GTZ – EUEI/PDF (Energy for sustainable Development)

Lesotho Energy Access Strategy project

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DRAFT HOUSEHOLD ENERGY ACCESS STRATEGY

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1. Introduction ... 1
2. The Status Quo ... 1
2.1 Policy Environment ... 1
2.2 Overview of Lesotho energy sector ... 2
2.3 Results from energy survey ... 3
3. The conditions of improved energy access for cooking – the basic scenarios ... 5
4. Energy Vision and Policy Goals ... 11
4.1 Contributing towards the improvement of livelihoods ... 11
4.2 Contributing towards the protection of the environment ... 11
4.3 Contributing towards economic growth and investment ... 11
4.4 Ensuring access to basic energy technologies and services ... 12
4.5 Ensuring security of supply ... 12
5. Household energy policy objectives ... 12
5.1 Improve the choice of affordable energy options for households ... 12
5.2 Provide information on energy resource options, and their cost-effectiveness 12
5.3 Assist in reducing indoor air pollution resulting from burning of biomass ... 12
5.4 Promote the efficient use of biomass, to reduce households' heating expenses 12
6. Household Energy Access Strategy ... 16
6.1 Barriers to implementation ... 16
6.2 Perspectives and opportunities for an Household Energy Access Strategy ... 18
6.3 Energy service requirements and potential energy supply alternatives ... 18
6.4 Required infrastructure developments to supply energy ... 20
6.5 Investment requirements and affordability issues ... 21
6.6 Thematic areas of the household energy access strategy: ... 21
6.6.1 Increasing access: Ensuring supply of modern energy sources ... 21
6.6.2 Increasing affordability: End-user credit mechanisms ... 23
6.6.3 Increasing sustainability: Biomass energy supply mechanisms ... 23
6.6.4 Increasing efficiency: Biomass efficient cook stove programme ... 24
6.6.5 Increasing information availability: Household awareness raising, information dissemination and training programme ... 24
6.6.6 Increasing institutional capacity: Efficient institutional co-ordination initiative. 24
6.6.7 Monitoring and Evaluation: Addressing data gaps and checking progress 25
6.7 Opportunities in household and productive use of energy ... 25
6.7.1 Affordability case study 1 : PV lighting vs. paraffin wick lanterns ... 25
6.7.2 Affordability case study 2: replacement of paraffin for cooking and heating 26
6.7.3 Procedure: test introduction ... 27
6.7.4 Agriculture ... 31
6.7.5 Household industry ... 31
6.7.6 Service sector ... 33
6.7.7 Energy supply and distribution ... 34
7. Pilot projects ... 35

1. Introduction

Energy is a key input for human development and survival. Globally, there is strong emphasis on the sustainable use of energy - to alter the way that energy is utilised so that social, environmental and economic aims of sustainable development are supported. Addressing sustainable energy issues in developing countries also include addressing poor people's energy needs. Poor people often suffer from the lack of adequate and reliable sources of energy, resulting in perpetuating their state of inequality and suffering. Governments are faced with the challenge to formulate policies and strategies to ensure that the energy requirements of the poor are met, also in a sustainable manner.

An outstanding characteristic of low-income household energy use is a high level of biomass dependence. Biomass energy accounts for nearly 60% of the primary energy supply in sub-Saharan Africa and satisfies the cooking and heating needs of 90% of the population. While some households have access to commercial fuels such as electricity, gas and paraffin (kerosene) the cost and availability of these fuels, restrict their widespread use.

Given the low level of access to commercial energy services in Lesotho, and following a request from the Government of Lesotho, the GTZ-administered EUEI Partnership Dialogue Facility (PDF) assisted the Department of Energy (DoE) in Lesotho in to develop a strategy for the promotion of access to modern energy for low-income groups in rural and peri-urban areas. The objective was to therefore; to develop an implementable and comprehensive energy access strategy to address especially the non-electricity energy access needs of the low-income part of the population, both for household and productive uses.

The scope of the Household Energy Strategy is limited to households and micro businesses (often household-based) in un-electrified areas of Lesotho, but it is noted that even where households do have access to electricity, other fuels may still be used, especially for thermal applications and the Draft Household Energy Strategy may therefore also be applicable to address sustainable biomass fuel use in electrified areas.

2. The Status Quo

The following section will provide a short overview of the Lesotho situation with regard to the policy environment, energy sector in general and household energy sector in particular.

2.1 Policy Environment

An Energy Policy Framework was drafted in 2002 and replaced the existing Lesotho Energy Master Plan published in 1988, updated in 1991. An Energy Action Plan was drafted in 2003, aiming to operationalise the Energy Policy Framework. Both documents (the Policy Framework and Action Plan) are considered to be in a draft status and have not been officially accepted by Government. However, both documents are accepted as the *de facto* guiding energy policy documents of the country. The official "draft" status of both documents does create a level of uncertainty and it is recommended that Government officially adopt both documents as *de jure* policy documents.

A household energy access strategy in Lesotho requires to be harmonised with the following existing policy documents and action plans:

- Lesotho Poverty Reduction Strategy
- Draft National Forestry Policy
- Lesotho National Forestry Action Programme
- The Electricity Masterplan
- Lesotho National Environmental Policy
- Appropriate Technology Services Policy
- Local Government Act (established the decentralisation policy)

As energy is a cross-cutting issue in many other sectors such as health, education, agriculture and infrastructure, it is imperative that implementation of the projects identified in the Household Energy Access Strategy be implemented in a co-ordinated manner. It is recommended that a multi-sector energy co-ordination committee (MSECC) be established and the set-up, financing and management of the MSECC will be presented as a separate project.

2.2 Overview of Lesotho energy sector

The following section is not intended to describe the Lesotho energy sector in detail but to provide a short background overview. For more detail on energy supply and demand statistics, see for example the Draft Energy Policy Framework (2002) and Alfstad (2005).

The Lesotho energy sector is characterised by a low level of energy consumed from commercial sources (electricity, petroleum, coal and gas) with a high level of consumption of energy from biomass sources. Electricity is supplied by hydropower and Lesotho has been largely self-sufficient to meet local demand, however, Government notes in the draft Energy Policy Framework (2002) that future expansion programmes may change the situation. Other commercial fuels such as petroleum products, gas, paraffin and coal are imported from South Africa. Solar energy is utilised by some households for electricity supply and the baseline study conducted as part of the project fund an average of four percent of households in the sample to be using solar.

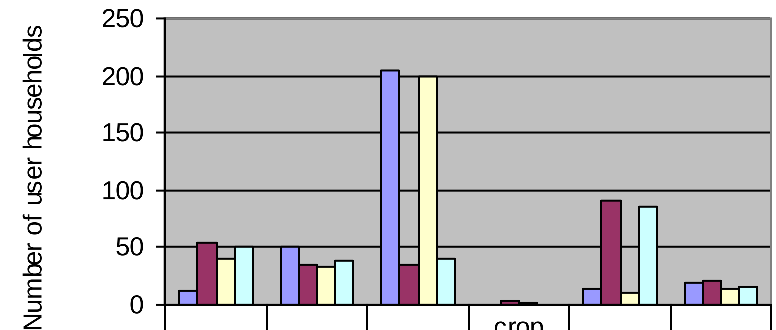
Various sectors such as households, institutions, agriculture and transport consume energy in Lesotho but focussing on households, data indicates that eighty six percent (86%) of all households in Lesotho do not have access to electricity (Bureau of Statistics, 2007). Household access to electricity increased from 5.6% in 1994/1995 to 14% in 2002/03, however, the increase mainly occurred in urban areas with "Maseru Urban" experiencing an increase of 17.7% from 1994/95 to 2002/03. The low level of electrification in the country as a whole and also in urban areas indicates a high level of dependency on other fuels.

Rural households meet their energy requirements mostly from biomass energy sources (wood, shrubs, crop wastes and dung) supplemented by a paraffin. Urban households use mostly paraffin supplemented by biomass, gas and coal in specific areas. The residential sector consumes more than 90% of the country's total energy consumption (EPF, 2002) and the Poverty Reduction Strategy (2003) states that between 1993 and 1999 the percentages of households that depended on collected fuel rose from 55% to 66%. The PRS (2003) concluded that energy in Lesotho is therefore and environmental as well as a poverty issue. For more detail on household energy consumption, please see the Draft Energy Policy Framework (2002) and Bureau of Statistics, 2007.

2.3 Results from energy survey

The baseline survey showed:

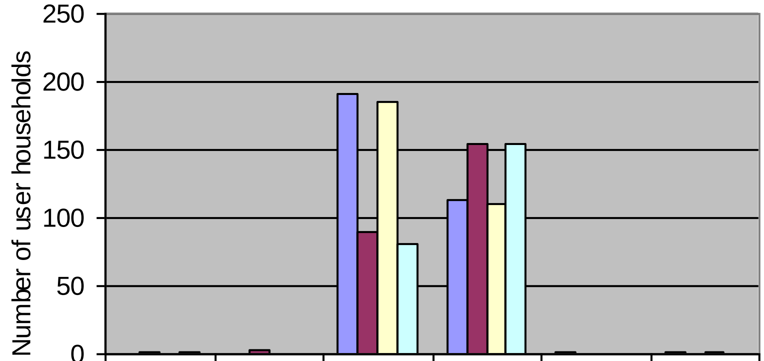
- All energy carriers are available – except electricity.
- Practically all commercial fuels are considered too expensive.
- The typical household in the study areas cooks mainly with wood, complemented by some paraffin. A minority uses dung, shrubs or gas as main and as complementary fuel.



	Dung	Shrubs	wood	crop residue	paraffin	gas
Summer most used	13	51	205	0	14	20
Summer also used	54	35	35	3	91	21
Winter most used	41	33	200	1	11	14
Winter also used	51	39	41	0	86	15

- Most households use wood for space heating in winter. Dung, shrubs and paraffin use for heating is marginal.

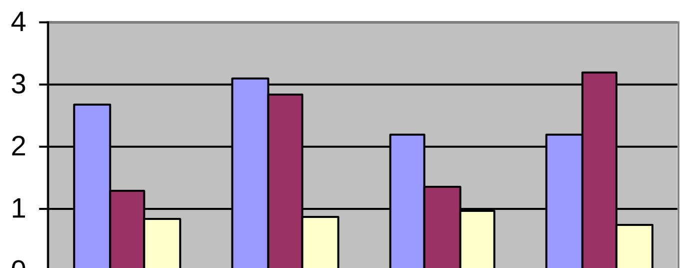
Lighting fuels used by households



	Shrubs	wood	paraffin	candles	sun	gen set
Summer most used	0	0	191	113	1	1
Summer also used	1	3	89	155	0	0
Winter most used	0	0	186	111	0	1
Winter also used	1	0	81	154	0	0

- Lighting is important all year round, with almost exclusive use of paraffin as primary fuel and candles as secondary fuel.

Fuel collection: how often, how long, who?

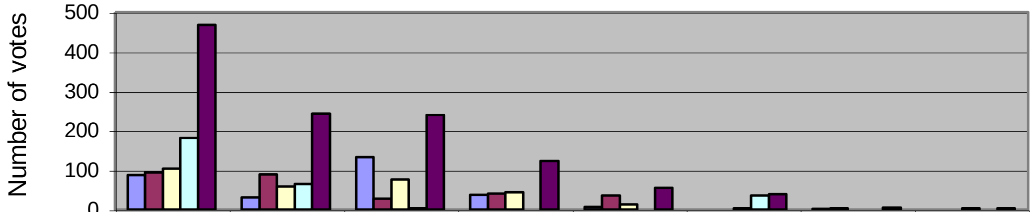


	Dung	Shrubs	crop residue	wood
Collection frequency per week	2,7	3,1	2,2	2,2
Average duration per trip (hours)	1,3	2,8	1,3	3,2
% females collecting	84%	88%	96%	74%

- Between 2 and 3 trips a week are undertaken to collect fuel. Weekly collection times are between 3 and 9 hours. Fuel collection remains a female activity.

- Most owned thermal appliances are open fire, paraffin wick stoves, poula stoves and gas stoves. On the average, a household owns two thermal appliances.

Preferred fuels



	electricity	paraffin	gas	wood	coal	solar	Shrubs	Dung
Cooking	88	30	132	38	7	0	2	0
space heating	94	89	27	41	35	0	3	0
water heating	104	59	76	44	13	3	0	3
lighting	181	64	4	0	0	36	0	0
total	467	242	239	123	55	39	5	3

- Given a free choice, users would prefer electricity or gas for thermal applications, and electricity to light their house.

3. The conditions of improved energy access for cooking – the basic scenarios

Different energy choices imply different costs, different en energy consumption rates and different GHG emissions. Also, there are dynamical effects, depending on the time scale in which energy decisions are put into practice. The simulation model presented here describes the conditions and dynamics of fuel use for domestic cooking in off-grid locations in Lesotho, in terms of cost, GHG emission and consumption impacts of different fuel and appliance choices. The quantification of these choices is a useful decision tool for energy planning, and a basis for the estimation of impacts of different energy policy options. The model is based on the "meal portion" method developed by Grupp and Balmer (2002).

The main parameters are:

- the number of meal portions (MP) prepared, and
- the fuel consumption, cost and GHG emission per MP for different stove-fuel couples.

The task is facilitated by the fact that reliable experimental results have been published by Smith (2000). The above-mentioned parameters don’t vary much between different places which means that, even in the absence of data for a given location, a first and quite precise estimate of fuel consumption and GHG emission by fuel switching can be produced on the basis of published generic data. In the framework of this project, fuel consumption, cost and emissions have been calculated on the basis of South African data. In a second step, these values were determined directly in the framework of the baseline survey of this study. Agreement between the two data sets was reasonable.

The model is based on the demand for domestic cooking energy services. The actual observed supply shares for this demand by different fuel/appliance combinations are used as a starting point. The impact of different fuel choices on consumption, emissions and cost are calculated

The following inputs are used:

- Population (for the discussion of nationwide impacts)
- Population growth
- Average household size
- Average per-household fuel expenses for collected and commercial fuels
- Evolution of fuel expenses
- Per unit hardware costs for stoves
- Average useful life of these stoves
- Use rate of different fuel-stove combinations
- Evolution of use rate of these combinations.
- Number of cooked meal portions per capita and year
- Energy delivered into the pot per meal portion
- Fuel efficiency of the various fuel-stove combinations

The simulation interval is 20 years with a step of one year, starting in 2006.

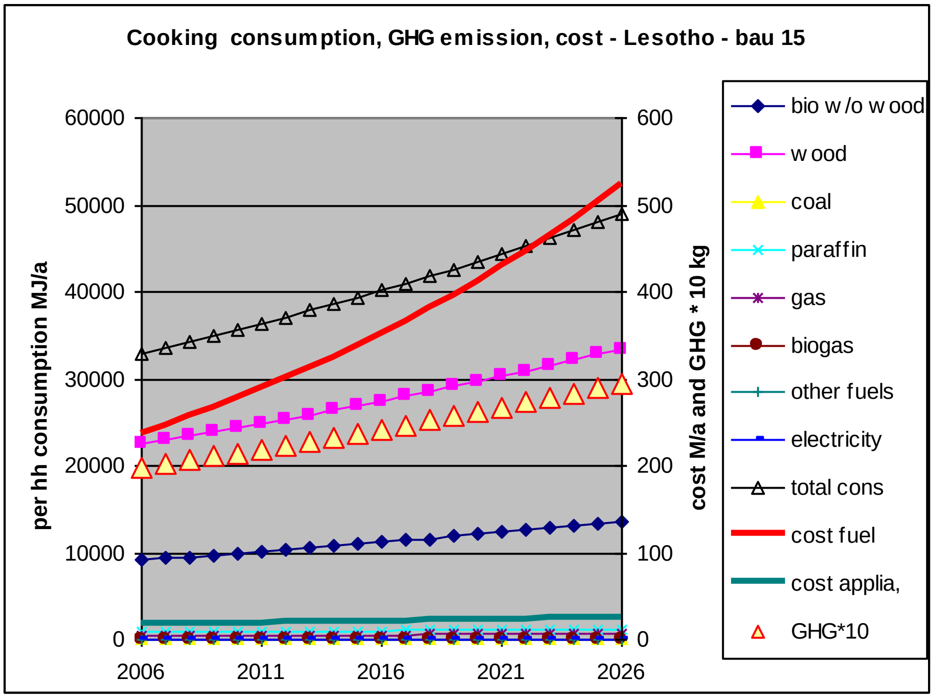
Three scenario types have been run with the help of the model:

- Business as usual (“BaU”) – constant parameters at the actual levels
- Fuel shifting – the choice of different growth rates for the shares of different fuel / appliance options
- Impact of combined measures.

The results are presented in diagrams and tables. Except where indicated otherwise, results refer to one household consisting of 5 members. Demographic growth is applied to the number (and not the size) of households. Solid biomass is referred to as non-wood biomass (“bio w/o wood”: dung, crop residue) and wood (wood and shrubs).

Business as usual

“Business as usual” implies that the cooking habits and options including evolution rates are assumed to remain unchanged.



The diagram shows the evolution over time of the main per household parameters. Lines with data points denote per household energy consumption in MJ/a, values are shown on the left hand ordinate ("y-axis"). Costs in Maloti are shown in lines without data points, values are found on the right hand ordinate ("z-axis"). Greenhouse gas (GHG) emissions in kg CO_2 equivalent (note the factor 10 on the right hand ordinate) are shown in the bi-colour data points without lines.

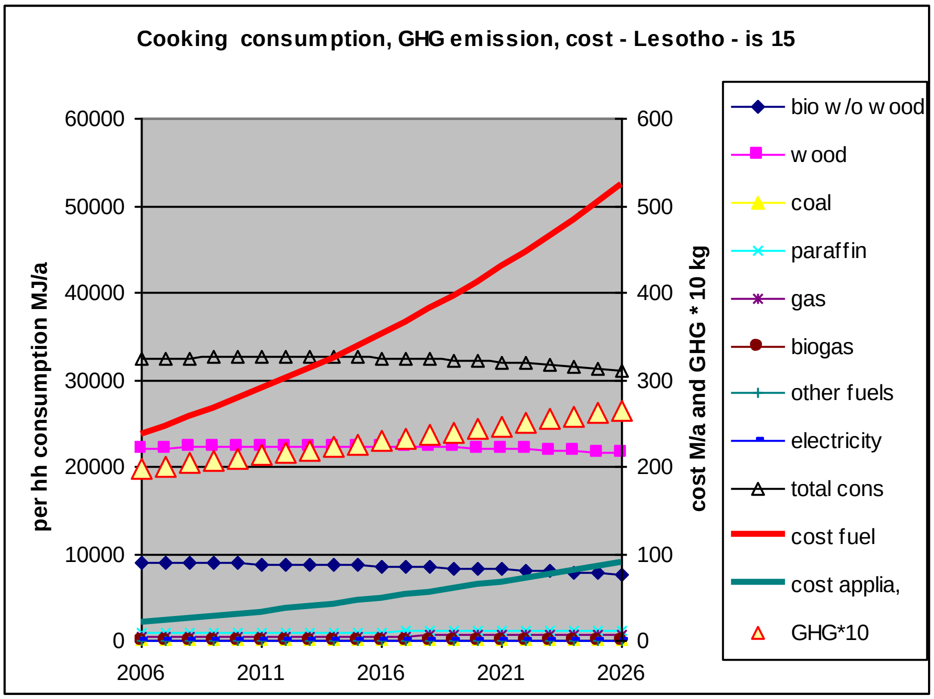
The upward trend in total fuel consumption and GHG emissions is caused by population growth. The rise in cost is caused by the combination of population growth and fuel cost increase. Appliance costs are negligible. However, since they have to be paid for up-front, they are felt more painfully by households than fuel costs which can be paid in small individual payments.

The problem with the energy policy option in this scenario is that it combines the disadvantages of rising cost with dwindling resources which narrows down future options.

Optimisation of biomass : improved wood and biomass stoves (is)

The replacement of 3-stone fireplaces (fuelled by wood and non-wood bio-mass) by improved stoves results in important reductions in fuel consumption. Fuel costs keep rising, like in the Business as Usual scenario, since no changes in fossil fuel use rate are assumed. Appliance costs are higher, but still only a fraction of the fuel costs.

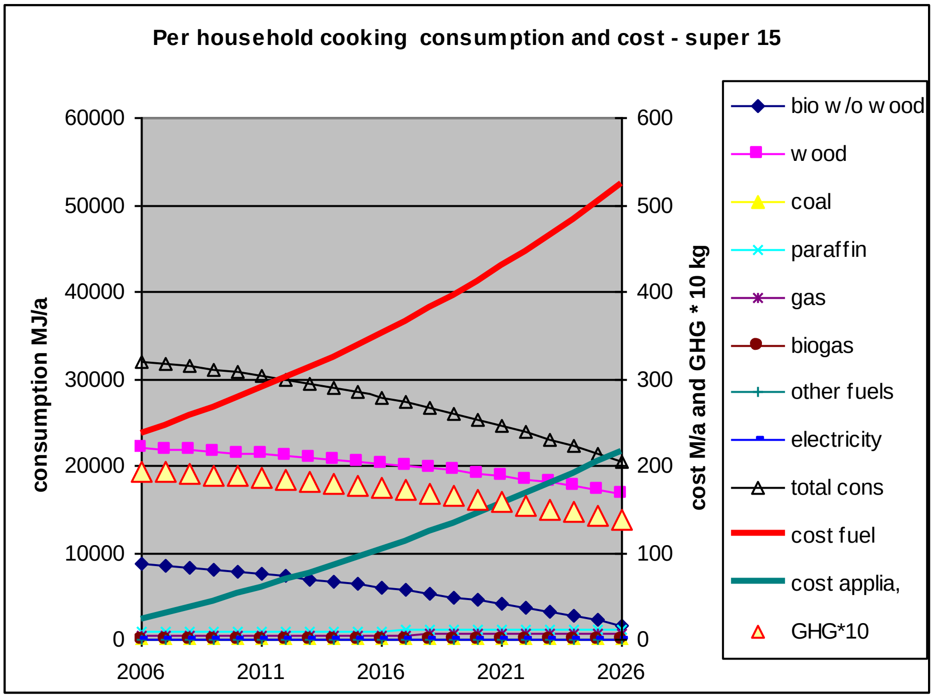
The rise in GHG emissions is caused by population growth and by the fact that improved stoves, despite of lower per meal-portion emission; emit more GHG per fuel mass unit compared to 3-stones.



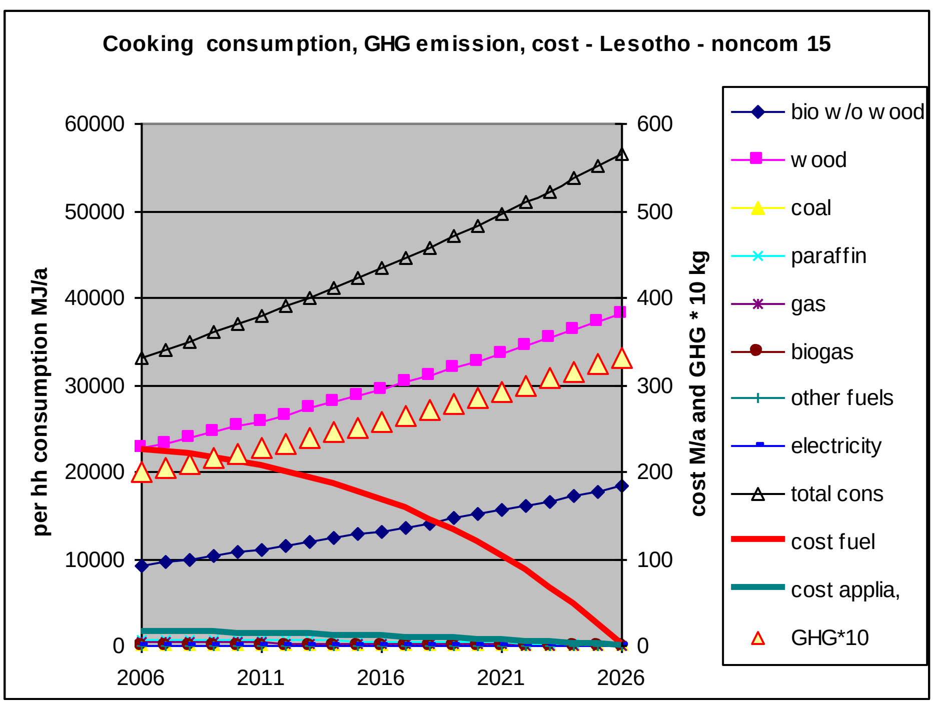
Optimisation of biomass : "super-biomass" stoves

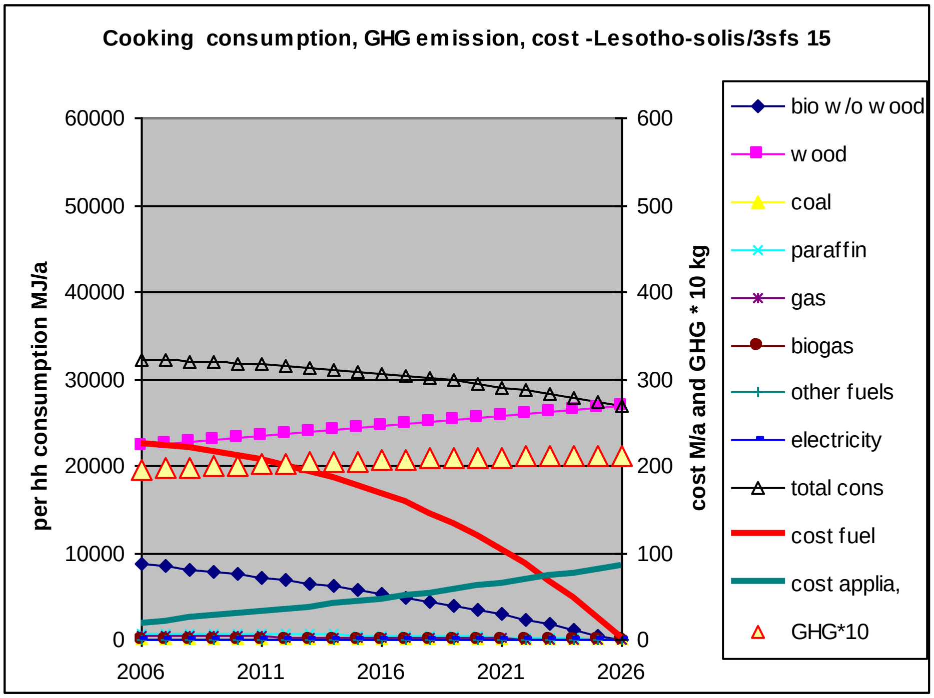
Would it be worthwhile to further improve improved stoves ? This scenario checks the effects of the introduction of hypothetical upmarket, high performance, clean-burning wood and biomass "super"-stoves, in replacement of 3-stones. Results show higher consumption savings and lower GHG emissions, but at sensibly higher appliance costs.

As in the preceding scenarios, fuel costs remain unchanged, since the use of commercial fuels has not been varied.



An obvious option to reduce fuel *and* hardware costs is the replacement of commercial by non-commercial fuels. The corresponding explosive growth of non-commercial fuel use and of GHG-emissions, as shown in the diagram, would be disastrous on all accounts and could not be sustained during the simulation period.





In the top diagram, fossil fuel and 3-stone cookers are progressively replaced by improved wood and biomass stoves. Solar cookers are introduced, up to a saving rate of up to a saving rate of 0.4. These assumptions lead to a strong decrease of fuel consumption, GHG emissions and fuel costs, but also to a higher hardware costs.

Better results are obtained by the additional introduction of heat boxes (bottom diagram). The model takes into account the fact that heat boxes need a heat source for the initial heat-up. It is assumed that use rates of heat boxes are the same as solar cooker use rates. The data on solar cooker use rates and fuel savings are taken from the results of the DME/GTZ solar cooker field test in RSA.

The following conclusions can be drawn;

- The traditionally dominating fuel/appliance couples cause specific problems: fossil fuels are not affordable, bio-fuels in 3-stone stoves pose problems of availability and environmental impact
- The most expensive options are the switch to fossil fuels, followed by business as usual, i.e. the option of non-action and non-investment in the short term
- The least expensive – but also the least attractive - option is a massive switch from commercial to non-commercial fuels.

- Sustainable low-cost scenarios imply the switch away from 3-stones and from fossil fuels, towards improved stoves and/or non-fuel stoves (e.g. solar cookers and heat boxes).
- Hardware costs for cookers are generally far lower than fuel costs – except for the case of “free” fuels: thus it is preferable to invest in fuel saving cookers instead of fuel.

4. Energy Vision and Policy Goals

The vision for the Energy Policy Framework for the Kingdom of Lesotho, which is consistent with the general context as expressed in national development plans, is as follows:

> *Energy is available at affordable costs for effective and efficient service delivery, according to the principles of environmental sustainability and integrated management by all sectors, to maintain the desired economic and social development to the satisfaction of every citizen of Lesotho.*

Policies presented in the Energy Policy Framework for the Kingdom of Lesotho are based on the following energy policy goals.

4.1 Contributing towards the improvement of livelihoods

The energy sector will contribute towards poverty alleviation in Lesotho. This will be achieved through facilitating the provision of affordable technologies and services, and through the creation of income generation opportunities that sustain and improve the lives of Lesotho citizens. Furthermore, Lesotho citizens will be encouraged to deepen their involvement in making decisions that affect them.

4.2 Contributing towards the protection of the environment

Lesotho’s energy system, which includes the supply and consumption of energy resources as well as other related processes, will contribute towards environmental sustainability.

4.3 Contributing towards economic growth and investment

The energy sector in Lesotho will contribute towards economic growth through initiatives that emphasise efficiency in energy sector management, job creation as well as those that position Lesotho as a competitive player in the southern African region. Emphasis should be placed on the creation of conditions that encourage private investment, but which ensure that ownership of energy sector resources continues to rest locally.

4.4 Ensuring access to basic energy technologies and services

A choice of reliable and quality technologies and services will be made available to all Lesotho citizens. The technologies and services are likely to be sourced from within Lesotho as well as the southern African region.

4.5 Ensuring security of supply

The Government of Lesotho will ensure security of energy supplies to meet the national requirements from diversified sources that are subject to local resources, regional agreements and economic feasibility.

5. Household energy policy objectives

Household energy policy goals are described in the Energy Policy Framework (2002) as follows:

5.1 Improve the choice of affordable energy options for households

Government will take measures to ensure that commercial fuels, such as paraffin, LPGas and diesel, as well as their associated appliances are available and affordable for rural and urban customers for use in the home, agriculture, small business, telecommunications and community facilities.

5.2 Provide information on energy resource options, and their cost-effectiveness

With a view to encouraging the most cost-effective use of energy, Government will seek to enhance household awareness on different energy sources and appliances.

5.3 Assist in reducing indoor air pollution resulting from burning of biomass

No specific statement is provided but the lack of adequate data on the linkages between household fuel use and energy use is noted. The Energy Policy framework (2002) notes that Government recognises that, for some considerable time to come, biomass will continue to be used as a domestic fuel, particularly in rural areas. Reduction of the negative health impacts of household energy use must be tackled both through encouraging a switch to cleaner sources of energy as well as in adopting biomass combustion methods which will result in less exposure by people to harmful emissions. This involves the use of improved stoves and ventilation. Policies and strategies for adopting alternative sources of household energy, and for encouraging more efficient and safer combustion of biomass fuels

5.4 Promote the efficient use of biomass, to reduce households' heating expenses

Government will promote the widespread adoption of sustainable building practices and retrofit measures for existing buildings in order to reduce energy requirements and to improve comfort levels.

The household energy policy goals in the EFP (2002) are supported by a list of possible implementation strategy outlines. Not all listed strategy outlines concerned households in non-electrified areas nor were regarded as feasible, and the following table contains the three recommended strategies per energy goal. Where the strategy outline is presented in italics, it was not originally contained in the EFP (2002).

Theme	Household energy policy statement	Identified strategies (contained in EPF plus additional recommendations in italics).
Improving the choice of affordable energy options for households	Government will take measures to ensure that commercial fuels, such as paraffin, LPGas and diesel, as well as their associated appliances are available and affordable for rural and urban customers for use in the home, agriculture, small business, telecommunications and community facilities.	1. Provide incentives to the oil industry to invest in distribution outlets in rural areas. 2. Consider extending credit to households to purchase gas, diesel and paraffin appliances. 3. Work with Appropriate Technology Section and others to develop/identify affordable cooking and heating technologies which will enable efficient and safe combustion of biomass and commercial
Providing information on different energy sources	With a view to encouraging the most cost-effective use of energy, Government will seek to enhance household awareness on different energy sources and appliances.	1. Commission comparative studies on the utilisation of different energy sources for different household uses, and in different areas; 2. Collate existing, and develop new information dissemination programmes and awareness campaigns on the life-cycle economic cost-effectiveness of household energy use; 3. Collaborate with relevant government departments/institutions and NGOs disseminating information on energy saving devices and energy supply companies to ensure that correct advice is given to the public about products and services relevant to them 4. Establish an Energy Information Centre at the DOE to provide information to energy consumers of the various options for energy supply and rational use of energy.
Reducing health impacts caused by burning biomass fuels	*Government will reduce the negative health impacts related to energy use in Lesotho*	*1. Collect baseline information on the status of health and energy use in Lesotho;* *2. Encourage fuel switching to cleaner and more efficient forms;* *3. Encourage the adoption of cleaner biomass energy technologies* *4. Implement an information and training campaign to popularise the Basa njengo Magogo clean fire lighting method* *5. Reduce domestic use of coal*
Promoting thermally efficient dwellings	Government will promote the widespread adoption of sustainable building practices and retrofit measures for existing buildings in order to reduce energy	Liaise with all relevant authorities in ensuring that building regulations as pronounced in the Building Control Act are adhered

	requirements and to improve comfort levels.	to; Conduct awareness campaigns on energy efficiency in buildings and houses; Liaise with Local Authorities and other relevant bodies responsible for site allocations in order to facilitate building of energy-efficient houses.

From the summary table above, as well as additional policy statements and strategy outlines contained in the EFP (2002) and Energy Action Plan (2003), it is possible to identify 7 thematic areas in which the proposed household energy access strategy can be organised:

1. Increasing access: Ensuring supply of modern energy sources
2. Increasing affordability: End-user credit mechanisms
3. Increasing sustainability: Biomass energy supply mechanisms
4. Increasing efficiency: Biomass efficient cook stoves
5. Increasing information availability: Household awareness raising, information dissemination and training programme
6. Increasing intuitional capacity: Efficient institutional co-ordination initiative
7. Monitoring and evaluation: Addressing data gaps and checking progress

The thematic areas will be described in more detail and unpacked into a number of specific projects in the section below.

6. Household Energy Access Strategy

The section will outline the barriers to implementation of a Household Energy Access Strategy, the criteria that such a strategy should adhere to,

6.1 Barriers to implementation

One of the fundamental steps necessary to enable the implementation of any strategy is the need to understand the barriers confronting it, and how to overcome those. Several barriers are self-evident and are described below. However, there is also a barrier relating to the state of the country itself – the issue being that energy is a relatively low priority area when compared to things such as HIV/Aids, hunger, orphan children, unemployment and education. It is beyond the scope of the strategy to address all these issues but it is important to bear in mind that energy plays an integral part in all and that one of the chief roles of the National Department of Energy should be to actively co-ordinate with all Government role-players to ensure that energy as an important input into all sectors are addressed and recognised.

Barriers to the successful implementation of a Household Energy Access Strategy would include but not be limited to the following:

Household poverty

Poverty is widespread and although it varies across regions in Lesotho, household income levels are very low. Bureau of Statistics (2007) states that 67.5% of households in rural areas did not earn an income, while 32.5% of households in urban also areas earned no income. It was further observed that household's main source of income for 2002/03 was from private business and farming sectors of the economy. PDC *et al* (2007) reported an average of 37% of households in the sample had no regular monthly income while an average household income was determined to be in the order of M582 (average household size of 4.6 members). The reality is therefore, that households have limited levels of income which have to be spread over a range of expenses, most deemed more important and pressing than energy. Furthermore, PDC *et al* (2007) concluded that all energy carriers were available in the sampled areas, except electricity but all commercial fuels were considered too expensive. It is therefore, the affordability of energy sources, rather than the availability that forms a barrier to household use. Household poverty will be a major obstacle to improving access to clean and modern household fuels and making financing or credit facilities available to enable households to purchase fuels and/or appliance will have to be a cornerstone of the approach.

Ruling paradigm in energy provision

The current ruling paradigm in energy supply is to focus on electricity – households desire it, Governments aspire to achieve universal access to electricity in their countries and donor organisations fund expensive grid and non-grid expansion projects. This forms a barrier to implement a Household Energy Strategy at a number of levels. Firstly, households equate electricity with modernity and projects attempting to implement improved biomass stoves for example are criticised for "trying to take people backwards, instead of forwards". Government and the electricity supply authority should embark on a national communication campaign, clearly outlining the electricity expansion plans for the future, so that communities will be certain where they stand in terms of planning. Government itself will provide more barriers in this regard – care would have to be taken that all available resources are not usurped by electrification projects, but that adequate resources will also be allocated to "less-desireable" projects such as improved cook stoves or tree-planting projects. The Department of Energy and the recommended Multi-sector Energy Co-ordinating Committee should be prepared to take on a lobbying role to ensure an equitable distribution of available resources. Lastly, donor and other funding agencies tend to favour large-scale

Environmental constraints

As outlined in the Energy Policy Framework (2002), the history of forestry development in Lesotho spans over 150 years and comprised a variety of approaches. The Energy Policy Framework (2002) notes that the following issues hinder successful forestry programmes in Lesotho:

- harsh climatic conditions, in particular severe droughts;
- competing land uses (grazing, settlements, etc);
- unclear ownership of trees planted;
- very limited consideration of forestry and tree planting in planning and execution of other land use practices;
- continued unsustainable harvesting of wood for energy purposes;
- unclear and inconsistent incentive policies for people to plant trees, coupled with conflicting incentives for other activities, such as road building in rural areas.

The Energy Policy Framework (2002) concludes that any forestry intervention is likely to fail if the abovementioned issues are not taken into account. Again the requirement of an integrated approach is clear – the problems can not be solved by the Department of Energy alone.

6.2 Perspectives and opportunities for an Household Energy Access Strategy

It is easily forgotten that the development of the energy systems in industrialised countries was no straight forward process. One of the most expensive detours was caused by the unconditional bias for central grid electricity for all energy uses except transport. This error has long been overlooked by energy sector decision makers; it is finally starting to re-surface due to the recent changes in favour of efficiency and renewables. This view has resulted in vast amounts of excess greenhouse gasses emitted as well as investment lost and time wasted.

One of the few structural advantages favouring developing nations over industrialised countries is that developing countries, instead of just retracing the detours of history, can avoid dead-end streets and costly errors committed by other countries, before. As explained by J. Goldenberg called, they can "leapfrog" (see also Ho 2005), or, in other words, chart their own development path, guided by historical experience.

Leapfrogging requires a clear picture:

- of the past: what has been tried, what were the accomplishments, errors and the results
- of the present possibilities, needs and limits.

At the outset, leapfrogging is an energy planning exercise; it calls for adaptations in energy costs and benefits, efforts in communication and application of precisely tuned incentive measures. Important indicators for the realism and applicability of this exercise are the perception, acceptance and feasibility under real-life circumstances. To this end, several measures (e.g. the test implementation of measures by "pioneer groups" and the set-up of a structure for the qualification of ad-hoc experts) are proposed here.

In general, the inception, large scale testing and application of new energy policies could be a sector of activity where the structural advantage of countries like Lesotho could be transformed into internationally competitive export activities. Due to current global and national realities in Lesotho, it is considered vital to base the proposed Household Energy Access Strategy, not on the model of industrialised or industrialising countries, but on a new approach.

6.3 Energy service requirements and potential energy supply alternatives

In un-electrified areas of Lesotho, the most basic energy service requirements are met on a very low level concerning both quantity and quality. Serious quantitative energy service gaps exist in cooking, space heating, lighting and communication.

On the qualitative side, the fuels actually used cause serious problems. Apart from high costs and therefore un-affordability of fossil fuels, these problems include:

- Local indoor and outdoor air pollution by traditional cooking modes
- Problems of procurement, affordability, availability and user friendliness
- GHG emissions
- Other environmental problems, such as soil erosion and deforestation.

In general, technological solutions should not be discussed in terms of a one-dimensional comparison between single characteristics of single devices, but in terms of comparison between different energy services that can be expected from a combination of different technologies. For example, we do not try to answer the question whether improved stoves or solar cookers are the “best” cooking option, but, rather, what mix of the different options would be the most suitable to a given profile of cooking needs. The question is therefore, which solution is adapted to the different and diverse user traditions and requirements. In the cooker example, a typical optimised strategy could be the use of solar cookers for the sunny season and during the day, improved stoves for cooking at night, in the cold season, and heat retention devices for all simmering processes. Also, recent fuel developments should not be discarded; they include solid biofuels, gel and liquid fuels (such as vegetable oils, ethanol and methanol), as well as biogas and methane from other sources.

In order to obtain a more sophisticated view of the comparative advantages of different cooking strategies, the impacts of appliance and fuel replacement strategies for cooking have been analysed with a simulation model (presented in 0). All identified sustainable and low cost development paths are based on the replacement of fossil fuels and of traditional 3-stones by more efficient biomass stoves and/or non-fuel appliances, such as solar cookers and heat retention devices.

The most important contributions to energy service for space heating include improvements in thermal insulation, reduction of fresh air intake by tighter fitting openings and by cleaner burning heat storage stoves, and direct solar gain. It is possible that the remaining energy needs for space heating can be met by adapted heat storage elements charged by solar gain or fuel cooker waste heat.

As for the specific energy services of electricity, the situation in off-grid Lesotho is next to a clean slate: everything is still to do – and all opportunities are still open. Electricity is the most “ under-offered” energy carrier in off-grid Lesotho. It is also paradoxically the most popular, as the present study has shown. Potential users see electricity as the answer to all energy needs. In the mid-term perspective, this seems very unlikely to materialise. Taking into account the low population density, a massive high capacity grid extension would be prohibitively expensive – but this does not rule out local grid extension efforts.

It is essential to use newly created electrical capacity in priority for electricity specific, high efficiency, low power purposes:

- lighting, cooling, communication in the domestic sector
- power tools, computers, telephone and internet access for professional use.

These specific uses can have a lasting positive impact through the improvement of domestic living conditions and the creation of internationally competitive professional services, e.g. in the IT sector. The use of electricity for thermal purposes implies high costs for generation and distribution and should be given lower priority. For specific electricity, off-grid or mini-grid electricity development is a logical option. However, this should not exclude other, future orientations. In particular, user acceptance will depend on the question whether off-grid solutions will be perceived "to keep the grid away", or whether they are open to future developments such as the unlikely but possible arrival of the central grid.

6.4 Required infrastructure developments to supply energy

The underlying question is twofold:

- what would be the required infrastructure for a given energy supply system?
- what are the desirable energy supply options which can be implemented within minimal infrastructure investments?

In other words, infrastructure requirements should be seen as one of the central criteria for the choice of energy supply systems. The main infrastructural elements impacting on the future of the Lesotho energy supply system are:

- training, qualification and motivation of specialists
- communication, including high speed internet access
- transport
- sustainable biomass supply
- local capacity for the manufacture, distribution, user support (including monitoring, metering, billing), financing of energy systems
- political and regulatory stability in order to put energy investments on a sound and predictable basis
- appliance- and energy-related labels and norms.

Clearly, marginal costs for different energy carriers in Lesotho cannot be compared to marginal energy costs in countries where all infrastructure requirements are met and written off. But, as mentioned above, this is not only a disadvantage, since it allows for no-detour investment in the most modern sustainable energy technologies.

6.5 Investment requirements and affordability issues

There is nothing like a free lunch – someone has to pick up the tab. If the tab is affordable, as in the case of initial investment for limited projects, a « someone » can usually be found. If the tab is substantial, as in the case of general access to energy, the investment has to be ultimately carried by the client. Also, gifts have a tendency to be under-valued by recipients, as multiple experiences in the sector of development aid show. This – rather trivial – statement does not imply that poor rural users should organise their energy access without any help ; they can't and they won't. By the way, why should they? The mitigation of the impending climate disaster is a) not of their main responsibility, and b) way beyond their means. Finally, as Klingshirn observes, why should the rural poor be the only user category to finance their energy system without assistance? After all, in investing into a sustainable development path, they serve the common interest, as well as their own, their own interest being:

- Savings in cost and time
- Convenience
- Safety
- Reduction of local pollution and pollution-related health problems
- Access to more recent, modern appliances
- Access to modern energy-related services
- Less fuel procurement and reliability problems.

As for the common interest, we can note:

- Diminishing pressure on resources and prices
- Less demand on central generating and distribution capacity for commercial energy carriers
- Less investment needed from utilities and other energy providers
- Less GHG and other emissions.

6.6 Thematic areas of the household energy access strategy:

Specific projects recommended as part of the household energy access strategy can be divided into seven thematic areas. The following section will provide more detail on the themes as well as a list of recommended projects.

6.6.1 Increasing access: Ensuring supply of modern energy sources

To facilitate the access to modern energy services, several types of measures can be adopted:

- Fuel subsidies
- Subsidised acquisition of high efficiency or non-fuel energy appliances
- Subsidies for the switch towards the use of sustainable energy sources.

Experience shows that subsidies in the energy sector can be an expensive way to miss their target. The following problems have been observed:

- Subsidies have the tendency to be absorbed by suppliers with the effect that none of the subsidy reaches the user.
- Announcement effects, a classical political tool, can be very effective - a simple announcement of a future subsidy is enough to stop investment dead. This was very aptly illustrated when the capital subsidy for PV systems were announced. The public did not understand that the subsidy was only applicable in the non-grid concession areas and businesses selling PV systems reported a significant drop in sales.
- "Grid lock" effects occur when several agencies have to agree on - and finance - a project.

Fuel subsidies have an immediate effect to diminish fuel costs which is felt directly by low-income households. However, the longer term effects are disastrous. The cost for the state (and ultimately, the taxpayer) is very high, the signals sent to the consumer are erroneous: lower prices lead to higher demand (which, in turn, leads to higher resource pressure and, thus, higher prices). Also, fuel subsidies discourage energy savings and transformation of the energy system, while encouraging black market sales over the border to countries without subsidies.

Subsidies for energy saving appliances avoid part of these inconveniences, since they reduce pressure on resources. This leads to lower energy costs; however, this type of subsidy is not tied to actual use of the new appliances which – as the solar cooker example shows – can have difficulties to be actually used. Also, the user has a tendency to attach little value to gifts.

The third alternative is to encourage the *production* of energy in a sustainable way, as opposed to subsidise the corresponding *hardware*. In other words, subsidise kWh instead of generating capacity. The following argument is developed for the case of electricity, but is as valid for non-electric energy carriers.

A solid majority of experts believe that the best and the most cost-effective sustainable energy market stimulation schemes are of the structure of the German EEG for the production of renewable electricity:

- utilities have the obligation to buy and admit renewable electricity into the grid,
- the price per kWh has to cover the cost plus some profit, and can be decreasing over the years
- the investment is financed by long term credit schemes
- all conditions, such as the basic contract between the state and the individual and prices agreed to are guaranteed for at least 10, better 20 years.

The incentive impact is high, since all parameters point the same way. The user wins if his system produces more energy, at least cost, over a maximum period of time - which is exactly in the common interest. Finally, this system avoids costs for the taxpayer, since it can be designed in a zero-sum way. Costs are carried by the stakeholders who profit from the system, such as users and utilities who don't have to invest in expensive extra generating and distribution capacity.

Although the baseline study concluded that all commercial fuels except electricity were available in the study areas, and that affordability was more problematic than accessibility, the Government of Lesotho would like to pursue the increased accessibility to LPGas as a pilot project. Negotiations with the gas industry are underway to formulate and implement a pilot project in co-operation with Total Gas. Details of the pilot project will be provided in more detail in section 8. Pilot projects.

6.6.2 Increasing affordability: End-user credit mechanisms

Against the backdrop of widespread poverty and the findings on affordability and availability, only two options are available to increase household use of fuels other than biomass: making the fuels cheaper or providing credit in order for households to be able to afford it. Since fuel and appliance subsidies are extremely costly to implement (both from a Governmental and an economical point of view), this avenue would not be recommended before a thorough analysis of the cost and implication of a subsidy programme has been investigated. The door therefore, is not closed on subsidies but a specific project is recommended that would estimate the cost and other requirements of such an initiative.

End-user credit mechanisms should be established to finance the purchase of appliances as well as fuel and appliance combinations (in the case of LPG) and home loans to include energy efficient design principles in new or existing houses. Micro-credit is not readily extended by existing banks and pilot projects will have to experiment with different delivery models. These projects will be elaborated in the pilot project section of the strategy.

Specific projects recommended under the strategy theme would be:

- Commission an in-depth study on the cost and requirements of a household fuel subsidy programme in Lesotho;
- Supply a package of energy efficient lighting (PV lantern) and cooking (Rocket stove, solar cooker en heat retention HotBag) to households;
- Supply loans to house owners or new builders to include energy efficient design options in their homes (retro-fit or newly built) such as ceiling insulation, use of energy efficient materials and design;

6.6.3 Increasing sustainability: Biomass energy supply mechanisms

Biomass energy will be used by the majority of the people in Lesotho for the foreseeable future. However, current use practices are unsustainable and the supply of biomass energy should be addressed through a co-ordinated effort with other relevant stakeholders to implement the Forestry Act of 1998. It is recommended that the Department of Energy choose one project to take the lead in implement it. The project should be selected in co-operation with the Forestry Department.

6.6.4 Increasing efficiency: Biomass efficient cook stove programme

A SADC programme entitles the Programme for Biomass Energy Conservation (ProBEC) is operational in Lesotho and broad stakeholder meeting was held in July 2006 (Katsvairo, 2006). The major areas of intervention in Lesotho are the following:

- Institutional stoves: Construction of 500 fuel efficient "Lion stoves" at World Food Programme feeding points, mostly schools;
- Retained heat cookers: Promotion of a local product, efficiency testing and field trials to test user acceptance of the product;
- Energy savings techniques: Information dissemination campaign to promote energy saving kitchen management techniques;
- Promotion of biogas, especially where waste removal is a problem;
- Establishment of a project management unit

It is recommended that the ProBEC work plan for the introduction and impact monitoring of biomass efficient stoves be followed and supported.

6.6.5 Increasing information availability: Household awareness raising, information dissemination and training programme

Information dissemination and awareness raising programmes are normally very costly, difficult to implement and very difficult to ascertain the impact and behavioural changes brought about by the intervention. Only one specific project is recommended under this theme, namely the implementation of a pilot demonstration programme to popularise and alternative coal fire lighting method, also known as the Basa njengo Magogo method. The Basa njengo Magogo (BNM) alternative fire lighting method represents the highest impact on health from a benefit-cost and employment point of view since the method can potentially reduce ambient air pollution caused by the use of household coal in a relatively short period, by approximately 40-50%. Pilot studies implemented in South found that 99% of households who attended a demonstration used the BNM method and continued to use it after a month, households saved on average 25 kilograms of coal, translating in a R26 saving per month. Laboratory tests of the method concluded smoke is reduced by 90%.

6.6.6 Increasing institutional capacity: Efficient institutional co-ordination initiative.

As stated on a number of occasions in the document, the need for co-ordination and co-operation in the energy sector is real and immediate. It is recommended that a Multi-sector Energy Co-ordination Committee be established and funded to be supported by a secretariat.

6.6.7 Monitoring and Evaluation: Addressing data gaps and checking progress

The general lack of energy data is widely acknowledged. For effective monitoring and evaluation, adequate baseline energy data will have to be available and all projects implemented under the strategy would require monitoring and evaluation as well. Data collection and research can be an expensive exercise and the keep the project focussed, only two data collection exercises are recommended, namely:

- Establishment of the health related impact of energy use in Lesotho and
- Evaluation of the cost and implementation of a household energy subsidy scheme in Lesotho.

7. Opportunities in household and productive use of energy

7.7.1 Affordability case study 1 : PV lighting vs. paraffin wick lanterns

Fuel savings have a monetary impact only in cases where commercial fuels are used, as in the case of lighting, where the dominating fuels in off-grid Lesotho are candles and paraffin lanterns. As first pointed out by Louineau (1994), photovoltaic lighting is a cost-efficient alternative to paraffin lanterns. Since then, prices for paraffin have gone up and prices for PV have come down. An estimate of the investment requirements and the affordability of portable PV lanterns and of PV home systems is shown in the following table.

Lighting	Renewable cost			Conventional cost					
	price	lifetime	cost/a	price	life	fuel/a	comp cost €/a	savings	ghg emission
Units	€	years	€/a	€	years	€/a	€/a	€/a	kgCO2equ/a
PV lantern	33	5	6,6	7	5	37	38,4	31,8	100
SHS 50 Wp	260	10	26	35	5	185	192	166	500
Battery	70	5	14						

Columns 2 to 4 are labelled “renewable cost”; they show the price, the estimated durability and the annual cost of PV lanterns and 50Wp PV solar home systems (SHS, with batteries listed separately to account for the shorter lifetime of batteries compared to the other components). Columns 5 to 8 (“conventional cost” show the corresponding data for wick lanterns, columns 9 and 10 the annual savings and an estimate of avoided GHG emissions.

The results show once more that fuel costs dominate total costs, even in the case of PV lanterns costing five times as much as wick lanterns. Pay-back times are in the order of 1 year (for PV lanterns) to 2 years (for home systems), corresponding to yearly savings of 30 to 170€.

This leads to the proposition of a low-income acquisition strategy, backed by a revolving micro-credit scheme:

The table shows a five-year revolving credit scheme using rounded figures. The household contracts a one-year micro-loan (line year 1 in the table) for the acquisition of a PV lantern, buys the lantern and pays back the loan within one year via the monetary fuel savings caused by the use of the PV lantern replacing paraffin).

After this year, the household has the choice, either to stop there and to profit from the service of the PV lantern which is completely paid for, or to continue with the revolving credit scheme and to acquire a « cooking and heating set », i.e. a set of measures and appliances adapted to the harsh climate in Lesotho, consisting of:

- basic thermal insulation and caulking measures, preferably using locally available materials such as straw, hemp or clay
- an improved biomass stove for heating and cooking, particularly in the cold season, when heat is needed ; a particular design requirement is a stove pipe, to evacuate the smoke – this is mandatory in better insulated houses
- a low price solar cooker, for the hot season and during the day
- a HotBag heat retention simmering device

These devices need careful selection, efficient production, distribution, monitoring, user support and adaptation to the local situation.

At an estimated cost of €90, the payback would take place in years 2 to 4. Bank credit costs could be paid in year 5. Year 6 would see the replacement of the solar lantern which re-starts the credit cycle.

	PV lantern		Cooking and heating set		Diverse costs	Debt position
year	acquisition / use	pay-back	acquisition / use	pay-back		
1	PV lantern €30	€ 30				€ 30
2			cook set €90	€ 30		€ 90
3				€ 30		€ 60
4				€ 30		€ 30
5					credit costs €30	€ 0
6	*PV lantern*	*€ 30*				*€ 30*

7.7.2 Affordability case study 2: replacement of paraffin for cooking and heating

Clearly, the prices cited above are very tight in order to fit into low-income budgets. However, there are clients whose fuel expense savings allow for higher investment, particularly the households using commercial fuels for cooking and other thermal uses.

The baseline study of this project has shown that « single use » paraffin households spend on the average €520 per year on paraffin.

Even a partial shift towards higher efficiency appliances would allow for sufficient savings to finance the acquisition of these appliances and of PV home systems of sufficient size to power lighting, multi-media, refrigerators, small power tools and computers for web-based professional activities.

In order to see such a programme succeed, several institutional requirements must be met:

Institutional backing: all stakeholders must have the feeling that they are not alone; that they are involved in an ambitious, but down-to-earth endeavour creating not only appliances and energy savings, but also economic and other spin-offs, mainly jobs and income in an otherwise bleak economic environment.

Everyone, from individual users over service providers to institutions must be seen to get involved.

It should be noted again that this programme is user financed, by a credit scheme, and that pay-back rates will not exceed monetary savings caused by the programme. This applies to the programme in full swing. The costs incurred by the set-up of the programme (e.g. the selection and adaptation of appliances, the “pioneer group” field testing and monitoring) should not be charged to the user,.

The experience of the Grameen Bank in Bangladesh has shown that the corresponding payment risk is very limited due to the mutual interest and the corresponding peer pressure in successful pay-back of all involved.

Access to funding should be facilitated by the unique combination of high tech and poverty alleviation for the rural poor, both directly through improved access to energy and indirect through economic spin-offs. Also, the fact that the rural poor open a new technological frontier, not only for themselves, but also for the rest of the country, could be used for image sponsoring. Other options include:

Commercial sources: sale of know-how, patents, products, franchising of products for the outdoor sector, market studies for other low-income markets

GHG financing, inspite of the recent decline of the negotiated carbon value - more reasonable values will prevail once the back-log of old certificates will be absorbed.

7.7.3 Procedure: test introduction

Pioneer groups

To adapt the programme concept to local realities, we propose the test introduction of energy hardware and procedures to (and by) pioneer groups, with the objective of studying the corresponding impacts under controlled conditions. This can create a sound basis for investment and CDM-type financing tied to environmental impacts.

Pioneer groups are individual households or clusters of households acting as test buyers and test users of energy equipment. These groups acquire equipment at prospective prices for mass produced products, with the help of loans.

Monitoring

Monitoring of use, costs, impacts, acceptance and user reaction should not only use conventional, but also complementary innovative techniques, such as automatic metering, recording devices, video and web cam control, cross-check measurements, etc.., and should be performed by the pioneer groups and by control monitors.

Local and international technical infrastructure

Development results should profit from international experiences, and should be applied to other countries' needs, in return.

Initial know-how can be provided by international experts, concerning technology, environmental impacts, experiences accumulated in other countries, as well as by local ad-hoc specialists concerning local constraints and opportunities.

Long-term participants in "pioneer groups", in sufficient number, at reasonable conditions, will be needed, as well as an adapted test space.

Qualification of local specialists will be one of the most important tasks.

In the set-up phase, efficient procedures should be based on existing international test know-how and equipment, in close cooperation with the pioneer groups.

Set-up of a "Lesotho Energy Acces Science and Technology Centre (LEASTec)"

Once the set-up is underway, and generally in the long run, it will be cheaper and more efficient to perform the necessary testing and development activities locally. As a complement to existing consultancies, an up-to-date energy test and development centre (Lesotho Energy Access Science and Technology Centre - LEASTec) should be set up, with a staff of in the order of 10 to 20 experts and post grad students. The specific technical activities and other services of this centre could be proposed to other LDCs for the qualification of technicians and scientists in the field of energy service development. This qualification can be proposed as a specialised service.

From the beginning, results should be published in peer reviewed journals with the explicit intent to control the quality of activities. Assistance for publications for scientists from other countries could be part of the centre's services.

The development of innovative sustainable energy systems will be critical, not only for developing countries, but for industrialized countries as well. Top-level scientific and technical know-how in this field will be increasingly important. Unfortunately, there is a shortage of capacity in this field world-wide. Funding for the corresponding activities is still scarce, particularly for LDC applications, creating a bottleneck for development and leading to isolation of LDC experts. A small, but dynamic unit situated in a country like Lesotho and specialised in r&d and high level education in LDC energy systems would not be very costly, could acquire independent funding and contracts, and would be a good start in the right direction: the development and practical testing of viable concepts for an energy system, a system for an easier access to energy for all, a system "made in Lesotho".

To give an idea how such a concept could be put into practice, the following section describes the initial steps that could be taken:

- Conclude consulting contracts with confirmed specialists in the field, to work out a detailed concept
- Hire a fulltime coordinator
- Appoint a motivated and motivating steering committee
- Select a site adapted for experimental and theoretical work (easy access to RSA, to Maseru and to the rural areas)
- Build a small building using REN with space for offices, rooms, a small prototype workshop for basic mechanical, thermal, electronic experiments, as well as a small seminar room
- Set up a basic test site for outdoor REN tests (with a water supply, PV electricity, data acquisition, test shed ..)
- Hire resident experts (half local, half international, students and post-grad level)
- Set up an adapted QC system, to guarantee quality results (e.g. ISO 9000)
- Establish flat rate communication with the outside, to encourage constant two-way communication with the most advanced REN activities worldwide.

Strategy outline

Phase 1: inception

Selection of the most adapted technology packages according to energy service needs of households

Analysis of affordability based on present energy expenses

Information of potential institutional partners

Phase 2: Set-up

Acquisition of initial funding

Set-up of pioneer group field test: methodology, selection and training of pioneer group members

"Dry run" feasibility check of monitoring procedure

Set-up of Lesotho Energy Access Science and Technology Centre (LEASTec)

Contact of potential partners in TT, image sponsoring, manufacturing, distribution, client support...

Business plan

Set up of public-private-partnership (PPP) arrangements

Phase 3: Start-up

Contracting of partners

Test acquisition of appliances by pioneer groups

Start up of test use and monitoring

Phase 4: Test use and accumulation of results

Phase 5: Evaluation and adaptation of technology and procedure

Phase 6: Market takes over.

7.7.4 Agriculture

The existence of a small commercial agricultural sector is confirmed by the number of households engaged in this sector and earning an income from it. Of the total household sample population, 61 (19%) are involved in commercial animal husbandry while 53 (17%) of households sell crops. Productive use opportunities within this sector include;

- **PV electricity for irrigation**; while agriculture contributes only 15% of the GDP, it does employ approximately 40% of the economically active population. Small scale commercial farming is the most amenable sectors for the promotion of rural incomes as they have an abundance of some of the more critical agricultural inputs; cheap (family) labour and land. PV electricity for water pumps and surface pressure are well suited to powering water pumps with their durable construction and effective remote power delivery.

  According to mean average rainfall, Lesotho should be able to support healthy agricultural activity. However, rainfall varies regionally from year to year and the country does experience extreme weather condition periodically – including drought[1]. The introduction of irrigation will effectively smooth out the variations in water supply and promote productivity which will strengthen the position of current small producers as well as attracting new recruits.

  Animal husbandry; there are few direct PU opportunities in commercial animal husbandry. While water pumps used in crop production may provide water for cattle and other animals, there is little that energy/technology can do to promote incomes in this sector. Some of the indirect opportunities would include a greater supply of feedstock for animals which would promote the carry capacity of the area and in turn, the incomes of the households involved.

- **PV lighting in chicken broilers;** chicken broilers require lighting to ensure that the broiler chicks feed on a 24 hour (rather than a 12 hour) cycle. PV electricity is well suited to low powered applications such as lighting. The sale of briler chicks

- **Alternative technologies**; while PV is well suited to water pumping, irrigation and lighting we should appraise other alternatives as well. LPG generators would be another option but they are not commercially accessible as yet and are perhaps oversized (inefficient) for some of the above tasks.

7.7.5 Household industry

The most prominent household industry is beer brewing, with approximately 30% of the households generating an income from this activity. Other activities such as sewing, metal work, carpentry, hair dressing, traditional crafts (grass, pottery, etc.) also feature but not as prominently. Some of the productive use opportunities here would include;

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[1] FAO, Land and Water Development Division, http://www.fao.org/ag/agl/aglw/aquastat/countries/lesotho/index.stm

- **PV electricity for sewing machines**; Sewing machines and over lockers carry an electrical rating of between 80-120W. They are low-powered appliances which serve a primary needs market, i.e. clothing. With casual clothing, traditional clothing, school uniforms, sports, etc. there are many sub-markets within the clothing production sector which need to be serviced. PV electricity is well suited to powering sewing machines, a relationship witnessed across the developing world. Options would include direct PV powered machines with modified 12V motors[2] or standard AC options using batteries and inverters.

- **LPG for welding**; A small number of households indicated that they made an income from metal. LPG gas is an ideal fuel for fusion and brazing as it is a clean burner and easy to control. While the demand for welding will be limited in any single locality, the numbers would be considerable over the entire unelectrified rural population. There is some level of LPG usage at the moment so distribution may only require strengthening of the chain rather than developing it in its entirety.

- **LPG generators for carpentry**; the larger tools associated with carpentry – such as saws and sanders – are medium rated appliances between 800W-1500W. These are not particularly well suited to PV electricity. Far more efficient use would be made of LPG generators. These are not really commercial at this point but there arrival is inevitable[3]. Petrol and diesel generators would offer a very similar service although the fuel itself may be less accessible than LPG. Smaller applications associated with carpentry – such as drills – may be suited to PV, but this would impose some limits on its usage.

- **PV for hair dressing/barber shop**; hair dressing in the more conventional sense requires heat (for instance, hair driers) which is not efficiently produced by PV or generators. However, barbers may which to use electric clippers for hair cutting which would be a lot quicker than scissors and would present a more professional business front. PV is well suited to electric clippers which are available in 12V DC or 230V AC. Hair cutting is a 'basic need' so demand should be wide and consistent.

- **Improved biomass for beer brewing**; Beer brewing is an existing demonstration of productive use, using woody biomass for the brewing and sale of beer. However, a biomass programme, focusing either on biomass itself or efficient cookers, would add considerable value to this activity. With close to 30% of rural households (over 100 000 households) brewing beer, this is an activity portal through which the regulation of biomass usage would have a significant national impact.

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[2] Prof Uken from the Cape Peninsular University of Technology develop a direct powered sewing machine using a 12V DC motor from a motor vehicle windscreen wiper. The machine does not require a battery. See, for instance, http://library.iea.org/Textbase/work/2007/neet/uken.pdf

[3] One of the authors has recently undertaken consulting work for a gas company on the market and service offers around LPG ICEs (internal combustion engines).

- **PV electricity for shoe repairs**; PV is well suited for some of the smaller appliances associated with shoe repairs/manufacturing such as a grinder/buffer. This application is used for shaping soles and heals as well as roughening surfaces for adhesion. The larger applications such as patching machines (leather sewing machines) would require a considerably larger installation as it is likely to be used continuously and it uses more electricity. It is unlikely that a patching machine would be widely used given the reasonably high capital costs ($1 000+). Although that said, the 'service usage' discussed above indicated high usage of shoe repair services (38% of households).

7.7.6 Service sector

A wide range of services are utilised by rural households across Lesotho. Some of these services are available within the local economy while others are accessed outside of these economic localities. There are a number of productive use opportunities which are worth discussing. It should be noted that the range of services utilised overlapped somewhat with households income generating activities (for instance, welding, carpentry, sewing and shoe repairs) so will not be repeated here.

- **PV electricity for electrical repairs**; the basic electrical repairs operation required very limited power; usually focused lighting and soldering. These are well suited to PV and are available in 12V DC. While the market appears quite limited with only 8% of households currently utilising these services, the access curve for radios, televisions and 'hi-fis' is likely to increase considerably over the next few years. The global development agencies[4], governments and other stakeholders increasingly recognise radio (and to a lesser extent, TV) as the most prominent medium of communicating with rural folk. Radio offers access to information and knowledge and is increasingly being used as a medium for education as well[5].

- **PV for cellular phone recharging**; while the number of households utilising this service is presently small, this situation should change quite dramatically over the next few years. Network coverage will improve and the rural Basotho will experience a technology leap as cellular technology reaches regions where terrestrial technology has not yet made its mark[6]. While the current demand may not give rise to the most bankable business plan, demand will grow. Until such time, such businesses would do well to cluster related service offers and income streams. For instance, cellular phone recharging businesses should also offer public phone services or perhaps even car battery re-charging.

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[4] For instance, the Food and Agricultural Organisation (FAO) has a rural radio programme. http://www.fao.org/sd/ruralradio/

[5] The Freeplay Foundation in South Africa distributes Lifeline Radios to rural communities around the world to assist with training, education, HIV/Aids, etc. http://www.freeplayenergy.com

[6] For a list of projects/activities supporting this end see http://www3.wn.apc.org/africa/projects.htm

- **PV for car battery charging**; Twelve percent (12%) of the sample households claimed to have had their car batteries – used for household energy – charged either in the local village or outside this locale. PV is reasonably well suited to charging batteries although this does require fairly large installations; probably 500Wp and upwards. While there are 1000s of examples of PV battery charging stations across the developing world, the upfront capital costs can be quite prohibitive. What this requires is more innovative business operational and ownership structures – for example there are community owned charging stations in the Philippines and Thailand[7] – to overcome the first cost issues. While charging costs will be higher based on higher capital costs, the remote power advantage of PV battery charging stations means that the operator(s) can factor in customer transport savings into the charging costs.

- **PV for public phones**; 16% of the sample group have used public phones. There will be limits to the ability to provide this service due to the current extent of the network (these public phones will be cellular or GPRS data based services as landline services are not well developed in rural areas).

7.7.7 Energy supply and distribution

While there are productive use opportunities linked to improved access to biomass and modern energy resources, there is certain income generating opportunities to be found within the development of the distribution infrastructure itself. For instance, energy stores – small owner operated retail businesses – might be the most appropriate vehicle to ensure access to remote rural areas. Holding reasonably large volumes – and thereby reducing unit costs – the energy stores offer managed local infrastructure for the distribution of energy resources. This may additionally be bundles with other energy based services such as cellular phone charging, etc.

Depending on the biomass strategy recommended, there will be income generating opportunities in the management of lots, distribution of woody biomass, etc. One of the principle challenges here is that biomass fuels are regarded as a 'free good' without any established monetary value. Improved supply strategies may need to be operationalised on the basis of cash transactions which would necessarily commercialise these resources. There are signs that such processes are emerging, with those households consisting of elderly folk having to pay others to collect wood and dung, although payment may be for labour rather than the goods.

Nevertheless, depending on the shape of the energy supply strategy that emerges from the access programme, there will be a number of income generating opportunities associated with the operationalisation of this strategy.

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[7] See for instance, http://technosol.de/battchg.pdf

8. Pilot projects

The TOR called for a number of pilot projects for implementation immediately after completion of the programme. In terms of productive use, we would recommend focusing on a sewing business. Using PV electrical power, the pilot would assess/demonstrate how access to modern energy supplies would enhance the business case of an existing sewing business.

Optimal location/site

- The target will be an existing sewing business
- The business and its existing market will be located in an off-grid area
- There should be at least 250 households within a 5 km radius (HH density of 3.2/km^2)

Technology and hardware requirements;

- 50Wp PV module, charge controller, 60Ah+ battery
- Electric sewing machine
- Instruct beneficiary on routine maintenance requirement

Assessment

- Undertake an assessment of the business's pre-electrical performance (benchmark). Incude number of customers, type of jobs and net profit
- Limited training should be provided
- Allow operation for a full year with 2 x 6 monthly visits
- Assess business's performance 12 months later against benchmark data
- Assess technology performance.

Approximate hardware costs: $600

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