing population. Cost was treated as a secondary consideration and little attention was paid to cost recovery. A number of major problems arose from this approach, ranging from inefficient use of fuels by the final consumer, unsustainable levels of subsidy which ultimately have to be met from the national budget and lack of financing of new investments to respond to growth and provide more equitable access to energy.

Recent experience, however, shows that expansion of modern energy is best achieved when economic principles determine energy pricing and subsidy policies. Prices or tariffs should be set to inform consumers of the real economic opportunity costs of using energy, thereby encouraging efficient and productive use of energy and ensuring that energy suppliers can operate on a sustainable basis, including making investments to expand access to modern energy for the bulk of the population. Ideally, the policy on energy pricing should be to ensure that the full costs of supply are recovered - not just operating and maintenance costs, but also capital costs.

Importantly, adherence to competitive prices which fully recover costs need not be incompatible with affordability. By creating efficient and well capitalised utilities, higher quality service at a lower cost than would occur under an inefficient utility can be provided to all consumers. Likewise, efficient and financially sound utilities are better able to fund capital expenditures such as grid extension and take greater risks in meeting the needs of the poor than an inefficient and undercapitalised utility. Greater efficiency also means reduced pressure to raise tariff levels.

Yet, as the introduction of a policy of cost recovery may lead to prices which seem 'high' relative to historical norms, broad-based suppression of prices on the grounds of affordability must be avoided as doing otherwise will only lead to subsidies going to those who already have access (generally richer households and firms) and those who are willing to pay in the absence of subsidisation. That the most common forms of subsidies often end up with those who least need them has been confirmed in a number of studies. The regressive nature of most subsidies can be reduced through targeting, although many targeting programmes are not "targeted" enough, with the result that the majority of poor still do not benefit. Likewise, subsidies for use only benefit the poor if the poor are connected. Although many of the poorest do not live near to the grid, most are unable to connect even when the grid is available because they cannot overcome the cost to connect.

For this reason, government or donor resources available for subsidies contribute more to equity and efficiency objectives if they are spent on once-off capital subsidies than on subsidies to recurrent costs. Subsidies to energy prices simply reduce the cost of energy for those who already have access to high quality sources

and tend to encourage the formation of political lobby groups which seek to keep the recurrent price of energy low on a permanent basis. This often leads to unsustainable drains on national budgets, prejudicing social expenditures elsewhere. If instead resources available for energy subsidies are spent primarily on once-off capital subsidies which enhance access to modern forms of energy, a much more equitable outcome is assured.

No matter the form of subsidy, governments must ensure the costs and benefits are carefully monitored. In designing the subsidy, care should be taken in ensuring that only the intended customers are recipients. Where subsidies are no longer meeting their aims, they should be adjusted to ensure their validity or else removed as soon as they are no longer needed. The government needs to have good information and to act boldly in the face of public resistance that changes in subsidies and subsidy removal typically provoke.

There are good examples in SADC of countries successfully implementing targeted subsidies to accelerate the pace of expansion of energy access while also emphasising cost-recovery. These include *Botswana's rural electrification subsidies* introduced as part of the country's 1988 rural electrification scheme, the overall goal of which was the reducing of rural poverty. The scheme, which today is called the Rural Electrification Collective Scheme (RECS) is described in more detail in Annex A2.1. Another good example are the subsidy mechanisms introduced by the government of Mauritius in order to promote electrification and the rapid adoption of LPG as a cooking fuel (details in Annex 4). Data was continually collected to allow the government to determine levels of affordability and fine-tune the efficient targeting of subsidies. Against a background of rapid economic growth and rising incomes, prices were kept at levels where the average monthly household expenditure on energy services went down from 10% to 6%. The rationale for on-going cross-subsidies such as the electricity block tariff is the fact that low income families still spend nearly 10% of their budget on energy services while higher income families spend less than 4%.

7 Energy Access and Development

The most important issue here is the need to integrate the planning of energy investments with productive uses in order to enhance economic productivity. This needs to be done at the social level as well as macro-economic and micro-economic levels. At the national, macro-economic level, energy supply and access need to keep just ahead so as to facilitate and not constrain growth in GDP. At the micro-economic level, the issue is to recognise that energy end uses designed for economic production are an important tool for poverty reduction. The energy investments have to be implemented in parallel with training programmes for productive uses. For example lighting and small power for productive energy use in rural areas have the potential for promoting at modest cost the growth of night time trading and cottage industries to complement day time farming activities. Social synergies also need to be harnessed, such as the role that access to higher quality energy forms can play in improving the livelihoods and independence of women.

Making convenient, high quality sources of energy available to the majority of SADC citizens and expanding the range of end-uses of energy available to them is part of the over-arching challenge of prevailing over widespread under-development and poverty in the region. By the same token, raising people's incomes will enable them to improve their access by making them able to invest in more sophisticated energy devices and to afford the associated recurrent energy costs.

The only countries which have made real strides in meeting these objectives are Seychelles and Mauritius. These are also the countries which are rated highest amongst their SADC peers in terms of overall development. In this project, Mauritius has been studied in detail (see Annex 4). Successive governments in Mauritius have had clearly defined policies and strategies for achieving full electrification and for promoting LPG as the cooking fuel of choice for Mauritian households. At the time of the last census in Mauritius:

- 99% of households had electricity in their homes
- 91.5% of households used LPG for cooking

The last census was in the year 2000. The access figures will be even higher by the next census scheduled for 2010. It is interesting to note that in 1972 only 1.2% of households were using LPG and the bulk were using wood (55.1%) and kerosene (32.4%). By 2000 wood and kerosene use had gone down to 4.3% and 3.4% of households respectively.

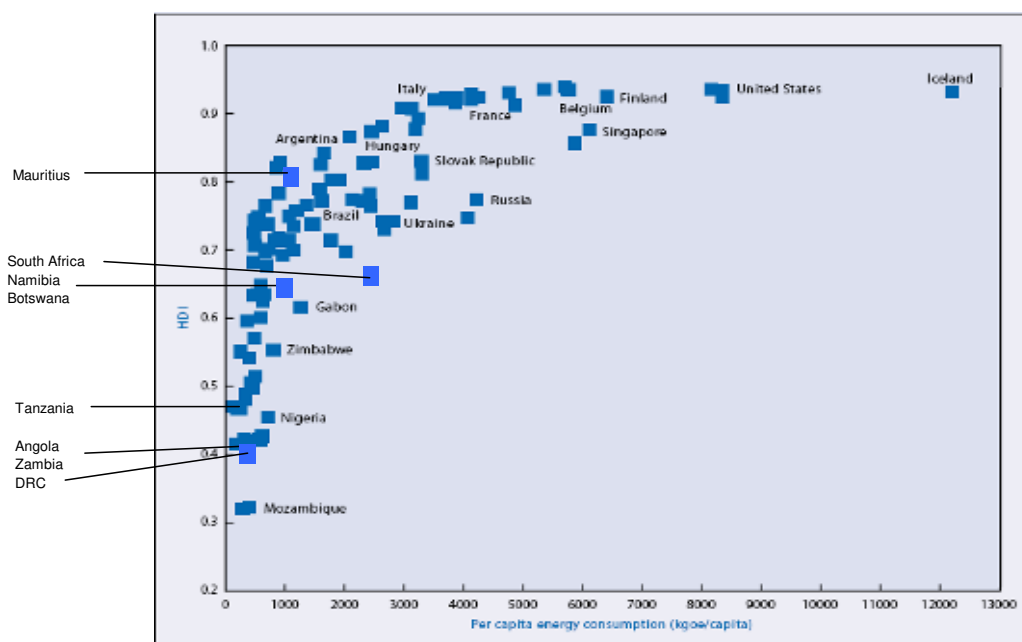
The electrification programme in Mauritius was underpinned by an expansion of generation capacity that relied on waste material (bagasse) from the crushing of sugar cane. This called for coordinated planning and development of the sugar and energy sectors. With the change in trade preferences, Mauritius is radically altering its economic structure, greatly reducing the role of sugar in the economy, and as part of this has to rapidly invest in new sources of electricity generation.

The experience of Mauritius serves to emphasize the symbiotic relationship between energy access, energy usage and overall economic development. It is no coincidence that as the Mauritian economy grew and diversified, the population acquired greater access to modern forms of energy and used higher levels of energy in their income-generating activities and more sophisticated applications of energy in their homes. The Mauritian success was based on careful coordination by the government of national economic and energy development, coupled with a precisely designed subsidy strategy, which was fine-tuned during its implementation.

Building on the Mauritian approach, the regional energy access strategy for SADC must similarly be seen as part of the much bigger strategy for the overall socio-economic development of the region. This is in turn dependent on effective energy sector policies and strategies: the two need to be properly coordinated. The long-term SADC vision is for improved energy access and higher levels of employment and income to move in tandem, with the region progressively becoming wealthier and more urbanised and with usage of convenient, high intensity energy sources becoming the norm in all SADC homes.

It is not just improved energy access that counts, but also the need for SADC citizens to be able to use energy more efficiently, while nonetheless using much more energy overall. As is shown in Figure 2, there is a strong correlation between energy usage per capita and overall socio-economic development, captured here in the UNDP's 'human development index', which is a composite of educational, health and economic indicators of well-being. The average per capita primary energy consumption in sub-Saharan Africa is around 600 kg of oil equivalent per annum: while some SADC countries exceed this figure, 9 of the 15 Member States lie below this average. Industrialised country levels are of the order of 4,700 kg of oil equivalent per annum.

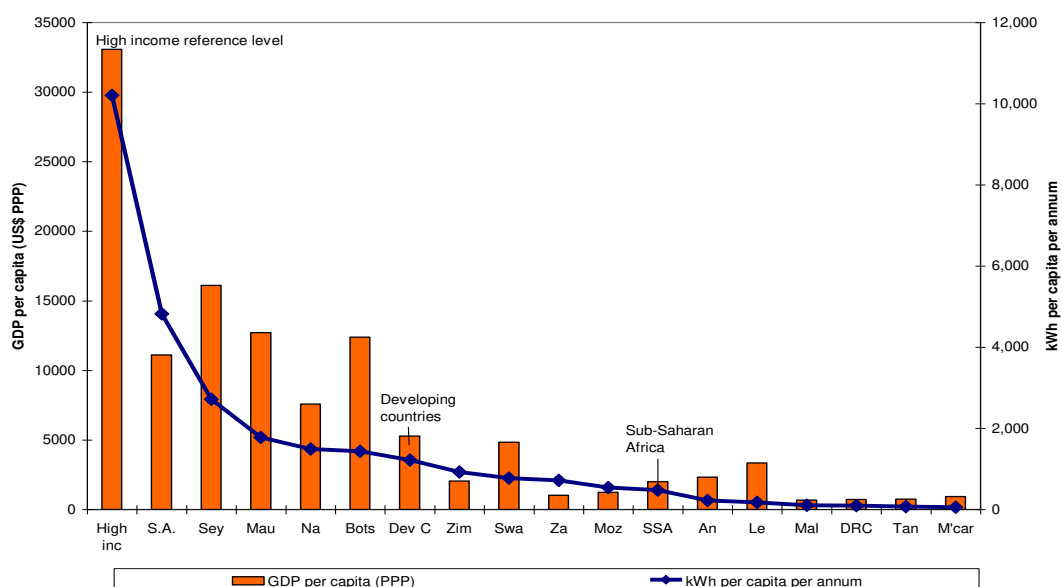
Figure 2 Human development index and energy consumption



Source: UNDP, World Energy Assessment, 2004 and Human Development Report, 2008

As is shown in Figure 3, there is also a strong correlation between electricity consumption and GDP per capita (GDP is measured in the graph in terms of purchasing power parity).

Figure 3 GDP (US\$ PPP) and electricity consumption (kWh) per capita (2005)



It must be emphasized that the energy data in the graph is the simple average found by dividing total electrical energy consumed by the population. It thus

reflects electricity used in production as well as electricity used in homes. Countries with large, electricity-intensive industries (such as South Africa, Zambia and Mozambique²) have high electricity consumption ratios relative to GDP per capita.

The proportion of households using electricity in their homes is a separate issue and available data is shown in Table 6.

Table 6 Electrification: proportion of households using electricity

Country	Urban	Rural	National average
Seychelles	99%	99%	99%
Mauritius	99%	99%	99%
South Africa	90%	64%	80%
Botswana	71%	42%	58%
Zimbabwe	80%	24%	44%
Namibia	70%	18%	40%
Swaziland	65%	26%	35%
Zambia	47%	13%	25%
Lesotho	65%	3%	19%
Malawi	70%	4%	17%
Mozambique	19%	3%	14%

Source: Questionnaire responses and utility annual reports.

It must be stressed that it has simply not been possible to fulfil the hope at the start of the study to assemble comparative data using a common set of definitions. The data in the table need therefore to be viewed as indicative, rather than definitive, and not too much store should be placed on direct comparisons between the countries. The table does, however, accurately convey the broad picture of a few countries being at or nearing universal access to electricity, while other SADC countries are far from this target. This is despite many countries accelerating electrification efforts. The achievements of South Africa in electrifying over 5 million homes between 1990 and 2007 are particularly notable in this regard.

Universal access to electricity is a long-term goal that all countries aspire to: the problem is that electrification is extremely expensive, and the costs of electrification

² In Mozambique's case, if the aluminium smelter MOZAL is excluded, per capita consumption of electricity falls from 545 to 64 kWh per capita per annum.

programmes have to be balanced against competing national investment requirements. Unit costs of electrification rise as the 'easy' areas close to the grid are electrified and plans have to be made to electrify more distant settlements. In the context of coordinated national development, it is important that centres which are included in rural electrification programmes have demonstrable economic potential, which will be unlocked by access to electricity. 'Electricity is a catalyst for development' has proved to be the case in some notable examples within the SADC region, but often centres are electrified without the economic base or the complementary investments in other infrastructure (roads, water, telecommunications), and in such cases there is a high opportunity cost in tying up investment in electrification which is not properly utilised.

Long-term spatial development patterns also need to inform the design of electrification programmes. As economies grow and economic activities become more urban-based, more and more people will reside in urban areas and will loosen and eventually cut their ties with the rural areas. Some rural localities which appear to justify electricity now, may not warrant being electrified in the future.

8 Energy Access and Capacity

Capacity, or the ability to develop and implement energy access projects and programmes, is a function of organisational and individual skills and resources supported by an enabling environment. The enabling environment, in turn, consists of the structures of power and influence along with the institutions within which the individuals and organisations are embedded. Hence, capacity covers the interdependent components of skill, procedures, incentives and governance.

In terms of an energy access strategy, this means that countries must not only have individuals with the technical know-how and knowledge of the related issues, but the procedures, incentives and governance structures to allow the know-how to be put to use. Achieving capacity thus may be the most complicated part of this strategy – individuals and organisations may create perfect strategies focusing on collecting the right types of statistics and promoting optimal applications and portfolios, all while integrating these plans with the broader development goals of the nation. If the proper procedures, incentives and governance structures are not in place, the words will remain just that.

Departments of Energy in SADC countries tend to self-assess themselves in terms of the number of staff rather than the capacity of their staff. Some departments have very few staff dedicated to the energy sector, while others have very large staff complements. There seems to be little correlation between department size and performance. It is interesting to note, for example, that Mauritius, which (with Seychelles) is one of the two countries in SADC with essentially universal access to high quality energy, has a very small department of energy within a multi-sector ministry where only a few officials are dedicated to the energy sector. The other people are also responsible for other infrastructure services, including water and wastewater. The country has no independent regulator but has been successful in attracting private sector investment in the energy sector because of Mauritius' general commitment to creating a positive investment climate.

The Seychelles Energy Commission similarly has a small staff (6 people, of whom 2 are administrative). Other countries with much less notable achievements in terms of energy access than Mauritius and Seychelles have energy departments that have up to 50 people but which still complain about 'capacity constraints' in terms of staff and skill shortages. The enabling environment is not generally recognised as a factor, but appears to be a more fundamental constraint than the size and structure of the energy department *per se*. The achievements of Mauritius and Seychelles with their limited staff show that it is not the size that matters, but the knowledge and environment within which the staff operate.

Limited financial resources are also cited as a contributing factor for capacity constraints. Inability to pay competitive salaries and other conditions of service have led to high staff turnover and losing trained staff to other employers within or outside the countries of the region.

Given these realities, there is need for SADC to play a key role in facilitating the development of capacity. There are three key areas to be covered:

- *The individual:* Those charged with formulating and implementing energy policy must have the proper skills and knowledge. This spans all aspects of the energy strategy; e.g., the types of statistics to be collected; the types of technologies available to ensure individuals have access to an efficient, affordable and healthy portfolio of energy; and understanding of the linkages between energy and socio-economic development; etc.
- *The organisation:* All organisations involved in improving energy access must understand the goals and objectives of the strategy. Member states should thus take stock of what their involved organisations are working towards and must ensure the objectives of all stakeholders involved energy policy are aligned. Critically, compatibility of the objectives where more than one organisation is involved must occur.
- *The enabling environment:* No energy strategy, no matter how well articulated, informed, or understood by all stakeholders, can be implemented if the proper incentives and institutional procedures are not in place. Hence, as part of any energy strategy, Member States should take stock of how individuals and organisations communicate with one another and are motivated. For example, if either vertical or horizontal cooperation is needed in planning and implementing energy policy, is it occurring? If not, what are the procedures that prevent it? Or, how can procedures be arranged to ensure it takes place? Without a enabling environment, energy access policy will not become a reality.

Part C – Elaboration of the SADC Energy Access Action Plan

9 SADC Energy Access Plan

9.1 Action Plan items

For convenience, the Action Plan table from Section 2.1 is repeated below. There are 4 main implementers (first column), each with a number of specific activities to be carried out (second column).

Table 7 SADC Regional Energy Access Action Plan	
Implementer	Activities
Member States	<ol style="list-style-type: none"> 1. Publicise adoption of SADC Regional EA Strategy & Action Plan 2. Support resource mobilisation by SADC Secretariat 3. Prepare improved national energy access strategies and masterplans using GIS-based information on access 4. Adopt appropriate pricing and subsidy policies 5. Strengthen national regulation of the energy sector 6. Improve coordination of energy and development planning 7. Plan & implement pilot projects with Drawdown Facility support 8. Participate in sharing of experience with other Member States
SADC Energy Programme	<ol style="list-style-type: none"> 1. Secure resources for implementing SADC EA Action Plan 2. Recruit and support Energy Access Adviser 3. Assist in recruiting and supervising Consultants 4. Chair Drawdown Facility Board 5. Report periodically to SADC Energy Ministers and officials
Energy Access Adviser	<ol style="list-style-type: none"> 1. Recruit and supervise the energy access consultants 2. Establish and maintain SADC Energy website 3. Establish and manage the SADC Regional Energy Access

Implementer	Activities
	<p>Drawdown Facility</p> <p>4. Support Member States to develop National Energy Access Strategies and pilot projects</p> <p>5. Update SADC Energy Access Database, Yearbook and annual SADC Regional Energy Access Reports</p>
Consultants	<p>1. Develop Energy Access Reporting Guidelines</p> <p>2. Develop summary measure(s) of energy access</p> <p>3. Develop Guidelines for National Energy Access Strategies</p> <p>4. Document best practice in energy access subsidies</p> <p>5. Compile the SADC Energy Access Database, Yearbook and first annual SADC Regional Energy Access Report</p> <p>6. Present findings at a regional stakeholder workshop</p>

9.2 Outline TOR for the Energy Access Adviser and the Consultants

The energy access activities to be carried out by the Member States and the SADC Energy Programme, as laid out in Table 7, are already part of their mandates. By contrast, the Energy Access Adviser and the consultant team are to be contracted specifically to assist in the implementation of the SADC Regional Energy Access Action Plan.

Consequently, Terms of Reference (TOR) will be required for these two implementing agents. The following two sections provide the main aspects to be included in the TOR for the Regional Energy Access Adviser and the Regional Energy Access Consultants. The TOR are premised on the funding for the various activities already being in place. If this is not the case, the envisaged implementation timetable would need to be modified.

9.3 Outline TOR for the Regional Energy Access Adviser

9.3.1 Introduction

Improving energy access is a major goal of energy policy in all SADC Member States. In 2008, with support from EU-EI, the SADC Energy Programme contracted consultants to assist in drawing up a SADC Regional Energy Access Strategy and Action Plan. The goals, objectives and main elements were agreed at a high level SADC Regional Energy Access workshop held in Maseru on November 4, 2009.

The Executive Summary of the Strategy and Action Plan is attached to these TOR as an annex - the full document is available on the SADC website. One of the main recommendations is that an Energy Access Adviser needs to be recruited to spearhead implementation of the Action Plan. The definitions, principles and strategic framework laid out in the Strategy document are to form the basis for the approach to be adopted by the Adviser.

9.3.2 Goal and Objectives

SADC is seeking to employ a Regional Energy Access Adviser in order to have an official whose time and efforts will be exclusively dedicated to implementing the Regional Energy Access Strategy and Action Plan. The goal of the strategy is to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC region have access to adequate, reliable, least cost, environmentally sustainable energy services.

The specific objectives that the Adviser will be expected to pursue will be to

- establish within the Secretariat:
 - “ SADC Energy website, which will be centred on energy access but will cover the entire spectrum of activities of the Energy Programme
 - “ SADC Energy Access Drawdown Facility for energy access pilot projects
- oversee the development of, and update thereafter, the SADC Energy Access Database and annual reporting structure (Yearbook, Energy Access Reports)
- work with Member States on their national energy access strategies and energy access pilot projects, catalysing emulation of successful models.

9.3.3 Duty station and duration

The Adviser will be employed by the SADC Secretariat and will be based in Gaborone, Botswana. The assignment will involve travel to the 15 SADC Member States. The Adviser will report to the Senior Programme Manager for Energy and will receive support from all energy staff within the Secretariat.

The contract period will be three years, with the possibility of extension.

9.3.4 Main tasks

The main tasks of the Adviser will be as follows

1. Recruit and supervise the energy access consultants

Draft TOR for the SADC Regional Energy Access consultants have been prepared. Acting on behalf of the Senior Programme Manager for Energy, the Adviser will be responsible for recruitment and day-to-day supervision of the consultants. This will include:

- « finalising the TOR for the consultancy;
- « advertising the consulting assignment, using established SADC channels and procedures and those adopted by the funding agency;
- « receiving and processing proposals, working with the recruitment committee to select the preferred bidder, managing contract negotiations and issuance of the contract;
- « being the liaison person between the consultants, the Member States and the Secretariat;
- « monitoring progress in the implementation of the consulting assignments;
- « assisting in the organisation of the workshop and in ensuring inclusion of stakeholder views in the final deliverables.

2. Establish and maintain SADC Energy website

There is need for the SADC Energy Programme to have a dedicated website, similar in scope and coverage to the well received SADC water website³. The intention is that the core of the SADC Energy website will be issues relating to energy access, but the website will need to cover the entire spectrum of activities of the Energy Programme.

³ <http://www.sadcwater.com/index.php>

In respect of the website, the role of the Adviser will be to:

- « discuss with the Energy Programme team the presentation and coverage that is required;
- « prepare text and graphical materials for inclusion on the website;
- « investigate whether the SADC Secretariat IT division has the capacity to assist in establishing the website – if not, contract an outside supplier using standard SADC procurement procedures;
- « work with skilled IT personnel to implement the ideas and ensure that a user-friendly website results;
- « make Member States and other potentially interested parties aware of the new website;
- « continually update the website with topical and useful materials.

3. Establish and manage the SADC Regional Energy Access Drawdown Facility

The Adviser will be responsible for proposing rules and procedures for the use of the Drawdown Facility. The Adviser will assist the Senior Programme Manager for Energy to constitute and establish the Board for the Drawdown Facility.

Once the Board and the modalities are in place, the Adviser will:

- « liaise with the Member States and assist them to prepare project proposals for submission for funding;
- « receive and screen applications from Member States;
- « prepare documents for the Drawdown Facility Board, attend and minute the meetings and inform applicants of the outcome;
- « monitor the implementation of the pilot projects;
- « prepare and post materials on the website to disseminate useful information about the pilot projects to all interested parties.

4. Support Member States to develop National Energy Access Strategies and pilot projects

While the main role and responsibilities of the Adviser will be at the regional level, the Adviser will also be required to work with the Member States to assist in their efforts to develop national energy access strategies and to formulate pilot projects and submit these for funding from the Drawdown Facility.

The value added that the Adviser will have to offer is regional experience and perspectives. The Adviser is to pro-actively seek out opportunities to act as a "facilitator" or "catalyst" in advancing the energy access agenda and promoting the replication of successful projects and programmes. In assisting to develop pilot projects, the Adviser should pay particular attention to encouraging pilot projects which would involve more than one Member State.

5. Update SADC Energy Access Database, Yearbook and annual Reports

The consultants will be assuming primary responsibility for the SADC Energy Access Database, the first Regional Energy Access Yearbook and the first annual SADC Regional Energy Access Report. The role of the Adviser is to be fully informed on all aspects of the database, yearbook and annual report in the first year, and to take responsibility for these in the following year.

9.3.5 Summary of deliverables

The main deliverables that the Adviser is to provide are as follows, with times being from the date of employment:

- Within 3 months: contracting of Regional Energy Access Consultants
- Within 4 months: establishment of the Drawdown Facility Board and agreement on the modalities for operating the Facility, including a system of monitoring of project performance
- Thereafter, ensure that regular meetings of the Board are held (every 4 months is envisaged, but this timetable will have to be adjusted according to the flow of energy access projects)
- Within 5 months: establishment of the SADC Energy website, with regular updating thereafter
- Prepare quarterly reports (with the first report delivered at the end of the first six months of the contract start date) detailing support given to Member States and future plans which fulfil the completion of Task 4
- Work with and ensure that the consultants complete the SADC Energy Access Database and prepare the Yearbook and first annual SADC Regional Energy Access Report for the next annual meeting of the Ministers of Energy. The exact timing will depend on when the Adviser commenced work and on the stage reached in establishing the energy access reporting system (see TOR for the consultants).
- One year on from this, the Adviser would have primary responsibility for the updating of the database and Yearbook and for preparing the second annual SADC Regional Energy Access Report.

9.3.6 Skill profile

The Adviser should be a seasoned professional with at least 10 years experience in the energy sector. Academic background could be in engineering, science, economics or other relevant disciplines. Recent experience and orientation should be towards energy access issues.

Experience in the recruitment and supervision of consultants and/or in the development of websites, would be advantageous. The working language will be English, but knowledge of French and/or Portuguese would be useful.

9.3.7 Annex

The Executive Summary of the SADC Energy Access Strategy and Action Plan are to be attached as an annex to the TOR.

9.4 Outline TOR for the Regional Energy Access Consultants

9.4.1 Introduction

Improving energy access is a major goal of energy policy in all SADC Member States. In 2008, with support from EU-EI, the SADC Energy Programme contracted consultants to assist in drawing up a SADC Regional Energy Access Strategy and Action Plan. The goals, objectives and main elements were agreed at a high level SADC Regional Energy Access workshop held in Maseru on November 4, 2009.

The Executive Summary of the Strategy and Action Plan is attached to these TOR as an annex - the full document is available on the SADC website. One of the main recommendations is that consultants need to be recruited to assist with certain specific elements of the Action Plan. The definitions, principles and strategic framework laid out in the Strategy document are to form the basis for the approach to be adopted by the consultants.

9.4.2 Goal and Objectives

The Energy Access consultants are to assist the SADC Energy Programme to implement the Regional Energy Access Strategy and Action Plan. The overall goal of the strategy is to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC Region have access to adequate, reliable, least cost, environmentally sustainable energy services.

The specific objectives of the consultancy are to:

- develop energy access reporting guidelines and compile the SADC Energy Access Database, the baseline Yearbook and the first annual SADC Regional Energy Access Report;
- develop one or more summary measures of energy access which can be used for national benchmarking and for quantifying overall progress over time;
- document best practice in energy access subsidies;
- develop Guidelines for National Energy Access Strategies.

9.4.3 Timing and duration

The work is to commence within 3 weeks of the signing of the contract and may involve up to 15 person months of effort. Allowing extensive time for consultation during the projects, the chronological time for completion is one year.

9.4.4 Main tasks

1. Develop Energy Access Reporting Guidelines

The reporting guidelines are targeted at the Member States. The first sub-task will be to establish what systems of energy access data gathering exist in a sample of the Member States (these being in part the result of previous similar projects on the establishment of energy databases in SADC countries) and how these can best be adapted to the current requirements. Draft reporting guidelines are to be discussed with the same sample of countries before being finalised and distributed to all Member States. The intention is that the Guidelines will be immediately deployed so that comparable energy access information will be made available by the Member States for Task 5. A specific time period (such as 6 months) with need to be agreed and stipulated for this.

2. Develop summary measure(s) of energy access

An energy access index (EAI) is to be developed to provide a summary measure of national energy access. This is needed so as to be able to rank or benchmark countries in terms of overall energy access and to quantify progress over time in improving energy access.

The ideal measure of access would be 'ability to choose' a high quality form of energy for a particular end use, whether or not the high quality form is actually chosen. Thus affluent households, able to buy sophisticated energy devices and fuels such as LPG for cooking and heating, may choose to continue to use biomass for some end uses for a variety of reasons, including attributes such as the cultural aspects of families congregating around cooking fires. It is difficult in practice to distinguish between poor households

for whom biomass is the only fuel to which they have access (albeit access that is often costly in terms of the time and effort required to collect the fuel) and households using biomass for certain end uses when they could easily afford and choose other, cleaner fuels.

In this context, a more workable but arguably more problematic starting point for the EAI is likely to be the usage-based definition given in Section 1.2 of the Strategy document, where it is recognised that usage is the result of the energy being available, affordable and acceptable (this reflecting both cultural acceptability and the consumer's willingness to pay for that form of energy for that end use).

If the proposed EAI is to be comparable across countries, it would necessarily have to be based on information that is already or can readily be collected in each country. Task 2 is therefore to be carried out in parallel to Task 1.

In the spirit of the successful UNDP Human Development Index (HDI), the EAI could take the form of weighted average of factors for which comparable data is available. Like the HDI, the EAI is likely to have to be a pragmatic compromise rather than what one may ideally seek to have, but may nonetheless prove to be useful.

Ideally there should be one single summary EAI, but if this proves to be too problematic in practice, a small number of complementary summary measures may be offered instead or as well as the EAI, for example EAIs for different end-uses (such as lighting, cooking, heating and heavy power).

3. Develop Guidelines for National Energy Access Strategies

Energy access is first and foremost a national responsibility, rather than a regional one. The objective of this task is to produce a set of Guidelines for the formulation of National Energy Access Strategies that will be useful for SADC Member States. The regional benefit is to come through the consultants ensuring that the Guidelines are based on best practice within SADC, as well as in other regions. The Annexes of the Strategy document provide a starting point.

The Guidelines are to be designed so they will be useful to any SADC country, but the immediate short-term focus should be on countries working on strategies at the time that the consultancy commences. An initial scan of the Member States will be needed to identify which countries fall in this category.

4. Document best practice in energy access subsidies

Offering subsidies is an important policy for a Member State to consider as an element of a National Energy Access Strategy. The principle laid out in the Strategy is that access subsidies should be prioritised over consumption subsidies. Member States have requested an analysis of how subsidies have been used most effectively in the past to improve energy access in SADC

countries and elsewhere in the world. The objective of this task is to respond to this request.

The output of the task on subsidies is to be incorporated into the National Energy Access Strategy Guidelines, both in the main text and through an annex giving the details.

5. Compile the SADC Energy Access Database, Yearbook and first annual SADC Regional Energy Access Report

In this task, the objective will be to draw together the information from the Member States which has been produced on a uniform basis using the Energy Access Reporting Guidelines produced at the end of Task 1. A spreadsheet model or other simple database is to be constructed to aggregate the information from the Member States and provide the energy access benchmarking comparisons.

The information from the database is to be used to prepare a baseline SADC Energy Access Yearbook and to work with the Energy Programme to draft the first annual Energy Access report. The Yearbook and Energy Access Report will be presented to the next annual meeting of the SADC Ministers of Energy.

6. Present findings at a regional stakeholder workshop

An important element of the consultancy will be a regional stakeholder workshop at which the work undertaken during this consultancy will be presented and discussed. The timing of the workshop will be agree with the Energy Programme during the inception visit.

9.4.5 Summary of deliverables

The main deliverables that the consultants are to provide are as follows, with times being from the date of commencement of the contract:

- Within 2 and 4 months respectively: draft and final Energy Access Reporting Guidelines, including the data requirements and calculation procedures for the EAI(s);
- Within 6 and 8 months respectively: draft and final Guidelines for National Energy Access Strategies, including analysis and information on subsidy best practice;
- SADC Energy Access Yearbook and first annual report on Regional Energy Access for the Ministers of Energy. The deadline for these deliverables will depend on the timing of the annual meeting of the Ministers of Energy and on the whether the Member States have had adequate time to produce the data needed according to the Energy Access Reporting Guidelines.

9.4.6 Skill profile

The consultants should have extensive experience of energy access in developing countries, of working with regional economic communities and of preparing guidelines for strategy formulation and for information gathering.

9.4.7 Annex

The Executive Summary of the SADC Energy Access Strategy and Action Plan are to be attached as an annex to the TOR.

Annexes - Introduction and Context

As recorded in Section 1.1, the goals of the SADC Energy Access Strategy are at the strategic level to harness regional energy resources to ensure, through national and regional action, that all the people of the SADC Region have access to adequate, reliable, least cost, environmentally sustainable energy services, and at the operational level that the proportion of people without such access is halved within 10 years for each end use and halved again in successive 5 year periods until there is universal access for all end uses.

To achieve these goals, the SADC Energy Access Strategy is composed of 7 elements:

- **Statistics:** improved systems of providing accurate information, especially quantitative data, on energy access.
- **Applications:** focus on energy end-uses rather than technologies
- **Biomass:** recognition of the dominant role of biomass in the present and projected energy balance of most SADC countries.
- **Prices:** cost-reflective but competitive prices
- **Subsidies:** prioritise access over consumption subsidies
- **Development:** focus on use of energy to enhance economic productivity for poverty reduction and enhanced quality of life
- **Capacity:** ability and willingness to implement, operate and maintain energy access projects and programs

Although all elements should be part of any national energy access strategy, the individual SADC members will require a different mix of options fitting these elements, based on their stage of development and particular situation. The goal of these annexes is to inspire countries in formulating their own strategies by offering a rich set of ideas from which to draw upon.

To achieve this goal, the set of annexes is structured into three broad sections. In the first annex, institutional and strategic arrangements are emphasised to illustrate that the choice of individual solutions, such as grid electrification or solar home systems, alone is not enough. Rather, any set of individual solutions chosen to enhance access to modern energy must be supported by a set of structures and strategies that recognise the broader political, economic, social and technical realities of the country.

The two annexes that follow are centred on individual solutions relevant to ensuring a portfolio of choices to consumers. As universal access to electrification is the end-goal to which all countries strive, one of these two annexes is dedicated to approaches which support this outcome. However, in recognition that this goal is

unlikely to be achieved for some time to come, the second of these “options” annexes outlines non-electrical choices for the portfolio.

Specifically:

- **Annex 1, Institutional and Strategic Case Studies**, provides examples of how various nations have incorporated political, economic, social and technical realities to ensure the chosen approaches to enhancing access to modern energy are not compromised. This Annex begins by highlighting modern energy’s ability to improve the macro-economic realities by describing how **Mauritius and Tunisia successfully integrated electrification planning into broader development goals**. The Annex also provides commentary on why integration is so important, and the consequences of its absence. The Annex then turns to political and institutional realities, by elaborating on how **Tunisia fostered cooperation and communication among its various institutions to create an “enabling environment”**. The Annex concludes with a discussion of how economic and social realities at a micro level are incorporated through the **formation of Energy Shops**, or stores which are expressly set up to offer consumers a “portfolio” of energy options in recognition that both culture and income, among others, will keep households using energy in all forms, including biomass.
- **Annex 2, Grid-Based Portfolio Options**, looks at different financial, institutional and technological approaches that have successfully supported uptake of electricity. The first section describes how **Botswana has targeted subsidies to low income-users** while the second section focuses on the **cooperative approach to ownership and its role in providing rural electricity in Bangladesh**, although a more general discussion is also included. The remaining two sections focus on technological approaches to electrification, with one detailing how **the European approach to setting up the grid may not be the most appropriate or cost-effective method** for southern Africa while the second details the role that **mini-grids** can play.
- **Annex 3, Off-grid Portfolio Options**, discusses a number of non-grid options and programmes which seek to enhance energy access. These include **regulatory support for small private power project investments, solar home systems, the International Finance Corporation/World Bank programme “Lighting Africa”, site-specific renewable energy technologies such as biogas and wind pumps, biomass, and biofuels**. The list is not meant to be exhaustive, but rather to emphasize that enhancing energy access must include a portfolio of options, and that countries should seek to find a portfolio mix which best meets the needs of its citizens.

Country studies of **Mauritius, Namibia and South Africa** are presented as **Annexes 4, 5 and 6**. Finally, **Annex 7** discusses the responses to the questionnaire sent at the start of formulating this Strategy. It includes 2 tables, but the main detailed summary tables are too large to be conveniently presented in a word document, and can more conveniently be accessed via the accompanying excel file SADC Questionnaire Summary.xls

A1 Institutional and Strategic Case Studies

A1.1 Integration of electrification with overall economic development strategy

A1.1.1 Key Components

- **Successful electrification programs** are **not done in isolation** of other policies, but are instead **integrated with other development policies**; and
- Overall policy development should seek to **harness synergies**; e.g., electrification is prioritised to occur along with provision of other social (health and education centres) and physical infrastructure (roads, water, telecommunications).

A1.1.2 Key Lessons

- **Energy provision** is essential, but **not sufficient**, to socio-economic development.
- **Total benefits** are **greater** than the sum of the **individual components**;
- Integrating electrification and development creates **donor enthusiasm**, thereby **leveraging external funding**;
- Integration must be accompanied by **detailed economic analysis** to support choices which maximise benefits to all sectors and not just a specific sector; and
- The integrated approach **accelerates development**.

A1.1.3 Detailed Description

The experience of two countries is presented here to illustrate the benefits of close integration of electrification with national development strategies – Tunisia and Mauritius. A more general discussion on the continued absence of integration in many other countries follows.

Tunisia

In the mid-1970s, the Government of Tunisia launched a rural electrification programme as part of a broader strategy to encourage rural development. At the time of inception, only 6 percent of households had access to electricity. In 2000, the corresponding percentage was approximately 88 percent. Centred around the goals of increasing income, reducing unemployment, and improving living conditions taking into account the environment, gender status, and the expected rate of return, the government understood that not only was electrification integral to these goals,

but that electrification done externally of these policies would not achieve its development potential. Hence, the government has been adamant that full coordination and integration of its development policies occurs.

The capacity for this successful integration derives from an iterative five year planning process which must consider individual projects as part of the broader development picture. Consideration involves trading off the economic, social and financial outcomes of one project against the economic, social and financial outcomes of another, regardless of the sector. This allows for specific projects to compliment one another, thus ensuring greater overall returns to government expenditures. To guide decisions, regular national household and employment surveys are undertaken to rationalise and prioritise actions, including the regions to be electrified.

Enabling this process of tight integration was officially initiated in the early 1970s through the country's IVth Five Year Plan (1972-1976), which chose the three pillars of basic education, improved health services and rural electrification as the core of its rural development policies. As time passed, these pillars were complemented in subsequent Plans by additional development programmes, although the original three pillars remained part of the core. By the turn of the century, investments in drinking water, transportation and communications infrastructure, health and education were paralleling investments in rural electrification in target districts.

To foster integration, individual actors in key sectors were given incentives to make full use of the newly available electricity. For example, as part of the development of the agricultural sector, a water conservation program offered subsidies for 60 percent of the value of electric pumps and drip irrigation pipes. Those who took advantage of this were quickly rewarded: e.g., in the Bizerte area tomato farmers saw returns increase from 25 tons per hectare to 120 tons per hectare, a nearly fourfold increase; for potatoes, the yield increased from 15 tons per hectare to 35 tons per hectare.

Besides capital subsidies, there is also a recurrent subsidy to the electricity tariff to promote rural development, including in the agricultural sector. Irrigation benefits from lower tariffs overall and is offered a low off-peak tariff encouraging night-time irrigation. Similarly, the national utility encourages oil pressing and milling/grinding, both of which benefit from their own tariff, tariffs which are substantially lower than the average low-tension tariff. These policies are accompanied by additional stimuli, such as low-interest loans and subsidies for irrigation, storage centres for agricultural products, milk collection centres and other rural industries (e.g., repair shops, hair salons, etc).

More broadly, while there has been no specific study measuring the link between rural electrification and socioeconomic benefits in Tunisia, a positive correlation between the two has been captured:

- Rural electrification: Between 1976 and 2000, rural electrification rates increased from 6 percent to 88 percent;

- Poverty: Between 1956 and 1995, the incidence of poverty has decreased from 40 percent to 7 percent;
- Life expectancy: Between 1956 and 1995, life expectancy has increased from 50 years to 70 years;
- School enrolment: Between 1956 and 1995, the country has achieved nearly total primary school enrolment;
- Women's status: Today, women make up almost one-third of the Tunisian labour force; and
- Income: Between 1975 and 1999, real GNP per capita has increased from US\$ 770 to \$2,060, with regional disparities reduced and income distribution improved.

Moreover, one of the drivers of rural electrification and development was to reduce rural to urban migration. It is noteworthy in this regard that urban growth fell from 4.3 percent to 1.2 percent between 1975 and 1999.

This integrated approach has attracted international favour with donors.

Mauritius

As described in detail in the main body of the report and in Annex 4, and thus only briefly discussed here, Mauritius' success in achieving near global electrification critically depended on coordination between energy and macroeconomic policy development and implementation. By coordinating policies across multiple sectors, various departments were, and are, given a clearly articulated vision which facilitates cooperation and a shared motivation. For example, the rural electrification programme was facilitated by the government's decision to promote tourism as one of the pillars of the economy. As most tourist hotels had to be developed at the beaches along the coast, the grid network had to be extended outside the main cities to the sea coast thereby passing through the rural areas.

Although cross-cutting policies such as this are facilitated by the nature of Mauritius' government set-up – ministers and permanent secretaries have multi-sector coordination and management responsibilities, important in energy as infrastructure cannot be developed independently of economic and social development projects – other countries can still utilise this approach by ensuring priorities and policy objectives are jointly formulated and integrated across numerous government sectors.

More broadly, Mauritius' overall development success is often attributed to such integration. Indeed, the development of the energy sector in post-independence Mauritius has been driven by two broad objectives – (a) increasing energy supplies to facilitate economic growth and (b) substitution of traditional energy with modern energy to improve quality of life, while saving the country's limited forest resources. These two objectives are interrelated because energy access for enhancing

economic productivity creates the income that people need to improve the quality of household energy.

The absence of integration

Despite the success of Tunisia and Mauritius, integration of energy into broader development planning in most other countries is the exception rather than the rule. This is well evidenced by the number of international donor projects and studies initiated in the past few years expressly seeking to address this absence.

With regard to measurement, consider a UNDP report, issued in 2007, analyzing the treatment of energy issues in available Poverty Reduction and Strategy Papers (PRSPs). The study also tracked how energy priorities are further reflected in terms of targets, timelines and budgetary allocations in Medium-Term Expenditure Frameworks (MTEF). Although the extent to which energy is linked to the various MDG goals varies by region, Africa ranked at the bottom of the list in establishing relationships between the two. Unsurprisingly, there was strong emphasis in African PRSPs on the role of energy in macroeconomic growth and its importance as a factor of production, but very little consideration for its relationship with social development goals; i.e., the PRSPs assume that energy provision is sufficient to bring socio-economic development, despite it being essential but *not* sufficient. Critically, expansion of electricity supply was stressed as the main principal strategy for meeting energy needs, although this priority was not linked to other development goals. Only in a handful of African PRSPs did the provision of other energy sources receive attention, with modernisation of biomass, despite being the predominant energy source, mentioned briefly in just two of the thirty African PRSPs included in the study. Yet, despite the statement of energy provision's importance, only 37 percent of African PRSPs explicitly allocated budgetary resources to national energy priorities in the MTEFs.

In the absence of integration with broader development goals, the common historical pattern of electrification for electrification's sake will result in immense expenditures with little returns. Encouraging an economic base at the end of the lines must accompany any plan to extend the grid. This is well illustrated by an African Development Bank project performance evaluation of a rural grid extension project in Tanzania. The project was undertaken to electrify three rural towns in south eastern Tanzania. At the time of project proposal, it was envisioned that half the electricity demand at the time of connection would come from cashew nut factories located in the area, with the remainder going to water pumping, hospitals, secondary schools, etc. This corresponded to a forecast demand of 15.56 GWh and a peak of 3.98 MW. Actual demand at commissioning was just 0.872 GWh, part of which was due to the closure of the cashew nut factories prior to the project being implemented. Yet, construction went ahead on the belief that adequate demand would arise.

As with so many other rural electrification projects, projected demand did not materialise for the familiar reasons. Energy is an essential, but not sufficient, component of socio-economic development. The inability for the consumers to pay the upfront connection charges meant that the prospective customers could not

connect which, as the evaluation report notes, negated the very objectives of the project. That this is a common failure among energy provision programmes in many countries has become the focus of a number of international efforts to instil integration into broader energy planning, including the UNDP and its country offices, the World Bank, and the EU through programmes such as the European Energy Initiative for Poverty Eradication and Sustainable Development's ENABLE project.

Hence, while 'electricity as a catalyst for development' has proved to be the case in some notable examples within the SADC region, it is more often the case that centres are electrified without the economic base or the complementary investments in other infrastructure (roads, water, telecommunications). As exemplified in Tanzania, there is a high opportunity cost in tying up investment in electrification which is not properly utilised. Mauritius and Tunisia do not need to be exceptions to the rule, but rather should be emulated, along with the procedures and structures proposed by the likes of the work of the UNDP, the World Bank and the EUEI.

A1.1.4 Further Reading

African Development Bank, 2006, Republic of Tunisia, Rural Electrification Project Completion Report, African Development Bank.

Cecelski, E., Ounalli, A., Aissa, M., and J. Dunkerley, 2005, Rural Electrification in Tunisia: National Commitment, Efficient Implementation and Sound Finances, World Bank.

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A1.2 Tunisia and Institutions

A1.2.1 Key Components

- **Coordination among various institutions;** and
- **Developing a low-cost grid** based on local utility's own adaptation of a single-phase North American distribution design.

A1.2.2 Key Lessons

- **Clear, well-defined and transparent decision-making processes** will help actors know what is required and expected of them;
- **Codification of coordination procedures** may be important in ensuring communication and interaction;
- **Careful planning** through **data collection** and analysis helps **prioritise projects** while **directing expenditures** to their highest use value;
- Stepping away from convention as part of a **redesign of a grid** better suited to the needs of Tunisia's geography, energy use profile and locational development goals meant **immense cost savings** without compromising customer needs;
- **Strong political commitment**, particularly in supporting the utility to implement its distribution system design contrary to convention, is instrumental to keep momentum; and
- Recognising that in certain settings electrification may be better achieved through **alternative or complementary approaches**, such as PV.

A1.2.3 Detailed Description

In the mid-1970s, the Government of Tunisia launched a rural electrification programme as part of a broader strategy to encourage rural development. Centred around the goals of increasing income, reducing unemployment, and improving living conditions taking into account the environment, gender status, and the expected rate of return, the government understood that not only was electrification integral to these goals, but that electrification done externally of these policies would not achieve its development potential. This approach was officially initiated through the country's IVth Five Year Plan (1972-1976), with rural development commencing via the three pillars of basic education, improved health services and rural electrification. As time passed, these pillars were complemented by additional development programmes. At the time of inception, only 6 percent of households had access to electricity. In 2000, the corresponding percentage was approximately 88 percent.

Noteworthy about this success is that it was achieved via institutional arrangements that are not, at first glance, necessarily conducive to coordination. Tunisia's government is, like many African nations, made up of multiple institutions and disparate agents focused on a single sector. However, Tunisia was able to maintain effective coordination between these agencies through a strong coordinating body and well-defined procedures for integration and communication.

Specifically, rural electrification is influenced by over five separate government bodies located across the national, regional and local level. At the national level, the various actors include the Ministry of Economic Development (MDE), which

defines overall rural development policy, including the framework for rural electrification; the Ministry of Industry (MI), which develops overall energy policy and, with regard to electricity, houses the National Rural Electrification Commission (CNER), supervises STEG, and provides input to the five-year planning process; the Ministry of Environment through the National Agency for Renewable Energy (ANRE), which is responsible for energy conservation and renewable energy, including PV-based rural electrification; two separate funds for projects not approved as part of the planning process; the regional executive agencies of the Ministry of the Interior (or Governorates together with their Delegations), which select and manage rural development projects, seek local input from leading citizens, and allocate funds; and STEG, which implements the rural electrification program through a regional structure mirroring the Governorates, thereby ensuring regular consultations between the two bodies.

The key to keeping so many institutions coordinated is strong government commitment actualized by well-defined structures and procedures. The primary body through which this coordination and planning occurs is the CNER. Chaired by the MI's Directory of Electricity and Gas, it consists of representatives from across all institutions listed in the preceding paragraph. Regular meetings allow the separate actors to keep current on all plans for rural electrification and related programs while also offering an opportunity for discussion and early identification of problems. The CNER's work is supplemented by continuous interaction at both the vertical and horizontal level among the various institutions. Local input is ensured through the project selection process, which actually begins at the local level. Finalization then occurs through iterations between the sub-regional, regional and national level.

As with the interactions, the process of iteration is well-defined and forms a fundamental component of the five year planning process, which must consider individual projects as part of the broader development picture. See Annex 1.1 for a full discussion of how electrification is integrated with the general socio-economic development of Tunisia. In the first step of this iterative process, areas are chosen according to the five year plan's preliminary development themes. Done in three clearly defined steps, the first involves identification of zones for rural development based on income, unemployment, environmental quality, gender status, expected rate of return, costs of job creation and improved living conditions. The second step involves the selection of potential projects and targeted beneficiaries while the third step involves identification of rural electrification projects by STEG following a detailed survey of the chosen zone.

In this last step, the Governorate asks the Delegations to list all non-electrified areas and to identify potential sites for agricultural pumping and water drilling. The Delegations create this list with assistance from local representatives. STEG then supplements this list by identifying the required infrastructure to electrify the identified sites, including the length of line needed for various voltages, the type of infrastructure best suited to electrify the corresponding homes, whether the homes are suitable for electrification, etc. STEG uses this information to estimate the costs of electrifying various locations within the chosen zone. These costs are then fed back to the MDE as scenarios for electrification and include, for each site, the

number of beneficiaries, the costs of the project, and the rates of electrification. ANRE undertakes a similar study for PV-based electrification, which requires coordination with STEG to ensure identified projects are remote from grid extension plans.

With the costs and benefits of potential scenarios thus identified, final selection is made after the five year plan's rural development objectives are made official. Budgets are accordingly set for each development area to ensure the maximum potential of expenditures. These budgets are defined by project ceilings and all projects under the ceiling are included in the Five Year Plan. As an example, consider the IXth Five Year Plan, which included a project ceiling of 2,200 TD (1530USD) per beneficiary for rural electrification. Funding of this ceiling was spread across the beneficiary (200 to 600 TD, or 140 to 420 USD), STEG (200 TD or 140 USD) and the Governorate (up to 1800 TD, or 1250 USD), with the Governorate's portion defined as a maximum percentage of costs, or 82 percent. If a project's cost exceeds this ceiling, but is deemed of special importance, it may be eligible to receive funding under the National Solidarity Fund or the Presidential Fund.

Perhaps of equal import in the success of Tunisia's electrification has been the institutional freedom, as part of Tunisia's enabling environment of capacity, given to STEG to eschew the imported European model of electricity for one suited to the needs of Tunisia. Best described as a "technological leap", STEG developed a low-cost grid based on its own adaptation of a single-phase North American distribution design. Prior to this redesign, the entire electricity system in Tunisia was based on the European three phase model, as is the case with most rural electrification programmes with Africa. Although the model is suitable for the dense populations and heavy loads characteristic to Europe, its use in Africa has resulted in poorly adapted and oversized networks which carry unnecessarily high costs for connecting small rural loads. However, when Tunisia decided to expand and accelerate rural electrification, STEG undertook a technical audit to assess the costs and benefits of alternative systems. The results revealed that the European model was unsuited for the needs of Tunisia, and rather, after numerous economic and technical studies, a system based on a modified North American model was developed. Called MALT, it has dramatically reduced costs, thereby allowing far more households to be electrified within the same budget. As shown in Table 8, the initial overall cost reductions were estimated to be between 18 and 24 percent. A more recent evaluation by NRECA International of similar systems in other countries places the estimated cost savings between 30 and 40 percent.

The success of MALT, which was undertaken with a view to promote efficiency and cut costs, encouraged STEG to continue developing and implementing cost-cutting technical innovations, with the utility constantly implementing innovative solutions to best meet the needs of customers in an efficient manner. The support given to STEG by the government to carry on was critical to maintaining its motivation to do so. Yet, the institutional arrangements and incentives surrounding STEG keep it mindful of its role within broader development policy. For example, if larger loads or specialised machinery are expected in villages, STEG will undertake technical

studies to determine the most cost-efficient approach and appropriate design, recognising that a one-size-fits-all design is not the most effective approach.

Table 8 Estimated Savings of MALT System, Compared to Three-phase Distribution System, 1975

Network Level	Cost Reduction
MV network	30 – 40 %
MV/LV substations	15 – 20 %
LV network	5 – 10 %
Overall	18 – 24 %

In summary, successful coordination and innovation has emerged, in large part, due to the construction and adherence to a clear and well-defined process as well as the incentives and encouragement created by the government as part of its capacity to turn policy into action. Although the process is often criticised for being too mechanical, it has nonetheless led to an enabling environment which, for the most important, has created actual outcomes. While the process and roles are open, objective and transparent, debate and criticism are still allowed. Indeed, in first creating the MALT system, STEG faced a great deal of criticism and argument over its proposals. Likewise, the system has not always worked perfectly. For example, the time difference between selection and installation of PV projects has sometimes resulted in the grid being extended to areas where PV installation has recently occurred (20 percent of such cases are characterized by the grid arriving just three months to a year after installation), resulting in wasteful duplication.

A1.2.4 Further reading

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A1.3 Energy Shops

A1.3.1 Key Components

- Recognise that energy consumers use a portfolio of fuels, and want them all to be readily available, thereby offering a **one-stop-shop of multiple technologies and fuels**;
- Concentrate on **enhancing the satisfaction of energy needs rather than promotion of a single technology or fuel**; and
- Cater to **all income levels**.

A1.3.2 Key Lessons

- The better the **data** available, the better roll-out can be prioritised and tailored to customer needs;
- Energy shops offer a means of creating **local employment**;
- Although **multiple approaches** are being tested (ownership versus fee-for-service), no single model has emerged as the clear winner; and
- Good approach to **engage with the community**.

A1.3.3 Detailed Description

In recognition that energy consumers use a portfolio of fuels and technologies (in particular often continuing to use biomass for cooking even when the house is electrified) numerous governments are adopting initiatives aimed at creating one stop energy stores, which in Namibia, for example, are to be called 'Energy Shops' while, in Botswana, 'Energy Service Companies'. Formally pioneered as part of the South African solar concessions, discussed in Annex 3.1 and Annex 6, energy shops provide a one-stop-shop for numerous energy technologies and fuels aimed at enhancing energy access for the surrounding area by making available improved fuels and appliances.

Namibia

Namibia has made the Energy Shop approach the centrepiece to its Off-Grid Energisation Master Plan (OGEMP), the final version of which was issued in

January, 2007. The underlying objective of the OGEMP is to provide access to appropriate energy technologies to everyone living or working in one of three types of areas: (1) off-grid areas, or areas that will not have electricity within 20 years; (2) pre-grid areas, or areas that will not have access to electricity within 5 years; and (3) “grey” areas, or areas where it is not clear how or if electricity will be providing – e.g., informal settlements.

Intended to be rolled out over a twenty year period, the first two years of the OGEMP will aim to have one energy shop established in each of the thirteen regions in the first year and one again in the second year, so that two shops exist in each of the thirteen regions by the end of the second year of the rollout. Thereafter, new energy shops will be established according to a national priority plan, which is based on a point scoring system developed as part of the Regional Electricity Distribution Master Plan.

Table 9 OGEMP Point Scoring System for Prioritising Energy Stores

Facility/Point Score Item	Points Awarded	Facility/Point Score Item	Points Awarded
<u>Constituency Capital</u>	80	<u>Other Infrastructure</u>	
<u>Health Facilities</u>		Agricultural development centres	60
Hospital	80	Agricultural extension office	20
Health Centre	60	Per borehole	5
Clinic	40	NamPost	15
Outreach point	20	Per household to be connected	1
<u>Schools</u>		<u>Proximity to existing powerlines</u>	
Senior secondary school (11-12)	60	Village to powerline (0 to <=1km)	0
Junior secondary school (8-10)	55	Village to powerline (>1 to <=5km)	10
Combined school (prim & sec)	50	Village to powerline (>5 to <=10km)	20
Senior primary school (5-7)	40	Village to powerline (>10 to <=20km)	30

Facility/Point Score Item	Points Awarded	Facility/Point Score Item	Points Awarded
Junior primary school (1-4)	30		
Hostel	60		

Specifically, this points scoring system begins by proposing alternative locations for the Energy Shops and then defining a market area around the proposed location based on distance to the shop. Defined as a “catchment”, the area is scored according to the type of facilities located within its boundaries as well by distance to existing powerlines. The points for the associated attributes are shown in Table 9. The total point score is determined by summing the points, with the top-scorers thus receiving priority. At the end of twenty years, 156 Energy Shops are expected to be operating, with well managed businesses targeted to run them. These selected businesses would then receive extensive training and support to properly run the Energy Shops.

Implementation of these Shops must be done with limited funding. As there are approximately 106,554 households to be targeted by the OGEMP, the technology is available as a purchase only approach. Yet, support is to be provided through the establishment of a centrally managed Consumer Credit Finance Revolving Fund. Current expectations are that the fund would offer 6-month, 1-year and 5-year loans at the prime interest rate. The revolving fund is assumed to provide loans equivalent to N\$400,000 (USD 51,920) per year per energy shop.

Overall, the fund is projected to break even in year 13 and, thereafter, will take in more than it makes in loans. This will help offset the total cost, which includes funds to administer the Revolving Fund (estimated to range between N\$1,288,912 (USD 167,301) and 3,705,627 (USD 480,990) per annum), funds to actually establish new Energy Shops while monitoring and training existing shops (estimated to range between N\$834,600 (USD 108,331) and 2,624,800 (USD 340,699) per annum), and funds for sub-contractors and outputs (estimated to range between N\$800,309 (USD 103,880) and 1,151,000 (USD 149,400) per annum). Overall, the estimated annual average funding requirement is N\$ 6,839,779 (USD 887,803) while the estimated total requirement for the entire twenty years is N\$136,795,585 (USD 17,756,067).

Interestingly, an innovative approach utilised by Namibia is to offer Recommended Energy Baskets. These Energy Baskets are made up of a wide range of affordable and appropriate energy technologies, compatible fuels, and compatible appliances, with the final basket consisting of a total energy solution. By focusing on energy services rather than technologies, the goal of these baskets is to move away from promotion of a single technology by emphasizing energy needs and energy services as part of a package which covers the entire spectrum of a household’s energy needs. Hence, recommended energy baskets include not only technologies and fuels, but the appliances that can be correspondingly effectively operated.

Ten recommendations for households are proposed as part of the OGEMP, with two depicted in Figure 4, while an additional eight recommendations have been prepared for particular types of institutions (e.g., schools, hospitals) or businesses (e.g., food and beverage SME), with one of these depicted as the final panel of Figure 4. Critically, these baskets include an estimate of the total monthly cost of operation plus the total upfront costs. Households or other customers can then choose the energy basket based on the energy services required, the funds available and their willingness to spend. Similarly, the Energy Shop can use the energy basket recommendations to advise possible clients without experience in the particulars of the individual components, such as solar system sizing. Items can be removed in the event the client already owns the appliance.

Figure 4 Sample Household Energy Baskets

Energy Basket 1: Household - Option 1									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel Subtotal	Required Energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
12 V Rechargeable Battery (105 ah)	1	N\$ 500.00	N\$ 500.00	~	Vah/month	~	~	N\$ 13.80	Total monthly operation & maintenance budget
Low power electric light 11 W CFL, fitting: round bulkhead & pull-switch	2	N\$ 293.00	N\$ 586.00	1800.00	Vah/month	N\$ 0.04	N\$ 126.00	N\$ 16.28	
Tso Tso Stove / Vesto Stove	1	N\$ 350.00	N\$ 350.00	40.00	kg/month	N\$ 1.13	N\$ 45.20	N\$ 4.17	
SUB-TOTAL			N\$ 1,436.00				N\$ 171.20	N\$ 34.24	
TRANSPORT OF PRODUCTS TO ENERGY SHOP			N\$ 150.00						
INSTALLATION			-						
TOTAL PRICE			N\$ 1,586.00						

Energy Basket 8: Household - Option 8									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel Subtotal	Required Energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Glass plate - double	1	N\$ 150.00	N\$ 150.00	4.60	kg/month	N\$ 12.78	N\$ 58.79	N\$ -	Total monthly operation & maintenance budget
220V electric light 15 W CFL with fitting	4	N\$ 30.00	N\$ 120.00	~	Vah/month	N\$ -	~	N\$ 2.44	
HiFi - AC	1	N\$ 500.00	N\$ 500.00	~	Vah/month	N\$ -	~	N\$ -	
TC - AC	1	N\$ 1,000.00	N\$ 1,000.00	~	Vah/month	N\$ -	~	N\$ -	
Electric fridge A++ (150 l)	1	N\$ 6,800.00	N\$ 6,800.00	~	Vah/month	N\$ -	~	N\$ -	
Solar PV 200W, 600VA - AC	1	N\$ 22,500.00	N\$ 22,500.00	~	~	~	~	N\$ 27.00	
9 kg LPG Cylinder (N\$ 173 deposit)	1	N\$ 288.75	N\$ 288.75	~	~	~	~	N\$ -	
SUB-TOTAL			N\$ 31,358.75				N\$ 58.79	N\$ 29.44	
TRANSPORT OF PRODUCTS TO ENERGY SHOP			N\$ 1,200.00						
INSTALLATION			N\$ 1,400.00						
TOTAL PRICE			N\$ 33,958.75						

Energy Basket 14: Food and Beverage SME									
Appliance / Fuel	Quantity	Appliance / Fuel Cost	Appliance / Fuel Subtotal	Required Energy	Units	Unit Cost	Monthly Fuel Cost	Monthly Maintenance Cost	
Glass plate - double	4	N\$ 150.00	N\$ 600.00	6.00	kg/month	N\$ 12.78	N\$ 306.72	N\$ -	Total monthly operation & maintenance budget
220V electric light 15 W CFL with fitting	6	N\$ 30.00	N\$ 180.00	~	Vah/month	N\$ -	~	N\$ 3.67	
Electric fridge A++ (150 l)	1	N\$ 6,800.00	N\$ 6,800.00	~	Vah/month	N\$ -	~	N\$ -	
Electric freezer chest (225 l) 12/24 V DC	1	N\$ 8,800.00	N\$ 8,800.00	~	Vah/month	N\$ -	~	N\$ -	
Food processor (household)	1	N\$ 800.00	N\$ 800.00	~	Vah/month	N\$ -	~	N\$ -	
Microwave	1	N\$ 1,500.00	N\$ 1,500.00	~	Vah/month	N\$ -	~	N\$ -	
Solar cooker (goat size)	2	N\$ 800.00	N\$ 1,600.00	~	Vah/month	N\$ -	~	N\$ -	
Solar PV 680, 1200VA - AC	1	N\$ 55,000.00	N\$ 55,000.00	~	~	~	~	N\$ 300.00	
9 kg LPG Cylinder (N\$ 173 deposit)	4	N\$ 288.75	N\$ 1,155.00	~	~	~	~	N\$ -	
SUB-TOTAL			N\$ 76,435.00				N\$ 306.72	N\$ 303.67	
TRANSPORT OF PRODUCTS TO ENERGY SHOP			N\$ 2,500.00						
INSTALLATION			N\$ 2,000.00						
TOTAL PRICE			N\$ 80,935.00						

As for the technologies, fuels and appliances, these were chosen so that:

- they are readily available on the Namibian market;

- they would, in combination, satisfy all basic household energy requirements; and
- they would require minimal operation and maintenance cost.

The focus was also on decentralised stand-alone systems rather than hybrid mini-grids as there is little data available on the density of households in the off-grid and pre-grid localities, making it impossible to recommend or plan mini-grids without making hundreds of field visits. Additionally, while mini-grids may be a more cost-effective option, the time required to co-ordinate with the Regional Electricity Distributors, Local Authorities and local community would delay roll-out.

South Africa

In South Africa, the government, in 1999, initiated a programme to grant private companies the rights to establish off-grid energy utilities in designated concession areas (these concessions are described in detail in Annex 3.1). Although the concessions were essentially based on dissemination of Solar Home Systems (SHS), concessionaires were expected to adopt a delivery model promoting a range of fuels and appliances. One such concessionaire, NuRa, has been quick to take this up, seeing them as not only an important service for its customers, but as an opportunity to bring in additional revenues. Like many other SADC countries, woodfuel and paraffin tend to be the dominant energy sources in rural areas. NuRa thus decided to promote LPG, understanding that the absence of uptake was, in part, due to its infrequent availability in these areas. As such, NuRa has made it an explicit objective to improve access to LPG over time, and has started selling LPG as part of its services alongside other fuels. Importantly, the infrastructure created as part of the concession allows NuRa to sell LPG with a very limited mark-up, which enables many consumers to purchase a fuel they might otherwise not have been able to afford. Today, LPG is NuRa's top fuel seller.

Not only have the NuRa energy shops been able to enhance access, but, given their local nature, they have been able to contribute to the economic and social development of the communities in which they are located. The NuRa stores provide a vital source of employment in these areas and allow the utility to engage more easily with its customers. As members of the community, NuRa staff engage with schools and institutions to hold energy information seminars to raise the profile of energy in education and health; identify common problem areas; identify possible delivery of education materials and pamphlets; and present generic data and information on energy economics and savings options (CFLs, geysers, insulation of buildings).

Botswana

In Botswana, the Botswana Power Corporation is implementing, on behalf of the Botswana Ministry of Minerals, Energy and Water Resources, the Renewable Energy-based Rural Electrification or 'RE-Botswana' Programme. Designed to remove the barriers to wide-scale utilization of renewable energy and low GHG

technologies, the programme aims to meet the basic electricity needs of individual households while encouraging the development of the private sector in the provision of renewable energy in Botswana.

Specifically, the RE Botswana Programme is using the successful fee-for-service approach used by the South African solar concessions (and described in Annex 3.1 and Annex 6) and is expanding the list to explicitly cover not only SHS, but distribution of improved cookstoves as well as a lantern charging service. To help fund and run the shops, the RE Botswana Programme is seeking participation from private partners to access risk capital and alternative streams of income. The partner is expected to form a joint venture with BPC Lesedi, a company set up for this very purpose and with its major shareholder being the Botswana Power Corporation. The aim is to establish a franchise network of small privately owned energy service companies licensed to provide products and services to households, Government and business customers.

Crucially, the services will be aimed at all income levels and energy uses, with users able to choose from two lighting and power options: (1) a solar charging service which entails retailing rechargeable electric lanterns and batteries with the provision of a recharge-for-a-fee service; or (2) rental of SHS on a fee-for-service basis. These options will be packaged with efficient cooking appliances, including improved efficient woodstoves and heat retention devices.

Different ownership and financing models will be used depending on the support requirements of the product or service and its affordability. For example, for the Solar Charging Service, finance is unlikely to be required. Conversely, those who choose the SHS will not likely purchase the system but will pay an initial 'joining' fee followed by a fixed monthly rental charge. In return, the system will be installed and maintained at no additional cost.

A1.3.4 Further Reading

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A2 Grid-Based Portfolio Options

A2.1 Botswana – Assistance in Overcoming High Connection Charges

A2.1.1 Key Components

- **Government loans with subsidized interest rates** to assist households in overcoming the high connection cost;
- Financing requires **minimal down payment** while **offering flexible repayment plans** requiring **no income guarantee or security**; and
- Requiring customers to **form groups of four or more** to achieve **economies of scale** in connection arrangements.

A2.1.2 Key Lessons

- The rural poor can be electrified while maintaining **full cost recovery**;
- Informed modification through **regular data collection and evaluation** can ensure **timely identification and removal of problem or barriers** and **efficient targeting** of financing mechanisms; and
- **Political will and commitment** must be sustained throughout the programme.

A2.1.3 Detailed Description

In 1988, Botswana adopted a rural electrification scheme with the goal of reducing poverty. To achieve this goal, the programme has undergone numerous modifications to ensure both uptake and affordability by the intended beneficiaries. These modifications are the result of continual evaluation and adaptation of financial mechanisms to ensure participation by the poor. As described below, this continual evaluation and modification is perhaps one of the greatest factors underlying the programme's success, a success all the more remarkable given it coincided with an insistence on full cost recovery by the consumer.

In its current form, the scheme, called the Rural Electrification Collective Scheme (RECS), aims to reduce the burden of the upfront costs of connection. To do so, the programme requires customers to form into groups of four or more to benefit from economies of scale (i.e., lowering the cost of the connection while increasing affordability) when applying for a connection. Together, the group pays 5 percent of the upfront costs of the connection before work begins, with the remainder paid back over 18, 60 or 180 months depending on the customers' preference. Similarly, the loans have no requirement of income guarantee and security and often attract interest rates lower than those available for commercial loans, an additional gain to affordability. The cost of connection is thus fully recovered, ensuring the sustainability of the programme. No further assistance is provided.

In addition to this financing component, the RCS, in 1993, introduced standard costing. Available to consumers within 500 metres of reticulation corridors, the service allows household to obtain a connection at the approximate cost of acquiring a 50 Wp solar home system. The goal of this approach is to enable customers in a village to pay the same amount for electricity, thereby extending the grid deeper into villages.

Although RE programmes which insist on full recovery of the capital costs elsewhere in the world are often linked to the absence of success, the case of Botswana shows otherwise, recognizing of course the subsidisation of the interest rate. Between 1996 and 2003, access to electricity by rural households increased five-fold, with 80 percent of households not having been able to connect in the absence of the scheme. As mentioned above, a critical component of this success has been continual monitoring and adaptation of the scheme.

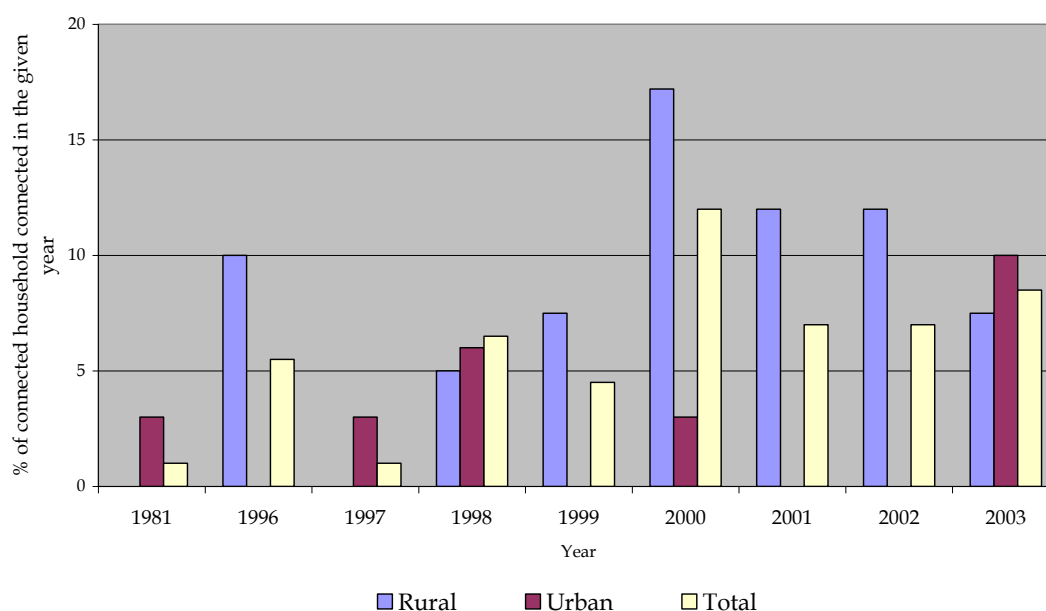
Indeed, through the collection of good data and careful analysis, adjustment of the scheme occurred when results were not as predicted. The purpose of these adjustments was to ensure both proper targeting to achieve uptake. For example, in developing the repayment schemes, various options were assessed in relation to estimated monthly energy consumption under various income levels and use types (e.g., middle income households with cooking versus middle income households with no cooking). These options were gradually adjusted as monitoring and evaluation provided better data and experience.

Additionally, the deposit for the RCS has been gradually reduced from 40 percent to 5 percent concurrently with a lengthening of the maximum repayment period to 10 years in 1996 and 15 years in 1999. The evolution of these changes is set out in Table 10 while Figure 5 sets out the corresponding annual rate of electrification for urban and rural customers.

Table 10 Evolution of RCS

Year	Deposit	Maximum Repayment Period	Interest Rate
1990	40%	10 years	8%
1995	10%	10 years	9%
2000	5%	15 years	Prime + 0.5%

Figure 5 Annual Grid Connections



Beyond these specifics political will and commitment have been strong throughout, and it is likely success would not have been as complete had these factors been absent. Additionally, the ability of Botswana to import power did make the job easier, suggesting that further integration of power markets and coordination of investment within SADC could greatly facilitate energy access.

It must be mentioned that, despite the success of electrification – electrification was 10 percent in 1990 and today sits at approximately 39 percent, while rural electrification rose from 3 percent to 37 percent – a significant proportion of the very poor have not benefited as these households cannot afford the down payments or the monthly repayment schemes. Fortunately, Botswana, in recognition of this, is implementing complementary programmes such as the Renewable Energy Based Rural Electrification Botswana Programme. This will include the packaging of lighting and power options with efficient cooking appliances including improved efficient wood stoves and heat retention devices (hot bags). Different ownership and financing models will be used depending on the support requirements of the product or service and their affordability. See discussion of Energy Service Companies in Annex 1.3.

A2.1.4 Further Reading

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A2.2 The Use of Rural Cooperatives with a Particular Focus on Bangladesh

A2.2.1 Key Components

- Arrangements whereby **utilities are owned, managed and operated by the consumers** to extend the distribution grid into rural areas;
- Thirty-three year **government loans** at a 2 percent interest rate and with an eight year grace period to **cover the initial costs of grid extension**; and
- **Donor involvement** through grants valued at over US\$ 1.4 billion given interest in the cooperative approach.

A2.2.2 Key Lessons

- Involvement by the end-users as owners / operators has led to a **high focus on customer needs, high repayment rates, adherence to strict policy about efficiency, and transparency**;
- High capital costs combined with low/no financial returns but positive social returns **requires initial financial support** from either the government or international donors;
- **Takes time** for RE schemes to become **financially solvent**; and
- **International donors are enthused** by democratic ownership structure by the consumers and are thus **keen to provide funding**.

A2.2.3 Detailed Description

The Origins of Rural Cooperatives in Bangladesh

Prior to 1977, the electricity sector in Bangladesh was characterised by the existence of a vertically integrated government run utility with sole responsibility for generation, transmission and distribution of power. Similarly, availability of electricity in rural areas was virtually non-existent, with access limited to the 10 percent of the population residing in the urban and peri-urban centres.

To kick-start electrification in the rural areas, the government borrowed an institutional model essential to expanding electricity to rural America in the 1930s and 1940s. This institution is the cooperative, or utilities owned by the members they serve through a democratic process of involvement. In an environment not unlike many developing nations today, the rural population in America had limited access to electricity, particularly in relation to urban areas, which were predominantly electrified. Utilities which had successfully electrified these towns and cities were largely adverse to entering rural areas given the low density and low ability of the residents to pay. With a strong desire to use electricity combined

with the success of cooperatives witnessed in farming, rural communities decided to utilise the cooperative approach for electrification.

However, as the communities soon found out, economies of scale were strongly needed to make rural cooperatives a success. Hence, the separate agencies not only began to band together, but sought out government support. With the then President, Franklin Roosevelt, a strong believer in the importance of electricity for all Americans, a Rural Electrification Agency was set up to give support along with low-cost financing, highlighting the fact that some type of financial and technical assistance will likely be required. Communities thus pushed ahead, enjoying the ability to oversee the electrification of their area. In less than 20 years, electrification of rural areas had jumped from less than 10 percent to almost 90 percent. Today, there are over 1,000 rural electricity cooperatives supplying 12 percent of households.

Based on this success, Bangladesh sought emulation through the creation of the Rural Electrification Board (REB). With a mandate to expand and improve the distribution network in rural areas, this model entails divestiture of the distribution of power to the end-users of electricity, with the consumers being both owner and operator.

Similar to the approach taken in the United States, the REB organizes local cooperatives, called *Palli Biddut Samities* (PBS), to own, operate and manage a rural distribution system as an autonomous organisation registered with the REB. In setting up a PBS, between 5 and 10 *thanas*, or administrative districts, are chosen and a 20 year load forecast prepared. This forecast is used to identify load centres for purposes of identifying the location of the distribution sub-stations. To construct the infrastructure, the PBS is given a thirty-three year term loan covering the cost of the system at a per annum interest rate of two percent and a grace period of eight years. The PBS then operates on a financial principle of “no-loss and no profit” to maximise consumer welfare. Factors guiding the tariff structure include cost of service, cost of the power purchases, operating and maintenance expenses and depreciation and interest expenses

Organisationally, the by-laws for the PBSs are established by the REB, as are a set of operational, technical and administrative standards. The REB also assists the PBSs with the construction of the distribution network; technical assistance for operating and maintenance activities; assistance in conducting tariff fixation studies; staff training; setting annual targets in key performance areas; and procuring funds. PBSs, in turn, are responsible for the purchase and sale of electricity; sub-station and line maintenance; consumer complaint handling; line extension and consumer connection; motivating consumers to use electricity safely and efficiently; and tariff setting.

Bangladeshi Experience to date

Given the huge capital cost required, the creation of PBSs has occurred in stages, with 13 established in the first phase. Today, the total stands at 70, representing 433 of 482 subdistricts and 47,084 out of 84,320 villages. Coverage is to be extended to

all villages by 2020. Although extension of the distribution network has been successful, uptake has been less so. In 2003, approximately 30 percent of the rural population was electrified. Importantly, while the rates of electrification are skewed towards non-poor households – in 2000, 80 percent of non-poor households were electrified relative to 19 percent of poor households – the absolute numbers are near identical – 4.06 million poor households relative to 4.08 non-poor households.

One explanation for this split is the high upfront cost, which includes a connection charge, a membership fee and a security deposit. When the PBSs first started, consumption was not subsidised, although a lifeline tariff is now in place to support demand. Likewise, there is cross-subsidization between the different user types, with commercial and industrial customers typically charged more than domestic customers. Opportunities to cross-subsidise, however, are quite limited due to the relatively small customer base of most PBSs (the number of customers varies from 35,000 to 270,000) combined with the relatively low number of commercial and industrial customers.

As for financial sustainability, 58 of the 67 PBSs are able to pay for their operating costs including power purchase costs from their revenues. This is a significant accomplishment, particularly in comparison to urban utilities whose financial performance is worse despite a better customer mix and load density. Analysis of nineteen PBSs established after 1995 shows that it can take anywhere from three to nine years to generate enough cash revenues to cover operational costs. However, generation of sufficient revenues to cover interest and principal payments has been less successful. Just under half of the PBSs established prior to 1998 were able to generate sufficient revenues to cover interest costs while approximately fifteen percent could cover principal payments.

Financial difficulties are linked to a number of different issues. Until 1991, the REB's jurisdiction was limited to designated rural areas, while distribution in the urban centres remained within the domain of the government-run utility. However, the lack of acceptable performance led the major multilateral donors to withdraw all financial support from BPDB, and the government has since been transferring the distribution assets to REB control. However, these service areas, despite being more densely populated, are characterised by high system losses and poor collection efficiency (in 2005, system losses were 11 percent higher than those in the PBS and collection rates 7 percent lower).

Additional financial difficulties have resulted from increased outages, which have thus decreased revenues. In the fiscal year 2005, as many as 34 PBSs lost at least 5 percent of their sales volume, of which five lost at least eight to nine percent. Generation capacity will have to increase if PBSs are to not only cover current costs, but meet future requirements to expand electrification. Customers want to be assured of a reliable supply of energy before making a wholesale switch and any barrier to this reliability will hinder uptake even where affordability is not an issue. More fundamentally, sufficient capacity must be available to meet the growing demand from extension of the distribution grid.

Interestingly, there is a high level of donor interest and support, based in part on donor enthusiasm for the co-operative approach. Since its inception, nearly \$1.4 billion has been provided to the PBSs by nearly twenty donors. This money is funnelled to the REB, which subsidises the operational deficit of the PBSs through a mix of government grants and loans, donor grants and loans, and a 1 percent service charge obtained from the PBSs.

Involvement by customers is likewise important to the success. As the customers are also the owners, the end-users have been directly involved in the planning and management of the distribution network.

Experience from other countries

Although rural electric cooperatives have been implemented in a number of countries across the world, including both developed and developing nations, their use in Africa has been limited to one country alone, with Tanzania offering the only viable example. Even in Tanzania, the cooperative is limited to one area with just 250 customers. Covering the Urambo District, the electricity in the area was originally provided in 1985 by three diesel generators sets to provide street lighting which were the responsibility of the Ministry of Works, the Urambo District Council, and TANESCO, the national electricity utility. Operation of the system was inconsistent, however, due to lack of funding and poor maintenance.

Hence, in 1993, management of the system was transformed to a cooperative. Supported by both TANESCO and the Swedish Environmental Institute (SEI), training was offered to local community members to manage and operate the system and funding provided to cover the start-up costs, although the customers are required to cover the cost of eventual capital replacement. Called the Urambo Electric Consumers Cooperative Society, the tariffs thus include not only a 30 percent capital recovery allowance, but the full cost of metering, maintenance and fuel. In 2002, the tariff was over ten times that of TANESCO, or 0.47USD/kWh versus 0.03USD/kWh, a difference which reflects both the subsidisation of TANESCO and the diseconomies of scale. Despite the high cost, the financial sustainability of the cooperative has led other villages in Tanzania to express an interest in similar set-ups.

The general absence from Africa, however, does not imply irrelevance. Experience from both Bangladesh and other countries has revealed a number of applicable lessons. These include:

Encouragement from the top: Although establishment of rural electric cooperatives is usually a bottom-up solution to the failure of top-down approaches, encouragement from the top (i.e., national government or international donor) may nevertheless likely be required. Indeed, although the conditions may be right for establishment of a rural cooperative – desire for electricity and little interest by the utility to provide it – many communities are neither likely to know that the option is possible and/or will not have the financial or technical capability to start a cooperative (the latter issues are discussed below). Hence, the communities of

many countries may need national or international encouragement to initiate a rural electricity cooperative.

Yet, communities may not blindly accept the idea of cooperatives. For example, in rural areas of Kenya, mismanagement of agricultural cooperatives, which led to the decline or closure of some farms, has led many to have a negative image of cooperatives, no matter the type. This could prevent a barrier to potential establishment of rural electricity cooperatives. Likewise, as cooperatives often require a minimum level of skill or training to run them, some have been taken over by the elite for their own benefit, likewise, creating a negative image of them among the poor. More generally, many community members may simply not be aware of the idea of a cooperative. Hence, in many instances, education and awareness on cooperatives themselves may need to precede their establishment, especially as success depends on the dedication of the members.

Reliance on government/donor financing: As exemplified by the case of Bangladesh, the capital intensity of electrifying rural areas combined with the relative poverty of these areas implies the need for financing, with either the government or donors being the only realistic option. The low or negative returns discourage the entry of private capital (and hence the private utilities themselves). However, the positive social returns do mean that government or donor involvement is not unwarranted, although it does mean that the cooperatives seeking independence will likely not achieve it.

This fact is illustrated by the involvement of US government, through the Rural Electrification Administration, which required government supervision of the cooperatives. However, as shown by the US, this oversight gradually reduced through a well-defined strategy to transfer government functions and responsibilities to the cooperatives.

As thus shown in not only the US and Bangladesh, but many other countries with rural electricity cooperatives, some autonomy will likely need to be ceded to obtain the financing necessary to overcome the high capital expenditures. This is especially so given the low or negative financial returns and positive social returns. Conversely, however, if cooperatives are to remain successful, the absence of complete autonomy must not be characterised by political interference, an oft-cited reason for the decline of rural electric cooperatives in the Philippines. Political patronage has likewise proved to be the downfall of a number of Indian rural electric cooperatives. Bangladesh avoids this partly by not allowing directors to be affiliated with any political party.

Training: Running and operating an electric utility requires a high level of technical and business acumen often missing in rural communities. Hence, if rural electric cooperatives are to be community-oriented, training will be necessary. This has certainly been the case in Bangladesh and, similarly, in the case of the single Tanzanian rural electricity cooperative, which received training from but the national utility and international sources.

A2.2.4 Further Reading

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Ul Hassan, R., and R. Rashid, 2007, Analysis of Financial Viability of Rural Cooperatives (PBS) under Rural Electrification Board Bangladesh, Master Thesis, Blekinge Institute of Technology.

A2.3 Mini-grid Projects

A2.3.1 Key Components

- **Stand-alone low-voltage distributions system** supplied by either a single generator or a combination of generators (hybrid, often with renewables in the mix);
- Provision of **continual power** for **variable demand profiles**;
- Able to **service 230/400 VAC standard appliances**; and
- **Capital costs are typically lower than grid extension** to remote rural villages, although the use of renewables may negate this, with off-setting reduction in O&M costs.

A2.3.2 Key Lessons

- The **technology needs** and its uses must be **fully understood** to ensure adequacy and reliability;
- The **overall resilience and adaptability** of the system needs to be **considered in the feasibility studies** as electrification may make energy use different from expectations;
- Both the **operating and capital costs** of potential designs should be **considered**;

- A **village-by-village approach is not optimum**, and should be replaced by a **strategy which prioritises** across, and makes selections from, all villages; and
- **Prioritisation could be based on a scoring system** which provides points according to the types of loads to be served in a village (e.g., household versus clinic) and other important factors, such as population density.

A2.3.3 Detailed Description

Use of mini-grids in remote rural villages has been explored by a number of countries as a lower cost alternative to the extension of the national grid. Technically, mini-grids are stand-alone low-voltage distribution networks connecting end-consumers in a village or neighbourhood. Supply is often provided by a single generator, typically a diesel generator or micro-hydropower plant, although increasingly mini-grids are becoming hybrid in that two or more electricity generating options are selected according to the least cost energy resource available. Options may include a wind turbine coupled with a solar system or a solar system combined with a diesel generator.

Similar to the main grid, mini-grids provide around the clock power for variable demand profiles and are able to service 230/400VAC standard appliances. Mini-grids are ideal when several consumers are close together, where the energy needs of the average consumer exceed 0.5 to 1/kWh per day, and where there is a need for standard power and a willingness and ability to pay.

Examples of mini-grids in Namibia and South Africa are presented as illustrations.

Namibia

A scientific research centre located in a remote, semi-arid area of Namibia, Gobabeb has recently constructed a hybrid mini-grid with funding from the Danish Development Agency. Although the grid meets the immediate energy needs of the Training Centre, it was constructed with the longer-term goal of demonstrating the viability of a mini-grid using renewable energy and energy efficiency measures. The mini-grid will also be examined for its ability to improve livelihood and social conditions for semi-dense rural communities. Once the system has been successfully demonstrated at Gobabeb, it will be replicated in both Namibia and other SADC countries, where applicable.

The mini-grid itself consists of a photovoltaic array consisting of 370 modules with a total capacity of 26 kW peak and a total installed cost of NAD 1.1 million (USD 153,230); storage batteries with a capacity of 200 kWh and installed at a cost of NAD 220,000 (USD 30,646); power converters which allow for uninterruptible power during a change from inverter to generator and vice versa, installed at a cost of NAD 440,000 (USD 61,292); and two 50 kVA, three phase diesel generators, installed at a cost of NAD 165,000 (USD 22,984).

The technical beauty of the system derives from the power converter, which has its own control system. This system starts the generator if the battery voltage is low or when consumption exceeds a set point (e.g., 20kW). The system also switches off when a specified battery voltage level is reached or when the power drops below a certain point. The operation of the system can also be programmed for various times of the week (weekday versus weekend). Economically, benefits arise from the fact that, prior to its installation, electricity was available for only sixteen hours a day and was produced via a more expensive diesel generator. Today, electricity is available around the clock via a cheaper source. The Desert Research Foundation, which owns the Gobabeb centre, is now researching how to replicate these benefits for a Namibian village consisting of fifty households, a school, clinic and shop.

Although the system at Gobabeb is unique in that end-users are rather atypical – researchers from the developed and developing world – the system has been useful in showing how accommodating and flexible hybrid mini-grids can be. Indeed, one of the main difficulties of designing the system was the need to accommodate large swings in demand, and this requirement has been fully met. While the centre typically houses thirty residents at any one time, occupancy can range from ten people one week to 120 the following week, with energy required for cooking, refrigeration, computing, audiovisual equipment and lab equipment requiring power.

South Africa

The potential of mini-grids to electrify remote areas is similarly being tested for a more typical set of end-users elsewhere in South Africa. In 2002, the Department of Minerals and Energy, in conjunction with the South African Council for Scientific Research, launched a pilot project investigating a standalone grid in the village of Lucingweni. In this village, six 6-kW peak wind turbines and an array of 540 solar panels rated at 0.133 kW-peak each were installed to provide power to approximately 220 households. With an installed capacity of 97 kW, the useful energy is approximately 125 watts continuous, providing each household with just over 3 kWh per month.

Deemed sufficient at the start of the pilot, average demand quickly outpaced generation capacity. As found throughout South Africa by Eskom, electricity demand soon doubles after people acquire access to electricity. The village of Lucingweni was found to be no different, a fact which was problematic for the villagers as they expected they would receive a level of service and performance similar to that provided by the national grid. However, while household connections were provided with a 20 ampere trip switch, most households bypassed it. System overload thus led to frequent disconnections of power by the generators and, within one year, the system stopped operating continually. This, in turn, created a breakdown in trust between the village users, the formal government and technology developers.

With regard to its economic and financial viability, the hybrid mini-grid entailed high capital costs, estimated to give rise to an average energy cost of R 7.76/kWh. Although the capital costs were subsidised in this instance, analysis shows that the

system would not be financially sustainable based on the user charge, which did not even cover the operating costs. Indeed, analysis shows that construction of a mini-grid alone would not be the most cost-effective approach to electrifying remote rural villages. Rather, based on both the capital costs and operating costs, the most cost-effective system would involve a hybrid mini-grid combined with solar home systems. Although this analysis is specific to Lucingweni, the following factors influenced the calculation, and thus should be considered as part of any analysis determining the design of future systems:

- Proximity to the national grid (and the cost of extending these grid lines);
- Availability of energy on these lines (many rural grid lines may already be at their load limit, as is the case in South Africa);
- Knowledge of existing or proposed grid electrification plans in the region (a grid line might be about to come nearby);
- Local density of the loads that need energy (cost of local reticulation);
- Resource levels at the site (wind, biomass, solar, micro-hydro) – this will affect the cost of delivering energy from renewable resources;
- Current household and social infrastructure energy and more specifically electricity demand (water supply, health centres, schools) (different energy supply options may service these needs in different ways);
- Income levels, willingness and ability to pay;
- Current economic activity, and potential for future economic activity (productive use of energy) – critical in assessing the likely benefit of different electrification options;
- Capacity in the demand area to undertake the necessary support; and
- Capacity in the region (institutional, private sector or other) to provide ongoing support, management and second level maintenance.

Beyond the technical and financial considerations, the South African government has determined that a village by village planning approach is not optimum. Thus, the government is considering a “benefits point method” which considers costs in financial terms while assessing the benefits using a weighted points system. For example, in considering the load to be served, a given level of points would be assigned to various end-users based on the “importance” of electrifying that load; e.g, fifteen points to a school or clinic compared to one for a household. This would enable rapid assessment while allowing for comparisons across regions and technologies.

Such an approach has been successfully used elsewhere, including by the Namibian government for its Off-Grid Energisation Plan, discussed in Annex 1.3. Other examples can be found in the Namibia Electrification Master Plan, the Eskom/DME/DBSA electrification model and the Uganda Integrated Rural Electrification Master Plan.

A2.3.4 Further Reading

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Department of Minerals and Energy Pretoria, 2008, *New and Renewable Energy: Mini-grid hybrid viability and replication potential*, Final Report, Department of Minerals and Energy, South Africa.

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For information on Gobabeb in Namibia, see <http://www.gobabebtrc.org/degreee/>

A2.4 Introducing low-cost methods in electricity distribution networks

A2.4.1 Key Components

- Low-cost equipment design
- Low-cost network design
- Capacity building for managerial and technical skills required for optimising designs.

A2.4.2 Key Lessons

- Most distribution equipment and networks, especially in rural and low income areas, are overdesigned.
- Institutionalising low-cost culture is an integral element of strategies for increasing electricity access for low income groups.

A2.4.3 Detailed Description

ESMAP Technical Paper 104/06 (full reference in Section A2.4.4) addresses an important but often neglected subject in energy access strategies for the rural and low income areas. Although the report is written in a repetitive style that can prove to be tedious to the first time reader, there are important lessons that are useful to

take into account for the development of an energy access strategy and action plan. Using case studies of experience from several countries, the authors observed that electricity distribution networks and equipment for rural and low income areas were generally over-designed. The authors concluded that there was therefore a need (a) to disseminate information on low-cost strategies, (b) to develop capacity to undertake the necessary engineering analysis and work, and (c) to introduce the managerial and operational culture required for institutionalising the planning, design and implementation of low-cost methods.

Dissemination of low-cost technologies

Examples of some low-cost technologies appropriate for sparsely populated and low consumption areas identified in the report are:

- a) **Low-cost equipment design:** for example use of ready boards to cut down on initial connection costs, use of poles without cross arms, use of transformer and conductor sizes optimised for the actual expected load, and use of credit, prepayment and load limiters as appropriate. There are many applications where three phase transformers and motors are used when single phase equipment would be cheaper and more appropriate. Because of low incomes, for many years most rural households use electricity only for lighting and small power applications. Many current minimum standard sizes are therefore oversized for the load expected over the lifetime of the equipment. For example, the ESMAP report cites a load study (undertaken in 2000 as a cooperative project between Makerere University, Kampala, Uganda Electricity Board and Lund Institute of Technology, Sweden) which found that in Najjeera village outside Kampala, all four transformers had a peak power demand of less than 6 kVA, whereas the rated capacity of the transformers were 100 kVA.
- b) **Four-wire grounded neutral medium voltage system:** used in **North America, Australia and Tunisia** which allows for an extensive low-cost single phase distribution network comprising a phase and neutral conductor. As is the case in many sub-Saharan countries, many of the SADC distribution networks are based on European standards that are more applicable to high density, high demand population centres. It was observed that many of the networks are designed for an after diversity maximum demand of 2.5 to 3.5 kVA when in practice the demand is 0.4 to 0.7 kVA. While these network standards may be appropriate for urban areas, they are overdesigned for the low consumption and low population densities of the rural areas. The North American system was designed for dispersed rural loads similar to those in sub-Saharan Africa. The success of Tunisia's rural electrification program, which is expected to reach 97% of rural households by 2010 from a low of 6% in the mid-70's when the program started, is attributed in part to the adoption of a modification of the North American single phase system which was found to be more appropriate for the Tunisian countryside. It is important to point out that a single phase network using two phase conductors rather than a phase and neutral can also be developed based on the European system. Although slightly more expensive it does have the advantage of cheaper upgrading to three phase when necessary.

- c) **Single Wire Earth Return system (SWER):** over 200,000 km installed in rural **Australia** and **New Zealand**. This system is economical for areas with low consumption and very sparsely populated and where it is possible to achieve low resistance earths and there is little likelihood of interference with open wire communication systems. With greater use of fibre optic and wireless communication the issue of interference with communication is no longer a major one. The low costs results from the simple design that is easy to construct because it uses only one conductor, allows longer span lengths (hence fewer poles, insulators and other materials), and is easily maintained and upgradable. Drawbacks of the SWER system include limited load capacity, less than 500 kVA, and higher system losses due to the earth return.
- d) **Shield Wire System (SWS):** used in **Ghana, Ethiopia Brazil** and **Laos**. In Ghana this has been used on over 500 km of 161 kV lines, in Ethiopia on 370 km of 230 kV lines, in Brazil on 200 km of 132 kV lines and in Laos on 190 km of 115 kV lines. This is a system where the shield wire of the high voltage power lines is used for the dual purpose of lightning protection and carrying power for communities near the power lines. This requires the wire to be insulated from the steel towers so that it can be energised at medium voltage of 20 to 35 kV with the power being tapped through take off towers erected near load centres. For the shield wire to perform its lightning protection duty it is necessary that the insulators used for the shield wire have arcing horns with accurately set gaps. The additional cost of the high voltage system that is needed to allow the shield wire to be used for power transmission is minor compared to the savings in cost of over 80% compared to building a separate medium voltage line. The limitation to single phase operation, unless a line has more than one shield wire, is generally not of much concern for most of the rural loads served by this system.

Construction cost savings that can be achieved are of the order of 15% to 50% while operating cost reductions of the order of 10% to 20% are possible. Upgrading of voltage is another way of cost reduction. For example the costs for 11kV and 22 kV lines and transformers are not very different and yet there is a significant increase in load carrying capacity and loss reduction with the higher voltage.

Engineering and planning skills for low-cost technologies

The capacity to implement the engineering analysis and planning work to optimise network and equipment design is the second major challenge identified in the ESMAP report. Many utilities only train new engineers to reproduce the inherited standardised equipment and system designs. There are no systematic studies to compare plans and designs to operational experience with the objective of coming up with revised standards.

It is also important for the skills development to include the local manufacture of equipment where this is justified by cost and market volume. Some minimum equipment sizes are imposed by foreign suppliers rather than local market conditions. For example the minimum size of imported three phase transformers may be 25 kVA when the market requires 1 to 2 kVA, the sizes that have been

developed for local manufacture in the Nepal Rural Electrification program. In Nepal it has also been demonstrated that the use of a combination of large and small transformers can reduce network losses by using the large transformers during high consumption seasons where there is irrigation demand, and the smaller transformers during low consumption season when there is only household use.

Regulatory authorities also require capacity to be able to revise technical standards to allow for connection to both formal and informal structures.

Managerial and operational culture for low-cost technologies

The experience of Tunisia is highlighted as a good example of the institutionalisation of a low-cost management culture arising from a bold initiative to adopt an alternative approach to what had been inherited from the past. Utilities are usually too conservative to break with tradition. The wisdom of the Tunisian choice is demonstrated by the fact that 51% of the country's electricity network comprises single phase lines and 78% of the substations are single phase.

Regulatory agencies can play a significant role in developing a low-cost culture through appropriate pricing incentives and penalties. Average costs per customer connection can be regularly measured for use as a regulatory tool.

A2.4.4 Further Reading

Borchers, Qase, Gaunt Mavhungu, Winkler and Okese, Thom: National Electrification Program (NEP), November 2001: "1994-1999 Summary Evaluation Report, Department of Minerals and Energy", South Africa.

Cecelski, Dunkerley and Aissa, Ounalli, 2004: "Low-cost Electricity and Multisector Development in Rural Tunisia" Paper and Presentation Slides – The Energy and Mining Sector Board Lecture Series.

Karhammer, R., Sanghvi, A., Fernstrom, E., Aissa, M., Arther, J., Tulloch, J., Davies, I., Bergman, S., and S. Mathur, 2006, ESMAP Technical Paper 104/06: "Sub-Saharan Africa: Introducing Low-cost Methods in Electricity Distribution Networks" Washington DC

A3 Off-grid Portfolio Options

A3.1 Tanzania – Regulatory support for small private power project investments

A3.1.1 Key Components

- **Standardised power purchase agreements (SPPA)** for small power projects connected to the main grid or to isolated mini-grids.
- **Standardised tariff methodology (STM)** based on the principle of avoided costs of the buyer, currently the national utility, TANESCO.
- All small power projects paid a standard main grid or mini-grid tariff, as the case may be, subject to minimum and maximum prices established in the year of execution of the agreement and adjusted for inflation every year.

A3.1.2 Key Lessons

- Extensive stakeholder consultations used as part of the policy development.
- **Standardised agreements are an effective way of communicating government policy for the promotion of small private power projects.**

A3.1.3 Detailed Description

The Ministry of Energy and Minerals in Tanzania has established a framework for the promotion of the development of small power projects utilising renewable energy technologies. Small power projects are defined as 100 kW to 10 MW. The main principles governing the framework are the minimisation of the information required, minimisation of regulatory requirements and decisions and the use of standardised documents to minimise case by case negotiations. The framework is expected to facilitate accelerated rural electrification by minimising negotiation time and development costs for local and foreign private investors.

The framework is the culmination of a long process that started with the National Energy Policy of 2003 followed by the enactment of legislation establishing the rural energy agency and rural energy fund (Rural Energy Act, 2005), regulator (Energy and Water Utilities Regulatory Authority Act, 2006), and providing for the restructuring of the electricity sector (Electricity Act, 2008).

Following several consultations with stakeholders, including soliciting public opinion, the Energy and Water Utilities Regulatory Authority (EWURA), has approved a standardised tariff methodology and set the power purchase tariff for 2009. The same process of consultations is being used to develop the rules and guidelines for small power development such as procedures for application of the necessary land and business permits and regulatory licenses, the minimum

information to be exchanged between buyers and sellers, requirements for environmental and social impact assessment and mitigation, annual reporting, etc.

The tariff for projects connected to the grid is based on the avoided long run marginal costs determined by the national power utility, TANESCO. The tariff for those connected to isolated mini-grids is based on the avoided costs of diesel generation and transmission. The mini-grid tariff is therefore significantly higher than that for the main grid. There is provision in the mini-grid power purchase agreement for automatic conversion to the main grid agreement on the date of interconnection of the isolated grid to the main grid. It is not clear how the seller is compensated for any adverse financial and other consequences of such conversion. The standardisation of tariff methodology is less likely to be a problem than the standardisation of tariff levels.

Although the effectiveness of this approach in attracting investment is still to be tested, there are two principal lessons that can be derived. The first lesson is involving the public and other stakeholders in policy development, a process that is not always followed in many countries. The second lesson is the effective use of model agreements to communicate the policy.

A3.1.4 Further Reading

Baker, Judy L (editor), 2009: "Opportunities and Challenges for Small Scale Private Service Providers in Electricity and Water Supply - Evidence from Bangladesh, Cambodia, Kenya, and the Philippines" The World Bank and PPIAF, Washington DC

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A3.2 Solar Home Systems in South Africa

A3.2.1 Key Components

- Granting **private companies** the **rights to establish off-grid energy utilities** in designated concession areas;
- A **government subsidy of R3500 per solar home system (SHS) installed**, with basic SHS starting from R4000, the difference of which must be financed by the concessionaire;
- A **small upfront connection charge** (starting at ~R100 for the basic system), payable to the concessionaire by the customer, followed by a

monthly tariff (starting at ~R58 for the basic system), also payable to the concessionaire;

- A **monthly government subsidy**, as part of its free basic electricity, valued at R40; and
- **Concessionaires are responsible for all costs above the capital subsidy**, including marketing, maintenance, battery replacement and operational costs, recoverable through the monthly tariff and connection charge.

A3.2.2 Key Lessons

- Through the **fee-for-service approach**, the **concessionaire acts just like the well-understood utility** in that it provides a service – electricity – in exchange for remuneration, thereby **reversing historical failure of SHS**, as typically SHS fall into disrepair due to lack of maintenance;
- **Capital subsidies** may be necessary to encourage participation;
- **Thermal needs will not be met;**
- **Customers are willing to upgrade** to larger systems, and thus a range of options should be made available as a means of boosting profitability; and
- More **people are employed** than would be the case in an equivalent grid project.

A3.2.3 Detailed Description

With over two-thirds of the population having access to electricity, South Africa has realised that extension of the grid may not be the most cost-effective means of meeting its commitment to provide universal access to electricity by 2012. Hence, as an alternative approach to grid extension, the government, in 1999, initiated a programme to grant private companies the right to establish off-grid energy utilities in designated concession areas. This decision was based on the notion that non-grid electricity through solar home systems (SHS), a hitherto unsuccessful technology, could be a cost-effective means of electrifying rural areas if accompanied by the appropriate institutional arrangements; i.e., concessions. Specifically, concessions were seen by the government as a potential way to attract larger, better organised private companies which, importantly, had their own sources of financing. This, in turn, would speed the rate of electrification while reducing costs through both the mechanisms of private infrastructure as well as the economies of scale inherent in supplying off-grid electricity in the defined areas. Likewise, concessionaires would have direct ownership of the hardware and assets, which was meant to facilitate the raising of capital on the money markets while encouraging strong financial and maintenance controls characteristic of the private sector. As the last chain in the link, these controls were meant to attract international development funding.

To encourage participation, the government has granted a capital subsidy of R3500 (1999 USD: 594/2003 USD: 468) directly to the concessionaire for each SHS installed. Worth at least three quarters of the cost of the SHS, depending on the type of system, the concessionaire is required to finance the difference between the capital subsidy and the installed cost of the system. Additionally, the concessionaire must cover all costs associated with marketing, management, installation and transport. On the demand side, households pay an installation fee equivalent to approximately 3 percent of the capital subsidy paid directly to concessionaire and then are charged a monthly service and maintenance fee payable directly to the concessionaire. This monthly charge, however, is reduced through the extension of the government's free basic services for the poor free basic electricity subsidy, with the reduction being worth approximately 75 percent of the monthly tariff.

Table 11 SHS Installation in South Africa

Concessionaire	Concession Area	Total Number
NuRa	Northern Kwa_Zulu Natal	6,541
Solar Vision	Northern Limpopo	4,758
Shell-Eskom –replaced by 3 smaller companies in 2005/2006	Northern parts of the Eastern Cape and Southern Kwa-Zulu Natal	5,800
EDF-Total (KES)	Interior Kwa-Zulu Natal	3,300
Renewable Energy Africa (REA)	Central Eastern Cape	0
Total		20,399

Source: Prasad – See Annex 6.

Under this set-up, six concessionaires are operating in four rural areas (Eastern Cape, KwaZulu-Natal, Mpumalanga and Limpopo) chosen for their remoteness from the grid and thus low probability of being connected in the short-term. (Although some houses opting for a SHS have since been connected.) Despite an initial target of 300,000 SHS, only 20,000 to 30,000 households have been installed. Table 11 displays installation levels for each of the concessionaires in 2004.

The slower than expected uptake is attributable to a number of factors, primary among them being the government's failure to pay the capital subsidy. Additionally, the remoteness of the chosen concessionaire areas has made it difficult for the companies to reach and provide service to their customers. Many locations are characterised by poor roads, the absence of transport, and no or poor communication. In some cases, houses are inaccessible by car, thus requiring the installers to carry in the equipment. The absence of such amenities serves as a dual

problem in that employment and earning opportunities are limited, making it difficult for the customers to afford the systems.

One of the more successful concessionaires to date has been that of NuRa, a joint venture between the largest Dutch utility NUON and Rural Areas Power Solutions (RAPS) of South Africa. Responsible for the northern part of KwaZulu Natal, the potential customer base is characterised by a local density of the less than 15 households per square kilometres in some areas and very little grid infrastructure. To commence operations, NuRa secured funding to complement its own from the Dutch Government. Covering the cost of the first 400 SHS, installation commenced at the end of 2001.

In terms of its offerings, the basic SHS includes a 4 light, 50 Wp solar system with a 100 Ah battery, which delivers approximately 175 Wh per day, or enough to power a black and white television, a 9 V radio and the accompanying lights for three to four hours. Initially offered at a monthly tariff of R58 (1999 USD: 9.85/2003 USD: 7.75) (which, as mentioned above, covered maintenance costs and battery replacement costs), the FBE subsidy has reduced this by R40 (1999 USD: 6.80/2003 USD: 5.35) from February 2003, making the effective rate R18/month (1999 USD: 3.05/2003 USD: 2.40).

On the concessionaire side, the capital subsidy provided to NuRa, as mentioned above) is R3500 per SHS while the total outlay is currently over R4000. The difference, or approximately R500 (1999 USD: 84.90/2003 USD: 66.82), is financed by the company, which must also cover all additional costs. Detailed financial modelling, however, does show that the utility can be financially viable, but only once the customer base is large and household systems have been installed for some time.

Of surprise to NuRa has been the interest in larger SHS, and it has thus responded by offering a range of systems, including 100 Wp arrays, 200 Ah batter storage and a 150 W inverter suitable for powering larger (colour) televisions, sewing machines, shop cash tills and other low power AC appliances. As the government subsidy remains constant regardless of the cost of the system, the monthly tariff and connection fee must rise accordingly. For example, a four light double system with inverter has a connection fee of R300 (1999 USD: 50.94/2003 USD: 40.10) and a monthly tariff of R166.17 (1999 USD: 28.22/2003 USD: 22.21), or R126.17 (1999 USD: 21.42/2003 USD: 16.86) allowing for the FBE subsidy of R40. Yet, by 2004, more than 10 of these systems had been installed with another 30 contracted for. Indeed, just under half of all customers opt for a system larger than the basic option. In the first year of operation, over 800 systems were installed and, by December 2008, NuRa had 9,667 customers.

Critically, the concessionaire approach implemented by the South African government has reversed the history of failure of SHS in rural areas, thereby showing they can be a robust compliment to grid extension. Prior to this programme, SHS had been unsuccessful due to a lack of maintenance, despite having a long life when properly serviced. Throughout rural areas it is quite common to find SHS which are five years old and in a state of disarray due to lack

of maintenance and support infrastructure. However, by employing a fee-for-service approach as part of the concession, the maintenance is now borne by the concessionaire, whose staff are trained explicitly for this purpose. Thus, in practice, the concessionaire acts just like the well-understood utility in that it provides a service – electricity – in exchange for remuneration. This remuneration, in turn, covers the cost of maintenance as well as the cost of replacing the batteries. In the process, the scheme has dispelled the idea that solar energy is free and that people in rural areas could manage relatively complex solar systems by themselves.

As an additional benefit, the concessions are shown to employ more people than an equivalent grid project. NuRa estimates that it employs one employee for every 164 customers compared to the local electricity utility, which employs 1 employee for every 255 customers. For installation, NuRa employs up to 10 local consultants, who each employ between 6 and 10 people.

Yet, despite the lower capital expenditures, SHS are unable to meet the full energy needs of households, particularly thermal needs. Thus, as described in Annex 1.3, complementing these approaches with multiple products able to service various energy needs is a necessary component if the concessionaire is to be seen as a “full service” energy utility. This includes distribution of third generation biomass stoves, as described in Annex 3.4.

A3.2.4 Further Reading

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A3.3 Lighting Africa

A3.3.1 Key Components

- World Bank/IFC joint venture to **leverage new advances in lighting technologies** to develop products and business models which offer **cheaper**, cleaner and healthier lighting for **non-electrified consumers**, including both households and businesses;
- **Compiling, analyzing and publically disseminating data** on market potential, customer needs, and distribution channels;
- **Assessment of financial needs and development of a credit facility** to support business in providing or contributing to the distribution of

modern off-grid lighting, including **compilation of a guide to financing sources**;

- **Financial grants** to support innovative off-grid lighting projects; and
- Creation of a **business-to-business website** to facilitate networking and business connections.

A3.3.2 Key Lessons

- Still in the **early stages**, so difficult to fully assess;
- Market research shows there is **strong customer demand** for non-grid lighting sources;
- **Businesses** interested in modern off-grid lighting **do not know how to connect with one other** to develop the market and formulate a distribution chain; and
- Many of the **key components** can be **utilised by SADC**.

A3.3.3 Detailed Description

Launched in September 2007, Lighting Africa is a joint World Bank/International Finance Corporation initiative seeking the rapid scale-up and delivery of affordable, non-fossil fuel lighting, along with opportunities for cost reductions. The initiative was developed to meet the lighting needs of all African households currently without electricity, including rural, urban and peri-urban dwellers. Often, among the poorest, lighting is the most expensive item among energy uses, with approximately 10 percent of total household income spent on kerosene and candles. Although the programme is technology neutral, it was motivated by new advances in lighting, including compact fluorescent lamps (CFLs) and light-emitting diodes (LED), which revolutionised stand-alone lighting while offering a clean, durable, low-cost, higher-quality form of lighting. These technologies are to be leveraged to develop products and business models specifically tailored to Africans without electricity. Despite being a relatively new programme, progress is already being made.

One of the main approaches adopted was to hold an international competition on relevant ideas and technologies and from the entries fund sixteen proposals to implement off-grid lighting projects. Covering all corners of Africa, four are located in SADC: Namibia, Tanzania, and Zambia.

- Namibia: Entitled “Village Lighting Solutions to Improve Education, Health, Safety and Productivity in Rural Namibia”, this project intends to bring lighting to rural households using a low-cost combination of microbial fuel cells (MFC) – which passively generate energy from organic waste matter – and polymer LEDs (PLEDs). The aim is introduce lighting devices into 9,000 homes within 27 months.

- Tanzania: Tanzania has two projects receiving funding from Lighting Africa:
 - “Providing Affordable and Reliable Solar Systems in Northern Tanzania” seeks to convince Savings and Credit Cooperative Societies (SACCOS) to finance solar PV for provision of electricity and income generating activities. SACCOS are “local” micro-finance organizations established by those individuals living in the same area and who know one another or who work together and which receive lower interest loans. Currently, the most popular system – a 14 Wp amorphous silicon solar panel, a lead-acid battery of 25-50 Ah and two fluorescent lights which can be used for three hours each night – costs TZS 234,000 (USD187). However, with the cost of kerosene for lighting in rural areas costing double that in urban areas, or approximately 2,000 TZS/litre (USD1.60/litre), monthly expenditures typically run between 12,000 and 18,000 TZS per month (USD9.60 to USD14.40 per month). The system would thus pay for itself in less than two years. However, with the rural minimum wage being approximately 50,000 TZH (USD40) per month, these households can obtain the system only with suitable financing, which the SACCOS are meant to provide.
 - “Family Pedal Power and Lighting Project” will provide battery powered LED lights supported by human-powered generators rented to community members at price parity with kerosene. The generator produces electricity through pedalling (the average individual produces about 70 watts through pedalling), which is then stored in a 12V deep cycle battery. This is used to charge 6V batteries, which are then distributed with low wattage LED lights. Capable of producing lighting for up to three hours per night for one month, one system (generator plus deep cycle battery) can provide lighting for up to 200 homes. Available at an upfront cost of USD10, the project plans to install 20 generators and 3,000 lights through local NGO partnerships. Initial studies expect the generator to break even in two years time.
- Zambia: the project which is called “Lighting the Way”, involves modular white LED lighting systems that can be purchased in increments much the same way as kerosene appliances. In Zambia, 98 percent of the non-electrified households use kerosene lamps as their primary energy source, so a key component of the project is to mimic the economics of how kerosene is bought and sold. The final product will cost less than \$3 per module and \$25 per watt. Providing better light than from a kerosene lamp, the intention is to make available a cheaper and healthier lighting source which will, in turn, allow shops to stay open later and children and adults to learn and study after dark. The initial roll-out will be to 5,000 households in rural and urban

communities in Zambia, and, in five years, the goal is to distribute half a million systems.

Although the projects receive both financial and business support, the latter is also being disseminated in a generic form for the public domain. For example, the programme has conducted market research in five countries to capture data on market potential, an understanding of consumer needs and lighting preferences, product attributes and design characteristics, and distribution channels for product delivery. Countries for which information was collected include Ghana, Kenya, Zambia, Ethiopia, and Tanzania.

Although the results of this type of research are invaluable to energy supply businesses, it is quite prohibitive for any single potential start-up firm to carry out this type of survey work and analysis on its own. Where governments could address some of these concerns through their own data collection, economies of scale could be massively reaped and one of the key barriers to business creation overcome. Fortunately, the World Bank, as part of this programme, is standardizing its market research programme so other countries may carry out their own studies with greater ease.

Additional support is provided through a financial guidebook which lists key sources of funding; networking opportunities to help potential businesses establish business linkages and partnerships while identifying new products, services and business models; and a product quality assurance program to help enhance consumer awareness, support the industry in providing technologies appropriately tailored to the African consumer base, and boost confidence in new lighting products.

Finally, to help industry overcome one of the key barriers of identifying relevant market players across the supply chain while scoping market opportunities, Lighting Africa has set up a business-to-business website. Via this platform, members can create a business website to share information about their company, browse other members' pages, join discussion forums and exchange information about upcoming business opportunities. The website currently has over 1,700 registered members.

Although the programme is relatively new, and thus difficult to evaluate, it is clear that it is implementing a number of key lessons from other projects, thereby increasing the probability of success. This includes data collection and analysis, commitment, facilitating partnerships, education and awareness, and support, in the first instance via the World Bank, and, thereafter, assistance in finding new sources.

A3.3.4 Further Reading

See <http://www.lightingafrica.org/>

(Information on website includes Lighting Africa Financing Guide and Market Intelligence and Market Research)

A3.4 Site Specific Renewable Energy Technologies

A3.4.1 Key Components

- Renewable energy technologies which provide **site specific energy**, including wind pumps, biogas, and solar water heaters;
- Often characterised by **high capital costs and low operating costs**; and
- Typically have **lower lifetime cost** relative to traditional/common technologies.

A3.4.2 Key Lessons

- **Financial support must be provided for the upfront capital cost** if poor households are to be encouraged to use site-specific renewable energy technologies;
- **Continual information and awareness campaigns** are necessary if end-users are to **gain acceptance and interest** in a technology and fuel otherwise unfamiliar, particularly in terms of potential energy savings over the life-time of the technology;
- **Research and development** focused on **adapting production of technologies to local needs** and capabilities will not only create employment, but ensure spare parts are readily available;
- **Increased access to financing** for manufactures and end-users will support uptake; and
- **Sustained political commitment** is needed for roll-out to be successful.

A3.4.3 Detailed Description

The past few decades have been marked by a strong interest in site specific renewable energy technologies. These cover a range of energy types, such as solar, wind and biogas, and a host of end-uses, including heating, cooking and heavy use, such as for pumping water for irrigation or ploughing. While a full discussion covering all technologies and applications is beyond the scope of this section, a number are highlighted below to show the potential. These are wind pumps, solar water heaters and biogas.

Wind pumps

For centuries, water has been lifted via power produced from the wind, or rather from windmills. Called wind pumps, the technology is often used to pump drinking water, either for human or livestock consumption, from boreholes in remote arid or semi-arid rural areas. Wind pumps are also used in agriculture through small-scale irrigation. One of the benefits of wind pumps is their ability to operate in the lightest of breezes, with power produced in wind speeds as low as

eight kilometres per hour. The towers come in a range of heights to best match local conditions. The technology, however, has not been extensively used in Africa, although a number of countries, such as South Africa, have successfully utilised them.

Consider the case of wind pumps in Kenya. Currently, there are a total of 360 wind pumps in operation across the country. Where installed, these pumps have helped to increase agricultural activity and improve water supply for remote rural populations. Likewise, their introduction has created industrial opportunities, with most pumps made locally and the bulk of components sourced from local stores and workshops. Most of these projects have been installed, however, through donor-led projects, with the poor unable to afford the capital cost. Similar experiences are being realised in other countries, including in Tanzania.

Solar water heaters

There is, perhaps, no more abundant energy resource in SADC Member States than solar. For example, in South Africa, average solar radiation is between 4.5 kWh and 6.5 kWh per square metre, and the country has expended much effort on harnessing this power wherever possible. One programme of the significance has been the roll-out of solar water heaters, which, as its name suggests, uses energy from the sun to heat water. Where this replaces electricity, the average household can expect its electricity bill to drop by 40 percent. Cost reductions are also estimated for those not using electricity, which is often the case among poor households regardless of whether the household is otherwise electrified (e.g., low income households with electricity often do not use electricity to heat water). Rather, these households tend to use either a fuelwood fire or kerosene to heat their water on the stovetop

Although the rated life expectancy of a SWH is typically fifteen years, many operate for over twenty-five years. The 40 percent electricity savings thus equates to a significant amount over the lifetime of the SWH. Depending on the system and the amount of water used, the payback period is estimated to be between four and eight years. A key benefit of SWH is their adaptability to the specific needs of the household, with options ranging from low cost integral systems, to medium cost close coupled systems, to more expensive systems.

Despite these saving, SWHs have not always received favourable uptake. First appearing in South Africa in the 1970s, the use of solar water heaters was heavily supported by the government through a widespread communication strategy educating consumers about the lifetime electricity savings available from their installation. However, with the most commonly installed heater costing approximately R3500 (USD 500) for a 200-litre capacity, uptake was essentially limited to middle and high-income households, with low households unable to afford to upfront cost. Yet, despite the absence of participation by the poor, the magnitude of the acquisitions created an entire industry of local manufacturers, which, in turn, provided employment to a large number of individuals. Although the industry collapsed in the early 1980s following the discontinuation of the

promotional campaign, the foundations of the industry remained, important given the renewed interest of late.

Indeed, over the past few years, South Africa has been experiencing widespread blackouts as the country finds itself short of electricity. Electric water heaters consume approximately 40 to 50 percent of household electricity, which, in turns, makes up approximately 17 percent of the national load. Hence, there has been a resurgence in interest of SWH, as these could potentially reduce the overall national energy demand by 4.5 percent, with most of this reduction occurring during the daily peak. To help shave the peak, the electricity utility Eskom is offering subsidies for the purchase of SWH.

Initiatives to improve energy use by the poor through renewable energy strategies are also becoming prevalent. With little access to financing, and thus an inability to afford the capital cost of SWH, the poor heat their water on electric, paraffin or LPG cookers, an inefficient and expensive approach. Hence, an NGO-initiated pilot was implemented in Durban to both establish baseline hot water consumption patterns (amount, time of usage and cost) and whether locally manufactured SWHs could meet the demand. Confirming their suitability, the pilot project offered a 50 percent capital subsidy, with the balance paid in cash by the household.

Despite the requirement to cover 50 percent of the capital cost, over 700 low-income families requested systems, demonstrating a demand among the poor. Accompanied by a community awareness and promotion program, which includes plays by local youth groups, prizes and displays, sales are expected to boom, particularly once consumers have access to appropriate financing. A second project includes subsidization of 500 SWHs through the Central Energy Fund, a government-supported company managing the future energy needs of the country, in conjunction with GEF and the UNDP.

Similarly, the City of Cape Town, as part of an initiative to support renewable energy, has committed to ensuring that ten percent of all households have SWH by 2010, including low-income households. One aspect of achieving this target is a mandate for all new buildings to install SWH, although a number of exemptions do exist. Hence, the City has undertaken a project to retrofit 2300 SWHs in low income homes as part of a study exploring the institutional, financial, social and technical feasibility of SWHs among the poor. As a renewable energy, certified emissions credits for the avoided CO₂ emissions (as SWH replace electricity generated from coal) as part of the Clean Development Mechanism are available as a source of funding. The City estimates that this will bring in R 1,000,000 (USD 157,200) per annum over the 21 year life of the installations. This represents approximately 20 to 30 percent of the capital cost on a net present value basis.

Not only is this renewable energy technology seen as a means of supporting the alleviation of poverty, but it is also seen as a means to generating employment. As a well-established industry in South Africa, increased use (which could reach up to 18 percent of urban electricity demand) is estimated to create around 6,000 jobs while adding R175 million (USD 27 million) to the incomes of low income households, although some electric water heater jobs may be lost in the substitution.

However, to ensure the sustainability of these jobs, quality assurance standards must be adhered to. Their absence, combined with suspect SWH installations, helped contribute to the contraction of the industry in the 1970s.

Recognising that SWH can be an effective means of enhancing energy use among the poor at a low cost while at the same time creating a significant number of jobs, other African countries also have active SWH programmes. For example, Cote d'Ivoire has undertaken a project to train previously unemployed young people in the specifics of building SWHs adapted for local use. Not only does this project stimulate local employment, but it also seeks to lower the upfront capital cost of SWHs, a proven barrier to their uptake, particularly by low-income households. While imported units cost \$1,000 to \$2,000 per unit, locally produced units cost \$280 to \$430. Targeted end-users are community centers, health clinics, schools and individual homes. The benefits include improved access to hot water, better health where fuelwood would otherwise be used and an overall reduction on collection of fuelwood. For each 200 liters of water heated using solar energy, 50 kg of firewood is saved where a traditional stove is used and 16 kg where an improved stove is used, which, in turn, reduces pressure on the environment and local tree cover.

Biogas

China has been at the fore of successfully harnessing the energy available through biogas. Although the country is well-suited to the production of biogas through anaerobic digestion given the prevailing temperature and humidity levels, the success really stems from the Chinese government's commitment and support. Specifically, these favourable conditions have been seized upon by the Chinese government through government expenditures on research and development, with expenditure reaching on the order of 1 billion yuan (USD 121 million) per annum. Additionally, the Chinese government announced in 2003 its *2003-2010 National Rural Biogas Construction Plan* with the goal of increasing use of biogas to 20 million households by 2005 and 50 million households by 2010. By the end of 2002, more than 11 million households were using biogas. The plan also introduced a government subsidy for each biogas digester.

Using human, animal and food waste as inputs, anaerobic digestion provides methane biogas for cooking, important given much of the population otherwise depends on fuelwood. It is estimated that a typical digester (10 m³) can save 2,000 kg of fuelwood a year. The digesters also act as a means of dealing with human and animal waste, thereby preventing them from being discharged into rivers and improving sanitation. Biogas is also advantageous in that the digester sludge can act as a fertiliser while the effluent acts as a safe pesticide. On a larger scale (i.e., biogas typically produced from either a landfill or from anaerobic digesters up to 5,000 m³ in size and requiring a large scale source of waste, such as organic material from cities' or towns' sewage system or organic material from a slaughterhouse, the food industry, etc), biogas can be used for co-generation of electricity and heat, can be used as a fuel for vehicles, and can be used in ovens and lamps to heat greenhouses while simultaneously boosting the carbon dioxide level to boost photosynthesis and thereby plant yields. These multiple uses have thus resulted in numerous benefits to both individuals and the population of China.

A3.4.4 Further Reading

Global Network on Energy for Sustainable Development (GNESD), 2007, Poverty Reduction, Can Renewable Energy make a real contribution?:
<http://www.gnesd.org/Downloadables/PovertyReductionSPM.pdf>

Global Network on Energy for Sustainable Development (GNESD), 2006, Renewable Energy Technologies and Poverty Alleviation: Overcoming Barriers and Unlocking Potentials:
http://www.gnesd.org/Downloadables/RETs_II/RETs_II_spm.pdf

Prasad, G., 2007, Case 19: Solar water heaters (SWH), case study prepared for Create Acceptance, Work package 2 – Historical and recent attitude of stakeholders:
http://www.createacceptance.net/fileadmin/create-acceptance/user/docs/CASE_19.pdf

A3.5 Modernising traditional biomass

A3.5.1 Key Components

- **International players** developing and marketing **modern, highly efficient multi-purpose ‘third generation’ stoves** targeted at poor customers;
- Intermediate stage is second generation stoves – technically similar to standard improved stoves but **mass produced, with uniform quality and attractively marketed**
- Third generation stove technologies are still at the development and pilot stage, for example:
 - “ Leading electronics manufacturer **Philips** developed and testing an **improved fuelwood stove** which also a **thermocouple** to **generates electricity** to power external equipment like radios or lighting;
 - “ UK academic designed **Score stove**, which is an efficient fuelwood stove with thermoacoustic generator powering a refrigerator and giving the ability to power LEDs or for charge a mobile phone; and
 - “ **Bosch and Siemens** Home Appliances Group (BSH) is currently developing a “**high-tech**” stove fueled by a multitude of **plant oils**.
- First generation stoves offered local employment in stove manufacture; **employment** for third generation stoves will be upstream in the

preparation, packaging and marketing of prepared wood fuel (to some extent replacing charcoal supply chains).

A3.5.2 Key Lessons

- ❑ Biomass fuel is readily **available at either no or low monetary cost** and thus will **continue to play a key role in energy use** over the coming decades;
- ❑ **Consumers** may **prefer products seen as modern and commercially made**, with prior improved stove projects often seen as poor man's option;
- ❑ **Small scale, donor led projects** in promoting improved cookstoves have **not achieved extensive uptake**; and
- ❑ **Third generation** of improved stoves seeking to **modernise biomass**, although **too early to tell** if success will be achieved.

A3.5.3 Detailed Description

One of the primary reasons behind the continued use of traditional biomass energy is that it is readily available typically at no or low monetary cost. This, in turn, has led to a "crisis of the commons" with the resource being unsustainably harvested and utilized. Today, many households dependent on traditional biomass are finding more time must be spent on collection. In some cases, conflict has broken out over traditional fuelwood entitlements. Once it has been collected, fuelwood energy is often released through inefficient technologies which produce detrimental indoor air pollution. The negative side effects of using traditional biomass in these traditional stoves are immense.

Yet, despite decades of experience showing continued reliance of the population on traditional biomass through inefficient technologies, and despite the fact that electrification does not bring with it wholesale substitution to electrification for all needs, few government policies or strategies acknowledge that use of traditional biomass is here to stay, with or without electrification. Indeed, there is very little government policy and resources aimed at traditional biomass. Instead, the majority of work in this area has occurred primarily through small-scale, donor driven programs aimed at improving the use of non-modern fuels for cooking via the introduction of "improved" biomass technologies, the main one being improved cookstoves.

The primary features of improved biomass technologies are their higher efficiency and lower smoke levels. This results in not only lower costs to the consumer, but improved quality of life as users (mostly women) often see improvements in their health and eyesight, not to mention the need to spend less time cleaning the pots. Additionally, production of these technologies has typically been designed so as to be implemented by local artisans and craftsmen with the use of local materials, thereby acting as a source of employment and income. Often, these donor driven

programs have the dual goal of both disseminating the improved technology and creating employment and local industry.

Yet, despite the obvious benefits to those who use the stove, improved stoves have not become marketable products which consumers are eager to purchase, especially in rural areas. Despite the multitude of improved stoves in various countries throughout Africa and the world, common themes for this absence of success have emerged. First, improved stoves have been unable to mimic critical characteristics of an open fire which govern not only how the food is cooked, but the traditional methods individuals prefer to maintain. An open fire also serves purposes beyond cooking, and which are intertwined with social interactions that cannot be duplicated by an improved cookstove. Similarly, improved cookstoves have often not been of the highest quality owing to a number of reasons, such as inadequate training of artisans or the absence of quality control procedures.

With a much higher cost than the traditional stove, individuals are certainly reluctant to purchase a product which has a short life due to low quality. Likewise, those typically using a traditional stove are often simply unable to afford an improved cookstove, even if the quality is high. Where improved stoves have achieved a notable level of distribution, it is typically in urban areas where consumers are able to manage their money in a way that allows them to pay a higher upfront cost to achieve the long-term savings an improved cookstove provides through its higher efficiency. In rural areas, where fuelwood is often collected, and thus entails no financial outlay, it becomes difficult to justify the higher cost. Finally, a number of developers have failed to understand or target their audience: customary pots can not be used, marketing directed at men rather than women, who are the primary cook, etc.

This is not to say that there have been no successful improved stoves. For example, the Kenyan Ceramic Jiko, which is fuelled by charcoal, is currently used by over half of all urban Kenyan households. A number of fuelwood stoves have also found a customer base, although none has taken hold like the jiko and typically serves the margin only.

The absence of large-scale success after decades of effort is resulting in a radical re-think amongst those working on biomass energy. These individuals see a disparate set of influences converging towards a “third” generation of improved cookstoves. The influences include:

- Acceleration of the rate of technological development: this implies that as more improved stoves are developed, so too will the technology that powers them, with growth occurring at an exponential rate. In essence, technology advancement should make improved cookstoves more energy efficient and of higher quality, all at a lower or constant price;
- Big business and the “bottom of the pyramid”: this recognises that the four billion individuals living on less than two dollars a day are an economic force and that business should not ignore them. Multinationals have taken note, and are now successfully creating

markets given redesigned products aimed at this group. There is no reason that energy should be any different.

- Carbon financing: given the reduction in carbon emissions from substitution to an improved cookstove, financing may be available from both formal carbon markets (e.g., through the Clean Development Mechanism) and/or voluntary markets; and
- Public sector influence: the role of energy in improving the socio-economic livelihoods of those in poverty is receiving increased attention by both international donors and the governments of developed countries. This has helped mobilise both interest and monetary support for projects which seek to improve energy use among the poor.

That this convergence meets with success is critical. As noted above, the use of biomass is here to stay. This fact needs to be accepted, and the hope is that continued use of biomass will thus be accompanied by its modernisation through the development of high-quality, clean, sophisticated, energy efficient, and mass-produced technologies that are well-packaged and marketed. A number of potential contenders which may lead the way are described below.

- Philips super-efficient stove and thermocouple: Philips, a leading worldwide electronics-maker, is currently piloting a super-efficient wood stove that makes use of an integrated fan to inject air at high velocity. As noted by the developer, this enables good combustion, ensuring lower emissions and high efficiency. Relative to a traditional stove, the Philips' woodstove reduced carbon monoxide by up to 94 percent and particulate matter by up to 93 percent. The fuels savings (i.e., savings in wood) is up to 45 percent. The lifetime of the stove is 5 years, providing over 5,000 hours of service.
- The Score Stove: The Score stove is a high efficient woodstove developed by UK universities for use in developing countries. Similar to the Philips Protos, the Score stove creates electric power from the waste heat of the stove. Using half the wood of a regular fuelwood stove, the innovation is in the use of a thermoacoustic generator to power LEDs or for charging a cellphone. Designs are now being developed whereby enough power to generate a computer could be provided. Through this technology, the stove is expected to generate one hour of use per kilogram of fuel and has recently achieved a peak of 19.5 kW.
- The Protos stove: Bosch and Siemens Home Appliances Group (BSH) is currently developing a "high-tech" stove fueled by a number of plant oils. Although not specifically a biomass stove, there is hope that its low cost and "modern" appeal will make it a substitute for fuelwood use in addition to kerosene. Testing shows the power of the stove ranges from 2 to 2.5kW with an efficiency of 45 to 55 percent, an efficiency equivalent to that of LPG. Comparatively, kerosene wick stoves have a

power range of 0.8 to 2.2kW and an efficiency of 38 to 47 percent. Similarly, one liter of plant oil in the Protos stove will provide 3 to 5 hours cooking whereas a liter of kerosene in a wick stove will provide 1 to 2 hours of cooking.

Currently still under development, the viability of these third generation stoves has yet to be proven. Field tests have revealed a number of issues that the firms are now attempting to overcome before broader dissemination. Likewise, problems beyond the stove have emerged, which may limit success even if the technology is right. For example, a pilot of the Protos stove in Tanzania revealed that interest in the product, as indicated by the over 800 households expressing an interest in purchasing the cooker, drive up the price of edible oils. BSH thus refrained from selling the stove as people in the region struggle to buy basic necessities, and it did not want to place additional pressure on these households through higher food prices. Similarly, while local employment is expected to be created through the preparation, packaging and marketing of the prepared wood (the specification of which is quite critical to the correct performance of some of these stoves), this will undoubtedly displace critical employment in the charcoal supply chain. The extent to which one offsets the other will need to be carefully considered as charcoal supply provides an important source of employment.

A3.5.4 Further Reading

Hancock, D., and M. Balmer, 2009, New opportunities for delivering basic energy to low-income households in developing countries, Working Paper.

Philips super-efficient stove and thermocouple:

http://www.vrac.iastate.edu/ethos/files/ethos2007/Sat_PM/Session_4/Alders%20ETOS%20presentation%20Philips%20Woodstove%20v3.ppt

Score stove: www.score.uk.com

Shengzhou/Aprovecho/GTZ, 2009, Modernising Traditional Energy (or, how we will change the world), Concept Note.

Bosch/Siemens Protos stove (efficient, safe stove using any kind of oil or paraffin) <http://www.bsh-group.com/index.php?page=109906> or www.pciaonline.org Partnership for Clean Indoor Air.

A3.6 Small scale bio-fuel production

A3.6.1 Key Components

- Local production of a fuel whose cost is often lower than substitute liquid fuels
- Modifying diesel engines to run on bio-diesel

- Establishing multifunction platforms, or modified diesel generators coupled with ancillary modules such grain mills, dehushing machines and alternators which generate electricity and supply to distribution mini-grids
- Stoves and lanterns powered by bio-fuels
- Creation of income-generating opportunities for small-scale farmers and producers of bio-fuels, as well as diversification of income streams

A3.6.2 Key Lessons

- Provision of electricity and/or power where none previously existed through locally grown and produced fuel
- For existing diesel generators modified to run on bio-fuels, greater opportunities to minimise costs through alternative source of fuel when diesel is either unavailable or prohibitively expensive
- Assistance and encouragement required of small farmers through seed acquisition, training, knowledge-sharing
- Technical problems relating to bio-fuels' use in engines and small-scale appliances must be overcome if widespread uptake is to be feasible
- Need to balance competing agricultural interests, including irrigation and food security

A3.6.3 Detailed Description

Increasing attention is being devoted to the role that bio-fuels can play in meeting the energy needs of both developed and developing nations alike. The reasons underlying this interest stem from their potential for reducing dependence on imported fossil fuels, their ability to assist farmers through the expansion of markets, and their contribution to lowering greenhouse gas (GHG) emissions. Hence, in recent years, governments around the world, including some in SADC, have set targets for production, offered tax breaks and subsidies to producers, and set requirements on use (e.g., blending with petrol and diesel). Unfortunately, despite the projected benefits, this enthusiasm also resulted in a number of negative outcomes, including upward pressure on food prices, competition over water, and deforestation. Likewise, the practicalities of its use in engines and other devices have not been problem free. These outcomes have led to both a "re-think" on bio-fuels policy and calls for a more considered approach in creating a market.

Despite the waxing, waning, and, once-again, waxing enthusiasm, policy continues to be lop-sided, with the emphasis placed on the role large-scale production of bio-fuels can play in the transport sector. This is to the detriment of not only bio-fuels policy, but to energy access, particularly given the suitability of producing and using bio-fuels on a smaller scale and the corresponding socio-economic benefits that will flourish. Certainly, while many of the concerns associated with the

production and use of bio-fuels will continue, they may be better managed when bio-fuels are produced on a small-scale. Regardless, the role that bio-fuels can play in contributing to energy access should play a dominant role in both energy access policy and bio-fuels policy.

Jatropha and energy access in Zambia and Tanzania

To exemplify the role that bio-fuels can play, consider the use of bio-diesel produced from *jatropha curcas* as promoted through a project led by GVEP International – Gaia Movement entitled “Community Generated Power: Scaling up bio-fuel production for local use in Zambia.” The project illustrates the ability of jatropha oil to power engines currently designed to run on diesel following modification. The reasons for making the modification include providing a locally-produced source of fuel in areas where diesel is not available and thereby enabling mechanisation to activities such as milling, acting as a substitute to diesel when diesel price increases impact the ability of a customer to use the fuel, or simply providing a substitute to diesel to help minimise costs, regardless of affordability. By producing the fuel locally, income generating opportunities for villagers are also created.

Indeed, the benefits of having a locally produced fuel to hedge against the price of diesel is illustrated by a women’s organisation – the Shakapopela Association – which operate a hammer mill engine to grind maize grown by local farmers. Operating since 2005, the group started to see their profit markets shrink considerably when diesel prices rose precipitously in 2008. With the assistance of the bio-fuels project, the engine of their hammer mill was adapted to run on alternative oils, including jatropha oil. (Indeed, wider tests, of which the Shakapopela Association is just one, have shown that the modifications worked well under local conditions, with village mechanics now being trained to adapt diesel engines in their area.) While the women’s group is currently being supplied the jatropha oil directly, they are concurrently be trained in growing their own. The financial viability of the business has thus been maintained through the sustained productivity.

On a larger scale, jatropha oil is being used to power Multifunctional Platforms (MFP) in a project initiated by the Tanzania Traditional Energy Development and Environment Organisation (TaTEDO), the main objectives of which are the installation of three MFPs and associated machineries for oil seed extraction, grain dehulling/milling, and battery charging. MFPs typically consist of a 10 horsepower diesel engine, capable of driving ancillary modules such as generators, mills and pumps. Although capable of running on both jatropha oil and diesel (important at times of a shortage in jatropha), the running costs of operating with diesel have been found to be nearly twice that when operating with jatropha. The systems are run commercially by a local entrepreneur selected by the villagers who is, in turn, responsible for running the MFP, collecting connection/service fees, and maintenance. Training is provided in these areas.

Initiated in June of 2006, the project has achieved the following outcomes and impacts:

- Installation of MFPs in two villages (Engaruka Juu and Leguruki), which are coupled with grain mills, dehusking machines and alternators which generate electricity and supply to distribution mini-grids. An additional MFP has been installed at TaTEDO's sustainable energy centre in Dar es Salaam for training and demonstration purposes.
- Connection of 112 households (or approximately 500 people) to the grid, charged at a flat rate of 3 US\$ per month and all of whom benefit from better lighting and cost savings given substitution away from kerosene and diesel.
- In one village, an owner of a petrol generator – and the major consumer of electricity – spent Tsh 90,000 (US\$ 72) per month prior to installation of the MFP and Tsh 15,000 (US\$ 12) per month following the introduction of the MFP.
- In a number of households also running small businesses (e.g., shops, butcheries, bars and drug stores), the presence of electricity translated into longer business hours, especially after dark, and increased profit.
- Many villagers no longer travel long distances to access charging services for mobile phones and car batteries. For Engaruka Juu, the closest grid connected area is 60m away, a round trip which costs approximately Tsh 6,000 (US\$ 4.80).
- Income generating opportunities from seed collection. In Engaruka Juu, one person can collect approximately 20kg of seeds per day, equivalent to approximately Tsh 4,000 (US\$ 3.20). In 2007, this amounted to US\$ 525 based on consumption of 3,000 kg, income that was subsequently spent within the village. Importantly, this 3,000kg represents only a quarter of actual demand, representing potential for future income.
- Benefits accruing directly to women villagers. Women are the primary sellers of jatropha seeds, the associated income of which is described in the previous bullet. Likewise, availability of grain milling and dehusking significantly reduces the time required by women to travel to milling centres outside of the village, not to mention the unreliability and expensiveness of the mills. Finally, women participated in MFP business training.
- In the longer-term, improvements in health are expected due to better lighting provided through the displacement of kerosene lanterns. Likewise, improvements in education are expected as school enrolment, attendance and performance are expected to increase due to better lighting and improved productivity and income of parents.

In terms of economics, utilisation of jatropha oil means that the system can be operated at an overall lower cost than if run on diesel – often half. Yet, the supply of jatropha is not sufficient to supply total demand, with part of the undersupply

deriving from traditional farming practices. Hence, to provide adequate yields capable of meeting total demand, technical assistance will need to be provided, and small farms encouraged. This will equate to lower overall costs, which will, in turn, encourage uptake by poorer customers, who are currently cross subsidised through more profitable services such as battery charging and maize milling.

More broadly, the economic analysis of additional installations based on Tanzania data shows that a twenty-five MFP scheme would yield positive financial returns in five years time, with years one to four being mainly project development and investment. Overall, the net present value of such a project would be US\$ 426,166 using a discount rate of 14% (consistent with the Central Bank of Tanzania). The corresponding internal rate of return equates to 26%. When the analysis is done with a 100% increase in MFP costs and, alternatively, a 100% increase in fuel costs, the net present value remains positive – US\$ 254,512 and US\$ 325,010, respectively. Concurrently, the IRR drops to 20% for the increase in investment costs and 23% for the increase in fuel costs, signifying that changes in either of these factors will not jeopardize the resultant positive benefits.

Although the systems have been greatly accepted by the villagers, particularly by providing crucial social and economic community services through the provision of electric lighting, maize dehushing and jatropha seed pressing, challenges in addition to the absence of sufficient supply have likewise been encountered. These include the absence of organised availability of quality seeds, lack of awareness, no clear source of jatropha information, the absence of oil expellers being readily available, lack of ingredients for local biodiesel processing and the absence of a bio-fuels policy, which has created uncertainty in commitment and investment.

Furthermore, while not explicitly experienced in this Tanzanian project, one key concern is that, while generation systems may make sense financially in terms of willingness-to-pay, bio-diesel may not always be the “cheapest” option when diesel is available. Indeed, more likely, the cost of petroleum diesel relative to bio-diesel will fluctuate over time, petroleum diesel sometimes being the cheaper fuel. Although this does not propose a problem for users of services able to use both, it may prove problematic for farmers and processors of the bio-fuels – the more dependent on income these individuals are, the greater the risk and thus the greater the need to ensure diversity.

Use of bio-fuels need not be limited to powering generators, whether modified or not. Both lanterns and cookstoves powered by bio-fuels are in various stages of development and testing, with some being more successful than others. The reasons underlying the varying degrees of to-date success depend on cost (i.e., too expensive), unproven technology and the absence of a constant and reliable supply of bio-fuels.

Summary

The projects discussed above exemplify the potential opportunity in developing bio-fuels to enhance energy access. Economically and socially, development of a rural bio-fuels industry could provide great benefit to small-scale farmers and

entrepreneurs in production, transport and processing of not only the fuels themselves, but the processing of the by-products. As shown by an ODI study, small farmers producing sugar cane or palm oil for bio-fuels can earn between \$7 and \$16 per day, assuming an oil price of 65 \$/barrel. This eclipses any potential returns in traditional markets and could turn a natural comparative advantage into real economic gains. Critically, as with other agricultural programmes aimed at small-scale farmers, some form of assistance – e.g., seed distribution programmes, information exchange, technical assistance – will likely be necessary to promote cost reduction and efficiency improvements.

Beyond those directly benefiting from the production and processing of bio-fuels and its by-products, benefits will certainly accrue to the users of the fuel. Small scale industries relying on generators fuelled by petroleum diesel will benefit from lower priced bio-fuels. Similarly, introduction of MFPs will enhance energy access, bringing power to areas previously unserved. Where cost-effective stoves and lanterns can be disseminated, improvements to health will be realised given the harmful emissions are lower than with alternative options. Likewise, for those collecting fuels, real time gains will be realised as time will no longer need to be spent on finding and transporting fuel to the home – up to one-third of one's productive time has been shown to be spent on such activities.

Yet, if these benefits are to be fully realised, a number of practical issues need to be addressed. For example, biodiesel is not well-suited for lower temperatures, which cause it to gel through the formation of wax crystals. These crystals not only prevent the biodiesel from flowing, but they also can clog the fuel lines and filters of engines. This problem equally applies to storage, meaning that those in colder climates need to take special precautions. Biofuels and biodiesel also have excellent solvent properties, meaning that engine filters will need to be changed more frequently. Likewise, engine seals, particularly in older engines, are not always rated for biofuels, and thus any engine running on biofuels must be checked so that the proper seals are used. Some users of biofuels in engines previously running on petroleum based fuels also find that the engines and related appliances are not as durable and do not operate as well. Technical problems also have not been eliminated for many of the small-scale appliances specially developed to run on bio-fuels, with field tests proving that obstacles to operation still remain.

On a larger scale, where agricultural production is diverted from food crops to energy crops, food prices could arise, an increase that would disproportionately fall on the urban poor and the rural poor not engaged in farming. Indeed, food crops may directly compete with energy crops in multiple ways, including competition for land, investment and water. Similarly, energy crops may encourage deforestation as land is cleared to make way for their production. Yet, on a small-scale, such competition is not insurmountable, particularly when the resultant benefits are kept within the local community. As experienced by the above projects, a balance can be achieved and conflict between these competing interests minimised.

A3.6.4 Further Reading

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<http://www.compete-bioafrica.net/>

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For information on TaTEDO, see www.tatedo.org.

A4 Mauritius Country Case Study

A4.1 Introduction

The Republic of Mauritius is a group of small islands consisting of the island of Mauritius, the island of Rodrigues and several other smaller islands scattered in the South West of the Indian Ocean. The country has a multi-racial population of Asian, African and European origin estimated at nearly 1.3 million as at the end of 2007. Mauritius gained its independence from Britain in 1968, became a republic in 1992 and a member of the Southern African Development Community (SADC) in 1995. The GDP per capita of over US\$6000 is one of the highest in Sub-Saharan Africa.

A4.1.1 Rationale for case study on Mauritius

Within the SADC region Mauritius is unique in being the only country that has achieved total electrification of the country as well as near universal access and utilisation of other commercial energy services. The last census taken in 2000 showed that 99.2% of the population and 99% of the households had access to electricity (Table 1.1).

Table 1.1: Availability of Electricity (Based on Household Survey of 2000)

Geographic Location	Population		Population with access to electricity		Households		Availability of Electricity in Households					
	Number	%	Number	%	Number	%	Yes	%	No	%	Not stated	%
Urban	498716	100	495955	99.4	130918	100	130124	99.4	769	0.6	25	0.0
Rural	669779	100	663033	99.0	166963	100	164861	98.7	2060	1.3	42	0.0
TOTAL	1168495	100	1158988	99.2	297881	100	294985	99.0	2829	0.9	67	0.1

Source: Central Statistics Office

Since universal access to modern energy services is the aspiration of all the other countries, this case study has a number of useful lessons and observations. Due to the relatively high income levels in Mauritius compared to the rest of the SADC region, some of the lessons may not be relevant for the poorest in rural areas that live on less than US\$1 per day. However other countries could apply the successful energy access strategies used in Mauritius to improve the quality of life for their urban and peri-urban populations.

It is interesting to note that the country's impressive energy sector developments, which include significant private sector investments, have been achieved within a fragmented governance framework and in the absence of an independent energy regulatory agency. This is evidence of successful coordination of the various public and private sector stakeholders. A separate study of this could yield useful lessons for other countries.

A4.1.2 Key energy sector stakeholders and legislation

The information and data used in the study was obtained from interviews with, and documents provided by, senior officials representing the following energy-related public and private organisations: Ministry of Renewable Energy and Public Utilities (MRPU), the Central Statistics Office (CSO), the Central Electricity Board (CEB), the State Trading Corporation (STC), Independent Power Producers (Compagne Thermique de Belle Vue Limitee (CTBV), Compagne Thermique de Savannah Limitee (CTSav) and Compagne Thermique du Sud Limitee (CTDS)), LPG distributors (SHELL and Yip Tong Group (for TOTAL)) and the World Bank's country office for Mauritius. The websites of these organisations also provided a lot of additional information.

Other relevant organisations that were visited via the internet include institutions of higher education and in the sugar industry (Mauritius Sugar Authority and Mauritius Sugar Industry Research Institute (MSIRI)). Bagasse, the fibrous cane residue from the sugar extraction process, is the most important renewable energy resource in Mauritius. The relative roles of the different organisations in the energy sector is summarised in the following table:

Table 1.2: Main institutions with significant roles in the energy sector in Mauritius

Institution	Role		
	Energy policy and planning	Energy Regulation	Energy Delivery
Ministry responsible for energy (currently designated the Ministry of Renewable Energy and Public Utilities (MRPU))	Electricity and renewable energy technologies	Competitive bidding for IPP	CEB Board membership
Central Electricity Board (wholly owned state enterprise under the MRPU)		Electricity generation licences; Electricity pricing	Electricity Generation, transmission, distribution & supply
State Trading Corporation (STC) (wholly owned state enterprise under the Ministry responsible for commerce – currently designated the Ministry of Business, Enterprises and Cooperatives)		Petroleum pricing	Imports of Petroleum products
Central Statistics Office (Energy and Water Unit) (under Ministry of Finance and Economic Planning)		Energy statistics	
Independent Power Producers (mainly in the sugar industry)			Electricity Generation
Private oil companies (Shell, Total, Indian Oil, etc.)			Distribution and sale of LPG and other petroleum products
Board of Investment			Investment promotion
Mauritius Sugar Industry Research Institute (MSIRI); University of Mauritius	Research	Research	Research

The ministry responsible for energy, currently designated the Ministry of Renewable Energy and Public Utilities, MRPU, is primarily responsible for electricity and renewable energy in addition to the water and wastewater sectors. The principal laws governing the electricity sector which are administered by the MRPU are the Electricity Act of 1939 and the Electricity Regulations of 1939, as amended, and the Central Electricity Board Act of 25 January 1964. A new Electricity Act of 2005 and Utility Regulatory Authority (URA) Act of 2004 and the amendment passed in September 2008 are not yet operational. The government has initiated the process of establishing the URA which will facilitate the operationalisation of the new legislation. Pending the creation of the URA the CEB shares the regulatory functions with the Ministry. The CEB sets the electricity prices but subject to directions given by the Minister and approved by the President. The CEB provides technical advice to Government in the selection of Independent Power Producers and issues the generation licenses to the selected developers.

The petroleum sector is governed by the Petroleum Act of 1970, as amended, and the Consumer Protection (Control of Price of Petroleum Products) Regulations issued in terms of the Consumer Protection (Price and Supplies) Act of 1968. The Ministry responsible for commerce, which has oversight over the State Trading Corporation, is therefore also responsible for energy regulation. The STC is an importer of strategic commodities which currently comprise Petroleum Products, Liquefied Petroleum Gas, Flour, Rice and Cement. It supplies private companies that distribute to the end user. The STC also supplies fuel oil for CEB power stations. The prices of all petroleum products are regulated. Since 1 April 2004 the petroleum pricing regulations provide for an automatic pricing mechanism that requires the STC to submit periodic price recommendations to a Certification Committee that is chaired by the Director of the Central Statistics Office. The review period has recently been changed from quarterly to monthly in order to deal with the volatility in the international oil market.

Table 1.3: Electricity Generation in Mauritius

Year	Energy Source										Peak Demand
	Hydro		Fuel Oil & Kerosene		Bagasse		Coal and Bagasse		Total		MW
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	
1985	114.7	29.3	173.6	44.3	28.0	7.2	75.0	19.2	391.5	100	84.9
2000	95.7	6.1	868.5	55.5	111.5	7.1	489.7	31.3	1564.9	100	283.9
2007	83.86	3.8	888.4	40.5	44.01	2.0	1182.65	53.8	2198.9	100	367.3

Source: Central Electricity Board and CSO.

Although coal imports are increasing in importance in energy production, these are currently not regulated. Bagasse, the fibrous residue of the sugar cane extraction process, is the most important local renewable energy resource which provides most of the energy needs of the sugar industry. In recent years the Government has

provided incentives under the Sugar Industry Efficiency Act for the export of surplus bagasse energy into the national grid. This has given rise to several independent power producers who now provide more than half of the electricity energy generated in the country (Table 1.3).

A4.2 Historical development of the energy sector

The development of the energy sector in post-independence Mauritius has been driven by two broad objectives – (a) increasing energy supply to facilitate economic growth and (b) substitution of traditional energy with modern energy to improve quality of life while saving the country's limited forest resources. These two objectives are interrelated because energy access for enhancing economic productivity creates the income that people need to improve the quality of household energy. The direct link between economic growth and energy demand is shown in Table 2.1.

Table 2.1: Economic Growth and Energy in Mauritius

Year	GDP (Current Rupees) (Million)	GDP (1990 Rupees) (Million)	Primary Energy requirement (ktoe)	Electricity Generated (GWh)	Electricity consumption per domestic customer (kWh)	Electricity consumption per customer (all categories mixed) (kWh)
1991		34483	741.7	743.6	1082	2744
2000	105206	66607	1113.1	1564.9	1723	4043
2006	181968	82931	1376.8	2091.1	1852	5077
2007	206968	87409	1383.7	2198.9	1888	5218

Source: Central Statistics Office (Energy Statistics 1999 & 2007; Mauritius in Figures 2007)

The country's energy requirements have grown considerably since independence as it has developed from an agrarian economy with one dominant sector – the sugar industry, to a diversified economy where the main pillars now include textiles, tourism, fishing, financial services, ICT (Information and Communication Technology) and manufacturing of consumer goods. The following table shows the change in the energy sources, indicating a clear shift from a dominance of the traditional energy resources of wood, charcoal and bagasse to electricity, LPG and other petroleum products.

Table 2.2: Evolution of energy consumption by sector over 20 year period 1985-2005

Economic/Social Sector	Energy Consumption (thousand tonnes of oil equivalent (ktoe))											
	Wood and charcoal		Bagasse		Coal		Electricity		LPG		Other Petroleum Products	
	1985	2005	1985	2005	1985	2005	1985	2005	1985	2005	1985	2005
Sugar Industry	-	-	219.99	76.2	-	-	-	-	-	-	-	-
Other Industry	5.00	-	-	-	1.76	14.4	21.67	66.9	-	4.2	31.36	86.4
Transport	-	-	-	-	-	-	-	-	-	7.3	136.74	411.3
Domestic	15.93	6.4	-	-	-	-	30.40	52.2	2.12	46.7	18.06	10.2
Commercial	0.93	0.3	-	-	-	-	16.13	7.5	0.62	7.5	-	-
Agriculture	-	-	-	-	-	-	1.19	-	-	2.3	-	2.4
TOTAL	21.86	6.7	219.99	76.2	1.76	14.4	69.39	126.6	2.74	68.0	186.16	510.3

Source: Statistics extracted from Energy Statistics published by the CSO (Energy and Water Unit)

Before the Government decided to intervene the main traditional sources of domestic energy were wood, mainly in the rural areas, and charcoal and kerosene, mainly in the urban areas (Table 2.3). A household energy survey carried out in August 1985 by the then Ministry of Energy, Water Resources and Postal Services based on a sample of 1100 households estimated that the quantity of wood used for cooking was 100000 cubic meters per year and that of charcoal was 9000 tonnes. More than 80% of the fuelwood was collected free from state land, placing severe pressure on the country's forest reserves. Accidents from the widespread use of kerosene stoves were also very high.

Table 2.3: Principal Fuel Used for Cooking (Based on Household Survey of 1972)

Geographic Location	Total living quarters	Principal Fuel					
		Wood	Charcoal	Kerosene	Electricity	LPG	Other/Not stated
Highly urbanised areas (Port Louis/Curepipe & environs)	73983	21117	8314	37594	4619	1540	799
Mainly rural areas	75516	61225	1271	10890	933	3270	1007
TOTAL	149499	82342	9585	48484	5552	1730	1806
	100%	55.1%	6.4%	32.4%	3.7%	1.2%	1.2%

Source: Statistics extracted from Energy Statistics published by the CSO (Energy and Water Unit)

In 1986 the Government decided to promote the use of LPG as a substitute fuel for household cooking. The success of this initiative is shown in Tables 2.4 and 2.5 which record the results of the 2000 household energy survey. In contrast to the rest of the SADC region and Sub-Saharan Africa, wood, charcoal and kerosene are no longer a significant fuel for households in Mauritius.

Table 2.4: Principal Fuel Used for Cooking (Based on Household Survey of 2000)

Geographic Location	Households	Principal Fuel					
	Number	Wood	Charcoal	Kerosene	Electricity	LPG	Other/Not Stated
Urban	130918	1273	349	2971	985	125128	212
Rural	166963	11650	189	7058	601	147291	174
TOTAL	297881	12923	538	10029	1586	272419	386
	100%	4.3%	0.2%	3.4%	0.5%	91.5%	0.1%

Source: Statistics extracted from Energy Statistics published by the CSO (Energy and Water Unit)

A quarter of households use electricity for bath water heating, while nearly 40% use LPG (Table 2.5). Solar and other fuels are used by 12% of the households while twice that number either do not use hot water for bathing or have no dedicated heating system for bath water. In order to encourage the greater use of solar and other renewable resources the Government has recently launched a new initiative - the Finance and Audit (Maurice Ile Durable (MID) Regulations 2008). The MID fund is promoting solar water heating by subsidising purchases of solar water heaters. Its initial program has been oversubscribed - 29000 applications were received against an initial subsidy budget for 25000.

Table 2.5: Principal Fuel Used for Heating Bathing Water (Based on Household Survey of 2000)

Geographic Location	Households	Principal Fuel				
	Number	Electricity	LPG	Solar	Other	None/Not Stated
Urban	130918	50827	46751	5767	4788	22785
Rural	166963	24021	70040	5760	18600	48542
TOTAL	297881	74848	116791	11527	23234	71327
	100%	25.1%	39.2%	3.9%	7.9%	23.9%

Source: Statistics extracted from Energy Statistics published by the CSO (Energy and Water Unit)

Energy pricing and subsidies have been the government's main tools for influencing energy sector investment and consumption.

A4.3 Energy Pricing and Subsidy Policies - impact on energy access

Energy prices in Mauritius are controlled by the government through the Electricity and CEB Acts (for electricity) and the Consumer Protection (Control of Price of Petroleum Products) Regulations for LPG and other petroleum products. The Government has provided direct and indirect subsidies for energy services through explicit budgetary support to parastatals, cross-subsidisation and fiscal measures such as reduction or removal of duties. The specific measures undertaken for the most significant programs are explained below.

A4.3.1 Bagasse Energy Development Program

Since the inception of the sugar industry, bagasse has been used to meet most of the industry's energy needs. When the sugar industry's viability began to be threatened by the phasing out of its preferential access to the European market, the Government, in partnership with the private sector, came up with a Sugar Sector Action Plan in 1988 which outlined a number of appropriate survival strategies that included the bagasse energy development program (BEDP) designed to create a significant alternative revenue source for sugar producers while reducing the country's dependence on imported fossil fuels. To meet growing demand the utility at the time had the option of extending its diesel power plants or installing coal-fired plants, both options depending on imported fuels. The third and preferred option was to have the private sector develop bagasse cum coal generating plants that would export surplus power to the grid throughout the year. One of the earliest such plants had been developed by the Flacq United Estates Limited (FUEL) in 1985. In that year the quantity of fuel oil used for power generation dropped by 38% compared to 1984. Since then the share of electricity energy generated by IPPs has grown to more than half (56% in 2007) of CEB's requirements (Table 3.1).

Table 3.1: Electricity Generation in Mauritius

Year	Energy Source										Peak Demand
	Hydro		Fuel Oil & Kerosene		Bagasse		Coal and Bagasse		Total		MW
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	
1985	114.7	29.3	173.6	44.3	28.0	7.2	75.0	19.2	391.5	100	84.9
2000	95.7	6.1	868.5	55.5	111.5	7.1	489.7	31.3	1564.9	100	283.9
2007	83.86	3.8	888.4	40.5	44.01	2.0	1182.65	53.8	2198.9	100	367.3

Source: Central Electricity Board and CSO.

To encourage the necessary private sector investments the government introduced an IPP framework with tax incentives in favour of bagasse energy, favourable prices for bagasse used for purposes other than sugar manufacturing, electricity purchase

prices established on the basis of the avoided cost of diesel plant, and power purchase agreements guaranteed by the government. The success of these initiatives is highlighted by the private power plants listed in Table 3.2.

Table 3.2: Private power producers exporting to the Mauritian grid (2007)

Plant	Start date	Installed Capacity	Effective Capacity		Energy Generated in 2007	
		MW	MW	Crop MW	GWh	% Grid total
Compagne Thermique de Savannah Limitee (CTSav)	2007	87.0	74.0		335.8	15.27
Deep River Beau Champ	1988	24.5	22.0	12.0	129.1	5.87
Compagne Thermique de Belle Vue Limitee (CTBV)	2000	70.0	62.0	46.0	324.9	14.78
Flacq United Estates Limited (FUEL)	1985	36.7	27.0	20.0	163.3	7.43
Compagne Thermique du Sud Limitee (CTDS)	2005	34.5	30.0		229.5	10.44
Medine	1980	10.0	6.0		0.1	0.00
Mon Desert Alma	1997	11.2	5.0		13.6	0.62
Mon Loisir	1998	14.0	4.5		5.1	0.23
Union St Aubin	1997	12.7	5.0		25.1	1.14
IPP TOTAL		300.6	235.5		1226.7	55.78
CEB Hydro		59.4	53.1		83.9	3.81
CEB Thermal		372.8	323.6		888.4	40.41
CEB TOTAL		432.2	376.7		972.3	44.22
GRID TOTAL		732.8	612.2		2198.9	100.00

Source: Central Electricity Board (Note that some power plants reduce power exports to the grid during the crop season)

The recent IPPs (from 2000) have been selected on the basis of competitive bidding by the government acting with technical advice from the CEB. As operating experience has been gained the price indexation formulae in the power purchase agreements have been re-negotiated to achieve more politically and socially acceptable rates of return. In hindsight the government has recognised the desirability of having an independent regulatory authority to provide for a better balance between investor and consumer interests. The new legislation empowers the Utility Regulatory Authority to examine any power purchase agreement and make appropriate recommendations to the parties to protect consumer interests.

A4.3.2 Liquefied Petroleum Gas (LPG) Program

The promotion of the use of LPG as a replacement fuel for wood, charcoal and kerosene has been undertaken as a very successful public and private sector partnership. The Government, through the State Trading Corporation, is responsible for the importation and pricing of the product and private companies are responsible for storing and distributing to the end users. Shell and Total are the main wholesale distributors who sell to retailers at government controlled prices designed to ensure access by all households. On the other hand the price of dual purpose kerosene reflects the real market price. The table 3.3 below shows the evolution of household expenditure on energy services since 1961 which highlights the successful transition from kerosene to LPG.

Table 3.3: Evolution of average monthly expenditure on domestic energy services (1961 – 2006/07)

Fuel	Average monthly household expenditure (Rupees)															
	1961		1975		1980/81		1986/87		1991/92		1996/97		2001/02		2006/07	
	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%	Rs	%
Electricity	3.40	68	12.41	51	69.42	57	94.84	64	146.77	53	253.40	70	362.98	69	544.55	67
LPG	-	-	-	-	4.82	4	15.04	10	109.59	40	98.60	27	160.92	30	262.79	32
Kerosene	1.60	32	12.09	49	48.25	39	38.82	26	19.88	7	10.22	3	6.99	1	4.39	1
TOTAL	5.00		24.50		122.49		148.70		276.24		362.22		530.89		811.73	

Source: Computed from CSO household budget surveys.

The LPG promotion program started in 1986 when the Government reduced customs duty on LPG by 50% and gas burners were exempted from all taxes. The price of LPG sold in cylinders of up to 12 kg, which are mostly used by domestic consumers, is subsidised (Table 3.4). Prior to April 2004 the subsidies were provided by way of budgetary support to the STC but since then the corporation has been allowed to cross-subsidise. Private companies such as Shell started educational and safety campaigns to increase consumer confidence in switching from the traditional energy sources. Social welfare centres which are found in every village are convenient for such campaigns in the rural areas.

In order to benefit from economies of scale from bulk purchasing the Government in 2002 decided that the State Trading Corporation would, with effect from January 2003, take over the importation of the country's total LPG requirements from the existing importers. The country currently imports about 70000 tonnes per year of LPG. STC is considering building additional LPG storage facilities on the basis of a public private partnership initiative.

Table 3.4: LPG Pricing Structure - Domestic (Effective December 2008) and Non-Domestic (Effective April 2009)

		Domestic-size cylinders (Rupees/kg)		Non- domestic-size cylinders (Rupees/kg)	
		6kg	12kg	17kg	40kg
Wholesale price including 15% VAT (General market)		22.00	22.00	39.186	39.186
Wholesale price including 15% VAT (Government)	Health	-	-	31.711	33.724
	Police	-	-	39.186	35.161
	Prisons	-	-	39.186	35.449
Retail Price including 15% VAT		25.00	25.00	-	-

Source: Interviews with LPG distributors

A4.3.3 Electrification program

When the country gained independence in 1968 the peak demand was 31 MW, energy sales were 98 GWh and the number of customers was 91234. By 1981 the rural electrification program covering 153 villages and housing estates had been completed. However the completion of the grid network only marked the beginning of a process to get households connected and to invest in power supply to keep pace with increasing per capita consumption. In 2007 the utility sold 1950 GWh to 373803 customers and the peak demand was 367 MW.

In order to enable all households to access electricity from the grid the Central Electricity Board had to introduce a social tariff that is targeted at the low income groups. Under this tariff, customers whose monthly consumption does not exceed 75 kWh benefit. CEB requires customers to declare the connected load and the fixed charges vary according to the declared connected load. The domestic tariff has three classes – Tariff 110 for customers with a declared load of up to 300W has a monthly minimum charge of Rs40 (US\$1.41) and security deposit of Rs200 (US\$7.05), Tariff 120 for load above 300W and up to 5kW has a minimum charge of Rs167 (US\$5.89) and security deposit of Rs600 (US\$21.15) and Tariff 140 for load exceeding 5 kW has a minimum charge of Rs335 (US\$11.81) and security deposit of Rs1200 (US\$42.30). At present, 25000 households or 8% of households benefit from the concessionary tariff. Table 3.5 below summarises the current domestic tariff.

There is also a complementary subsidy scheme to facilitate connection to needy households where network extensions are needed. About 200 such households benefitted from this scheme in 2007.

Table 3.5: Electricity Pricing Structure for Domestic (Effective April 2008)

kWh Block	Price per kWh (Rupees)	Average exchange rate (Rupees/US\$)	Price per kWh (US\$/kWh)
Up to 25	2.87	28.36	10.12
26 -50	3.98	28.36	14.03
51 - 75	4.31	28.36	15.20
76 - 100	4.95	28.36	17.45
101 - 200	5.59	28.36	19.71
200 - 250	6.38	28.36	22.50
250 - 300	7.18	28.36	25.32
Above 300	7.97	28.36	28.10

Source: Central Electricity Board

The utility has supported these access schemes by sacrificing financial profitability. Between 1998 and 2007 the return on average net fixed assets was low (below 3%) or negative for all but 4 years. This weak financial position is the reason why the Government has had to provide guarantees on the power purchase agreements signed with the IPPs. It would have been more preferable to have non-recourse project finance which frees up Government resources for other social obligations.

The Government has now initiated electricity sector reforms designed to address this deficiency by introducing legislation that will transform the CEB from a statutory corporation to a commercial entity paving the way for private capital injection. An independent regulatory authority is also expected to minimise political influence on electricity pricing. The Utility Regulatory Authority Act establishes a Universal Service Fund that will provide explicit subsidies to support access to utility services in cases where it is not financial viable for private investment. This fund will be managed by the regulatory authority, removing the responsibility from the power utility and other commercialised corporations.

A4.4 Lessons from the key success factors for Mauritius' achievements in energy access

Many of the people interviewed attributed the country's success in its energy access strategies to its small size (making it easy to develop a nationwide grid by 1981, only 13 years after independence). However there are other similarly small countries in SADC that have not achieved this despite having achieved

independence at the same time or earlier than Mauritius. The country's experiences provide valuable lessons for other countries, regardless of size, to learn from.

The following three principal factors appear to be the secret of the country's success:

- a. **Efficient energy information and data gathering:** The Energy and Water Unit of the Central Statistics Office, which used to be a section of the Ministry responsible for Energy, has compiled an impressive database of energy statistics that has facilitated the government's policy and planning work. Their annual publication now called the Digest of Energy and Water Statistics dates back to the early years of independence. Other relevant statistical surveys have been done by the University of Mauritius and the Forestry Service of the Ministry of Agriculture and Natural Resources. Through these statistics the government has information on both traditional and modern energy services used by all sectors of the economy.

The country appears to be the only one that has statistics on consumption of fuelwood and charcoal although these are no longer as dominant in the energy supply chain. Other countries only acknowledge woody biomass as their major energy resource but make no effort to compile statistics on supply and consumption.

Information is also compiled that allows the government to determine levels of affordability that help to formulate appropriate subsidy policies. Prices have been kept at levels where the average monthly household expenditure on energy services has gone down from 10% to 6%. The rationale for cross-subsidies such as the electricity block tariff is based on the fact that low income families still spend nearly 10% of their budget on energy services while higher income families spend less than 4%.

- b. **Coordinated energy and macroeconomic policy development and implementation:** The World Bank's country office observed that the various government departments in Mauritius operate in a well-coordinated way with a clearly shared vision. It appears that one of the reasons why coordination skills are developed is due to the fact that Mauritius has a few government ministries where each ministry has several functions that would typically be standalone ministries in other countries. Ministers and permanent secretaries have multi-sector coordination and management responsibilities as an integral element of their job description. This is particularly important for the energy sector which is only a service to support economic and social development. Energy infrastructure cannot therefore be developed independently of economic and social development projects. For example the rural electrification program was facilitated by the Government's decision to promote tourism as one of the pillars of the economy. Since most tourist hotels had to be developed at the beaches along the coast the grid network had to be extended outside the main cities to the sea coast thereby passing through the rural areas.

The management of some economic or social sectors is also divided between several ministries, which then requires the creation of inter-ministerial ad hoc committees to ensure that all aspects of the sector are taken into account when formulating and implementing policy. The highly successful bagasse energy development program (BEDP) needed to be directed by a high level inter-ministerial committee which was chaired by the Ministry of Agriculture and included the ministries responsible for energy, finance, economic planning, environment and cooperatives. This was supported by a technical committee chaired by the Finance Secretary that included representatives of these ministries as well as the relevant parastatals, the private sector and research institutions.

Probably because of this effective coordination of different Government departments the Department of Energy has a very small establishment compared to other countries. Apart from an assistant secretary with specific responsibilities for the energy sector the other higher officials – three senior planners, a principal planner, deputy director and director – are also responsible for other non-energy utilities. It was however the opinion of the Assistant secretary that the efficiency of the department would be improved by having some of the planners dedicated to energy.

The country is building up on this strong multi-sector coordination capability by establishing a multi-sector utility regulatory authority which makes better use of scarce human resources than the single sector or sub-sector regulators that have been established in other countries.

- c. **Incentives for Private Sector investment:** Mauritius is highly ranked in terms of investment attractiveness. It is ranked first in Africa in the World Bank's Doing Business Survey of 2008. It is similarly highly rated by other ranking agencies such as World Index of Economic Freedom of the Wall Street Journal and Heritage Foundation, the Global Competitiveness Index of the World Economic Forum and the AT Kearney Global Services Location Index.

This focus on investment competitiveness is one of the reasons for the country's success in attracting private sector investment in power generation even before the implementation of the standard energy sector reforms – independent regulator and unbundling and commercialisation of the utility. The representatives of the IPPs that were interviewed did not see much need for a regulatory body because they have had no problems in their energy investments and operations. Some of them were even afraid that the regulator was not likely to be truly independent and therefore would only serve to introduce delays in decision making that could be counterproductive.

These experiences and observations demonstrate that what is critical in attracting investment is not the enactment of laws or establishment of institutions but the practical demonstration of political will and commitment to the country's economic and social development. The SADC secretariat

could help other countries to learn from Mauritius by establishing country and energy sector competitiveness rankings as a way to measure the political will and commitment of member countries to the goal of universal energy access.

A5 Namibia Case Study

A5.1 Policy, legal and institutional setting

A5.1.1 Rationale for the case study

At Namibia's independence in 1990, the country had highly differentiated access to energy. With a clearly articulated energy policy, strong government commitment and productive collaboration with energy NGOs, much has been achieved since then to improve access to energy, particularly for communities and households in the rural areas. Looking ahead, Namibia is beginning some promising new initiatives intended to build upon its previous achievements.

Although Namibia has a relatively high level of income amongst its SADC peers, its relative success in energy access has more to do with commitment and organisation than finance. The country has also had some instructive negative experiences in the energy sector. Namibia therefore offers some interesting lessons for other countries, justifying a case study.

A5.1.2 Energy policy, strategy and legislation

The main guiding document in the energy sector is the White Paper on Energy Policy, published by the Ministry of Mines and Energy in 1998. This is a well formulated and progressive document. Although more than 10 years old, it continues to provide a robust energy policy framework for Namibia.

The energy policy goals specified in the White Paper are:

- Effective energy sector governance
- Security of supply
- Social upliftment
- Investment and growth
- Economic competitiveness and efficiency
- Sustainability

One of the main themes of the White Paper is the relationship between energy and economic development – hence the emphasis on investment, economic competitiveness and energy for productive purposes.

In furtherance of the goal of social upliftment, energy access for households is given a prominent place in the policy. Rather than focussing on electricity alone, the policy is one of supplying a *range* of safe, affordable and appropriate fuels and appliances to rural households and community facilities. In respect of electrification, the targets set are that all low incomes households in urban areas

should have access to electricity while 25% of rural households should be connected to the national grid by 2010.

To achieve these targets and ensure security of supply, wide ranging reforms of the electricity sector are laid out, including the unbundling of the electricity supply industry, with Nampower becoming a transmission company and new players entering the industry in generation and distribution. The establishment of an independent electricity regulator is also envisaged to ensure that electricity tariffs are based on sound economic principles, “generally and as a whole reflecting the long-run marginal cost of electricity supply”.

The main energy legislation which is in force relates to petroleum product exploration, dating from 1991, and petroleum products and electricity legislation passed in 2000 and 2007 which reflect the policy framework established by the White Paper:

- Petroleum (Exploration and Production) Act, 1991
- Petroleum Products and Energy Amendment Act, 2000
- Electricity Act, 2007 (replacing Act passed in 2000)

A5.1.3 Key energy sector stakeholders

The ministry responsible for energy in Namibia is the Ministry of Mines and Energy. Several other ministries and government agencies have a strong interest in energy matters, such the Ministry of the Environment, the National Planning Commission and the Central Bureau of Statistics.

Outside of government, the main stakeholders are the users of energy. On the supply side, key stakeholders are:

- *in the electricity sub-sector:* Namibian Power Corporation (Nampower), the Regional Electricity Distributors (REDs), the municipal electricity departments in areas where electricity is distributed by local authorities and suppliers of equipment for stand-alone systems
- *in the petroleum sub-sector:* the National Petroleum Corporation (NamCor), private liquid fuel and LPG companies
- *in the renewables sector:* members of the Renewable Energy Industry Association of Namibia.

The Electricity Control Board (ECB) is the regulator established to mediate between the demand and supply side of the electricity industry. There is talk of the ECB extending its mandate to the energy sector as a whole, or even becoming a multi-sector regulator responsible for other forms of infrastructure service delivery (eg water and wastewater).

Non-government organisations involved in research, product and technology development and training play an important role in Namibia, examples being:

- The Renewable Energy and Efficiency Institute (REEEI)
- The Desert Research Foundation (DRF)
- The Cheetah Conservation Fund (CCF)

These institutions are effective in part because of the strong cooperation which exists between the Ministry, other public bodies and the NGOs. For example, the hybrid minigrid project being developed by DRF at Tsumkwe has strong support from the Ministry and Nampower. REEEI, which is located in the Polytechnic of Namibia, is directly financed by the government, but is given considerable autonomy by the Ministry in formulating its research and training programmes.

A5.1.4 Basic Income Grant (BIG)

Although not directly related to energy, it is relevant to mention a recent policy initiative in Namibia which is potentially extremely important as an overall strategy for addressing poverty. This is the proposal that a Basic Income Grant (BIG) of N\$100 should be paid each month to every adult Namibian without any conditions being attached⁴. From the viewpoint of tackling poverty, this is a very attractive notion because it abstracts from all the difficult issues around sector-specific subsidies and allows instead people to decide for themselves what their priorities really are.

In January 2008, a two year BIG pilot project commenced in the Otjivero-Omitara, a deprived area about 100 kilometres east of Windhoek. A mid-term evaluation carried out in 2009 found that the existence of the scheme resulted in a large influx of ineligible family members into the area, which diluted the per capita income raising effect that had been intended. Nonetheless, a number of positive developments in the affected community were observed⁵:

- reduction in household poverty and child malnutrition
- increase in school attendance and in frequency of use of health facilities
- increase in economic activity, with a significant expansion in the small business sector.

If rolled out at the national level, BIG would dramatically increase the demand for energy for productive and household uses.

⁴ There is an age limit of 60 years, but after that people become eligible for the already established government old age pension. In the pilot project, payments were given only to adults registered as living in the area in July 2007.

⁵ BIG Coalition (2009): *Making the Difference: Basic Income Grant Pilot Project Assessment Report*, Windhoek

A5.2 Major developments in the energy sector

A5.2.1 Reform of the electricity sub-sector

Electricity sector reforms have been envisaged in many if not most SADC countries. Namibia's reforms have progressed much further than other countries but still fall short of what was envisaged in the White Paper. The Electricity Act of 2000 paved the way for the unbundling of Nampower, the introduction of independent power producers (IPPs) to expand domestic generation capacity and the formation of 5 regional electricity distribution companies to supply electricity at the retail end of the industry.

The key objective of the reforms - to attract IPP investment - has not been met, and problems have been encountered at the distribution end too. The regional distribution companies had to take over the electricity departments of municipalities and other local authorities, and as these entities historically have relied on a premium on the electricity price to fund non-electricity activities, in the absence of replacement forms of finance they have been reluctant to relinquish their role in electricity distribution. Of the 5 planned Regional Electricity Distributors, only 3 have been formed.

Even before the White Paper, there was a private sector participation (PSP) agreement with a private operator, Northern Electricity, for a distribution concession in a defined franchise area in the central northern region. This arrangement lasted over the initial concession period of about 5 years (December 1996 to March 2002), but was terminated when the contract came up for renewal. Local interests in maintaining electricity-related revenue streams again seems to have been in play, because the detailed evaluations which have been carried out on the Northern Electricity experience all suggest that the arrangement was a remarkably successful example of a private arrangement responding and adapting to the needs and consumption characteristics of its customers while achieving fiscal sustainability at government established electricity tariffs. The success is attributed to "strong leadership, commercial focus (on reducing losses and increasing collections), effective management information systems and commitment to customer service"⁶.

In contrast to the PSP aspects, the electricity sector reform process has been more successful in respect of regulation. The Electricity Control Board (ECB) was established in the wake of the Electricity Act passed in 2000. ECB has built up a well deserved reputation for independent and professional regulation of the Namibian electricity sector, and it is partly for that reason that the Regional Electricity Regulators Association of Southern Africa (RERA) was located in Namibia. ECB has conducted regular tariff reviews and with the support of government is increasing tariffs progressively to LRMC levels, with the result that electricity tariffs in

⁶ Eco One Research (2002): *Northern Electricity Distribution Service in Northern Namibia A Case Study in the Private Provision of Rural Infrastructure*, report prepared for PPIAF, Washington DC

Namibia have risen significantly in recent years⁷. Tariffs vary across the country. The approved pre-payment metre tariffs for 2009/10 are N\$ 0.958 and N\$1.256 per kWh (including the ECB levy) for single and three phase meters, equivalent to 12.2 US c/kWh and 16.0 US c respectively.

Electricity access is subsidised, but consumption is not⁸. The full capital costs of the rural electrification programme are met by the government (see Annex 3.1), but on the consumption side there is no lifeline tariff. It is intended that domestic tariffs should be higher than industrial costs, in line with cost-reflective pricing principles, but this is yet to be fully realised. For off-grid electrification, government established a Guarantee Fund, which was operated by a competitively chosen commercial bank. The new 'Energy Shop' concept (see Annex 1.3) also includes a government-funded loan component.

The electricity supply industry in Namibia has shown remarkable adaptability in recent years, since the emergence of a regional shortage of generation capacity. Whereas Namibia traditionally relied on imports of firm energy from South Africa for the bulk of its electricity supplies, when the contract with Eskom came up for renewal after the regional generation shortfall had emerged, Eskom refused to offer anything more than emergency support. Namibia had to negotiate new import contracts with ZESCO (15 MW) and SNEL (50 MW) in Zambia and DRC and an innovative scheme with Zimbabwe whereby Nampower paid for the rehabilitation of some of the units at the Hwange Power station in return for 150 MW of firm imports reportedly at a very favourable price. Together with Ruacana hydropower station (250 MW) and a diesel station at Walvis Bay (24 MW), these sources add up to 489 MW, which is in striking distance of recent maximum demand levels eg 533 MW in 2008. Nampower also has the van Eyck coal fired station (120 MW) but this is extremely expensive to operate as the coal is imported.

A5.2.2 Emergence of a natural gas sector

There are some small generation projects to be developed to increase local electricity capacity, but the real solution lies in the development of the Kudu gas field. This field is located off the coast near Luderitz, and has proven reserves to supply a 750-800 MW power station for at least 20 years. The intention is to build a 600 MW power station in the first phase. Together with the upstream gas field development and the downstream transmission line investments, the total cost of the project has been estimated at around US\$ 1 billion.

Bringing such a large project to financial closure will require firm export contracts to be negotiated, power purchase agreements and many other legal and risk mitigation measures to be put in place. Although Namibia has been keen to

⁷ In 2005, government reduced the 10 year adjustment path that ECB had proposed in 2003 to 7 years, so LRMC levels are now due to be reached in 2010/11.

⁸ This is not true in the petroleum sector where subsidies are given to reduce the cost of liquid fuels in remote parts of the country. According to the questionnaire, these subsidies are of the same order of magnitude – US\$5.5 million per annum – as the money set aside for rural electrification capital subsidies.

promote the Kudu gas power project since the mid-1990s, it has not yet been possible to move the project to the implementation stage.

A5.3 Energy access strategy and projects

A5.3.1 Grid electrification

Namibia's National Rural Electrification Programme (NREP) was introduced shortly after the country gained independence from South Africa in 1990. In the first phase, the most densely populated areas were electrified first. Since 2000, a mix of on-grid and off-grid approaches have been used to progressively reach the more distant locations. The approach was one of 100% subsidies and of connecting all potential customers in a target locality. This led to much higher than expected consumption levels and hence to higher revenues and improved viability. Use of prepayment metres obviated billing and collection problems.

Electrifying rural households in Namibia is extremely difficult because of low population densities and dispersed settlement patterns. Against this background, the increase in the number of connections from less than 10,000 in 1990 (most of which have subsequently being classified as 'urban') to over 30,000 by 2005 is impressive. Nonetheless, the target set in the White Paper of 25% of rural households being electrified by 2010 will not be met – the figure will be more like 18%.

From 1991-2007, the total cost of the NREP amounted to N\$543 million. N\$310 million of this has come from government budgetary allocations, N\$ 120 million from Nampower, N\$75 million from NORAD and N\$17 million from Northern Electricity. At its peak in 1998, the NREP annual expenditure was N\$ 48 million (US\$ 8.7 million). By 2007, annual NREP expenditure had fallen to N\$ 24 million (US\$ 3.4 million). The current allocation is reported in response to the SADC Energy Access questionnaire to be around US\$5.5 million p.a.

According to a recent evaluation of NREP⁹, government commitment, demonstrated through the sustained capital subsidy for rural electrification, was crucial. Three factors are identified as being instrumental in the success of Namibia's rural electrification programme:

- the 100% capital subsidy enabled a rapid roll-out of the programme, providing essential services for previously disadvantaged communities, addressing poverty issues and stimulating the local economy, and improving the quality of life of many rural dwellers;

⁹ Ralf Tobich and partners, EMCON Consulting Group (2008): *Impact Assessment of Norad-Funded Rural Electrification Interventions in Northern Namibia*, Norad Collected Reviews 1/2008, Oslo

- the introduction of a dedicated electricity service in rural areas, initially by way of a public-private partnership and later through Regional Electricity Distributors, provided the basis for sustainable service delivery and continued electrification in these areas;
- pro-active private sector involvement in planning and implementation of the NREP and in electricity service provision significantly contributed to an efficient and cost effective development programme, yielding high levels of customer satisfaction, rapid electrification and a viable yet affordable rural electricity service of good quality.

A5.3.2 Off-grid approaches

Namibia has gone beyond other countries in elaborating a comprehensive Off-grid Energisation Master Plan for Namibia. This was completed in 2007 and is presently being implemented. The approach planned is the establishment of Energy Shops, which will be carefully vetted and which will sell suitable, approved energy products and appliances. It is intended that initially there will be one and then two energy shops per region. Thereafter, the roll-out will follow a priority plan extending over 20 years, by which time 156 Energy Shops will have been established.

Consistent with the idea of an energy portfolio, it is envisaged that a broad range of technologies and appliances will be available to households and businesses through the energy shops. Financing will be available through a revolving fund, administered by the energy shops, to enable customers to amortise the payments for large capital items. To assist in meeting the varied needs of customers, 'energy baskets' will be recommended. To assist customers to make informed choices, the information shown in Table 1 will be provided for each basket.

Table 1 Information provided for each energy basket

A	Appliances (e.g. gas plate, wood efficient stove, radio, microwave, grinder and refrigerator)
A	Technology (e.g. Solar 50W Direct Current, Solar 400 Watt Alternating Current)
A	Fuel (liquefied petroleum gas, wood)
B	Number of a specific appliance
C	The appliance cost
D	Energy requirements, where an appliance requires a purchased fuel
E	Monthly fuel cost
F	Monthly maintenance cost, where an appliances or technology needs replacement (the maintenance amount for solar systems includes the replacement of batteries after 3-4 years; the amount specified is the monthly amount which a household needs to "save" in order to purchase a complete new set of batteries after this period)
G	Total basket cost (includes technology and all appliances)
H	Total monthly cost is the amount a household will spend each month in order to ensure energy services over the long-term (the amount includes the funds "saved" for future battery replacements)
I	The Total amount reflects the sum of the cost of the energy basket plus expenses to operate the basket for one month
Note: Prices include 15% VAT, but exclude transport (from Windhoek) and installation. Prices are dated June 2006 and are subject to change. Updating energy basket prices will be an essential component of the implementation of the Off-Grid Master Plan.	

Source: Consulting Services Africa (2007): *Off-grid Energisation Master Plan for Namibia*, Windhoek

A5.4 Biomass

According to the 2003/04 National Household and Expenditure Survey of 2007, about 18% of urban households and 90% of rural households used wood, charcoal, coal and animal dung for cooking. Only 7.4% of rural households reported using electricity for cooking, much lower than the proportion of rural households reporting using electricity for lighting (13%) and owning a television (10.4%). This gives a quantitative indication of the notion that people continue to use biomass for cooking even when they have electricity¹⁰.

Table 2 Household source of energy for cooking (percent)

Energy source	Urban	Rural	Total
Electricity	60.4	7.4	28.8
Solar	-	0.0	0.0
LPG	11.5	2.0	5.8
Paraffin	10.1	0.6	4.4
Wood or charcoal	17.7	88.0	59.6
Coal	0.2	0.2	0.2
Dung	-	1.7	1.0
Number of households	150,533	221,145	371,678

Source: National Household Income and Expenditure Survey, 2003-04

One of the categories of products which the Energy Shops will market will be efficient wood stoves (such as Vesta and Tsotso stoves). Whether there will be significant uptake of these products remains to be seen. In the current situation, very few households have acquired improved stoves. For example, in the Rural Electrification Impact Assessment survey of 210 households in 6 districts in the centre and north of the country (a much smaller exercise than the national survey on which Table 1 is based), it was found that no households had improved stoves. By contrast, 86% of non-electrified and 60% of electrified households had 3 stone fireplaces. See Table 3 overleaf.

An interesting development by a non-government agency, the Cheetah Conservation Fund (CCF), is the harvesting of invasive thorn bush and conversion of this unwanted biomass resource into synthetic logs, which is sold as a long-lasting, low emission fuel. CCF has formed a company to market the product under

¹⁰ Nationally the main sources of energy for lighting are candles (38%), electricity (36%) and paraffin (15%).

the trade name 'Bushbloks'. CCF Bush (Pvt) Ltd, which has Forest Stewardship Council certification for its activities, is exporting Bushbloks to Europe and South Africa. The extent of invasive bush is such that it has been credited with providing sufficient carbon capture to more than offset carbon emissions from fossil fuel use and the burning of biomass, thus making Namibia a net carbon sink¹¹.

Table 3 Household cooking appliances (percent)

Cooking appliance	Electrified Household	Non-electrified household
3 stone fireplace	60	86
Electric hotplate	54	8
Electric stove	39	7
Gas stove	31	37
Microwave oven	12	7
Paraffin stove	5	18
Electric oven	3	0
Solar oven	3	1
Electric griller	2	0
Wood/coal stove	0	0
Number of survey households	137	73

Source: Rural Electrification Impact Assessment Survey, 2007

A5.5 Conclusions and lessons for other SADC countries

This concluding section assesses Namibia's energy access situation and attempts to tease out lessons (negative as well as positive) which may be useful for other SADC countries. The materials are organised around the S-A-D-C mnemonic used in the main report:

Statistics

Namibia does not have a consolidated and integrated database of energy statistics. The Directorate of Energy collects some energy data,

¹¹ Du Plessis, P. (1999) *Republic of Namibia: First Greenhouse Gas Inventory*. A report on sources and sinks of greenhouse gases in Namibia in 1994. Volume 1. Prepared for the Desert Research Foundation of Namibia (DRFN) as part of the Namibia Country Study on Climate Change.

but the Central Bureau of Statistics (CBS) collects other energy data, particularly household-level data that is relevant for assessing energy access. There does not seem to be the sort of strong working relationship that there ideally should be between the energy planners in the Directorate of Energy and the statisticians in CBS, which falls under the National Planning Commission.

Another problem is that relevant surveys and compilations of energy data which are made in periodic studies – such as the Rural Electrification Impact Assessment Survey used in Table 3 – do not seem to be systematically catalogued. Such studies are often valuable resources: better use needs to be made of them by ensuring that they are integrated into the national energy statistics information base.

○ **Applications**

Namibia's off-grid masterplan is very much based on the 'applications' or portfolio approach. The Energy Shop concept, offering consumers different 'baskets' of energy technologies to purchase, with subsidised loans to overcome up-front affordability constraints, looks very promising, but does not yet have a track record. Energy shops are discussed in more detail in Annex 1.3.

○ **Development**

Namibia has a good recent track record of economic growth. Continued rapid GDP growth is in part dependent on reliable supplies of electricity and it is commendable how rapidly electricity supplies at the national level were diversified when firm import contracts could not be renewed with ESKOM. The electricity sector has a strong regulator and there is significant movement towards cost-reflective electricity tariffs, both of which augur well for attracting much needed private investment into the electricity sector in the future.

The national rural electrification programme has been judged to be successful in development terms, in part because it has been properly planned and hence individual investment components have been economically rather than politically justified. However, the RE programme missed the opportunity to integrate the provision of electricity with an initiative to promote business development, which could have included components such as access to finance, assistance in identifying and developing markets, and training in accounts and business management. As a result, while existing rural businesses benefitted greatly from access to electricity, few new businesses were found to have arisen as a consequence of electrification¹².

¹² Ralph Tobich et al, op cit.

Electricity access is subsidised in Namibia, but consumption is not. This is not true of the petroleum products sector, where recurrent subsidies are given to equalise prices of liquid fuels across the country. Such subsidies are problematic because they distort prices and do not have any long-term development impact.

As an example of a 'thinking out of the box' approach to development, Namibia's Basic Income Grant is a challenging concept. If rolled out at a national level once the present pilot scheme has been completed, BIG could have a dramatic effect in addressing poverty and meeting the millennium development goals. The pilot BIG project has shown that there is a rapid increase in small scale enterprise activity in beneficiary communities, and all these productive activities require energy. Consequently, a national BIG programme would raise the stakes on enhancing energy access for poor communities.

○ **Capacity**

Namibia has a well articulated policy framework for the energy sector. In terms of energy institutions and individuals, the country's energy sector has good capacity. The Directorate of Energy in MME is well staffed with well qualified people, though not all established posts are currently filled (19/32). The Electricity Control Board and the energy NGOs have competent and highly motivated people and there are strong links to training institutions. It is notable in Namibia that there is a high level of cooperation between government/public sector institutions and the NGOs promoting energy access. There are also strong government-private sector relationships (eg the energy loan schemes operated by the private sector).

On the negative side, the progress made in electricity sector reforms has been slowed and in some respects reversed by political factors. Namibia has demonstrated that self-sustaining private sector provision of electricity distribution is possible at a cost which is affordable by rural customers – yet the concession arrangement with Northern Electricity was not renewed.

If there is an overall missing ingredient to energy sector capacity, it is a lack of dynamism. Greater purposefulness would drive the energy access agenda forwards with more vigour and momentum. This is not something that is amenable to external capacity-building initiatives. Where capacity-building *is* needed is for energy consumers: it appears that poor Namibian households often pay more than well-off households for energy services, because they don't know how to make the best use of the energy to which they have access.

A6 South Africa Case Study

A6.1 Introduction

South Africa's energy system is dominated by coal, which fuels 93 percent of electricity production. National coal reserves are abundant while oil and natural gas reserves are limited and small. Electricity prices are low compared to international standards but have recently risen and will continue to do so. Most household energy demand is met by electricity.

The majority of middle to high-income households use electricity for all their energy needs while the poor rely on inefficient and polluting fuels. Eighty percent of South African households have access to electricity and the remaining 20 percent are mostly located in rural areas where many of the poor live. These relatively high access figures mean that 80 percent use electricity for lighting and 67 percent use electricity for cooking. Many of those with access to electricity for lighting use polluting fuels such as coal or wood for cooking and they live in urban townships and rural areas. Clean energy services for the urban poor is a critical issue globally and Southern Africa is no exception. In the next 30 years about 95 percent of population growth is expected to occur in urban areas and without careful and good management the gap between those with access to modern and clean energy services and those without will widen (GNESD 2008).

South Africa views electricity as a necessary basic service, which is supported by the policy goal of access to electricity for all by 2012. It is unlikely that this goal is going to be met although the Minister of the new Energy Department made universal access to energy the first priority and in May 2009 the spokesperson for the Ministry stated that 'government would concentrate on supplying electricity to poor communities'.

Depending on fuel prices and subsidies the cooking fuel of choice varies from country to country. In South Africa the least expensive cooking fuel is electricity and 67 percent of South African households choose to cook with electricity (Fig 4). In Latin America and Mauritius the majority of household use gas, which is government supported and subsidised and is the least expensive fuel for cooking while electricity tariffs are relatively high.

A6.2 Use of fuels for different end uses

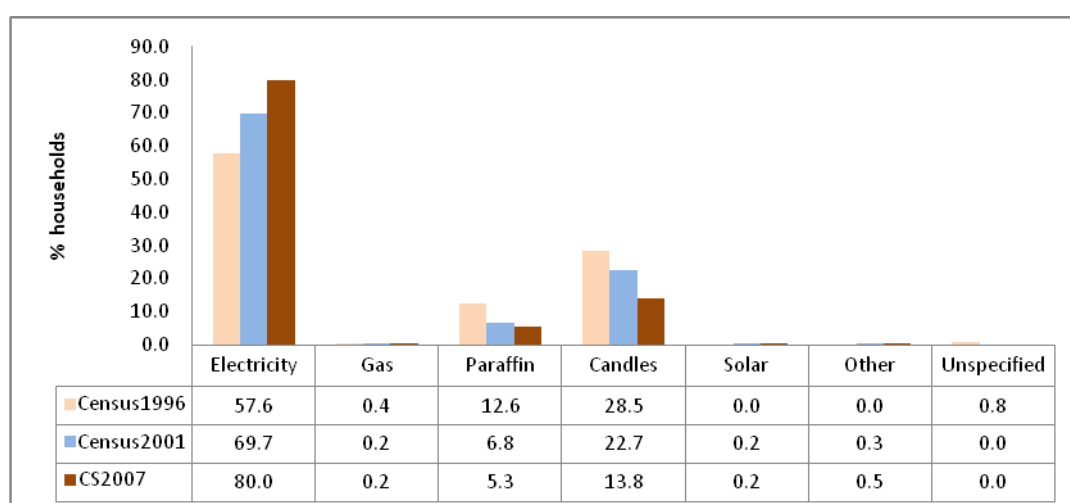
In this section energy transitions from 1996 to 2007 at the national level are analysed on the basis of two census (1996, 2001) and one representative community survey (2006). The next section looks at energy use in some rural and urban areas and the use by income group. Data were collected in local surveys, which are not necessarily representative of all such areas but indicate trends.

A variety of fuels are widely available particularly in urban areas but not all fuels are on sale in remote rural areas. Overall electricity for all end uses increased while the use of gas, paraffin, wood, coal and animal dung decreased (Statssa 2007).

A6.2.1 Lighting

The three major energy sources for lighting are electricity, candles and paraffin. Gas and solar energy are only used by less than 0.5 percent of the population (Statssa 2007). The use of electricity as the main source of lighting has increased from 58 percent in 1996 to 80 percent 2007 while the use of paraffin and candles as the main source of lighting decreased from 13 percent to 5 percent and 29 percent to 14 percent respectively from 1996 to 2001 (Fig 1). When households get an electricity connection they use electricity for lighting even if they cannot afford it for any other end use. Electricity then displaces the use of paraffin and candles for lighting. The 50 kWh provided by the FBE enables households to keep their homes lit during the month.

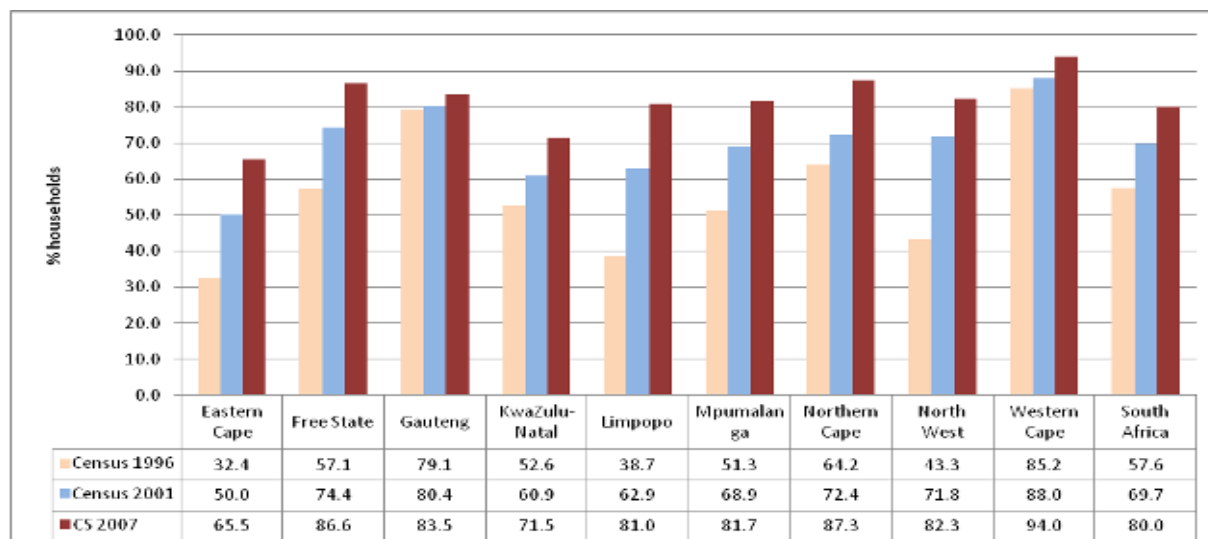
Figure 1: Proportion of households in South Africa using different energy sources for lighting (1996 - 2007) (Statssa, 2007)



The use of electricity for lighting is not evenly spread over the nine provinces (Fig 2) and this is closely linked to the electrification rate in the province. Eighty percent of all South African households used electricity for lighting in 2007. The Western Cape has the highest proportion (94 percent) followed by the Northern Cape (87 percent) and the Free State (87 percent) (Fig 2).

The Eastern Cape has the lowest proportion of households using electricity for lighting (66 percent) and the second lowest is KwaZulu-Natal (72 percent).

Figure 2: Proportion of households using electricity for lighting by province (Statssa, 2007)

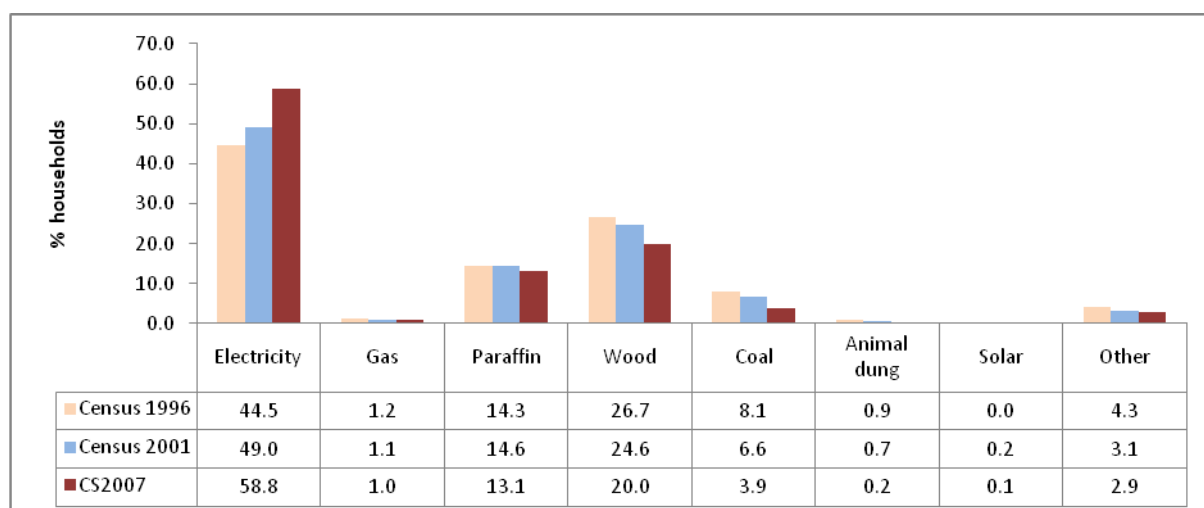


A6.2.2 Cooking and heating

The most energy intensive activity in households is cooking and water heating. The major energy sources used for cooking are electricity, fuelwood, paraffin and coal. Unlike in most other sub-Saharan countries charcoal is not widely used in South Africa. It is available in supermarkets and charcoal brickettes are a special braai (barbecue) fuel for middle and upper income groups at about R36 for 5 kg.

Fig 3 gives the proportion of households using different energy sources as their main heating fuel. Most poor household are multiple fuel users and with rising income they switch to electricity as their main fuel but will reserve paraffin or wood in case they run out of money to buy electricity.

Figure 3: Proportion of households using different energy sources for heating

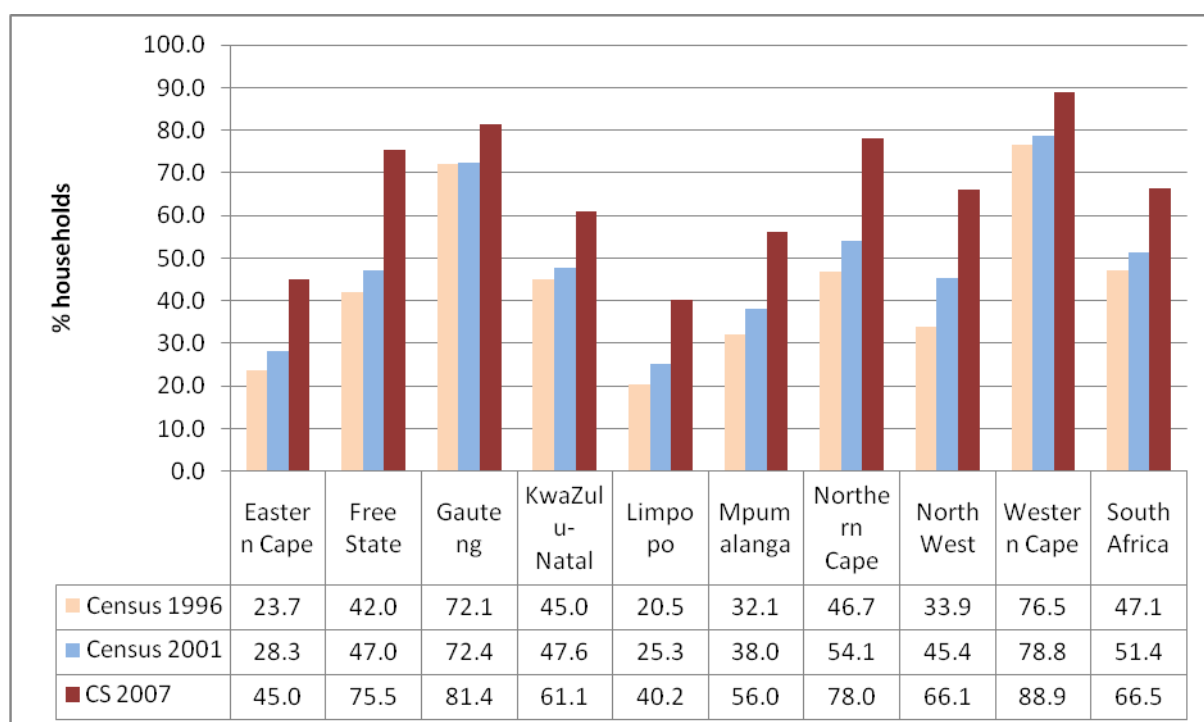


A6.2.3 Electricity for heating and cooking

The uptake of electricity for heating rose from 45 percent to 59 percent between 1996 and 2007 (Figure 3). That is 14 percent of households added electricity as their main heating fuel to their energy portfolio. At the same time the electricity connection rate increased by 22 percent that is 8 percent faster than the use for heating rate.

More households use electricity for cooking than for heating. The proportion of households using electricity for cooking rose by 20 percent from 1996 to 2004 and nationally 67 percent use electricity as their main cooking fuels (Figure 4). In 2007 the highest proportions are in the Western Cape (89 percent) and Gauteng (81 percent) and the lowest are in Limpopo (40 percent) and Eastern Cape (45 percent) (Fig 4). Space heating with electricity is most common in the big cities and the highest proportion of households using electricity for heating are the provinces with large urban populations that is Gauteng (77 percent) and Western Cape (80 percent). Rural households still prefer fuelwood. Being able to see the flame contributes to the preference for fuelwood.

Figure 4: Proportion of households using electricity for cooking by province



Getting access to electricity depends on government financing and the service provider making the connection but a household taking the decision to use electricity for cooking depends on household income, cost of electricity in comparison to other fuels, the knowledge of cooking cost for each fuel and the availability of other fuels. All these factors influence the decision and may play varying roles at different times. When household income is very low self-collected fuelwood if available might be the answer to bridge a time of financial difficulties.

Paraffin which can be bought in small quantities and on credit from the local spaza shop or borrowed from a neighbour is an urban solution to cash flow problems in poor households when the units of the FBE are used up and there is not enough money to buy more electricity units.

A6.2.4 Fuelwood availability and its use for cooking and heating

In Africa as a whole woodlands¹³ cover about 50percent of the land surface as compared to about 15percent closed forest and 10percent grassland (Scholes 2004). Many people's livelihood depends on woodland resources which are primarily fuelwood but also other products such as timber, fruit, fodder, medicines, honey, meat and mushrooms.

In South Africa only about 23percent indigenous woodlands remain while 40percent could potentially be natural woodlands but have been converted to other land uses such as agriculture, urbanisation, industrial sites and roads (Thompson 1999). Forests cover only about 0.3percent of South Africa's land surface (DWAF 1997) and they are generally well protected and are mostly found on state land or in protected areas (Von Maltitz 1999). Fuelwood is primarily collected from woodlands.

In South Africa about 13 million m³ of fuelwood (9.8 million tons dry mass) are used annually ranging from 0.6 – 7.7 tonnes per household per year with a mean around 687 kg per person per year and a gross use value per household per month of approximately R165; this would amount to about R3 billion use value per year when considering the 1.53 million rural household in the woodlands (Shackleton 2004). It is very difficult to assess how much of the fuelwood is sold and how much is self collected for family use.

Traditional fuelwood is the cooking fuel for the poorest of the poor in most African countries. When middle and high income groups can make the transition to modern fuels such as gas and electricity the lowest income quintile cannot afford this transition (Prasad 2008) even if they are connected to electricity. In South Africa use of fuelwood for heating declined from 27 percent in 1996 to 20 percent in 2007. Access to fuelwood for the poor will remain important for some time to come even if most households will have access to clean, safe energy in the near future. A fuelwood strategy is still outstanding.

Access to fuelwood and charcoal is much more important in other African countries because a much smaller proportion of households have access to modern fuels.

A6.2.5 Paraffin for cooking and heating

Paraffin is used both in rural and urban communities as a cooking and heating fuel. Its use as a heating fuel has declined by only 1.2 percent between 1996 and 2007 (Figure 3) much less than the decrease for fuelwood and coal. Paraffin is considered

¹³ Woodlands are a type of forest but they are not as dense as forests and their canopies are not continuous and overlapping (Scholes 2004).

a convenient fuel and it is much more widely available than coal. It can be purchased in small quantities often on credit from the local spaza shop and a cup of paraffin to cook a meal can easily be borrowed from a neighbour. Paraffin appliances are relatively inexpensive although they are quite dangerous and have fuelled many shack fires. In 2006 legislation on paraffin appliance safety has been passed and safe paraffin stoves are promoted and distributed. Unfortunately the old unsafe appliances are still available in some shops.

Paraffin prices have gone up faster than electricity prices and cooking a standard meal for four persons using paraffin costs more than the same meal cooked with electricity (See Box 2). However women participating in a cooking competition in Imizamo Yethu a township near Cape Town were using paraffin instead of electricity because they believed that paraffin was the cheaper cooking fuel. Perceptions of fuel cost of cooking are clearly a strong determinant for choosing the fuel.

A6.2.6 Coal for cooking

Coal is widely used as cooking and heating fuel near the coal mines in the industrial region of South Africa. Transport costs to the Western Cape are too high to make it an economic fuel there. The use of coal as a heating fuel has decreased by more than half between 1996 and 2001 (Fig 4). Poor households use very polluting coal appliances.

Basa Njengo Magogo method (BNM)

Approximately 1 million households use more than 1 million tons of coal per year. The health impacts of exposure to coal as a household energy source are estimated to be R1.1 billion per year. The Basa Njengo Magogo (meaning 'Light up, grandmother') method is a cleaner and more efficient fire-making practice and it addresses the fuel aspect of air pollution from coal. It consists in putting paper and wood on top of the coal instead of below and placing only a few pieces of coal on top of the wood. In the winter of 2008 the DME and DEAT launched the 'Clean fires campaign' in low-income areas where people use coal. (I have not yet seen any evaluation of the campaign).

The Nova Institute has disseminated the BNM method to 60 000 households in 2007/8.

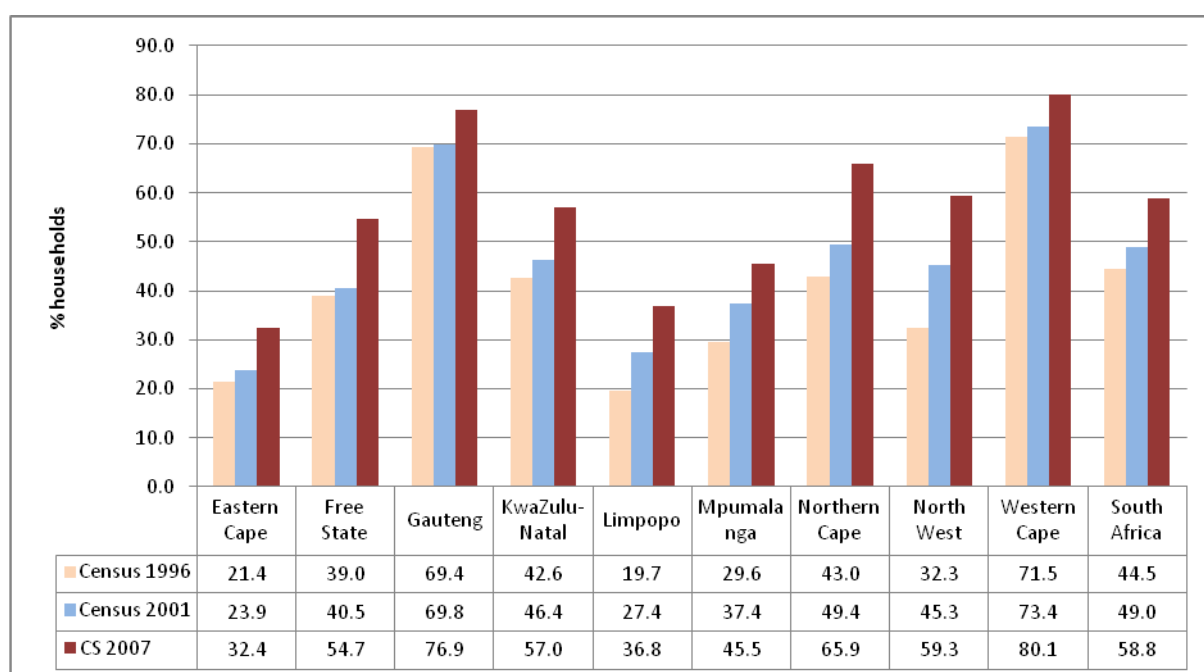
A6.2.7 Gelfuel for cooking

Gelfuel was originally marketed as a cooking fuel for camping and outdoor activities. It consists of over 80percent ethanol. It is now being promoted as a safe alternative cooking fuel to paraffin because it is less inflammable and doesn't spread as quickly as paraffin and thus is expected to reduce fires in poor urban townships.

However testing 13 cookers designed for use with gel and a number of gelfuels in the market the results showed (Lloyd and Visagie 2007) that gelfuel has very low

calorific values so that cooking a standard meal requires about three times more gel than an alternative fuel. The price would have to be one third of the alternative fuel to be competitive. It does not appear that they can be marketed at that price. Further when burning gelfuels emit a significant amount of pollutants. Another drawback of the gelfuel stoves was that they had no simmer possibility which increases the cooking cost. One of the conclusions of the test was that improvements are possible both in cooker design and in the gelfuel.

Figure 5: Proportion of households using electricity for heating by province



A6.3 The rural–urban divide – energy use by area of residence and income¹⁴

Rural areas have generally lower electrification rates than urban areas because distances to villages are longer and houses are more dispersed than in urban areas raising connection costs. In South Africa the rural electrification rate was 50 percent and the urban electrification rate was 80 percent in 1999.

Comparing patterns of electrification rates by income area of residence (Table 1) for 1999 shows that the poorest 40 percent of households (Q1 and Q2) in rural areas have the lowest electrification rates (41 percent to 45 percent) while the highest rural income group (Q5) has a high electrification rate (76 percent) almost approaching the national average for urban households (80 percent). In urban areas

¹⁴ This section is based on Prasad and Visagie 2005

the lowest-income quintile (Q1) has by far the lowest electrification rate and the difference between lowest- and highest-income quintile is 35percent. Almost all urban highest-income quintile households (98 percent) are connected to electricity. The difference in electrification rate between the poorest rural and the richest urban household is 57 percent.

Table 1: Estimated electrification levels of rural and urban household by income quintile (%)

<i>Rural households</i>					<i>Urban households</i>				
<i>Q1 (low)</i>	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>	<i>Q5 (high)</i>	<i>Q1 (low)</i>	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>	<i>Q5 (high)</i>
41	45	59	68	76	63	78	87	91	98

Source: UCT (2002); data from October Household Survey (1999)

Energy use patterns in rural and urban communities are different. Table 2 indicates household fuel use for cooking in a rural area in Limpopo and the urban township Kayalitsha in Cape Town, South Africa. Fuelwood is by far the most common cooking fuel in the rural area in Limpopo and 91 percent of households use it while urban households use mainly electricity (56 percent) and kerosene (37 percent) for cooking.

Table 2: Household fuel use for cooking in a rural Limpopo and an urban Khayelitsha, South Africa (percent) ¹⁵

	<i>Rural Limpopo¹⁶</i>	<i>Urban Khayelitsha¹⁷</i>	<i>National¹⁸</i>
Fuelwood	91	0	21
Kerosene	3	37	21
LPGas	3	6	3
Electricity	4	56	51

In rural households the proportion of households using fuelwood decreases from 98 percent for the lowest income group to 79 percent for the highest income group (Table 3). Electricity is little used for cooking and shows a weak trend in the opposite direction to fuelwood such that the highest income quintiles use it more frequently than the poorer quintiles. There are no distinct patterns for the other cooking fuels.

¹⁵ For sampling details see original authors

¹⁶ Prasad and Mapako 2005

¹⁷ Cowan and Mohlakoana 2005

¹⁸ based on census 2001 figures from SSA2003

Table 3: Household fuel use for cooking according to income quintiles in rural Limpopo and urban Khayelitsha, South Africa (percent)¹⁹

	Q1(low)	Q2	Q3	Q4	Q5(high)
<i>Rural Limpopo ¹</i>					
Fuelwood	98	93	96	89	79
Kerosene	2	2	22	5	2
LPGas	0	2	0	0	13
Electricity	0	4	2	5	7
<i>Urban Khayelitsha ²</i>					
Fuelwood	0	0	0	0	0
Kerosene	58	43	48	25	13
LPGas	7	5	5	2	13
Electricity	35	52	48	73	73

In the urban township of Kayelitsha households do not use fuelwood. The most frequently used energy for cooking is electricity. The proportion of households in the lowest income group (Q1) is 35 percent and this proportion rises to 73 percent for the highest income group (Q5) which is more than double that of households in the poorest income group. Kerosene use for cooking decreases from the lowest income group to the highest income group showing an opposite trend to electricity use. A higher proportion of low-income households (58 percent) than high-income households (13 percent) use kerosene.

Comparing energy expenditure by income (Table 4) indicates that households spend more in absolute terms on energy as income rises in both rural and urban locations. But poor households spent a higher proportion of their monthly income on energy (Table 4 row 3 and 6). The poorest rural households (Q1) spent 19 percent and the richest rural households (Q5) spent only 6 percent of their income on energy. Urban households in all income groups spent more in absolute terms but less as a proportion of their income on energy than rural household. The poorest urban households (Q1) spent 14 percent while the richest households (Q5) spent only 3 percent of their monthly income on energy. Considering the proportion of their income the poorest spent over four times more on energy than the richest households in their area.

¹⁹ Sources as in Table 2

Table 4: Monthly income and household expenditure on all fuels in rural Limpopo and urban Khayelitsha, South Africa (in Rand) ²⁰

	Q1(low)	Q2	Q3	Q4	Q5(high)
	<i>Rural Limpopo¹</i>				
Mean monthly income	341	613	934	1 424	2812
Monthly energy expenditure	64	89	79	98	160
% of monthly income spent on energy	19	15	8	7	6
	<i>Urban Khayelitsha²</i>				
Mean monthly income	514	928	1448	2149	4610
Monthly energy expenditure	74	93	90	104	133
% of monthly income spent on energy	14	10	6	5	3

The rural poor can still not afford to use electricity for cooking and continue to use fuelwood although access and use of electricity (50 kWh) is subsidized. Fuelwood can be collected 'free of charge' in most rural areas and this is a further incentive not to switch to electricity which has to be paid for. In urban Khayelitsha there is no fuelwood to be collected and it has to be paid for and households prefer to pay for paraffin, gas or electricity. Also urban households have higher incomes and can afford to pay for electricity.

In conclusion ranking households by income permits to analyse fuel use in a more differentiated way. It reveals trends suggesting that the higher income groups in urban areas are moving out of poverty but the poorest of the poor need further assistance. The urban households in the higher income groups gradually increase their electricity consumption for cooking and automatically are no longer eligible for Free Basic Electricity. Urban and rural households in the lower income groups need further support to buy clean modern fuels for cooking.

Access to electricity is necessary but not sufficient and other policy support such as the facilitation of income generation activities and SMEs are necessary so that the poor can lift themselves out of poverty.

²⁰ Sources as in Table 7

A6.4 Policies

South African energy policies have always been linked to the prevailing political situation. Pre-democracy (before 1994) energy policy and planning were characterised by energy security concerns and racially skewed provision. After the apartheid era the new democratic government addressed the inequalities of the past and electrification of previously disadvantaged populations was one of the priority areas identified in the National Reconstruction and Development Programme (RDP). The subsidised Integrated National Electrification Programme (INEP) in South Africa increased electricity coverage from about 36 percent in 1995 to 80 percent in 2007.

Even after being connected to the national grid many poor households could not use the electricity because they were not able to afford it, and continued to cook with wood, paraffin and coal. The electricity consumption rate among the poor therefore remained extremely low. When government realised that the poor did not fully benefit from the large investment in electrification the Free Basic Electricity Policy was introduced in 2003. The poor connected to the grid now receive 50 kWh free of charge every month, sufficient for lighting, black-and-white television, radio and occasional basic cooking. The government pays this subsidy to the electricity distributors.

Poor rural households have least access to electricity, and bringing electricity to rural homes is a great challenge. Extending the grid to every household in the country is not feasible now for technical and financial reasons, and the question arises as to what distance from the grid makes decentralised electricity supply such as photovoltaic systems for each home, the most appropriate solution – even if the grid is gradually expanded. The solar home system programme was designed to give more rural people access to limited electricity until such a time that they get grid connections. Solar cells are imported and some of the systems are assembled in the country. The extent to which NGOs and technology providers pushed the programme has not yet been explored.

As part of the INEP solar electrification projects were implemented in some of the more remote rural areas. As with grid electrification government heavily subsidised the solar electrification programme. The recipients of solar home systems (SHS) paid about R110, a fraction of the actual cost, which was approximately R3500 for the system. The service provider owns the SHS and charges a monthly fee of R58 for service and maintenance.

Renewable energy is one of the areas the government pursues in managing energy-related environmental impacts and diversifying energy supplies from a coal-dominated system. There are not yet any external pressures on South Africa to reduce GHG emissions and to disseminate RE technologies. The Government's White Paper on Renewable Energy Policy (2003) supports the establishment of RE technologies, targeting the provision of 10 000 GWh of electricity from renewable resources by 2013. This has the potential to create 35 000 jobs, adding R5 billion to the GDP and R687 million to the incomes of low-income households (DME, 2004).

Solar water heating and biodiesel have the greatest potential to contribute to meeting the target. RE is to be utilised for both power generation and non-electric technologies such as solar water heating and biofuels. By late 2005 the Department of Minerals and Energy (DME) completed a Renewable Energy Target Monitoring Framework to ensure that progress towards the 2013 target is effectively monitored (DME, 2005).

South Africa experiences high levels of solar radiation, with average daily solar radiation of between 4.5 kWh and 6.5 kWh per square meter. This resource is relatively predictable and well distributed throughout the country with some regional variations.

The provision of hot water using SWH technologies has the benefit of saving households money over the long term and mitigating GHG emissions associated with fossil fuel usage. SWHs are also the least expensive means of heating water for domestic use on a life cycle cost basis because solar energy is free (Agama, 2003).

In 2009 the Energy Regulator announced feed-in-tariffs. Details are still to follow but small-scale photovoltaics are excluded in the first phase.

Apart from subsidies for electricity the levy of value-added tax was removed from paraffin to make it more affordable. Paraffin is a widely used cooking fuel of the poor.

The government has introduced policies and strategies to support renewable energy in the country starting with the White Paper on the Energy Policy and the Renewable Energy Policy (DME 2003) up to the Biofuels Industrial Strategy of 2007 (DME 2007). From the initial stages policy support for renewable energy has steadily grown over the years. The latest support mechanism is the proposed renewable feed-in tariff published by the National Energy Regulator.

The White Paper on Renewable Energy (DME 2003) proposed the production of bioethanol and biodiesel for the transport sector. The Biofuels Industrial Strategy of the Republic of South Africa (DME 2007) seeks to stimulate rural development and reduce poverty in areas previously disadvantaged by the apartheid government. The strategy targets to act as a bridge between the first and the second economy and to create jobs in underdeveloped areas such as the former homelands where agricultural development was neglected in the past. It aims at a balanced development between emerging farmers and established commercial farming areas to ensure sustainable development for the biofuels industry. Biofuels development would transform rural economies and contribute to the government's Accelerated Growth Initiative (AsgiSA) as well as contribute toward the renewable energy goals, energy security and reduction of GHG emissions.

A6.5 National grid electrification programmes

A6.5.1 Integrated National Electrification Programme and Free Basic Electricity in South Africa

The South African government subsidises electricity to low-income households and has made access to electricity free or very affordable for the poor. The first phase of the Integrated National Electrification Programme (INEP) was subsidised and financed by the national utility Eskom and to a lesser degree by the municipalities. In April 2002, the Department of Minerals and Energy took over responsibility for funding INEP. By May 2005 the INEP had connected 232 287 households at a cost of R582 million, 2 233 schools (R100 million) and 50 clinic (R118 million). The INEP used blanket electrification or area coverage providing electricity supply to all potential customers in an area and not the usual selective electrification under which only customers applying and paying are connected. This facilitated Eskom's long-term planning and removed cumbersome quoting and payment procedures. The blanket approach significantly lowered connection costs (Bekker et al 2008). Technological innovations further reduced costs. These include the single wire earth-return technology (SWER) with only one phase conductor instead of three for a more robust supply system (better quality energy) and using a pre-payment metering system which reduced the cost of billing and reading meters, as well as reduced the problem of debt collection and non-payment by customers, by virtually preventing customers from using electricity when they cannot afford to pay for it.

The INEP connections are highly subsidised and newly connected customers paid about R 120, a fraction of the actual connection cost of approximately R 3.500. Electric service coverage rates increased rapidly from a low 36 percent in 1995 to 80²¹ percent in 2007. The INEP facilitated access to electricity but this did not mean that the poor could fully benefit from being connected because they could not afford to use the electricity and consumption rates among the newly connected remained very low. In 2003 the government introduced the Free Basic Electricity tariff so that the poor can benefit from the huge investments in national electrification. The national policy provides 50 kWh a month to poor household free of charge if their consumption does not exceed 150 kWh per month. Not all local authorities have implemented the FBE policy, mainly because of lack of capacity and institutional and funding problems. The City of Cape Town has a more generous approach and households get their 50 kWh free of charge if they do not use more than 400 kWh per month averaged over the year (see Box 1 below).

Targeting the poor by the amount of electricity they use leads to some mistargeting. Poor households having built a house or shack on land not zoned for housing are not only excluded from an electricity connection but also from the FBE. Backyard dwellers receiving electricity from the main house are excluded from FBE because they don't have a separate meter. On the other end of the income spectrum single

²¹ This figure varies depending on how electricity coverage or access is measured. This paper follows Statssa (2007). The figure gives the percentage of households using electricity for lighting.

middle to high-income occupants of dwellings may use less than 400 kWh per month and are then eligible for FBE. It is not easy to find an inexpensive and fair targeting method and the cost of targeting has to be weighed against the amount of mistargeting.

Supplying the growing number of urban poor in Southern Africa with clean energy services are major and urgent issues of fast urban growth and have to be addressed by multisectoral integrated approaches. This would be an important task for SADC to take up.

Box 1: An example from Cape Town

The municipality of Cape Town charges R191 (about US\$27) for an electricity connection of 40 Amp to a small plot (not larger than 40 m²) in July 2009. If the new customers cannot pay the connection fee upfront, the amount is charged to their prepayment account and deducted gradually at the rate of 14 percent when electricity purchases are made. No interest is charged on the advanced connection fee. If customers use less than 400 kWh per month they are eligible for 50 kWh free of charge per month (Free Basic Electricity). This amount is automatically credited to the customer's account when electricity is purchased. This connection is for households and is not suitable for the use of heavy machinery, e.g., welding equipment. The standard connection can be upgraded if required. This level of connection is suitable for many of the MSEs, especially small shops. The domestic consumption tariff increased by 36 percent to R 77.37 per kWh on 1 July 2009. The Free Basic Electricity (FBE) tariff increased by only 8.98 percent to 53.90 per kWh. The lower increase of the FBE tariff is cross-subsidised by the other consumers.

Why are some excluded from subsidised access?

Houses or shacks built on land not zoned for settlement cannot get a metered electricity connection and have to rely on extension cords to neighbouring houses which are metered. These private arrangements generally cost twice as much as electricity from metered access.

Howells et al (2005) suggested that the FBE favours electricity in comparison to other fuel sources and arguably states that LPG provides similar cooking service at much lower cost to society. South Africa generates electricity from locally abundant coal and has very limited gas resources. It imports gas for mainly industrial uses. In the last years gas prices have risen much faster than electricity. It is therefore doubtful that gas provides cooking energy at a lower cost even if the gas supply would be widely available. Cooking experiments in 2008 have shown that at the level of the household the least expensive energy source for cooking is electricity. Energy cooking costs depend on the fuel used, the type of meal ranging from quick stews to long-cooking meals boiled at high rate as well as the efficiency of the cooking appliance. An example of the cooking experiments in Imizamu Yethu giving different fuel costs is given in Box 2. Fuel prices vary and the graph in Box 2

indicates the approximate paraffin break-even price at different electricity prices (from Cowan 2008).

Also the Free Basic Alternative Energy (FBAE) tariff allows other fuels than electricity such as gelfuels to be included under the free basic energy tariff.

Box 2: Comparative fuel cooking costs (All figures and data from Cowan, 2008)

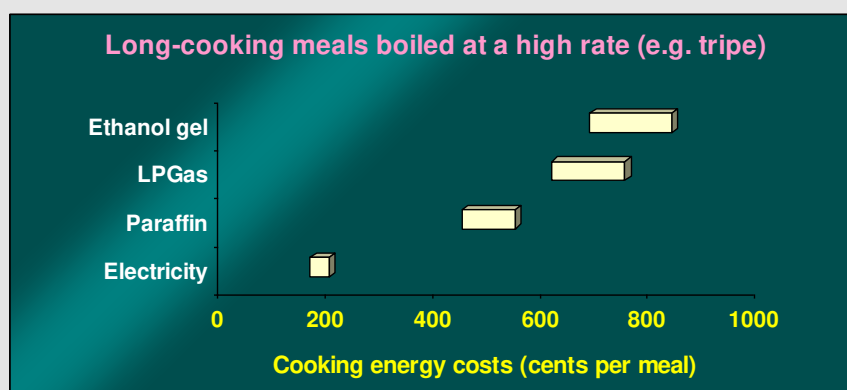
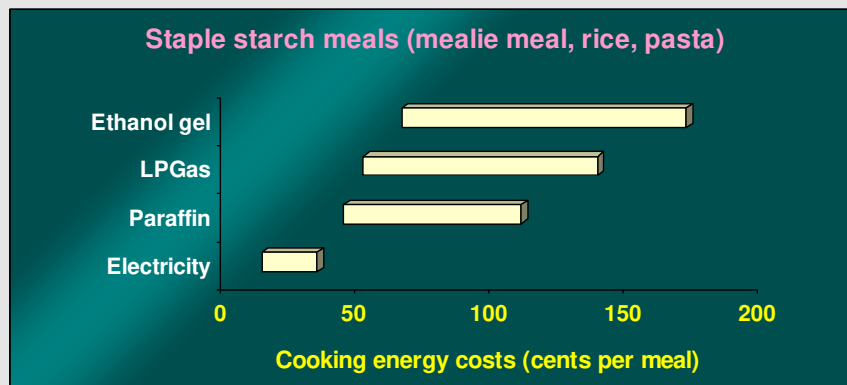
The local prices (mid 2008) for the fuels were taken as:

Fuel prices used in figures below:

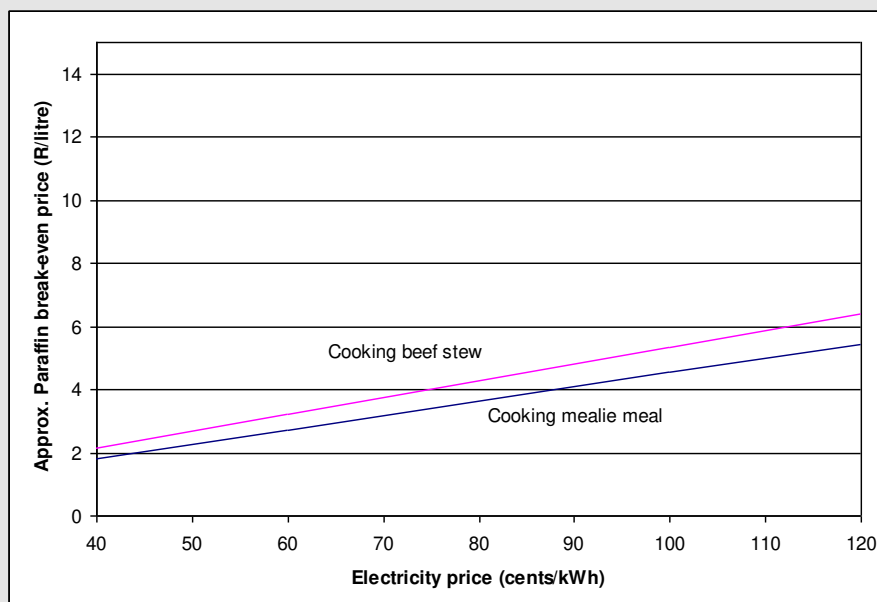
Fuel	Local R/unit sold	R/kWh (i)
Electricity	0.6 R/kWh	0.6 (ii)
Paraffin	11 R/litre	1.1
LPGas	20 R/kg	1.6
Ethanol gelfuel	9 R/litre	2.5

(i) See Cowan 2008 for calorific values of the liquid fuels, used to get R/kWh

(ii) Ignoring the Free Basic Electricity allowance



Approximate paraffin break-even price for different electricity prices



A6.5.2 A comparison of three different approaches to rural electrification

Two other countries in Southern Africa, Botswana and Zimbabwe successfully extended electrification to rural areas using different approaches. In Botswana the utility connects households on a cost recovery basis and customers can apply for loans for their electricity.

Two other countries in Southern Africa, Botswana and Zimbabwe, successfully extended electrification to rural areas, using different approaches. In Botswana the utility connects households on a cost recovery basis and customers can apply for loans for their electricity connection. Monitoring the implementation and impact of the rural electrification policy EECG (2004) found that if the upfront payment and the monthly repayments are small and extended over longer periods the uptake of connections increased significantly. South Africa highly subsidises electricity to low-income households. Under the National Electrification Programme (INEP) access to electricity is very affordable even for the urban and rural poor and in addition the Free Basic Electricity (FBE) allocates 50kWh per month free of charge to poor households. In Zimbabwe the Rural Electrification Agency (REA) targets rural growth centres where local government infrastructure such as agricultural extension, health services, schools and police stations are concentrated. Local councils facilitate enterprise development and lease stands to medium and small enterprises (MSE) which provide services including automotive, electrical,

electronic and general repairs, welding and spray painting, milling, carpentry, secretarial and general retail services.

The different approaches in Botswana and Zimbabwe are briefly described here.

Rural electrification in Botswana

The Rural Electrification Collective Scheme (RCS) started in 1988. The government extends the grid to the village and customers pay for the extension to their houses. Initially uptake was very slow and it took over ten years to adapt the scheme by gradually easing payment conditions but not the total amount until potential customers were able to afford the smaller instalments over a longer period and electricity access substantially increased.

Rural electrification in Zimbabwe

In Zimbabwe low take-up rates threatened the minimal returns on investment in rural electrification. The Rural Electrification Agency (REA) was established in 2002 to support income-generating activities for MSEs in order to increase electricity demand in rural areas and stimulate small-scale commercial and industrial development. REA provides loans and delivers electrical machinery ordered by MSEs, such as grinding mills, irrigation equipment and welding machines, to the production site. The Rural Electrification Programme is funded by a levy on all electricity bills starting at 1 percent in 2002 and rising to 6 percent in 2007 as well as government fiscal allocations.

Once small enterprises had access electricity demand went up and the variety and use of electric machinery increased such as grinding mills, refrigerators, welding equipment, water pumps, freezers, irrigation equipment and chain saws and at the same time the use of stand-alone generators declined.

Commonalities and differences

Commonalities

Although the programmes look very different there are some commonalities to start with. In all three countries there was political will to implement the programme and pro-poor policies supported it. The programmes were started and when it was found that they did not fully achieve their objectives adjustments were made over time. In South Africa the Free Basic Electricity tariff was introduced, in Botswana upfront cost and the repayment instalments were reduced and extended over a longer time and in Zimbabwe the cross-subsidy was raised from 1 percent to 6 percent to pay for the programme.

Differences

South Africa has a well developed economy and can afford the subsidy for the electrification programme. The Reconstruction and Development Programme

addressing the injustices of the pre-1994 apartheid regime gave the motivation and socio-political reasons for the INEP. Botswana insists on cost recovery and Zimbabwe cross-subsidises rural electrification. Zimbabwe's programme focuses very much on rural development and economic growth while there was no particular effort made in Botswana and South Africa.

The impact of rural electrification

South Africa's highly subsidised approach did not stimulate the economy in rural areas. There is no unequivocal evidence of new SMEs being created. It is not clear if rural electrification created employment (Dinkelman 2008) or if other infrastructure programmes carried out at the same time generated the new jobs. The third possibility is that a combination of electricity with additional other infrastructure such as health, education and roads increased the number of jobs in the newly electrified areas.

In the Zimbabwe model, government offices benefit from the access to electricity. New SMEs are started, jobs are created and the introduction of new goods and services stimulate the local rural economy.

A6.5.3 Lessons learnt from the South African Integrated National Electrification Programme

South Africa has enjoyed democratic rule since 1994. The economic power, which it inherited from the previous government together with its present political priorities, enables the country to support pro-poor policies and to implement a national infrastructure programme. Other developing countries may not be in a position to do so. It also has low-cost and reliable electricity supply and a favourable policy environment to support national electrification and subsidies for poor households.

The following lessons may be learnt from the South Africa experience;

- Policies were put in place and there was political will to implement the policies
- Electricity supply was available
- The electrification programme had dedicated financing, in the first phase from Eskom and to a lesser degree from the municipalities and in the second phase from the government
- Cost reducing technologies and pro-poor technologies were implemented, eg., 20amp supply, pre-payment meters
- The connections were almost fully subsidised giving all poor households in electrified areas access
- Monitoring and evaluation of the programme was carried out and adjustments were made

- Subsidy of 50 kWh was given to poor households which could not afford the use of electricity for basic lighting, media and cooking
- When subsidies are given the method of targeting poor households has to be well selected to keep the cost of targeting low, to avoid leakage to higher income groups and to include as many poor households as possible
- Even after electrification fuelwood remained the major cooking fuel in many poor rural areas. Rural households self-collect fuelwood where it is available free of charge. A sustainable supply of fuelwood will have to be maintained to meet the needs of poor households. Fuelwood use is declining in urban areas. Fuelwood cost, availability and convenience including pollution are the major reasons for phasing out fuelwood use in urban households
- Some groups of poor people such as people living on land not zoned for housing are excluded from electrification and Free Basic Electricity and backyard dwellers and backyard dwellers are excluded from FBE.
- In the solar concession areas very poor households are excluded because they cannot afford to make regular monthly cash payments of R58. Many very poor household find it difficult to pay the monthly service fee even if it is reduced to R18 with the FBE subsidy of R40 as these households still have to provide fuel for cooking and water heating
- The SME sector was not encouraged. This remains a task for the future
- Cost recovery was not considered essential. After the deprivation during the apartheid era large-scale electrification of poor households had and still has political and long-term socio-economic benefits.

A6.6 Off-grid electrification by solar home systems in South Africa

The South African Government generally supports renewable energy and the renewable energy policy stipulates a voluntary target of 10 000 GWh to be supplied from renewable sources by 2013. The target is approximately 10 percent of the country's electricity demand and at present less than 1 percent originates from renewable sources (DME 2004). Different players in projects and the industry give various explanations and reasons why the market has not responded more positively and the high initial capital cost is often given as the major explanation.

Solar home systems (SHS) using photovoltaic panels to generate electricity have been provided as part of the National Electrification Programme in remote poor rural areas to which grid electricity has not been extended. As a substitute for grid

electricity, subsidised SHS were expected to bring light and television services at a much faster rate than they actually did.

Access to clean and sustainable energy services particularly in rural areas is one of the major outstanding development challenges and the solar home system programme in South Africa addresses this challenge and is therefore also of interest to projects and companies employing other energy technologies in this context. For example the solar concessions have created an alternative energy delivery network which could be of interest to providers of other technologies such as improved stoves and fuels.

The solar home system programme is a pro-poor electricity technology programme in rural areas that the government highly subsidized. Private companies participated from the beginning and implemented the programme.

South Africa is committed to provide universal access to electricity by 2012 (Mlambo-Ngcuka 2004). Grid electricity is the general approach and about 80 percent of households already have access to electricity. For the remaining households the Energy White Paper indicates that Government will determine an appropriate mix between grid and non-grid technologies (DME 1998) and 'in remote rural areas where the lowest capacity grid system cannot be supplied within the capital expenditure limit, this situation will provide a natural opportunity for Remote Area Power Supply (RAPS) systems to be supplied' (DME 1998). In 1999, about 51 percent of rural households were still without electricity and it became clear that the supply technology had to be re-evaluated. Photovoltaic SHS were selected to provide a basic service to those households that cannot be grid-connected within acceptable cost parameters (Kotze 2000).

A pure commercial model and a utility model were considered for supplying SHS to rural households and it was decided to select the utility model and to involve the private sector in the non-grid electrification programme (Kotze 1997; 1998).

The programme grants private companies the rights to establish off-grid energy utilities in designated concession areas. This utility service provision is a fee-for-service model including the maintenance of the off-grid energy systems by the utility, which has exclusive rights to government subsidies to cover most of the capital costs for five years. The fee-for-service agreement will last for 20 years (Afrane-Okese & Thom 2001). By 2004 over 20 000 systems were installed in four concession areas (Table 5).

It was clear from the beginning that poor rural households for which the systems were intended would not be able to afford the initial capital cost and a government subsidy of R3500 for each installed system was included in the programme for the first five years. The subsidy was paid directly to the service provider. The customer had to pay R110 as an installation fee and a cellular phone charger was offered for an additional R20.

In 2003 the government introduced a subsidy for free basic electricity for grid-connected households, equivalent to 50 kWh per month. SHS users in the

concession areas received an equivalent monthly subsidy of R40 reducing the fee charged for maintaining and servicing the system to R18 per month for each household.

It is still doubtful if very poor rural people can afford even this highly subsidised service of PV just for lighting and media use. A survey of 348 households in the Eastern Cape Province compared access to electricity of both off-grid and grid and income and found that the poorest households (average monthly income R819) remained without any supply of electricity. Only households in the highest income group (R2307/month) could afford solar electricity and grid users in neighbouring areas where grid electricity was provided, had an average income of R1860 (ERC 2004). There is also a question whether and for how long the government can afford the high capital subsidy for each system.

Table 5: Concessionaires, concession areas and number of installations, June 2004 (ERC 2004)

<i>Concessionaire</i>	<i>Concession Area</i>	<i>Total number of installations</i>
Nuon-Raps (NuRa)	Northern Kwa-Zulu Natal	6541
Solar Vision	Northern Limpopo	4758
Shell-Eskom Replaced by 3 smaller companies in 2005/6	Northern parts of the Eastern Cape and Southern Kwa-Zulu Natal	5800
EDF-Total (KES)	Interior Kwa-Zulu Natal	3300
Renewable Energy Africa (REA)	Central Eastern Cape	0
Total		20 399

A6.6.1 Vision of the solar home system project

South Africa's high solar radiation means that the photovoltaic (PV) technology to generate electricity can be used almost anywhere in the country. PV technology is modular, allowing for upscaling or downscaling. PV systems of various sizes can meet a range of electricity needs but are not economic for thermal applications. The government's vision to supply photovoltaic SHS through the private utility model was as follows (Kotze 2000):

- It would speed up universal access to electricity envisioned in the Energy White Paper since non-grid electricity service had become increasingly cost-effective in remote areas.
- It could attract larger, better organised private companies with their own sources of financing.

- It would facilitate and rationalise electrification planning, funding and subsidisation at national level, allowing regulation and financing mechanisms to maximise targets and optimise resource allocation.
- It had the potential to reduce equipment costs (through volume discounts), transaction costs, and operation and maintenance costs (through economies of scale).
- It ensures service to customer over a long period of time (e.g. 20 years).
- The utility would own the hardware as assets, which should facilitate the raising of capital on the money markets, while the strong financial and maintenance controls characteristic of the private sector should facilitate the channeling of international development funding.
- This should facilitate relocation of technologies that may arise over time as the grid reaches more remote areas.
- It was expected that the service providers would adopt a delivery model that promotes a range of fuels such as gas or paraffin, in addition to SHS or mini-grid systems. This energisation model has been motivated by the realisation that electricity often does not meet all the energy needs of rural people who, after electrification, tend to continue to rely on multiple fuels.
- Most rural dwellers that have access to grid electricity are usually not able to afford higher consumption of electricity and they tend to use it mainly for lighting, radio and B/W television, services that can be equally provided by SHS. The service level that is subsidised under the non-grid electrification programme was set at 50 Wp.

The main disadvantages of the utility route were considered to be that the systems were installed at the clients' premises under their control but not under their ownership since the utility owned the systems and they were therefore prone to vandalism, neglect and misuse.

The service level of the subsidized SHS is limited and SHS technology is not very flexible and is limited in its application. The major energy requirement of poor households is cooking for which PV systems do not provide energy and higher-power media appliances such as colour televisions usually require a larger PV system than the standard 50 Wp SHS as does refrigeration. Some service providers made larger systems available on demand.

Other weak points of SHS utility model are that the systems are expensive, requiring large subsidies in order to be affordable for the rural households and a reasonable commercial venture for the supply utilities. Maintenance in very remote rural areas with very poor roads can be problematic. The payment of regular monthly service fees is difficult for households with low and irregular income. (In

one of the concessions the utility provided SHS to only those households with proof of regular income, effectively excluding the poor.)

SHS, the concession approach and the fee-for-service model are replicable in any rural area without grid electricity supply. A basic maintenance service is required and the battery has to be replaced at least every 3 to 4 years.

Solar concessions are not financially viable without the capital subsidy for new installations and the operational subsidy. The government seems to be deciding the replicability question by limiting the funds available for capital-cost subsidy and in 2005 government stopped paying the subsidy altogether. The future payment of the monthly operational subsidy is also doubtful. Unless something changes, the whole programme may slowly come to an end.

A6.6.2 What were the various expectations of the SHS?

The off-grid concession approach is being tried in four quite remote rural areas, chosen in relation to the national grid and located in four provinces (Eastern Cape, KwaZulu-Natal, Mpumalanga and Limpopo) in areas where it is unlikely that the grid will soon reach. However some household, which had opted for a SHS have recently been connected to the grid suggesting that electrification plans have either changed or have not been clearly communicated to the SHS providers.

The Eskom-Shell Joint Venture in the Eastern Cape was the first concessionaire to install SHS and others followed learning from their experience.

The actors and stakeholders in the programme have different expectations (Table 6). The major stakeholders directly involved in the programme are the off-grid customers, and the service providers. Eskom and municipalities are the licensed electricity distributors and they have to demarcate areas in their license area in which the off-grid service providers can operate and where grid electricity is not going to be provided in the very near future. Transparent electrification planning is necessary and should be communicated to the SHS service providers. The Department of Minerals and Energy is to facilitate the process, formulate policy and administer the capital subsidy for the systems and their installation. The Department of Provincial and Local Government is charged with providing services and channeling the free basic electricity subsidy to the service providers. The Electricity Regulator approves the installation of the systems according to the standards set by South African Bureau of Standards (SABS). Service providers are paid the capital subsidy only after the Regulator has approved the installation. The commercial providers of PV systems sell, install and manufacture components.

There are high capacity development needs in the villages where SHS are installed. Training local technicians to do O&M services creates some employment in disadvantaged rural areas, reduces the cost of the service and meets the villagers' expectations of getting jobs with the project.

Four companies are at present operating on a fee-for-service model in four concessions. Regulatory, institutional and contractual arrangements for off-grid

energy services have been worked out as the part of the programme. Among the achievements is the publication of a service standard for non-grid electricity customers. The standard outlines the service activities and the minimum standards for measuring the quality of service provided by the non-grid service providers. The standards give the National Regulator a basis for evaluating quality of service to non-grid customers.

So far the distribution has often been delayed by institutional and contractual challenges between government and service providers and it is unlikely that the target will be achieved within the next years if the capital subsidies are not paid and installation rates are not increased.

Table 6: Actors and expectations involved in the solar home system project

Actor	Expectation	Speaking for 'publics'
<i>Energy ministry</i>	Implementing 'electricity for all'	People without access to energy services, poor rural communities, redressing the injustices of the past
Municipalities as electricity distributors	Provide access to limited electricity through solar home systems	Communities without access to electricity
Regulator	Protecting customers	Quality of installations Approval of systems
South African Bureau of Standards (SABS)	Setting standards for solar home systems	Mark of approval for SHS manufacturers and installers
Eskom	Communicate electrification plans to SHS providers Gain experience with off-grid electricity roll out	Electrification planning Integrate off-grid electricity generation into the system
Service providers	Provide affordable electricity in remote rural areas and grow their business Create a business model for rural electrification and prove its viability, Innovate some aspects such as electricity metering for SHS	Business model development for SHS in rural areas Technology development Employees' and shareholders' interest
Customers	Accessing off-grid electricity for lighting, TV and cell phone charging	Interacting with the service providers to adapt the system to their circumstances

Actor	Expectation	Speaking for 'publics'
Villagers and village chief	Finding employment with the project Technical and business training Lighting increases area security	Improve infrastructure Create employment and training Increase security
Equipment companies	Develop new competencies Create new equipment components Gaining a market share	Employees and shareholders

The major expectations of the government were to speed up universal access to electricity. The programme targets 300 000 households for SHSs, 50 000 for each of the initially planned six concession areas. Since the SHS only provide electricity for lighting, B/W television and radio it was expected that the service providers would also provide fuels for thermal use such as gas and paraffin. Such fuels are not always available in remote rural areas.

Providing affordable, safe and clean energy to the rural poor is one of the difficult issues of rural development. Service providers are expected to prove that their business models are viable and can energise the countryside. The initial capital cost has either to be covered by subsidy or if cost recovery is essential the model has to be changed so that clients buy the system on credit and repay in small affordable installments over a given time period comparable to the rural electrification programme in Botswana. Microlending organisations can be approached for giving the credit and collecting the installments.

A6.6.3 How, when and on what basis were the different expectations negotiated?

In 1998 Eskom and Shell Renewables South Africa announced a joint venture with the objective to provide 50 000 households with SHS in the next five years. This project was widely publicised and politicised and might have influenced the Department of Energy and Minerals (DME) to speed up its off-grid electrification programme (Afrane-Okese 2003). In the beginning of 1999 the DME consulted with potential stakeholders, choose the concession model to provide electricity to off-grid rural areas and advertised the call for proposals. The wide publicity generated by the Eskom Shell Joint Venture created interest in the PV industry and 28 proposals were received. Out of these six were selected and added to the Eskom-Shell Joint Venture.

The companies faced major development problems such as poor roads, no transport, no or poor communication. Providing such services is government's responsibility and in this case the lack of basic services in the concession areas contributed to the cost to the service providers. Some houses are inaccessible by car and the installers had to carry the equipment into the valleys (Afrane-Okese 2003). The absence of basic services affects the rural people because it makes income generation and running small businesses very difficult. There is no access to markets and people find it hard to generate income to pay for their electricity service. These are problems of context and development affecting the project although they are not related to the acceptance of the technology. In effect the technology is acceptable because the areas have limited basic infrastructure. The SHS will provide light and television and will connect the households to the wider world.

A6.6.4 From visions to actualities

In the Eskom-Shell concession the first phase of the project was quickly implemented because 'promises needed to be fulfilled and many pressures towards service delivery to the deprived people existed' (Afrane-Okese 2003). From February 1999 to March 2000 about 6 000 SHS had been installed. The company ran into many problems, Shell and Eskom pulled out and the company was liquidated. Three smaller companies have taken over the concession area and are providing the services for the last few years. This indicates that the business model is viable provided the necessary adaptations to accommodate local conditions are made.

Accurate installation figures are difficult to get. It is estimated that 20 000 to 30 000 SHSs had been installed under the concession programme by 2004. Assuming an average household size of 4.5, this would imply that about 90 000 people have benefited so far. The initial target to roll out 300 000 SHS was not achieved in the planned timeframe. One of the major reasons being that government failed to pay the capital subsidy.

The technology was adapted and electricity prepayment meters were specially designed and attached to the photovoltaic systems.

Some customers wanted larger systems and some of the service providers adopted a flexible approach and provided them.

Generally the service providers have ensured continued services to their customers for five to seven years. The companies generally succeeded in establishing financial and maintenance controls.

A6.6.5 Key lessons of the transition process

In developed countries RE technologies are most often introduced for environmental reasons to reduce GHG emissions. In this case the major concern is access to electricity for the poor in remote rural areas and not the environment.

Although the SHS technology is easy to use, the introduction of PV technology in remote rural areas has often been compared to providing space age technology to

the least developed populations. In many cases the technology gap and the problems related to service delivery had not been identified as one of the potential major barriers to successful implementation and social acceptance. This knowledge gap extends into two directions. The service provider does not understand the needs and conditions of the customers and the customers do not understand the technology and the often complicated agreements that go with it. The methods for supplying the technology, negotiating government subsidies, etc., are not simple and have led to widespread uncertainty. The provision of SHSs has to be backed up by information and training, customer responsive service and maintenance and long-term contractual subsidy agreements with government.

SHS owners are happy having electricity for lighting and media but they still have to use other sources such as fuelwood, paraffin or gas for their greatest energy need, cooking. The monthly SHS service fee has been R58 per household for electric lighting and media only - a high cost for very poor households. The poorest of the poor can neither afford the initial installation fee nor the monthly service fee. In line with its policy of free basic services for the poor, government subsequently proposed a further monthly subsidy of R40/month for SHS users, reducing their monthly payments to R18/month. This makes SHS electricity more affordable to a wider range of poor rural households; but it is difficult to implement this subsidy, because it has to be administered at another government level, local government (in this case, some of which are poor rural district municipalities). Local government leaders may not endorse SHS subsidies if they have higher priority spending needs in their areas. As a result, the R40/month SHS operational subsidy proposed by national government has only reached a few of the concession areas. In one area, this subsidy was started, then stopped, causing quite serious problems for customers and the service provider. Customers residing in different municipalities find it hard to understand why their neighbour receives a monthly subsidy while they do not get any.

In all cases, the installation of SHSs has been highly subsidised by the government (R3500 or more per household) and the subsidy may be better used extending the grid. The individual and collective benefits of grid electricity supply are greater than the benefits of SHS services. Nonetheless, SHSs have their niche market in very remote rural areas, which cannot be reached by grid electricity in the medium to distant future.

The project did not facilitate income generation. Productive end uses for PV systems are known in other parts of Africa. The addition would have enhanced social acceptance and affordability.

The programme was effective in delivering electricity to the rural people despite the poorest being excluded. However, considering that the technology, delivery mode, financial and institutional arrangements have been new and in many cases untested, all stakeholders have learned during the process and it is hoped that the next phase of implementation will be easier. It remains urgent to provide energy services to the poor, but PV systems are only suitable in very remote rural areas where the grid will not reach in the future.

The reaction to SHS and the mode of delivery has been ambivalent. The collective benefits include greater security at night because houses and shops are lit. The individual customers are pleased with the limited applications of SHS and enjoyed having lights, watching TV and listening to the radio. They are disappointed that they cannot cook and use heavy electric machinery and consider this a drawback as compared to grid electricity. They still have to pay more for other fuels such as wood, paraffin and gas for their thermal needs such as cooking. Many also do not fully understand the fee-for-service model and are often ignorant of the government capital subsidy. In the Eastern Cape study only 57 percent of SHS-users would recommend a SHS to others while 96 percent of grid-connected households would recommend grid electricity to others (ERC 2004). SHS were rolled out in remote rural areas, which are generally poor. Some customers felt that the solar systems which have a much more limited range of applications than grid electricity were an inferior technology given only to the poor. This perception created a negative image of the technology.

The service providers showed that their business model to provide photovoltaic electricity to the rural poor was adaptable to the local conditions. They embedded it by and large successfully into the local environment. It appears to be a feasible model for rural electrification, which could be applied elsewhere.

A6.7 Biofuels

The major bioenergy crops expected to be grown for energy purposes are sugar cane, maize, soya beans, sorghum, canola and sugar beet. The biofuels strategy proposes sugar cane and sugar beet for ethanol production and sunflower, canola and soya beans for biodiesel. Due to food security concerns maize which is a staple food crop is excluded for ethanol production in the initial phases of the Biofuels Industrial Strategy (DME 2007). *Jatropha* an alien species is still under study for environmental concerns.

The strategy intends to achieve a 2 percent biofuel contribution to the national liquid fuel supply within five years. At this relatively low target land availability is not of major concern because 5 percent of the national diesel demand could be generated from underutilised land in the former homelands.

The strategy appears to be overoptimistic to expect the emergent farmers to produce 400 million litres of biofuels within the next five years from an almost zero starting base. If the experience of the Land Reform and Redistribution Programme is anything to go by the training of the new owners to become productive farmers takes much longer than generally thought. Brazil reported similar experiences in their social biodiesel programme.

Commercial farmers do not benefit from the subsidies announced in the first phase (5 years) of the biofuels strategy. Commercial farmers also opposed the exclusion of maize for biofuel production. They argued that they could produce 14 million tonnes of maize on average per year exceeding South Africa's annual maize demand of 9 million tonnes by 5 million tonnes. The surplus would then be

available for biofuel production and this would at the same time stabilize national maize prices.

Another criticism of the strategy is that the framework is so vague that investors cannot take a decision and feel discouraged to make any investment. So far the biofuels strategy has not stimulated any biofuel plantations and production. The only publicly available biofuel remains biodiesel from waste vegetable oil produced in small plants in Stellenbosch and Durban. According to the Central Energy Fund the finer details of the strategy are currently under review.

Working for Energy

Working for Energy is a new government project and part of the Expanded Public Works Programme (EPWP) focusing on renewable energy and energy efficiency and creating green jobs supporting development and climate. The Treasury allocated R65 million to the Programme in its recent Medium-Term Expenditure Framework. Skills learned in the Working for Energy Programme are expected to lead to permanent and sustainable jobs. Implementation will start in 2009.

A6.8 Supply and use of appliances

A6.8.1 Appliances

Electric appliances are generally available in both rural and urban areas and are often supplied by furniture stores frequently on credit. The cost of appliances is a barrier to using them for very poor households but the availability of credit facilities makes these appliances much more affordable to low-income households in South Africa than poor households in other African countries.

Many shops particularly in low-income areas sell paraffin appliances for cooking, lighting and less frequently for heating. After paraffin stove safety standards (SANS 1908:2006 and 1243: 2006) were approved in 2006 unsafe paraffin stoves were supposed to have disappeared from the market but they are still available in some shops.

Gas appliances are generally sold in urban centres but are more difficult to get in remote rural areas. Only 1 percent of households use gas for cooking and a much smaller proportion (0.2) use gas for lighting. Compared to paraffin appliances gas stoves are much more expensive and in addition there is the initial cost of buying the gas canister. Poor households cannot afford gas appliances. Neither gas nor the appliances are subsidised.

Solar ovens and cookers have not been accepted by households and those that were distributed are in most cases no longer in use.

Solar water heaters are easily available in urban areas where most of the companies are located. In 2008 Eskom started a domestic solar water heater programme to

reduce electricity demand especially during peak hours. Homeowners have to apply and receive the subsidy of 15 to 20 percent after the system has been installed and approved. All geysers in the Eskom programme must use timers to maximise electricity savings and provide the necessary reduction in peak-period use. Recommended sizes depend on family size for example a household of four uses about 300 l of hot water per day. The most common sizes range from 150 l to 400 l.

It is estimated that over 500 000 solar water heaters are installed in South Africa. Solar water heaters are marketed to the middle and high income groups.

In Kuyasa a low-income township near Cape Town solar water heaters are installed on 2300 houses. The project includes the fitting of ceilings and CFL lights and is funded by the government and CDM contributions. The ceilings improve the thermal performance of the house. Homeowners highly appreciate the hot water and the ceilings.

There are two solar water heater projects in the Nelson Mandela Bay Municipality. A pilot project in Zanemvula township plans to install 1200 low-pressure systems. The hot water storage capacity is 100l. Tassol was given the contract has already installed 400 systems. The project is financed by the municipality and carbon credits. Another much larger project was advertised by the Central Energy Fund entailing the installation of 100 000 systems over the next five years. They can be both flat plate and evacuated tube collectors and the offer should include 150l, 200l and 300l in the tender. The systems should have grid back-up and be compliant with South African Bureau of Standards and Eskom's demand-side management standards. The municipality would assess the homeowners as reliable customers and would collect the revenue and not the suppliers and the homeowners. The project would be able to attract Eskom's DSM subsidy and CDM funds. It is expected that a system cost would come down to R12 000 from the original R17 000. The closing date for submitting bids was in July 2009 and 180 bids have been received. Some suppliers submitted fee-for-service models.

A6.9 Conclusion

Most of the households without access to modern energy services are poor. Electricity and access to modern fuels are crucial for extending energy services to poor areas where most of the poor people live. Agricultural development, enterprise development, cooking, heating and lighting, community services and transport depend on modern energy services. They in turn will stimulate economic growth and development and will improve the quality of life of poor people.

Energy planning for the poor is a part of national planning and needs to be done as part of national and integrated local planning considering local circumstances, opportunities and challenges. To be sustainable energy plans need to be integrated with other infrastructure services and development.

In the last years there is a growing awareness that an energy development strategy which seeks to benefit the poor must not be restricted to electrification, but needs to improve access to complementary non-electric clean fuels, appliances and safe/efficient practices – and that this is applicable in both grid-electrified and non-grid areas.

Electrification investments could achieve greater development benefits if they are not solely driven by numerical connection targets, but instead are integrated in more detailed, cross-sectoral local development plans and implementation. The following have to be in place or have to be developed at the same time to implement the pro-poor energy programmes successfully:

- Political will
- Policies and Strategies
- Financial plans
- Availability of power or alternative energy
- Capacity of the utility or other service providers to implement
- Adaptation of electricity and alternative energy prices to the ability of the poor to pay

South Africa and other countries like Botswana have increased access to electricity for the poor in different ways. Overall the electrification programmes and projects have been successful. The prevailing situation and the available resources have greatly influenced the approach taken. These programmes suggest some general guidelines for pro-poor electrification and access to modern energy services.

- Pro-poor policies have to be formulated and approved if there is no policy framework to assist the poor
- There must be political will at all government levels as well as at the level of the service provider to implement pro-poor policies
- Additional power or alternative energy supply to the newly connected poor households must be available. It may be generated in the country as in South Africa or it may be imported as in the case of Botswana
- Dedicated financing must be secured. It may come from revenues of the service provider as in Botswana and the first phase of electrification in South Africa or it may be a direct subsidy from government as in the second phase of electrification in South Africa. In other African countries ODA plays an important role.
- The affordability of poor households has to be assessed and the mode of payment has to be adjusted to the ability of the poor to pay. The rural

electrification programme in Botswana is a good example of an adjustment process

- The sustainability of the pro-poor energy access programme has to be considered from the planning stage. South Africa and Botswana faced different situations regarding sustainability. In South Africa the utility and the government paid for the connections and there was no cost recovery from poor households. In Botswana cost recovery is part of the utility's policy and the repayment of the connection fee was adjusted so that the poor could afford to pay and the programme remained sustainable.
- Tariff design is important for the success of the programme. South Africa has introduced a concessionary tariff for the poor subsidised by the government, Botswana has just one tariff for everybody reflecting cost recovery in Botswana but not in South Africa. When households get electricity for the first time an information and education programme to acquaint the household members with the new technology is essential. It is more effective if an initial programme is followed up at intervals until household members have become familiar with the use of electricity.
- The electrification programmes in South Africa and Botswana did not include strategies for productive and income generation activities. As this falls outside the responsibilities of utilities and energy ministries cooperation with ministries and organisations active in SME development is suggested. If newly connected poor households take up well integrated productive activities using electricity they will be able to pay for the electricity they consume and will have an opportunity to move out of poverty.
- When private companies develop biofuels it is necessary that pro-poor policies are in place and the government has the political will to implement them. Newly developed energy resources present an opportunity for poor people to participate not only as poorly paid seasonal labourers but also as small holders growing feedstock for the biofuel refineries.
- From the viewpoint of a South African energy researcher, the following are areas where SADC could coordinate and play an important role:
 - “ Regional capacity assessment and development (already suggested)
 - “ Supplying the urban poor in Southern Africa with clean energy services are major and urgent issues of fast urban growth and have to be addressed by multisectoral integrated approaches.

- “ Support for efficient and sustainable charcoal production and dissemination of technologies
- “ Mass dissemination of safe, clean and efficient cookstoves
- “ Support for all aspects of biofuels including economic viability, substitution of imported fuels, biofuel targets in other countries (EU) and certification. Agricultural productivity is low in sub-Saharan Africa and cultivating biofuels might be an opportunity to stimulate agricultural productivity.

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A7 Summary of SADC Energy Access Questionnaire Responses

A7.1 Respondent details and detailed responses to the SADC Energy Access questionnaires

	Name	Designation	E-mail	Parent Ministry	Postal Address	Phone Number	Cell Number
Botswana	Kenneth Kerekang	Acting Director of Energy	kkerekang@gov.bw	Minerals Energy and Water Resources	Private Bag 0037 Gaborone	+267 3914221	+267 72270575
Lesotho	Mrs. Masekila Molapo	Senior Systems Analysis	molapo@energy.gov.ls	Natural Resources	P/Bag A91, Maseru 100, Lesotho	22322349/22313120	(+266) 58747159
Malawi	Khumbolawo Mulumbeni Lungu	Principle Energy Officer	khumbolungu@yahoo.com	Ministry of Natural Resources, Energy and Environment	Department of Energy Affairs, Private Bag 309, Lilongwe 3	+265 1 770 688	+265 999 922 356
Mauritius	Rajcoomar Bikoo	Director, Technical Services	rbikoo@mail.gov.mu; minpuuti@intnet.mu	Ministry of Renewable Energy & Public Utilities (MRPU)	Level 10, Air Mauritius Centre, President John Kennedy Street,	+230 210 0896	
Mozambique	Nazario Meguigy	National Director for Studies and Planning	nim@me.gov.mz	Ministry of Energy	Av. 25 de Setembro, 1218, Maputo	+258 21357600	+258 823295850
Namibia	Namulo D. Andreas	Engineer	anamulo.mme.gov.na	Mines and Energy	Private Bag 13297	+264 61 2848111	+264 812 837936
Seychelles	Mr. Guilly Moustache	Research Officer	gmoustache@gov.sc gmoustache@intelvion.net	Ministry of Environment, Natural Resources &	AART Chamber Building, Room 205, Mont Flueri, Victoria,	+248 421 699	+248 578 708
South Africa	No Response	No Response	No Response	Department of Energy	No Response	No Response	No Response
Swaziland	Mr. Henry Shongwe	Chief Energy Officer	shongweh@gov.sz	Ministry of Natural Resources and Energy	PO Box 57, Mbababe	+268 4047252 or 4046244/8	+268 6170436
Zambia	Oscar S. Kalumiana	Director of Energy	oskalumiana@mewd.gov.zm, oksibote@zamnet.zm	Ministry of Energy and Water Development	P O Box 51254, RW, Lusaka	+260 211 254686	+260 977 115429
Zimbabwe	Ikhupuleng Dube L.M.N Mabuwa L. Nechitoro	System Development Manager / Principal Energy Development Officer / Economist	idube@zesa.co.zw lmnmabuwa@yahoo.co.uk	Ministry of Energy and Power Development	Box 377 Harare / P. Bag 7758 Causewa	+263-4-774508/35 Ext 2703/2704 / +263 4 791761-9 / +263-4-780010	+263912416982 +263-11 701 915 / 263 912 438 173

The Excel spreadsheet giving a Questionnaire Summary (see separate computer file) has separate detailed sheets on energy sector stakeholders, current policy and energy access strategies, rural electrification, specific technologies and energy access programmes. The final sheet, on the role of SADC, is reproduced below.

A7.2 Responses on the role of SADC in energy access

	Which Roles Most Important	Others Identify	How can SADC best address	Which institutions could usefully contribute
Botswana	Ensuring regional power supply is currently the most important because of the power shortage situation in the region	Exchange of experience and coordination of planning within the region would be the most important was it not for the current power shortage; effective and coordinated planning would have warned and averted the region from the power situation.	Energy policies, legislation and regulations in all member states should be aligned with one another. This task could be coordinated by SADC.	No response
Lesotho	No response.	No response	No response	-National University of Lesotho -Lerotholi Polytechnic -Leloaleng Trade School -Catholic Technical School of Leribe
Malawi	-Ensuring regional Power supplies -Exchange of experience and coordination of planning within The region	No response	Harmonisation of Member States' policies and strategies.	-Ministry of Natural Resources, Energy and Environment (Department of Energy Affairs) -MERA -ESCOM
Mauritius	No response.	NA	NA	CEB (training for diesel and bagasse fired generating plants); and the CSO-Energy and Water Unit.
Mozambique	Ensuring regional power supplies; Exchange of experience and coordination of planning within the region; Advocacy and fund mobilization for the region.	Harmonization of Technical Standards and Specifications for the Region.	With the harmonization of the Legal Framework.	-REPN (Regional Energy Planning Network) -SAPP (Southern African Power Pool) -PIESA (Power Institute for East and Southern Africa) -EDM (Electricidade de Moçambique) - UEM (Eduardo Mondlane University).
Namibia	No response.	No response	No response	No response
Seychelles	Exchange of experience and coordination of planning within the region.	No response	News letter and journal.	Seychelles Energy Commission
South Africa	No response.	No response	No response	All in different roles.
Swaziland	All	NA	By having a unit within SADC to coordinate such activities	Advocacy and fund mobilisation for the region
Zambia	All	No response	-By being more proactive In marketing Energy initiatives through participation In promotions such as trade shows, holding bilateral consultative trade talks and adverting In regional media -For power supplies initiatives are already in place via for a such as SAPP -Government to government liaison would address exchange of ideas and offer avenues or opportunities for fund sourcing.	-Zesco Ltd -University of Zambia, Technology Development and Advisory Unit -Golden Valley Research centre -NISIR
Zimbabwe	Advocacy and fund mobilisation for the region.			-Scientific, Industrial Research and Development Centre (SIRDC) -National Universities of Science and Technology