Input into the World Bank Energy Strategy Consultative Process- 2010

Best Practice Models for Energy Related Projects

FINAL

Summary of key points

This report was produced in response to the World Bank consultation process around its future energy strategy in southern Africa, and is aimed at providing a practical energy model that will address the energy needs of lower income households who do not have affordable access to decent energy services currently. In South Africa, this is currently estimated at 2.5 million.

The report draws on working case studies, that have the potential to be scaled up, and demonstrates that it is possible to provide sustainable and efficient energy services using renewable energy . The case studies include wind and solar hybrids, biogas power plants using chicken manure, and biomass waste for power generation.

Based on our case studies, the best practice model shows that while initial capital costs are high, the savings in operations are significant. For example, the use of renewable energy means that the pricing of the electricity will not be subject to the variable but ever increasing costs of fossil fuels If we reasonably assume that Eskom prices will continue to rise, and if we use a mini-grid tariff of R1.50/kWh (not the cheapest case study in our model), our renewable energy decentralised model will become cheaper than an average predicted pre-paid electricity unit by 2015.

Municipalities theoretically have responsibility for all the citizens in their municipal area. In the Ekurhuleni Municipality, as an example, the financing of energy efficiency is implemented through a method of ring-fencing some income from electricity (derived from a stepped tariff system, whereby high end consumers pay more) could be adopted as a model to finance part of the energy security roll-out to lower income households.

Our model includes a variety of funding mechanisms: innovative and sustainable financing mechanisms including ring-fencing of funds and cross subsidisation; private funding by connecting mini-grids to large industrial biomass plants; or if this is not possible, grant and donor funding. Furthermore treasury funds could be allocated to local authorities or local projects directly, which should be regarded as government investment in energy security, similar to the roll-out of electrification infrastructure.

Besides the benefit of meeting energy needs, the model also yields a number of societal benefits, often arising as spin-offs from the project. For example, being able to run lights for two or three hours a night leads to a feeling of greater safety and comfort, particularly in crime-ridden areas.

With unemployment standing at 22.9%, sustainable energy projects must include a livelihoods component. A study that looked at the potential for employment in renewable energy sector found that in electricity generation, renewable energy could yield 25% more jobs than coal.

The report examines key lessons learnt that would be important for replicating the case studies and also puts forward some recommendations for policy formulation.

Government policy needs to examine how the future energy needs of the country's population can be met in a way that is affordable and efficient use of resources, and improves social equity. Other research papers have looked at specific solutions for large scale industrial users, but this study attempts to focus on the needs of the historically disadvantaged and a way to provide them with long term stability in meeting their energy needs.

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1. Introduction

The World Bank Group (WBG) has begun the process of preparing its new Energy Strategy for the next ten years. This report, prepared by the Green Connection, working with the Bank Information Centre (BIC), provides input into how the WBG could contribute towards energy security in Africa, focusing on sustainable energy options that address climate change, poverty, ecological and economic sustainability.

This report highlights the key constraints to sustainable energy security and reflects on the WBG's contribution to date in perpetuating or addressing these constraints.

The report draws on a selection of case studies based in Southern Africa that demonstrate successful renewable energy or energy efficiency interventions. These case studies are deemed successful if they meet the following criteria:

1. Contribute to sustainable development of local communities i.e.:
    a. Improve community health and wellbeing
    b. Enhance energy accessibility at affordable prices
    c. Enhance access to clean energy
    d. Enhance economic productivity
2. Contain policy implications on the national renewable energy and energy efficiency policy regime
3. Have a replicable best practice model in question, that can be rolled out when resources become available

Much of the analysis focuses on South Africa as this is the system most familiar to the author. However, case studies from other countries have enabled some application for the Southern African region.

There have been a number of attempts at scenario planning for renewable energy in South Africa. Other studies (Banks & Schaffler 2006, Marquard et al 2007, Holmes et al 2008) have focused on integrating renewable energy into a centralised grid as part of a model that would see non-renewable electricity generation replaced by renewable electricity generation.

However, within Southern Africa, there are areas, where communities have no access to grid electricity and where cooking, laundry, space heating/cooling, telecommunications and economic activities are carried out with limited access to, and inefficient use of, energy. Due to high levels of unemployment, there are also large communities whose residents and extended families rely on social grants for survival, and, despite having access to electricity, make use of a diversity of fuels to meet their energy needs (Mahote and Cousins 2003, Dugard, 2008, Annecke 2009)

This paper is responding to the expressed aim of the World Bank, namely, "reducing poverty and inequality through investment in human and natural capital, accelerating and improving the delivery of assets and services to the disadvantaged segments of society" (pg 10).[1] as articulated in the country strategy of 1999. This paper also seeks to initiate a best practice model that will address the lower income households who do not have affordable access to decent energy services.

The best practice model aims to ensure that energy projects proposed for such communities are appropriate for the level of technological expertise that exists within the community in order to ensure that the communities can maintain the equipment. Poor communities could reasonably be expected to use more electricity as their economic circumstances improve. It must also be possible

[1] South Africa CAS: Public Information Notice. 1999. World Bank Board Discusses South Africa Country Assistance Strategy Sept 8th, 1999. Report No. PIN17, pg 10

to extend and add energy services to allow for such growth , and that such energy services will be financially affordable to ensure future sustainability.

Drawing from various sources (McDaid 2009, Sugrue 2009, Annecke 2009), a number of key factors contribute to energy poverty in South Africa:

- Within urban areas of South Africa, households are often unable to access affordable energy services and/or are dependent on "dirty" energy through the use of fossil fuel household fuels such as paraffin.
- Those with access to grid based electricity based on fossil fuels or nuclear, experience rising tariffs due to escalating costs associated with non-renewable sources.
- Economic activity is often suppressed or retarded due to the inability to access reliable energy.
- Energy is often wastefully used, impacting on future supplies, and such wastage contributes directly to increasing climate change, rising prices and decreased quality of life.

For climate change reasons, it is no longer possible to continue to rely on grid based electricity that is fossil fuel based, and therefore there is now an opportunity to do things differently. Climate Change awareness has resulted in several critiques of our current consumerist lifestyle and a needs based approach is coming back into favour. (Zipplies & du Plooy 2008, McDonald 2009 etc)

This report aims to provide a practicable energy model based on real life examples, rather than encouraging an investment based on theoretical savings or theoretical predictions of renewable energy supply.

Characteristics that have contributed to the success of case studies have been compiled into a list of key lessons learned that would be important for implementers of such programmes to consider.

2. Limitations and assumptions:

There are a multitude of small projects that include renewable energy in their supply mix. Local government has initiated a number of interventions, some of which are in the planning stage and others that are just off the starting block. For this report, the focus is on projects that have been underway for some time, with an emphasis on a diversity of small projects.

This diversity means that it is more difficult to make comparisons across projects and to make generalisations. This study should therefore be seen as dipping into a wealth of experience and drawing out some key trends and lessons in order to develop a best practice theoretical model.

Key assumptions underpinning this study are as follows:

- Electricity is part of, but not the total, of modern energy services
- Grant funding is not a sustainable development model for long term financing of renewable energy and energy efficiency but it has proved vital for solar and wind projects to date, and forms part of the short and medium term solution

- Eskom/utility grid extension is unlikely to be economically viable for rural poor households in the foreseeable future (in terms of cost recovery for the utility).

This model assumes that some progressive governance is in place. This would include energy policies, acknowledgement of climate change and the need to respond, the political will to provide affordable energy services to low income households, and some institutional framework that could provide for future renewable energy development in a decentralised manner.

The case studies are attached as appendices and provide the detail of how each project was implemented and should be read in conjunction with this report.

3. Approach

This study seeks to reflect on the energy needs of poorer and marginalised communities, their levels of poverty and how energy services might be provided to meet their immediate and future needs in a developmental context. Eleven case studies were assessed using a questionnaire that attempted to draw out some of the key issues and to then build a best practice model.

Although this study focused primarily on poor households needs, and how these could be met, it must be mentioned that the agricultural and biomass small industry provided examples of how the energy needs of small business could be provided in a way that enhanced energy security, both for the industry and for the surrounding community.

Given that most Southern African countries have capital cities where commercial activities, and government business is conducted, the study also looks at how public buildings could reduce their energy usage and become more energy efficient.

4. Challenges of World Bank programmes to date

4.1. World Bank Intentions

According to a public notice on the country assistance strategy to South Africa in 1999, the World Bank Group and South Africa agreed that the role of the bank would be that of a “knowledge bank”. In that paper, the World Bank Group (WBG) acknowledged that South Africa is a dual economy characterised by a small number of relatively wealthy households with modern energy services and a majority of households characterised by high levels of unemployment (38% in 1999), and lack of access to potable water, adequate sanitation or energy services [2].

In 1999, the WBG defined its role as primarily working with South Africa to reduce the Apartheid legacy of poverty and inequality. This was to be achieved through a knowledge partnership, learning from South African experience and providing advice.

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[2] Report No. PIN17
South Africa CAS: Public Information Notice
World Bank Board Discusses
South Africa Country Assistance Strategy
Sept 8th, 1999

The Country Partnership Strategy operational from 2008 to 2012 states that it will continue to support its environmental portfolio but will shift its emphasis towards energy efficient low income housing and clean household energy, with a comprehensive climate change initiative that included " (i) a review of options and costs to implement a low-carbon growth strategy, (ii) preparation of an adaptation strategy for rural areas, with a particular focus on the poor, (iii) a strategy for mainstreaming climate change adaptation strategies into the water sector, (iv) implementation of the national strategy to promote energy efficiency, (v) support the national renewable energy program, including a GEF grant; (vi) development of the carbon finance market through the purchase of carbon credits; and (vii) development of appliance regulations and housing standards."[3]

4.2 Has World Bank lived up to its aims?

In 2009, The Clean Technology Fund (CTF) of which the World Bank is part, announced that they have entered into an agreement with Eskom in South Africa to provide funding for renewable energy and energy efficiency including solar water heater roll-out and 100MW Concentrated Solar Power (CSP). [4] This demonstrates some commitment to renewable energy.

However, the WBG is also considering a loan to Eskom that would also finance a 4764MW coal fired power station (Engineering news 2010) . Civil society organisations, within South Africa and internationally have protested and issued media statements, calling for the WBG to withdraw their support for coal power stations (Groundwork, 2009). The expensive WBG loan of $3.75 billion will continue the business as usual approach that has seen electricity prices rise so significantly over the last few years.

An example from South Africa indicates the trend. In 2009, the regulator granted the electricity utility a 31.3% increase in order to maintain coal supplies to keep "the lights on". In 2010, NERSA granted Eskom a 24.8% increase for the 2010/2011 year with subsequent increases of 25.1% and 25.9% over the next 2 years respectively[5]. Eskom claims that these increases are necessary in part for ongoing coal and for maintenance, and for the Eskom new build programme which consists mostly of coal and nuclear based electricity.

Civil society groups are adamant that the World Bank loan should not go ahead and that World Bank funding should not be available for coal projects.

4.3 Future World Bank Energy Strategy

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[3] **The World Bank** Report No. 38156-ZA, **2007**

[4] http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22381922~menuPK:34464~pagePK:34370~piPK:34424~theSitePK:4607,00.html

[5] www.ElectricityMonitor.co.za

The World Bank issued its Energy Strategy Approach paper in October 2009. The approach paper is out for consultation as part of the World Bank consultation process, with the strategy due to be finalised early 2011. The consultative paper highlights the need to respond to the needs of the poor.

The future WBG energy strategy to enable access to modern energy services could be based on a best practice model as outlined in this paper, rather than continuing to fund large scale centralised solutions like coal that disproportionately impact on the poorest of the poor.

5. The context of energy poverty

Various data sources indicate that between 45 and 55 percent of all South Africans presently live in poverty (i.e., between 20 million and 28 million people), [Cousins and Mahote 2003]

It is understood that we have a divided global society and that in South Africa there is an ever increasing gap between the rich and the poor. According to the 2007/2008 Human Development Index (Conradie 2008), the richest 20% take 62,2% of the income and expenditure cake while the poorest 20% only use 3,5%. In South Africa, an upper income household consumes an average of 1000 kWh per month (Zipplies & du Plooy 2008), while a poor household may be dependent on the allocation of 50 kWh of free basic electricity (FBE) if they have access to electricity at all (Anneke 2009). If we examine the energy use for the rural poor it would equate to a household with a total income of R20 000 spending R4 000 on electricity each month (CURES energy poverty report (Sugrue 2009)).

The government national electrification programme raised the electrification rate to 80% by 2007. This still leaves about 2,5 million households, mainly poor rural households, without access to electricity. However, access to electricity does not equate to use of electricity as electricity usage is dependent on disposable income. With high unemployment (based on 2008 national income dynamics data, the conservative unemployment rate is officially 23% although if one includes discouraged workers, the rate rises to about 29%[6]) , the electrification figures have to be seen in the context of 2 million disconnections that have taken place due to an inability to pay (Sugrue 2009).

Many poorer, marginalised communities use fuel wood and coal to meet their energy needs. The external costs of deforestation and health impacts of coal and wood smoke are difficult to quantify. Women are exposed to indoor polluting smoke through cooking. It is estimated that this was responsible for 2,7% of global disease burden in 2000. Future projected deaths due to indoor smoke- pollution for sub-Saharan Africa are 1,8 million children and 1,7 million adult women between 2000 and 2030 (Commission on Climate Change and Development 2009).

Eskom, the monopoly state utility, has successfully applied for tariff increases over the last 3 years, with the latest increase potentially resulting in the average township household electricity expenditure doubling over the next 2 to 3 years. Clearly this will mean more people stop using electricity, given that many people rely on state grants - average R800 total income per month.

These tariff increases are motivated by the need to upgrade and maintain existing infrastructure and build new power stations.

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[6] J. Keswell, UCT 2010, pers comm.

At this stage, the new build programme is based on coal and nuclear mix and the current price tag is R285 bn. In 2005, nuclear reactor construction costs for the Olkiluoto reactor in Finland were given as between $2 300/kW, equivalent to R18,4 million per MW. Today, the estimated costs are around $4 000/kW, equivalent to R32 million per MW. The project is 3 years behind schedule, and experts predict that costs will rise still further (Schneider et al. 2009). In 2008, credit ratings agencies such as Standard and Poor, and Moody's put forward a construction cost for nuclear plants of $5 000 - $8 000/kW, equivalent to R64 million per MW.

It is clear that poorer customers have little chance of rising out of poverty, and affordable energy for productive use will not be possible on this trajectory.

Earlier work carried out by Banks and Schaffler (2006), the author (2007,2009), Holmes et al 2008, and using the SNAPP tool developed by WWF, demonstrate that South Africa can meet its grid electricity needs using a combination of renewable energy and energy efficiency.

Renewable energy has been castigated as being more expensive than coal, and although international trends demonstrate that factors such as scale and learning result in decreasing costs, the cross-over point has yet to be reached in South Africa. Such a cross-over point for wind is predicted to be met before the next coal fired plant is operational (Glynn Morris, AGAMA 2009 pers comm.). However, while renewable energy supporters are happy to see increasing tariffs for coal electricity and environmentalists continue to agitate for full cost accounting to include the externalities that are society's burden for fossil and nuclear generated electricity, such rising tariffs impact hardest on the poor.

Drawing from our case studies, it is apparent that it is possible to provide electricity and cleaner energy in a more sustainable manner. While initial capital costs are high, the savings in operations and maintenance are significant and it appears that in the longer term, the provision of energy for the poor and marginalised would be financially sustainable and the use of renewable energy means that the pricing of the electricity is not subject to the variable but ever increasing costs of fossil fuels.

6. Case Study findings

The selection of case studies was informed by the assumption that a secure supply of electricity is not equal to energy security. However, all case studies chosen included electricity as at least part of their energy supply, as it is generally acknowledged that electricity is a necessary part of modern energy services, but that its use for hot water heating and cooking is generally inefficient. For example, the percentage of energy lost from the time a unit of coal is burnt to produce electricity, energy is then transmitted through the transmission and distribution lines and ends up being used to boil water on a stove is 70% (Sustainable Energy Africa, 2006).

In most case studies, the choice of technologies for hot water was solar water heaters and for cooking the use of liquid petroleum gas (LPG). Where biogas is available, this can obviously replace the use of LPG, further reducing the dependence on fossil fuels.

CASE STUDY SUMMARIES:

Table 1: Estimate of ongoing energy production costs

Case study: Electricity Generation	Description	kW installed capacity	Cost: US$Cents/kWh[7]	Capital costs covered by:
1. NuRa household Solar Home Systems (South Africa)	NuRa is an energy services company offering off-grid energy services, including 50Wp Solar Home Systems, and gas sold separately, on a fee for service basis.	50 W	US$ = 1.57c/kWh fee	Govt /Donor investor
2. Gobabeb Degreee project: mini-grid powered by solar/wind/diesel (Namibia)	Gobabed (30 households) is on a mini-grid which runs off a Hybrid System made up of a combination of solar, wind, and diesel generation, generating 26KWp.	Peak 26 kWp	US$ = 0.21c/kWh[8] for locals And US$ 0.64c/ kWh or visitors	Donor
3. Nollie se Kloof minigrid powered by micro-hydro/solar/wind system (South Africa)	Nollie se Kloof guestfarm produces offgrid electricity using a minigrid system of combined micro-hydro, wind and solar.	27 kW	US$ = 0.18c/kWh[9]	Commercial
4. ErongoRED Walvis Bay wind turbine (Namibia)	A utility-scale wind energy converter was connected to the electricity distribution grid to supplement the power supply to Walvis Bay and consumers at Mile 7.	220 kW	US$ = 0.26c/kWh[10]	Donor
5. Tanwat Wattle plant biomass combustion, surplus energy sold to mini-grid (Tanzania)	Tanwat combustion of wattle chips provides a cheap and reliable supply of energy to power the plant, with the surplus power sold to a local	2500 kW	US$ = 0.10c/kWh	Commercial

[7] Exchange rate = R7 to the US dollar.
[8] Residents pay R1.50/ kWh and visitors are charged R4.50/kWh
[9] Calculated over 20 years using capital cost of R121 000 generating 5.74MWh/year
[10] Namibian dollars N$1.84

	mini-grid and tea factory			
6. Katani sisal plant, producing biogas (Tanzania)	Katani Ltd in Tanzania is a sisal plant with a 300kW biogas digester which uses sisal waste as a feedstock. The biogas powers a 300kW generator, the electricity from which is used in the sisal plant's operations. Community facilities and households also benefit from the gas/electricity.	300 kW	US$ = 0.18c/kWh	Donor
7. KwaZuluNatal chicken farm – production of biogas	Farmers in SA built a biogas plant that uses chicken manure waste to generate electricity for the farm, the houses and the workshop, up to 11,000 kWh/month.	1130 m^3 digestor	US$ = 27c/KWh[11]	Commercial
8. Mini case study: Solar, gas and SWH retrofit of middle- and upper-income household	Jon Adams retrofitted his house in Johannesburg, South Africa, with Solar PV and battery pack, SWH for heating water and gas for cooking.	Has displaced 7345 kW	US$ = 360c kWh [12]	Private

Case study: Energy Efficiency	Description	Energy saved	Costs covered by:
1. Kuyasa solar water heaters/ ceilings, lighting	A retrofit project involving the installation of SWH, ceilings/insulation & CFL lighting in 2 300 low-cost existing RDP	Savings estimated: R625.83 per household pa	Donor/ future sustainable financed (Carbon credits)

[11] First year would be 27c/KWh and after 5 years, equals - US$ = 5c/kWh.

[12] R300 000 capital costs - provides 80% of energy needs @1000kWh per month- first year = R25/kWh - after 5 years, still costing around R5 per kWh.

	(Reconstruction and Development Programme) houses in Khayelitsha, Cape Town, using public monies and carbon credit financing. This project is Africa's first Clean Development Mechanism (CDM) – and the world's first Gold Standard.		
2. Ekurhuleni Metro Municipality: Public buildings energy efficiency	Ekurhuleni Municipality implemented an aggressive tariff structure for upper end users, and obtained permission from the regulator (NERSA) to ringfence a levy from the increases with which to retrofit public buildings and invest in SWH for low-income houses	53% Savings	Donor/ local govt
3. Mini case study: Sol Plaatje retrofitting of street lights	The Municipality of Sol Plaatje replaced existing streetlights in Seochaoreng and Barkly road with energy saving streetlights.	Saved 30% of electricity demand and reduced maintenance by a third	Donor

All references and data calculations in the following sections are drawn from the case studies unless another source is explicitly quoted.

Using the Ekurhuleni public building case study, it was assumed that this municipality might have similarities applicable to other main centres in southern Africa. The case study drew on the South African municipality energy progress report and looked at how the local authority had saved electricity through the retrofitting of the Edenvale Community Centre. In this case, the energy savings were 53% and such energy savings would pay for themselves over a relatively short time - about 1.2 years.

Sol Plaatjie Municipality was one of the local authorities that invested in energy efficient public lighting. The result was approximately 30% savings in electricity demand and because the new lamps last longer, the maintenance costs to the municipality were reduced by about one third. However, the municipality listed additional benefits as people being “happier” and ”more efficient illumination thus creating a safer area”. [13]

In the Namibian case studies, technical issues such as linking into a grid, either through a regional distributor of a small mini-grid, despatching etc and the use of mixed sources of generation showed great success. For example, the Gobabeb case demonstrated wind, solar and back up diesel generation smoothly integrated into one electrical grid, and used a diversity of energy such as solar water heating and gas for cooking. The Erongo REd wind turbine enabled the Regional Electricity distributor to test out the various aspects of integrating wind energy into a grid and to satisfy themselves it was a workable solution.

While the Gobabeb project focused on providing a high level of service, the NuRa project provided a diversity of household energy, a mix of solar electricity for lighting and gas for cooking, but not integrated into a grid but provided to individual households. In both NuRa and Gobabeb, grant funding covered the capex and a fee for service model is implemented for ongoing operations and maintenance: the fees are R11/kWh and R4.50/kWh respectively (For Gobabeb, residents pay a subsidised rate of R1.50 /kWh).

One case study, Nollie se Kloof, demonstrated that off grid power could be produced at a much lower price using a hybrid that included micro-hydro generators. Nollie se Kloof produced electricity at about R1.30 kWh using a minigrid system of combined micro-hydro, wind and solar. South Africa and much of Southern Africa is dry, prone to droughts and extreme weather events and climate change is likely to exacerbate such trends. Where small perennial streams are suitable, microhydro should be considered given that at this moment, systems with micro-hydro as a component provide a similar level of electricity as the solar/wind examples but at a much lower cost.

Three case studies, Tanwat, Sisal and Chicken manure biogas looked at the possibility of taking agri-industrial waste and using it to generate electricity for their own use and for the surrounding community.

In all three cases, electricity was able to be generated at less than R1.50 per kWh. For Tanwat, the cost was R0.70, for the sisal plant, it was R1.26 and for the farmer using chicken manure, his electricity production cost was 60c for the first year and after five years, his levelised cost of production was 12c per kWh, far less than Eskom new build predictions.

In the NuRa project, the cost to households is R11 kWh. This is a high cost to the household although “acceptable” from their perspective given that they have no alternative. The use of solar home systems would appear to be best used in poor households as an intermittent measure until resources are found to build a minigrid with a diversity of resources. Where feasible, the inclusion of micro-hydro into the minigrid will result in lower cost of electricity.

[13] Cities progress report - Sustainable Energy Africa 2009?

In our case studies, the most successful technical solution that provides energy services at the most affordable cost is a mini-grid system based on biomass and linked to an industrial activity such as farming or tanning etc. The integration of industrial and residential energy system appears to provide the most affordable electricity to poor households.

Where there are no industrial or agricultural biomass stocks, the mini-grid can be based on solar and wind combinations but some mechanism should be implemented to provide additional finance to ensure equity with the current grid tariffs for urban customers, at least until parity has been reached. Such parity is not a long way off if the current research and international growth in the renewable industry is anything to go by (Agama 2006, Banks & Schaffler 2006, WWF 2009).

In conclusion, therefore, home systems that use a diversity of energy sources such as solar for electricity and gas for cooking, etc provide a poorer quality of service for a higher price than grid or mini-grid sources in poor households and are not financially viable even in the medium term in wealthy households.

7. Factors contributing to case study success:

7.1 High levels of stakeholder participation from project design to implementation

Successful implementation of projects often relied on champions, either a local community member or government or donor or NGO. This entity was passionate about the project, refused to accept setbacks and had a knowledge of the institutional and regulatory hoops that projects might need to jump through. For example, in the NuRa case study, the donor Nuon, continued to support the project at times when the government cancelled the project, or withdrew support, with the result that even when the government withdrew completely, the project continued.

In the case of Kuyasa, innovative and creative financing, and the seizing of opportunities by the technical advisor, south south north, resulted in a best practice model that added value to people's lives, and addressed climate change mitigation in a practical manner. This, together, with a human rights developmental approach, adopted by the current programme managers, is honing and improving a financially sustainable energy model.

Many renewable energy projects are funded either totally or in part through donor funding. While this is understandable given that renewable energy is characterised by high up front capital costs, zero fuel costs, and very low ongoing maintenance costs, there may be a tendency for donors or donors and governments to impose such "benefits" onto communities.

From the cases studied, it is clear that engagement with beneficiaries and their involvement in the project from the beginning leads to the highest success rates. In the case of Kuyasa, the community decided who the first beneficiaries would be, based on need. In the Tanwat or Sisal plant, the commercial business identified the need, and engaged with the surrounding workers and community.

In contrast, two Eastern Cape projects, the Hluleka and Lucingweni failed due to a lack of acceptance or ownership by the community. The Lucingweni project was significantly vandalised (Aitken et al, 2008).

Community dynamics should not be underestimated and are necessarily fluid. The NuRa project is a good example of what could be termed short term political expedient thinking. Local politicians were in favour of the NuRa projects initially as these provided electricity to households. However, once a national political policy of providing basic electricity to all was accepted, local politicians ambitiously declared that the NuRa electricity was not sufficient to power all the energy needs of the community and should be stopped because Eskom would bring grid electricity to the rural communities. This resulted in breaks in the programme roll-out - see NuRa case study in appendix A for details. Currently, it has become clear that Eskom is highly unlikely to reach these communities with grid electricity and the NuRa systems are back in favour once again.

A case study that shows how to successfully engage communities from the outset of a project is the Green Connection's pilot Climate Change Awareness model, that was rolled out during 2007-2010, reaching 5000 people in its first year. The climate change model focused on creating awareness of possible climate change impacts in the rural Western and Central regions of South Africa which are predicted to be hardest hit.

The project consisted of several phases, including a survey to deduce current knowledge, a series of interactive workshops, the production of a climate change information and adaptation DVD, a handbook in 3 languages; a climate change website, and finally an evaluation phase where telephonic interviews gauged the reactions of participants to the model. The model provided a diverse range of energy interventions, including renewable energy technology, that local communities might implement in order to adapt to climate change (Final Report – Climate Change Communication Campaign, Green Connection, 2008).

A workshop presentation model was designed specifically to encourage participation and draw out information from participants' own experiences. The model included activities and videos such as: role-playing activity – mock radio interviews (an exercise which other conservation and community organization have since replicated), YouTube videos, and groupwork activity. In order to assist with livelihood development in the energy sector, the next phase of the project involves mentorship of local entrepreneurs in the roll out of specific energy interventions. The initial energy intervention chosen by the communities (in a series of workshops specifically developed to bring the community on board and get their buy-in) focused on fuel-saving stoves, and the use of solar pv and solar water heating are possibilities into the future.

The climate change adaptation awareness materials have also been used by rural NGOs such as the Green Network in KwaZulu Natal and will be used by Gender Advocacy projects such as GenderCC Southern Africa. Any RE or EE project developed for rural livelihoods should first ensure community participation and be transparent; and as such, when budgeting for such projects, it is useful to include a series of introductory and interactive workshops that can establish a good relationship between project developers and the community from the outset.

Lessons learnt:

It is important to have strong support and engagement with beneficiaries before the project starts

Well capacitated technical advisers that have experience with such projects must be on board throughout the project, and maintain strong links with the community members in order to feedback and address any technical hitches

7.2. Understanding legal and institutional frameworks

Climate or energy policies do focus the attention of political leadership and this can lead to sound financial support of mechanisms such as Renewable Energy Feed In Tariffs (REFITs) or willingness to buy power into the grid. The Namibian minister launched the wind farm, and praised the Gobabeb model for its potential to roll out to 2000 villages in Namibia. Both Tanzanian power plants were able to connect to the mini-grid due to a policy that allows independent power producers to sell their surplus electricity into the grid, without apparent difficulty. This shows positive institutional arrangements are in place, unlike South Africa, where despite the REFIT having been passed, institutional issues continue to delay the connection of power plants into the grid.

For most cities in South Africa, there are processes underway or have been completed to produce an energy plan/ strategy or climate change strategy that focuses mostly on energy. Although policies and energy strategies were important, projects can be successful without such legal intervention. Cities such as Cape Town initiated a process to put in place a by-law to compel all new buildings to have solar water heaters (with electrical backup) instead of electric geysers. This process has become entangled in bureaucratic internal consultations within the city and some intergovernmental strife as to where to locate the law, such that this law has yet to reach fruition. Yet Projects in the City of Cape Town, such as Kuyasa SWH project , continue without such bylaws, and are not waiting for the law to catch up either.

Local government is dependent on electricity sales for the bulk of their revenue and this is an important consideration to take into account. Energy efficient households and businesses mean less electricity sales and this means less income to the cities.

Knowledge of institutional arrangements allowed Ekhurhuleni to approach the regulator and get permission for an alternative mechanism. The mechanism provides a financially sustainable mechanism to institutionalise funding on sustainable energy implementation without creating unnecessary bureaucracy.

In the case of Ekurhuleni, a director of Energy position was created on an equal level to the three other directorates in the Electricity and Energy department. The targets set by the local government for renewable energy implementation are also captured in the Service Delivery Budget Implementation Plan.

Lessons learnt:

While energy policies and guidelines are helpful, the success of the project is not dependent on new legislation etc.

Good working knowledge of the legal and institutional frameworks enables sustainable energy proponents to find solutions that are practical and effective, so that implementation will take place ahead of institutional or legislative reform.

Private partnerships that are integrated into the broader community via a mini-grid and via a legal contract with government are also a recipe for success.

7.3. Innovative financing mechanisms

The key barrier to successful project implementation identified by those interviewed for the case studies was finance. Renewable energy solutions require upfront capital expenditure and in most cases, the beneficiary households are not able to raise the finance at a rate that is financial viable over a reasonable timeframe.

For South African cities, electricity derived income is the major source of income and therefore, cities appear reluctant to take steps that might impact negatively on their revenue base. The Ekurhuleni municipality has been able to provide finance for energy efficiency and renewable energy, clearly demonstrating its public benefit to the municipality. The Sol Plaatjie case also demonstrates that the financial savings achieved through energy savings and reduced maintenance was significant and warranted the upfront initial investment.

Although Eskom claims that there are only 2 million households that do not have access to the grid, it is also true to say that many connected households do not use electricity because they cannot afford to.

At an initial glance, the prices charged to end users appear high compared to grid electricity from the national utility, for example, NuRa - R11 /kWh. These reflect the real costs of providing electricity, as opposed to Eskom tariffs that do not include externalities, or reflect the total costs of new build. However, at the current moment, Eskom provides the urban dwellers who live close to the grid with electricity at about a tenth of the Gobabeb prices, and in Namibia, grid electricity in town would be about 55c/kWh. If this is a model to provide energy services to the poor, it is clearly inequitable that poorer less resourced communities should have to pay more for a similar level of service.

However, it is important to examine this in a little more detail. Firstly, from a utility perspective, the extension of a 22kv grid costs approximately R100 000 to R150 000 [14] per km and is not financially viable to supply such infrastructure to rural communities whose electricity needs do not justify such expense. Smaller mini grids and home systems are definitely a smarter use of resources than centralised large power plants with associated transmission losses and major grid extension costs. However, some mechanism needs to be found to provide additional finance into such systems to address issues of inequity.

For Nollie se kloof, the cost of Eskom electricity would have resulted in an initial payment of more than the capital cost of the renewable alternative installed plus an additional monthly fee for the equivalent level of energy service, whereas once the infrastructure is in place, the ongoing maintenance and operations will be minimal.

Within South Africa, the current electricity crisis has led a few wealthier households to consider taking themselves off the grid entirely. Such a case study is useful to consider as it could provide a

[14] See Erongo Red and Nollie se Kloof case study

model that illustrates the level of service that households in the programme would eventually need as their energy demand increased due to a raising of the quality of life.

The NuRa case study had a price tag for households of R11 kWh. In the Adams' case, his retrofit that used solar pv panels, solar water heaters and gas for cooking cost about R300 000. Over the first year, his average cost of energy would be R 25/kWh. Even if one spreads the capital costs over ten years, it is still R2.50 /kWh, and is likely to be much higher than Eskom provided electricity for some time. Even if individual home owners are prepared to pay such rates for energy security, such private initiatives are beyond the scope of poor households and alternative energy solutions need to be found.

Institutionally, who should take on the finance? Within the Tanzania sisal project, the finance was supplied by the private company. In Namibia, the Danish government partnered with Namibian government for the Gobabeb project and the Walvis Bay wind turbine. In South Africa, carbon finance is a key source of finance for Kuyasa. If we assume that it is not sustainable to rely on foreign grants (whether termed aid, carbon finance, or carbon debt repayments), then we need to find an efficient effective tried and tested method of managing and raising finance.

Options for financing include the use of renewable certificates and carbon financing through CDM. For the Kuyasa project, the first *gold standard CDM* African Project - the capital costs were provided through grant funding, city funding and Carbon finance. The current principles of carbon finance which have allowed developed nations to continue with business as usual while offsetting their emissions in a developing country appears to have failed to mitigate climate change. Given the state of the climate change negotiations internationally at this moment, it is not clear to what extent, climate change related finance will be available in the future.

Municipalities theoretically have responsibility for all the citizens in their municipal area. In Ekurhuleni, the model of ring-fencing some income from electricity and using it for energy efficiency could be adopted to finance part of the small scale roll-out. This is a potential model in capacitated and well-resourced municipalities such as Ekurhuleni but may not be possible within other smaller less capacitated local governments.

The use of stepped tariffs, where those that use more pay more, can have two complementary impacts. The higher end users may use less, contributing to overall energy savings, and the increased income from the higher rates for high end users, could provide some additional income that can be used to subsidise the free basic electricity allocation for poor households.

In the Ekurhuleni local authority, households who consume more than 2500kWh pay R1/kWh, and this is combined with an amount of 100kWh free basic electricity allocation. [15]

Lesson learnt:

Private sector driven electricity generation projects do not necessarily need finance support but need institutional support to enable them to sell excess electricity into a grid in a way that is financially viable for them. Access to the grid and tariff structures are important.

[15] Current energy projects - Ekurhuleni - part of SEA report on local municipalities.

For renewable energy and energy efficient projects driven by municipalities, innovative financing mechanisms including ringfencing of funds and cross subsidisation can enable sustainable energy implementation.

7.4. Appropriate technological interventions

The choice of technology must be appropriate to the community needs. The NuRa project has suffered due to lack of understanding about the quality of energy service supplied. Community members equated electricity with Eskom grid electricity, technically sufficient to meet all household needs. The provision of sufficient electrical infrastructure to meet lighting and some communication needs was acceptable when combined with the provision of LPG for cooking and water heating. It is important that recipient communities understand the limitations of the technology on offer.

The technical interventions need to be aligned with the need to provide services in a way that improves the quality of life of the poor and vulnerable households, improves their energy security, and has a positive impact on health and other societal needs, where possible in a financially sustainable manner.

Clearly, where households have a variable and minimal household income, the provision of housing should not add to the household burden. Retrofittings such as ceilings in houses was done as part of the Kuyasa project, with clear space heating benefits as illustrated in the case study.

Access to lighting enables home study in the evenings. A study carried out in Bangladesh reported that 90% of recently electrified households showed improvement in children's study (Commission on Climate Change and Development 2009). Such benefits contribute to addressing poverty but the benefit is only realised in the future (children's education).

It is also possible for commercial activity to continue after dark and enables television and other communication, and increases personal security. Being able to run lights for two or three hours a night leads to a feeling of greater safety and comfort, particularly in crime-ridden areas (Anneke 2009).

With unemployment standing at 22.9%[16], sustainable energy projects must include a livelihoods component. A study that looked at the potential for employment in renewable energy sector found that in electricity generation, renewable energy could yield 25% more jobs than coal. (Agama Energy 2003).

In Gobabeb, an energy manager was capacitated to enable maintenance and most repairs to be carried out on site. The Kuyasa project offers one person from each household an opportunity to be trained in a skill that would be of broader benefit to the community as well as the individual, for example, first aid. The Kuyasa project found that many of these people were able to get jobs subsequently, raising the level of household income and therefore increasing their ability to pay for energy services.

[16] http://www.indexmundi.com/south_africa/unemployment_rate.html

Other economic impacts were that households were able to use their financial savings to increase their economic productivity, for example, buying a fridge to store meat enables a woman to expand her food preparation business. (Mahote and Cousins, 2003).

An important finding for the case studies, particularly Kuyasa and NuRa, is that the benefits of the technology intervention are not necessarily immediate financial benefit. The Kuyasa project draws out the non-financial key issues that impact on the society. For example, the installation of ceilings meant that less sand came into the house, making life more comfortable and the ceilings also meant that the house was warmer in winter. Local homeowners were able to understand the science of the improvements as the data-loggers were in their homes and the results were provided to them as part of building their own understanding of energy issues. Other impacts are more difficult to measure. According to Mahote and Cousins (2003), when the ceilings were first installed, neighbours came to look. The owners tried to keep the ceiling pristine and white, as a sign of order and it appears that ceilings enhanced the status of homeowners in the community.

"The warmer houses in winter attract neighbours and visitors so that they become sites of important social processes. They have also improved indoor air quality which has in turn improved the health of the occupants. The ceilings also keep blown sand out of the houses, which is a problem in Khayelitsha. The net effect of the savings generated by these interventions is reduced strain on household budgets and social networks"(Mahote and Cousins, 2003).

Lesson learnt:

Technology interventions have health, education and other socio-economic benefits that are difficult to quantify. Although difficult to quantify, such benefits need to be included in integrated energy scenario planning for addressing poverty.

8. Best practice model

The case studies looked at the supply of electricity at household level, mini-grid systems for villages, production of electricity for industrial applications and some agricultural applications that could be used to supply electricity to the surrounding villages.

South African Local authorities have implemented energy savings measures and one or two case studies provide the illustrative possible impacts.

Generally, towns and cities use electricity in a less than efficient manner, and this study also took examples of energy efficiency for public buildings and looked at the implications of replicating this across the region.

Drawing on the case studies it is clear that the key barrier to meeting energy security needs for poor households is not a lack of technical solutions but the financial capital costs and the institutional mechanism to ensure sustained delivery in the absence of one-off donor projects.

Many renewable energy projects are initiated using donor funding, so for each case study, the source of the capital expenditure for the projects is indicated. It is important to note that in most cases, the start up of the project depended on donor funding.

The best practice model proposed in this paper, consists of two phases, phase1 is project based and runs independent of local government involvement. Many of the case studies show that renewable energy projects tend to be initiated as demonstrations. However, in order to be sustainable, institutional financing mechanisms need to be put in place. Phase 2 aims at local governments that would like to progress beyond policies, targets and strategies and implement renewable energy and energy efficiency in a financially sustainable manner. Appendix 1 attempts to show the phased approach of the best practice model.

Phase 1:

This best practice institutional model assumes local authority endorsement and acceptance of the sustainable energy project but does not rely on local authority staff to implement it. Kuyasa is an example of such a case study that specifically focused on low income households.

In this model, the project is identified by local community potential beneficiaries, together with developmental organisations such as Non government organisations working with communities. In the first phase the capital costs must either be borne by the external finance or the household must pay over an extended time period. Grant funding is sourced either from international aid money or national treasury grants. In the case of Kuyasa, the money was from the national Department of Environmental Affairs. This project also uses carbon finance as a funding mechanism but as outlined earlier, this is controversial, and the model should therefore not depend on such revenue

The implementation of the project is done through a private organisation or NGO, and external verification and monitoring takes place[17]. For Kuyasa, the current implementing partner has provided technical expertise in order to improve on the level of service initially proposed and is able to provide additional services to build the skills and economic opportunities of the participating community.

At the customer level, the participants gain the services they need, such as ceilings, lights and solar water heaters for which they pay a monthly fee. The monthly fee is not currently linked to the electricity billing system and it has proved a challenge to collect the monthly fees. Some creative thought is currently underway to determine how to ensure regular collection of the fees, including linking this into the city’s pre-paid billing system.

Such households have low levels of income, may be reliant on part time or piece work and would be dependent on paraffin or wood if the sustainable energy interventions had not been implemented. Although residents might be aware of the benefits of installing ceilings, lights and solar water heaters, the capital costs for individuals are expensive.

Will the local authority be sufficiently capacitated to oversee the maintenance and continued survival of the programme without the continual support of the technical partner.

Kuyasa has successfully rolled out 1662 solar water heaters and the implementing partner, SAEDF, plan to continue with the financial model they have developed, providing quality energy and social training services to local participants. The model would mean that revenues from paying households and carbon revenue would be ploughed back into organisation in order to continue implementation. Over the longer term, this might prove to be sustainable.

[17] For Kuyasa, such monitoring and verification is part of the CDM certification

Challenges : 1. Finding an institutional home

One challenge of such a model is to find it an institutional home that will oversee the continuation of the service beyond the life of the private company. While it is commendable that organisations like SAEDF are dedicated to continual support, not all project implementers would necessarily be available or prepared to do so. Such support is necessary to enable householders to know where to get spares, access repairs etc (Mahote and Cousins, 2003). In the NuRa case study, the stop-start nature of the programme increased its instability.

In the absence of benevolent NGOs, carbon finance streams and international grants, are there other financial institutions that would enable low income households to procure energy services at a rate that they could afford.

The Kuyasa fund [18]is a micro-financing institution that lends money to householders who are unable to access credit from conventional banks. The fund lends money for household improvements, such as extensions to homes etc. Such a fund has a rigorous process of screening, provides technical advice to ensure that the client is not wasting their money and has a process of revenue collection that is successful.

Such micro-financing institutions could also be used to enable local households to purchase solar water heaters, ceilings and lights themselves. The Kuyasa fund receives grant funding and large tranches of finance that it then uses to finance improvements to individual homes directly.

Challenge: Lack of intergovernmental co-operation

In the case of Kuyasa, both the Department of Environmental Affairs nationally and the provincial government provided money for the project. Retrofitting projects such as Kuyasa have broader benefits than energy services, as highlighted earlier in this paper. For example, health and social benefits, job creation and the provision of training are all positive spin-offs to date. However, there have been no allocations of treasury funds to Kuyasa from the health or labour budgets.

Government departments tend to operate in silos. Integrated energy solutions, as demonstrated by our case studies are not simple technical fixes. The technological intervention has a number of societal benefits, often arising as spin-offs from the project, rather than planned as part of the intervention.

The challenge is to evaluate sustainable energy projects in terms of their ability to meet broader socio-economic needs, and not to focus on the narrow technical or financial viability as the only means of determining and rating its success.

In the absence of grant and donor funding, it will be necessary to consider treasury funds to be allocated to local authorities or local projects directly. This should be regarded as government investment in energy security, similarly to the roll-out electrification infrastructure.

Phase 2

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[18] See Kuyasa fund - www.the**kuyasafund**.co.za

In Phase 2, the local authority plays an active role in providing energy efficiency and renewable energy in a systematic way that is integral to and not outside of its normal operations. The model is based to a large extent on the Ekurhuleni case study.

This model provides a best practice example of institutional, financial and performance monitoring for energy efficiency and renewable energy implementation.

Institutionally, the function was located within the municipality and given status through the creation of a separate but equally important directorate within the electricity department. Financially, no legislative or bylaw amendments were necessary in order to circumvent any other financial legislation. Instead, existing legal mechanisms that allowed a separate fund to be created through approaching the regulator were used.

The condition set by the regulator, that annual audits must be done, as well as the integration of the targets into the performance management of the staff (through the link to their performance bonuses), provides a monitoring and verification process that is externally auditable.

In Ekurhuleni, the money has been spent on refurbishment and addressing backlogs. The targets set for solar water heater roll out in 2010 are linked to the Eskom subsidy programme and the local government is focusing on solar water heaters for its rental stock while the subsidy programme linkages are resolved.

The regulator authorised the fund on condition that an external audit be carried out to prove that the money was only spent on the functions specified. For the first year, it would be recommended that a small percentage be requested, Ekurhuleni received 0.25% and in the first year, allowing systems to be set up and tried out, to overcome teething challenges.

A mechanism was also found that enabled funds to carry over to the next year if necessary. These funds are then used to carry out the stated aims of the ring fenced fund. Once the fund was established with its own structure within the local authority, amounts allocated to the fund can be specified within the tariff and not on top of it.

Such a mechanism provides a financially sustainable mechanism to institutionalise funding on sustainable energy implementation without creating unnecessary bureaucracy.

Once the concept of a dedicated fund for energy efficiency etc, is established, the structure can then be given status and priority within the local government operational framework. In the case of Ekurhuleni, a director of Energy position was created on an equal level to the three other directorates in the Electricity and Energy department. The targets set by the local government for renewable energy implementation are also captured in the Service Delivery Budget Implementation Plan. In the case of Ekurhuleni, the service delivery budget implementation plan is reviewed quarterly at the highest level in the city. The targets are perfectly measurable and are set in order to reduce or eliminate the city's backlogs in the area of solar water heating or renewable energy. The targets are also directly linked to performance bonuses and so municipal staff have excellent reasons to find creative ways to achieve their targets.

Examples of such targets used by Ekurhuleni for 2010 and 2011 are given below.

Performance indicator	Explanatory notes	TARGETS

		Backlog	2009/10	2010/11
Number of street lights replaced with energy efficient luminaries	Capex and maintenance funding.	100 000	5 000	5 000
Energy efficient lights in all EMM buildings – number of lamps replaced	Capex and maintenance funding.	50 000	10 000	20 000
Number of solar geysers installed	CEF to resolve financing barriers, admin matters in EMM.	200 000	2 000	5 000

This model provides a best practice example of institutional, financial and performance monitoring for energy efficiency and renewable energy implementation.

The Ekurhuleni model used initially for infrastructure backlogs, has been in operation since 2005, and clearly, the model is financially sustainable, providing a workable solution for municipalities to enable energy efficiency and renewable energy investment, particularly to lower income customers who would not be able to fund this service themselves.

Services to households that could be funded by this model could be investments in renewable energy technology, based, for example, on biogas from the sewage facility; or solar water heaters, or hybrid systems of solar/wind/micro-hydro.

With Electricity, implementation institutions can be REDs (Erongo RED), or local authority such as Ekurhuleni, or rural mini-grid as run by industry, for example Tanwat.

9. Implications for Policy formulation

As part of any country's commitment to addressing and responding to climate change, as well as a commitment to sustainable development, there is a need to direct a transition away from finite sources of energy such as coal or nuclear, and towards the increasing use of renewable energy. "Although coal is by far our largest non-renewable energy resource with an impressive energy reserve of 1,298,000 PJ[19], it is far less significant in comparison to our largest renewable energy resource, namely solar with an energy reserve of 8,500,000 PJ/year. The total coal reserve is 1,298,000 PJ, the annual solar reserve is 8,500,000 PJ. Thus, our total coal reserve is only equal to around 15% of the solar reserve that is available to us every year" Lukey, 2008.[20]

The case studies demonstrate that renewable energy and energy efficiency are energy services that can be rolled out in a manner that contributes to poverty alleviation. The case studies also highlight certain factors that need to be borne in mind during policy reviews. These factors are briefly discussed below.

1. *Matching energy to service demand*

[19] Our Uranium reserve is far less than our coal reserve at 157,853 PJ, i.e. it is only 12% of our coal reserves (Lukey 2008)

[20] Peter Lukey, 2008. Department of Environment Affairs, Presentation at WWF Renewable Energy conference, 7 November 2008 in Sandton.

Delivery of household energy services is often assumed to be electricity and there is a belief that grid based electricity is the "best" electricity. Policy formulation for energy services needs to look at the most efficient use of the type of energy. Lighting using electricity provides a safe effective form of energy while cooking with gas is a more efficient use of the energy resources, and preheating water with the sun is a no brainer in a country with the solar resources of South Africa and our northern neighbours.

2. Prioritising the role of local government

Energy provision to low income households and to smaller communities is often derived from national policies. While this is an integral of national planning, local government is often best placed to deliver. The role of local government, both as an institution driving service delivery and a financial institution responsible for revenue collection need to be considered.

3. Sourcing external financing and micro –finance where suitable

Credible micro-finance institutions can play an important developmental role in advising households on energy services they could invest in. Customers need to be informed about the financial and social benefits that generally outweigh the initial financial costs associated with measures for energy efficiency and, for example, solar water heaters .

Current capex for renewable energy is expensive and energy service delivery policy needs to link to industrial and education and training policy in order to create new renewable energy industries that, through economies of scale and derived learning, drive the price down.

Institutional arrangements need to be established for situations where external funders and investors to enter into agreements with local authorities or private partners as a kick-start programme for sustainable energy roll-out. Such institutional arrangements need to include a longer term relationship that will ensure relevant government institutions' capacity for long term project continuity.

4. Harnessing renewable energy employment opportunities

A study conducted in South Africa in 2003 investigated the comparative direct job opportunities associated with various energy technologies and found that renewable energy technologies offer at least 25% more direct jobs than the coal industry. The solar water heating sector could potentially provide 8733 gross direct jobs per unit of energy as compared to 700 in coal fired generation, for example.

In Kuyasa, teams of installers were trained and about 87 people are now employed in the project. In addition, part of the social compact, was that each household could put one person forward for training, and a number of those who received skills training are now employed.

With the climate change pressures on fossil fuel related jobs, the potential of the renewable energy sector, particularly in the biomass generation and energy efficiency sectors, needs to be included in government economic and industrial policy.

5. Incorporating women in energy-related matters

Although not a specific focus on this study, the Kuyasa social research study clearly indicates that the women were the decision-makers in the field of household energy security. Women managed the household budget and had to make energy choices dependent on available money, weather and ability to use social networks to get credit for paraffin or electricity.

Other research (Anneke 2009, Sugrue 2009) has clearly confirmed the role that women play in ensuring energy security for their households, and policy review processes and energy planning should ensure that there is space for women's voices to be heard, and their expertise utilised.

6. A decentralised energy planning approach

The best practice model that has been described here has focused on energy services for the poor and marginalised. The provision of energy services through this model would mean that the 2 million households not connected to the national grid would receive modern energy services without extending the national grid. Future energy demand predictions would need to take this into account. Peri- urban poor income households as well as wealthier households might adopt solar water heaters, gas cooking and could install solar and/or wind produced electricity and small industrial customers might switch to using waste for energy and meeting their own electrical needs and possibly feeding into the grid as has been demonstrated in Tanzania.

The end point would be a number of mini-grids operating under the local municipalities, mostly with private partners, and the role of the national utility and national grid would largely be one of back up and possibly supply to large industrial customers.

From an electricity consumer perspective, as has been stated, electricity price increases impact on disposable income and this will mean particular hardship for households that are dependent solely on the free basic 50 kWh per month.

Future electricity prices are likely to rise significantly. With Eskom consistently seeking tariff increases in order to fund its new build programme, the implications for the cost of food and other goods is likely to be significant. Imagine if the electricity tariffs had to rise to cover a 300% increase in construction costs over a period of four years. Such imaginings have been substantiated by recent press reports indicating that the Eskom tariffs could potentially rise between 300% and 670% over the next 5 years.[21]

10. Lessons for replicability:

Going forward, a number of key points arise.

10.1. Criteria to assess project potential

In order to scale up the implementation of renewable energy and energy efficiency, key lessons derived from this study form a set of criteria against which projects should be assessed in order to determine their chances of success:

- *It is important to have strong support and engagement with beneficiaries before the project starts, and throughout the project implementation*

[21] http://www.sowetan.co.za/article.aspx?id=1076461

- *Well capacitated technical advisers that have experience with such projects must be on board throughout the project.*
- *While energy policies and guidelines are helpful, the success of the project is not dependent on new legislation etc.*
- *Good working knowledge of the legal and institutional frameworks enables sustainable energy proponents to find solutions that are practical and effective, such that implementation will take place quicker than attempting institutional or legislative reform.*
- *Private partnerships that are integrated into the broader community via a mini-grid and via a legal contract with government can be highly successful.*
- *Private sector driven electricity generation projects do not necessarily need finance support, but need institutional support to enable them to sell excess electricity into a grid in a way that is financially viable for them. Access to the grid and tariff structures are critical.*
- *For RE and EE projects driven by municipalities, innovative financing mechanisms including ring fencing of funds and cross subsidisation can be put in place to enable financially sustainable energy implementation.*
- *Technology interventions have health, education and other socio-economic benefits that are difficult to quantify. Although difficult to quantify, such benefits need to be included in integrated energy scenario planning for addressing poverty.*

The financial model proposed in this study allows for the use of grant and development finance but if the Ekurhuleni financial model is used, it is not dependent on it. However, the *rapid* implementation of such a model would necessitate the part subsidisation of the capital costs as per the Kuyasa case study.

10.2 Scaling up project implementation

The easier steps for implementation (“low hanging fruits”) are the energy efficiency ones, the results pay for themselves within a short time period and the energy savings are easily demonstrated to other cities or towns that wish to do the same. Energy efficiency could also be scaled up significantly and the costs of such efficiency interventions can be recovered through electricity savings as per the Ekurhuleni and Sol Plaatjie case study.

According to Carl Wesselink, from the Kuyasa project, the costs of supplying the country’s 3 million low income houses with Kuyasa project type interventions would be a quarter of the amount of building a power station to supply them with electricity to run electric geysers, heat their houses and run energy inefficient lights. (Wesselink, pers comm. 2010).

Using the Kuyasa case study, that established a fee for service of about R30 per month, local municipalities or implementing agents would be able to collect approximately R360 per household per annum.

Using a form of cross-subsidisation, as allowed by NERSA under the Ekurhuleni model, such projects could be viable within a couple of years and certainly the savings in terms of health, and other socio-economic benefits make this something of great public significance.

If one looks at households being supplied with a mini-grid system, such systems would be beneficial for poor households as they would be shielded from ever-increasing electricity tariffs associated with continuing business as usual fossil and nuclear expansion. The electricity tariff increases granted by Eskom over the last three years have been lower than Eskom requested, and some new build has been delayed as a result. It could be assumed therefore that increases will continue. If we use a mini-grid tariff of R1.50 /kWh (not the cheapest mini-grid), then at a rate of approximately 25% increase per annum, the renewable energy decentralised model will become cheaper than an average pre-paid electricity unit by 2015.[22]

This is a very crude calculation and further detailed technical analysis would be necessary in order to refine the exact investment needed and the possible returns. However, it serves to illustrate an alternative energy scenario to the current emphasis on centralised power plants.

Government policy is to provide all households with electricity and indications are that it will be cheaper to provide households with solar/pv mini-grid systems than through extending the national grid. The question remaining is whether South Africa should borrow from the World Bank to fund such interventions?

What can the World Bank do?

Based on the case studies, the feasibility stages, engagement with beneficiaries, legislative and bureaucratic processes, financial management systems, and monitoring and verification systems take approximately 1-2 years to set up. The recommendation is that the World Bank consider financing a two year feasibility phase that puts in place the institutional framework to enable implementation of a programme as outlined in this study. In addition, the WBG could fund three pilot Kuyasa type projects in three municipalities ("phase 1" of the model proposed in this paper) and then integrate them into an Ekurhuleni type model ("Phase 2") - with funding to include technological expertise and monitoring and evaluation.

Phase 2 would then include further phases of implementation, rolled out in small units followed by monitoring and assessment in order to adjust the programme in the light of unforeseen changes. E.g. legislation change, new technology etc.

In South Africa, local municipalities include 60% of the electricity consumers. The Ekurhuleni local authority demonstrated how existing financing mechanisms within local government are sufficient to implement the energy services. Large financing institutions such as the WBG could lend to local government directly or provide finance to organisations like the Development Bank of South Africa (DBSA) in order for them to manage finance flows to local authorities on a national scale. It is conceivable that such a model could be rolled out for all local authorities in South Africa starting with the larger and more enthusiastic local authorities, and then providing mechanisms whereby capacitated municipalities could then assist less capacitated ones.

[22] Starting from a Feb 2010 base of 53c/kWh (prepaid as most poor households are on prepaid) and using Eskom tariff increases until 2013, and then extrapolating the trend of a further 25% for another 2 years.

For areas where local authorities are less enthusiastic, the private partner model could be followed. Large financing institutions such as the WBG could then lend the finance to the DBSA and allow them to direct financial flows to smaller projects.

There is always a temptation to take a best practice model and scale it up quickly, replicating it rapidly in many different localities. The case studies have emphasised the importance of working with communities and ensuring local buy in. Such an approach takes time. Demonstration projects with a few households such as the Kuyasa model allows for local members of the community to interrogate the project impacts and to be convinced of their worth. In this regard, the use of experienced local project implementers cannot be overemphasised. For all scaled up implementation, it is recommended that a phased approach be adopted. Communities be serviced sequentially, rather than a "massive upscaling all at once" approach which would roll out many projects simultaneously, resulting in insufficient expertise to make each project a success.

This best practice model (described in this study) provides for a qualitative and quantitative increase in the quality of life and provision of services to the poor and vulnerable communities, and does so in a manner that is not feasible for grid based utilities. The model is a decentralised one, does not rely on large transmission lines (therefore transmission losses are a non issue) and the end result is the provision of appropriate sustainable energy services at a cost that is conceivably less than if those same communities were to be provided with Eskom based electricity in the future.

Government policy needs to examine how the future energy needs of the country's population can be met in a way that is affordable and efficient use of resources, and improves social equity. Other research papers have looked at specific solutions for large scale industrial users, but this study attempts to focus on the needs of the historically disadvantaged and a way to provide them with long term stability in meeting their energy needs.

It must be emphasised that in producing this study, the idea is not to provide prescriptive solutions but rather to stimulate innovative thinking towards sustainable energy solutions for our future. If the World Bank Group is to play a positive role, it needs to become pro-active in seeking sustainable solutions to address poverty.

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