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Chapter Seven

Renewable Energy:

Harnessing the Power of Africa?

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This chapter aims to demonstrate that not only does South Africa have an abundance of renewable energy in the form of sun, wind, etc., but that this energy can be harnessed to meet the energy needs of the country. I argue that a commitment away from polluting coal and nuclear towards renewable energy would contribute to a healthy environment as well as improved socio-economic conditions for all citizens, providing a path of economic development which would grow the economy in a sustainable manner.

The chapter analyses the supposed challenges to the implementation of renewable energy, and how they can be overcome. The current electricity generation and distribution monopoly suits the current industrial powers, while government commitment to renewables has thus far been limited to paper statements, or pilot demonstrations.

The real challenge to implementing renewable energy is the lack of political will to transform Eskom. Civil society must therefore play a major role in lobbying government for change.

What is renewable energy and what differentiates this from non-renewable energy?

Non-renewable energy is derived from a finite source – for example there is only a limited amount of coal, oil and uranium in the earth from which to derive energy. Renewable energy is commonly understood to be energy from ongoing, natural processes,   Examples would be sunshine, wind, moving water, geothermal energy. Biomass is also regarded as a renewable energy source – plants can be grown over weeks or years, the wood burnt directly or plant material turned into gas or biofuels.   The South African White Paper on Renewable Energy (2003, v) defines renewable energy sources as "sun, wind, biomass, water (hydro), waves, tides, ocean current, geothermal, and any other natural phenomena which are cyclical and non-depletable."

In South Africa, while we have an abundance of renewable energy in various forms, estimates differ as to how much is useable. Eskom estimates that there is only about 1000MW wind power available around the coast (as quoted in African Wildlife 2006, 40). However, based on Department of Mineral and Energy (DME) 2004 figures, Banks and Schaffler (2005, 23) provide an estimate of 50GW.

Our solar resources are one of the best in the world, with solar radiation levels of between 4.5 and 7kWh/m^2. If we look at how much solar energy would be needed to meet the energy demands of each person, it is estimated that an area of 75m^2 per person would be sufficient (Banks and Shaffler 2005, 14).

While there are many different types of renewable energy, for the purposes of this chapter I focus largely on electricity generation using solar and wind. These options include:

Solar Photovoltaic:
Solar energy can be used to generate electricity; heat water; and to heat, cool and light buildings. For example, photovoltaic systems capture the energy in sunlight and convert it directly into electricity. Banks and Schaffler (2006, vi) predict that up to 14% of electricity supply in 2050 could be supplied by solar photovoltaics (PV). The major downside for PV is that it is difficult to store particularly if the focus in off-grid supply. However, Banks and Schaffler (2006, vi) believe that new technologies will greatly increase the ability to store electricity at a lesser cost than is presently the case.

Solar thermal:
Energy from the sun (solar energy) can be trapped in a solar water heater and used to directly provide hot water for homes. Installation of a solar water heater could reduce the use of electricity especially during peak times. Modern solar water heaters have a back up electric system for inclement weather (Ubushushu Bendalo pamphlet, 2006, Sustainable Energy Africa).

Alternatively, sunlight can be collected and focused with mirrors to create a high intensity heat source that can be used to generate electricity by means of a steam turbine or heat engine. (White paper on renewable energy, 2003,1).

Wind:
Wind turbines harness the energy of moving air in order to generate electricity. According to Greenpeace (2006) one third of the world's electricity can be supplied by wind. Within South Africa, wind energy is potentially significant along the coastal regions and along the escarpment. Banks and Schaffler (2006, vii) predict that wind energy could provide up to 80TWh.

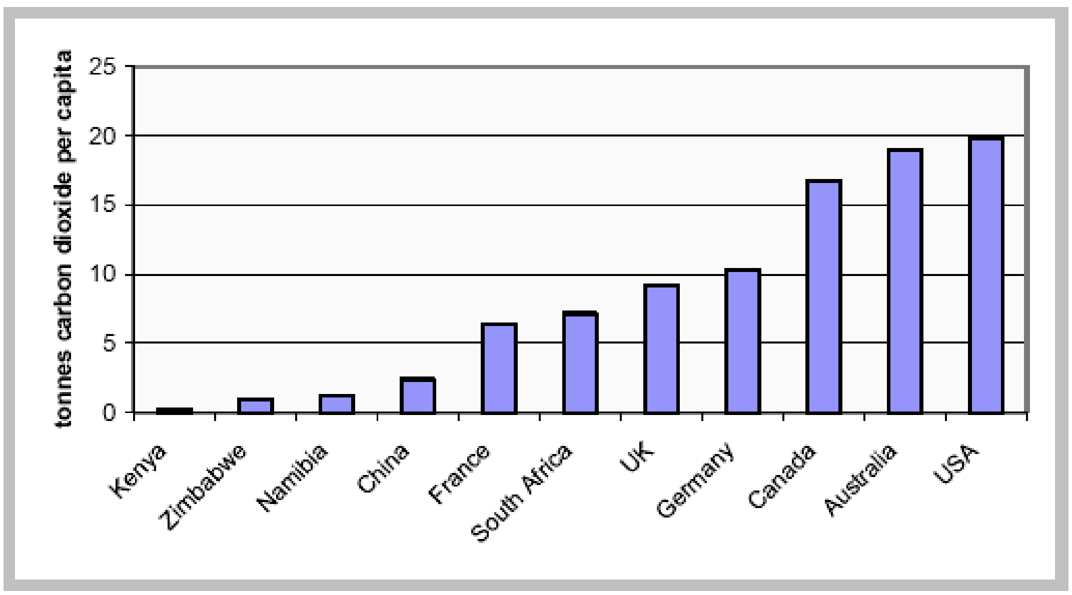
Why Renewable Energy is Important for the future of South Africa

Over the last decade, there has been an enormous expansion of renewable energy within the world. For example, in Germany, installed wind capacity was 68MW in 1990. By 2000, installed capacity was 6095MW and by 2004 it was 15000MW (Meixner 2003).

There are a number of reasons why South Africa should commit strongly to renewable energy, the most important are outlined below:

Climate Change – Offsetting coal-fired emissions:
It is now generally accepted that the continued production of greenhouse gases such as those produced by the burning of fossil fuels has resulted in a change in the world's climate. As mentioned by Bond (2002, 179) in his critique of NEPAD, South Africa is one of the leading greenhouse gas producers if corrected for population size and income (see Figure 7.1). Global initiatives such as the Kyoto protocol and its successor are likely to put increasing pressure on South Africa to reduce its emissions.

Figure 7.1: Comparison of Carbon Dioxide Emissions per capita (2001)



Source: DME Energy Efficiency Strategy 2005

Researchers examining the impacts of climate change predict that parts of South Africa will be at risk from projected climate change, warming and rainfall change (Midgely 2005, 4). The report points to the west coast of South Africa as becoming hotter and drier, for example, with severe impacts on biodiversity and sustainable livelihoods.

The implementation of renewable energy technologies (RETs) provides an opportunity to address climate change. By replacing 30000 to 40000 MW of fossil fuel with renewable energy, a considerable reduction in greenhouse gases can be achieved within the relatively short timeframe of 25 years. This can be achieved by continuing to provide high quality electricity.

Health and social benefits – reducing air pollution and creating jobs:
Many poor South Africans rely on solid or liquid fuels in poorly ventilated homes. This results in high levels of indoor air pollution with huge health costs. Households located close to each other, all using paraffin or wood stoves, results in increased air pollution outside houses as well (Hallowes and Butler 2004, 56). In her foreword to the Renewable Energy White Paper, Deputy Minister Susan Shibanga raised the issues of children's health as part of the motivation for renewable energy: "Research has indicated that one of the highest causes of infant mortality is from acute respiratory illness associated with the inhalation of wood smoke." (White Paper on Renewable Energy, 2003, i).

Renewable energy at the household level could mean using the energy of the sun, rather than paraffin, to heat hot water. Localized affordable electricity generation by small scale renewables leads to a reduction in dirty coal based electricity generation with an associated reduction in harmful emissions.

For women who - bear the burden of fuel collection as well as cooking in a confined space - renewable energy can be a catalyst for an increased quality of life. "Such improvements are generally part of integrated measures aimed at income generation via the pursuit of economic and agricultural development that afford women a more qualitative and productive time." (White Paper on Renewable Energy, 2003, i).

Job Creation:
South Africa is a developing country with a rapid economic growth and high levels of unemployment. Renewable Energy shows enormous potential to create jobs. If we contrast the conventional energy sector with the Renewable energy sector, we see the difference in job creation (see Table 7.1). In this example, jobs are measured as jobs per MW.

Table 7.1: Job Creation Potential of Renewable Energy

Renewable Energy Technologies	Total jobs /MW
Solar thermal	5.9
Solar PV	35.4
Wind	4.8

Biomass	1.0
Landfill	6.0
Coal current	1.7
Coal future	3
Nuclear	.5
PBMR	1.3
Gas	1.2

Adapted from Agama Energy (2003, 6-7)

According to Agama Energy (2003, 12), if all renewable energy technologies are included a total of 36 400 direct jobs alone could be created in the South African economy, with additional spin off potential. Such a model assumes a government commitment to a target of 15% of total electricity generation capacity in 2020 through Renewable Energy Technologies.

A key finding from the Agama Energy study was that the development of large scale renewable energy technologies will sustain and substantially boost the numbers of jobs in the energy sector, particularly because of the development of manufacturing industries.

It is important to note that while massive employment gains can be made quickly in the solar water heater (SWH) and biofuels sectors, initially RETs would require greater investment for skills training, which needs to be planned for.

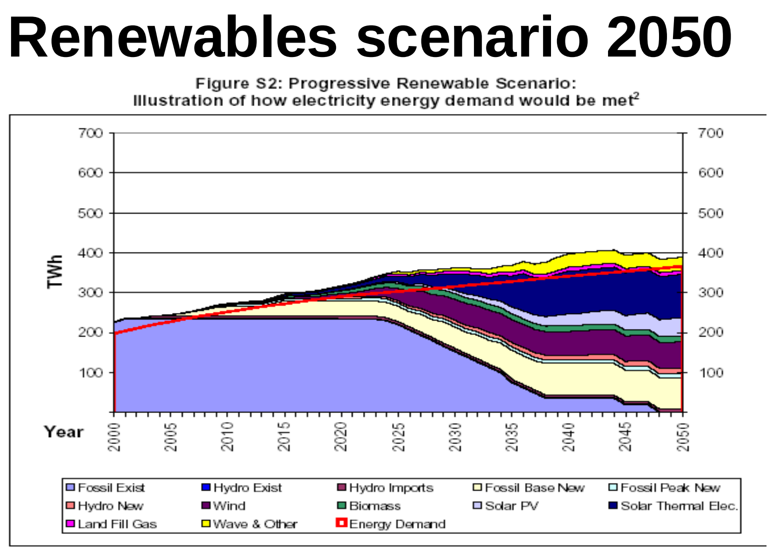
The most important conclusion arising from the study is that the South African economy needs a higher target for renewable energy than the one currently outlined in the White Paper on Renewable Energy, in order to derive the maximum employment benefit.

How much of our energy needs could we supply using renewable energy technologies?

The answer to this question would help government to decide where to put its capital expenditure and how to set up its infrastructure to best meet its energy needs. For this section it is convenient to draw largely on the report by Banks and Schaffler (2006, xii) who argue that it would be possible to provide up to 70% of South Africa's electricity needs by 2050 using renewable energy technologies (see Figure 7.2).[1]

[1] Banks and Schaffler (2005) do include small/micro hydro of up to 9900 GWh per annum in their progressive scenario scenario (Banks and Schaffler 2005, 26). These figures have been included in the arguments in this chapter. However, large hydropower schemes face a number of social/environmental and

Figure 7.2



Banks, Dougas and Schaffler, Jason. 2005. *The Potential Contribution of renewable Energy in South Africa*. South Africa

If we accept that South Africa must grow its economy, doing so in a way that meets the goals of sustainable development, then there will be a growing need for energy throughout the country. While energy demand management, and energy efficiency measures, could reduce the overall demand for electricity, it should be accepted that South Africa will also require increased electricity generation capacity.

For South Africa, according to Eskom's own projections, economic growth of 6% per annum translates into electricity demand growth of 4.4% per annum, requiring 47 252 MW to be built between 2005 and 2025. Eskom's capacity planning programme is based on a 4% growth in GDP, which translates into 2.3% electricity demand growth (Eskom presentation to Cosatu, 2006).

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political challenges which are discussed elsewhere, and their inclusion in the renewable energy mix is not supported by this author.

Can South Africa learn from renewable energy projects in the region?

It should be remembered that Africa has always had an interest in certain forms of renewable energy. In fact, the vast majority of communities throughout the African continent are still dependent on biomass in the form of wood stocks.

And yet, a report produced by the Energy Information Administration (EIA 2005), on the current status of renewable energy in various SADC countries only highlighted a bagasse plant and a solar power station. While Tanzania, Swaziland and Mauritius have shown interest in a bagasse plant, it was only Mauritius which, in 2001, built a 70MW plant. Plans for the others have either stalled or are in the feasibility stage. According to the EIA briefing, a solar power station was established in the Namib desert in November 2004.

Kenya has one of the fastest growing interests in solar power. More than 30 000 very small solar panels are sold in that country each year. The panels may only produce 12 to 30 watts but can be used to charge a car battery, which then provides sufficient power for a light bulb and other small power drawers. These small systems are of a type which is less efficient but more affordable than crystalline cells by a factor of four (Kammen 2006, 4).

The new energy policy approved by the Malawian cabinet in January 2003 governs the energy sector as a whole and outlines a clear commitment from government to support the development of a robust renewable energy industry in that country. The policy has set a target of 7% RETs contribution to the national energy mix by 2020, up from the current 0.2%. Areas identified for development include solar PV and thermal applications, wind for water pumping, biogas, mini and micro hydropower, biomass briquettes, liquid fuels from biomass processing such as fuel-ethanol, gelfuel and biodiesel. Various pieces of legislation to implement the policy are being finalised (Sibusiso Mimi 2006, pers comm).

In 2005, the Forum for Energy Ministers of Africa was formed. A paper commissioned for the forum focused specifically on energy and the Millennium Development Goals in Africa. The paper focuses on the provision of energy including electricity, the use of gas and biofuels. While acknowledging that the continent is rich in renewable resources the paper fails to describe any particular strategy for the development of these resources (Forum for Energy Ministers of Africa (FEMA), 2006, 12, 24), apart from one weak example of photovoltaics. PVs are merely put forward as an option in “selected rural areas”, suggesting a lack of commitment to heavy investment in this particular type of renewable energy. No other form of renewable energy is explored in any detail. Wind is mentioned only once in the Introduction.

The implication is that renewable energy does not form any large part of the Forum for Energy Ministers of Africa priorities. In fact, the Forum for Energy

Ministers of Africa (FEMA) paper concludes that “the energy initiative of FEMA is within the energy programme of NEPAD, and FEMA will therefore act as an advocate of the NEPAD’s energy agenda” (Forum for Energy Ministers of Africa (FEMA) 2006, 38).

The New African Partnership for Economic Development (NEPAD) has as a section on energy which clearly states that ”Africa should strive to develop its solar energy sources which are abundantly available”. However, the list of identified actions fails to include any specific action to be undertaken in order to realise this objective. In contrast, the use of hydropower is included as major part of the energy objectives, and an action is identified – to establish a task force to recommend priorities and implementation strategies for regional projects (Bond 2002, 148-150).

The FEMA Paper also provides a number of case studies and examples of providing energy services in Africa. Two case studies, Egypt and Zimbabwe, focus on how to provide energy in a way that would meet poverty reduction goals. However, the success of the Zimbabwean project appears mostly measured by its economic success – its “economic viability” – rather than “potential for poverty reduction”. Other factors contributing to success are listed as “efficient revenue collection, increased use of private contractors, capital subsidies for grid extension and cross-subsidies to support the poverty tariff” (Forum for Energy Ministers of Africa (FEMA) 2006, 30). In the Egyptian case, the following revealing remark was made: “Residential and commercial customers were *made to pay* economic rates for electricity used” (Forum for Energy Ministers of Africa (FEMA) 2006, 29, italics added).

There is a dichotomy between energy priorities for industrialization and poverty reduction (Hathaway 2005, 1). New growth in mining and energy intensive industries such as smelters bias identified energy needs towards industry. Such large demand for energy comes with a focus on grid-based electricity and large scale generation plants. Many new grid generation plans such as the Grand Inga in the Democratic Republic of the Congo (DRC) are anchored by proposed industrial expansion and electricity exports to neighboring countries.

Hathoway (2005, G8 statement) also raises the issue that many African governments are already seeking funding for billions of dollars worth of large hydropower dam proposals with little regard as to whether such proposals are in the best interests of their citizens. Hathaway proposes that G8 funding should be directed to renewable energy and adaptation to climate change (see, also, Hathaway and Pottinger (this volume)).

Southern African Power Pool (SAPP)

There are 12 utilities that are part of the Southern African Power Pool, from Botswana, Lesotho, Mozambique, Namibia, DRC, South Africa Swaziland, Zambia, Zimbabwe, Malawi, Angola and Tanzania (SAPP Annual report 2006, 3). The SAPP's vision includes "Ensur[ing] sustainable energy developments through sound economic, environmental and social practices", while its objectives include "Implement[ing] strategies in support of sustainable development priorities" (SAPP Annual report 2006, 2).

The 2006 Annual report acknowledged that the SAPP was becoming increasingly unable to meet electricity demands and that measures must be put in place to address this gap. However, the SAPP priority list focuses on rehabilitation projects, short term generation projects which have already obtained environmental approval and for which feasibility studies have been undertaken, and short term transmission projects. Medium to longer term investments include large scale hydropower in the DRC and Angola (SAPP Annual report, 2006,12). There is no meaningful reference in SAPP planning to the role of renewable energy. It can therefore be concluded that, like South Africa, the Southern African Power Pool has not taken on board the need to invest in renewables now to meet future demand in an environmentally sustainable way, undermining its stated vision and objectives.

What is the current status of renewable electricity generation in South Africa?

State-owned Eskom has embarked on a number of pilot projects with various partners as part of a research programme in renewable energy. This South African Bulk Renewable Energy Generation programme (SABRE-gen) is aimed at "large scale generation options". These projects include (Eskom 2006, 38-41):

- Solar - the "power tower", where sunlight is concentrated onto a focal point where it is then used to produce steam and power a turbine to produce electricity
- Solar - Dish Stirling which has a dish reflector and a generator unit. This was found by Eskom "not to be currently viable under South African conditions".
- Wind – three turbines on the Klipheuwel site. This is a research site and future installations would depend on its commercial feasibility.
- Biomass – The System Johannsen Gasifier uses wood and other biomass to produce a gas which can then be used to drive a turbine. The first non-research unit is to be piloted in the Eastern Cape.

Apart from Eskom, there are a number of other renewable energy initiatives within South Africa. Individuals have purchased their own photovoltaic systems, as well as solar water heaters. There are an estimated 30 000 wind mills pumping water. However, their total contribution is minute: installed capacity for solar and wind together is estimated to be only 283MW, compared to an existing grid production of 39 493MW (Banks and Schaffler 2005, 4).

Individual municipalities have also taken some action. The City of Cape Town Energy and Climate Change strategy identifies a target of sourcing 10% of its energy from renewable sources by 2020. Darling Independent Power Producer, the Central Energy Fund, the Danish Government, the South African Government, and the Development Bank of South Africa, have combined forces in the Darling Wind Farm Project which will be South Africa's first commercial wind farm. An annual 13.2 Gigawatt hours of electricity will be generated using four turbines (each generating 1.3MW). The City of Cape Town has agreed to buy the electricity supplied at a price agreed between the wind farm and the city on the basis of willing buyer/willing seller. The Global Environmental Facility has agreed to subsidize 50% of the costs. This is necessary as the "green electricity" is more expensive to produce than Eskom generated electricity for reasons highlighted elsewhere in this paper

City of Cape Town residents will be asked to pay extra and it will be a choice for customers if they wish to take up the offer. The wind farm is a start but will make a negligible impact on the city's energy demand. Current peak demand is 700MW while the wind farm is expected to deliver a maximum of 5.2MW (City of Cape Town 2006). However, it is hoped that DARLIPP will spur further renewable energy development in the city.

In the Eastern Cape, the Nelson Mandela metropole has also made a decision to obtain its bulk supply from renewables and cleaner energy. The mix includes solar water heaters, landfill gas, and wind. The wind farm has an initial target of 20 MW with a total envisaged of 65MW. This amounts to approx 5% of the metropole's electricity demand (Davin Chown, pers comm.,2006).

In Jeffries Bay (also in the Eastern Cape), a wind farm will be established with a proposed pump storage scheme attached to an already existing dam. The wind farm will have a capacity of 10MW wind with 5.5MW of pumped storage. The total demand for the area is 15MW. The renewables will be connected to the grid, and this combination of wind and pumped storage will provide some security of supply and answer the question of "what to do when the wind doesn't blow". Both projects will use the financial mechanism of willing buyer, willing seller and the details are currently under negotiation (Davin Chown, pers comm., 2006).

What can renewables contribute by 2020 and by 2050?

If we look at the Eskom's predicted electricity demand by 2025, we see that an extra 47 252 MW is required on top of the current capacity (Eskom presentation to Cosatu, 2006). Banks and Schaffler (2005) examine a number of different scenarios, however, with varying degrees of renewable energy in the mix. Their report examines the growth potential of different renewable energy technologies and provides some indications of cost.

While there are a number of renewable energy technologies such as biomass, landfill gas, waves and ocean currents, Schaffler and Banks (2005, 46) identify solar thermal and solar photovoltaics as large potential electricity producers for the future. They found that because renewable technologies start from a very small base, even modeling a 10 to 20% growth rate makes it difficult to reach a high renewable contribution by 2020. They developed three scenarios reflecting different amounts of renewable energy in the energy mix for South Africa, as follows (see also Table 7.2):

- Business as usual - This envisages the current fossil and nuclear plants to be replaced with more of the same, renewables would only contribute a negligible 4%. The growth required would mean the equivalent of building a 3.6GW power station every 30 months. Obviously, there would be severe environmental impacts if such a path were followed.
- Progressive renewable scenario - This scenario sees about 13% of total electricity from renewables by 2020. It is interesting to note that most renewable technologies become cost competitive with new fossil based generation plants before 2020. The report emphasizes the use of lower cost options (biomass, wind and landfill gas) from 2005 to 2020 although experience gained with solar thermal is important as by 2020, this is predicted to be the lowest cost option. Solar PV costs remain high but Banks and Shaffler (2005, 45) point out that solar PV can be installed on an individual basis almost anywhere and anticipate that solar PV will play a very important role in electricity supply.
- The High road scenario - Banks and Schaffler attempt to model a scenario where not only is a very large proportion of electricity generated from renewables but that there is a greater use of electricity to replace fossil fuels for example in the transport sector.

Whereas, the scenarios show a limited amount of renewables available by 2020, the scenario changes dramatically by 2050. The table shows the total amount of renewable energy provided (as a percentage of total demand) as well as the contribution by wind, solar PV and solar thermal electricity.

Table 7.2: Comparative contribution of renewables in 2050

Scenario Prediction at 2050	Total contribution of all	Solar thermal contribution (MW)	Solar PV contribution (MW)	Wind contribution (MW)

	renewables			
Business as usual	4%	Negligible	Negligible	negligible
Progressive	70%	27 311	21 479	25 287
High road	75%	46 682	38 677	30 503

Source: Banks and Schaffler (2005).

Does it make financial sense to shift to renewables?

While the costs of electricity generation from renewables are likely to decrease over time, the fossil fuel industries are likely to see increased costs. Oil scarcity, climate change concerns as well as increasing environmental safeguards applied to fossil fuel generation would contribute to this increase (Banks and Schaffler, 2006, 11). For example, in South Africa, an environmental fiscal reform policy paper has been released by the national treasury. Amongst some of the suggestions highlighted is an option to impose a tax on coal-derived electricity and exclude electricity derived from solar or wind from such taxes (Business Report, April 7, 2006).

Banks and Schaffler (2005) have included a suite of complexities in analysing and predicting the costs of electricity production into the future. The "progressive scenario" outlined above would have a unit cost of energy of about 28c/kWh (South African rand cents) by 2050. Compared to current costs of about R11c/kWh, this appears high but it is important to remember that Eskom is in a unique position due to its history (all currently-generating coal fired plants have been paid off) and any new fossil baseload is predicted to cost in the order of at least R25c/kWh (peak load predicted to cost R70c/kWh) (Banks and Schaffler 2005, 73).

In addition to operational costs, there are also the costs of developing new plant capacity. Significant investment will be needed to build new generation plants which use renewable energy. However, in the "high road" renewable scenario developed by Banks and Schaffler, while the capital costs may be higher, the operational costs are much lower and the overall cost per kWh of energy produced is lower than the "business as usual" path (Banks and Schaffler 2006, 54).

Using solar thermal as an example, the starting costs for a large plant are estimated to be R40c/kWh and predicted to decrease to such an extent that by 2012, the costs could be lower than new base-load fossil fuel plants (approximately R25c/kWh). By 2022 solar thermal could be the lowest cost option (Banks and Schaffler 2006, 19).

Wind electricity generation costs presently range from 27c to 70c/kWh, depending on the wind regime, which enables it to compete internationally with conventional fossil fuels. According to the International Energy Agency (IEA) (as quoted by Banks and Schaffler (2006, 22)), wind energy costs are predicted to decline by 40-50% over the next 15 to 20 years, making it a very attractive option for grid contribution. According to Chown (2006, pers comm.), the recently approved Darling wind farm will produce electricity at a cost of R47c/kWh. The wind farm is predicted to start generating power from July 2007.

Energy Demand Management

While there could be long term reductions in the costs of electricity generation, there are other areas where dramatic energy savings can be made. For example, focusing aggressively on energy demand management over time would enable the total energy demand to be reduced.

Solar water heaters (SWH) provide an example of the implications of such an energy demand management approach. According to City of Cape Town (2003, pg 4-3), the heating of hot water in middle to high-income electrified households constitutes 43% of residential peak demand, and any actions which could reduce this demand would have a significant impact on the need for electricity generation. Table 7.3 shows a comparison of energy savings, financial costs and jobs created for installed solar water heaters versus the government plans for the new proposed nuclear reactor near Cape Town.

Table 7.3: Comparing Solar Water Heaters and the Proposed Pebble Bed technology nuclear reactor

	Solar Water Heaters	Pebble Bed Nuclear Power Plant
Energy saved/supplied	890 GWh/ annum	750 GWh/ annum
Cost	R2.6 bn	R10 bn
Creation of jobs	13,440 jobs	135 jobs

Source: Presentation to Provincial Government, Ubushushu Bendalo, 2003

It is clear that the installation of SWHs would have a major impact on energy demand management while creating jobs and that this could be done at a significantly lower cost than, for example, the construction of a nuclear power plant. If renewable energy makes environmental, social and economic sense, why is it not being implemented across the country?

According to Mr Osman Asmal, Environment Department Head in the City of Cape Town, the reason that SWH was not implemented on a large scale throughout the city was partly the financial up-front costs which are already committed towards existing infrastructure. But another reason is that the city has not been convinced of the economic savings. It appears that the city has yet to conduct its own cost/benefit analysis which would show the savings to be made. Despite this, Cape Town is drafting a by-law which would make solar water heaters compulsory on all new houses.

CHALLENGES TO THE IMPLEMENTATION OF RENEWABLE ENERGY

It is clear that renewable energy technologies offer significant benefits to South Africa, yet renewable energy currently offers a very small contribution to the overall energy supply. Why is this? The DME's renewable energy policy of 2003 raises a number of challenges and barriers to large scale implementation of renewable energy, and proponents of renewable energy agree that there are some considerable hurdles to be overcome.

It is my view that many of these hurdles relate to the perception of renewable energy rather than any practical obstacles, and this is supported by the statement in the Energy Efficiency Strategy of government which admits that solar water heating"is financially viable but the barrier is lack of awareness/information about the technology" (DME 2005, 43).

How do we generate electricity when the sun doesn't shine or the wind stops blowing?

As wind and solar are intermittent energy sources, there is a necessity to ensure that at any one time there is sufficient energy available to generate electricity to meet demand. One way of doing this is to distribute generation sources throughout the country. For example, it is likely that at any one point in time, somewhere in the country, the wind will be blowing.

Another option is to provide back up storage. There are many different technical solutions to meet short and long term storage needs. Solar thermal plants use the sun's energy to convert heat into electricity. In California, there are plants with a capacity of 350MW which have operated for more than 10 years. The technology is therefore established, and solar thermal plants can be built on a large scale to meet industrial needs. Solar thermal plants can have storage through storage systems such as molten salt which would allow such plants to run 24 hours per day. Excess energy from the solar thermal plant is stored in the salt during the day and released to produce electricity during the night (Agama Energy 2003, 35).

Within South Africa, currently there is about 1580MW of pumped storage capacity (Banks and Schaffler 2005, 24). During periods of excess electricity generation, water is pumped into storage dams and during times of shortfall, the water is used to generate electricity. With our current demand of approximately 40,000MW this amounts to very little, and as a water stressed country, there is probably little scope for significant increases in this method of storage.

However, other storage systems such as hydrogen are being developed. As in pumped storage systems, hydrogen is produced during periods of excess electricity. The hydrogen in liquid form is then used as fuel to produce electricity during times of shortfall. As an example of the potential for such systems, it was predicted in Argentina that the installation of a wind farm of 1000km^2 would yield sufficient hydrogen equivalent to the 2003 transport needs of Japan, and that it would be economically viable to do so once oil reached US$35 a barrel (Spinadel 2003).

Are pilot projects necessary?

Despite the wealth of knowledge about renewables such as solar PV, solar water heaters and wind it appears that such technologies are not accepted within Eskom. In the main, Eskom's response to the international focus on renewable energy as been to put forward projects to assess the viability of the technology for South Africa. Examples include the Klipheuwel wind farm project in the Western Cape, the testing of solar water heaters, the solar funnel project in the Northern Cape.

Eskom's insistence on proving the effectiveness of technologies which are already proven in other parts of the world, has resulted in the stalling of the implementation of renewable energy technologies. The pilot phase of such projects then delays the full scale implementation of such technology. Such insistence on pilot projects further creates a perception that the efficacy of the technologies is in question.

In the case of the Klipheuwel wind farm pilot, criticisms leveled against the project include that the turbines are at the wrong height, and that the project is in the suboptimal site (Glynn Morris, Agama Energy 2006, pers comm., Davin Chown, Ecogenesis energy, 2006, pers comm.). Under such circumstances, it is unlikely that the research results will show wind energy as a viable option for South Africa. As the research results from such pilots would be used to justify Eskom's policy direction, and given Eskom's almost total control of energy generation, such pilot projects then retard the implementation of renewables in South Africa. Such doubts spread to other government departments and little government support is forthcoming for renewable energy technologies.

This needs to be contrasted with the pebble bed nuclear technology project which has received huge support from Eskom and large amounts of government funding despite having a financial track record which is abysmal compared to wind or solar technology (see Fig , this volume). While wind and solar technologies are established throughout the globe, the pebble bed technology is a new technology still in the developmental phase. The cost of the pebble bed demonstration plant "has increased by a factor of five and completion of the Demonstration Plant, expected in 1999 to be in 2003, is now still six years off." (Thomas 2005, 30). These figures also fail to reflect costs such as fuel production, as well as the nuclear regulatory regime required to ensure public safety.

Investment challenges

The solar thermal electricity plant which will be piloted in the Northern Cape, would use 6000 mirrors and span a 4km site. This solar technology is being assessed by Eskom and a key component of this feasibility assessment is the determination of the cost (Business Report, July 20, 2006). It is not clear how the cost comparisons will be calculated in order to factor in the benefits of renewable energy against the externalities of conventional coal and nuclear.

According to Awerbuch (2000, 5), the investment analysis tools for energy have not changed in 100 years. This might have been appropriate if we had to compare one central based fossil power plant with another but is less useful when faced with such a diverse range of energy resource alternatives today. If we use solar photovoltaics as an example, The costs of PV are almost all up front costs. There are almost no operating costs and no fuel costs.

However, these large initial investments are viewed as a hurdle and identified in the DME White Paper as the main barrier to implementation on a large scale. According to Awerbuch (2000, 4) this shows a lack of understanding of renewable energy technologies. In a gas turbine, for example, less cash flow is tied up in the loan because there is more outlay needed for operational expenses. In the case of PV, there is very little needed for operational expenses. Awerbuch argues that low risk investments can take on bigger loans, and higher loan repayments and that this is accepted practice elsewhere: "Where the asset is nearly systematically riskless, high loan to value makes a lot of sense. Everyone seems to understand that, for example, when you put up riskless Treasury bills against your margin loan, your broker might lend you 90% of their value. But you might only get 50% or 75% of value if you put up risky stocks" (Awerbuch 2000, 5).

It is worth noting, however, that a breakthrough has taken place in California. A Californian team has announced that it plans to build a solar panel production facility with a 215MW next year (2007), and thereafter producing 430MW annually. The investors include Google's two founders and the price quoted is US$100 million. The exciting impact on this technology is that it would bring the cost of PV to or below the level of **"**delivered electricity" in a large part of the world (Freeman and Harding, 2006,1).

Oil companies have also started to show an interest in renewable energy. According to Reuters (Business Report 4/4/07, 5), Royal Dutch Shell has invested US$1 billion in renewable over the past five years while BP invested US$500 million between 1999 and 2005 in solar, and US$300 million in wind generation in 2005-06.

This large scale investment appears to signal that renewable energy is becoming a viable financial proposition, able to compete with fossil and nuclear, and is no longer the preserve of academic institutions and government subsidized programmes.

Factoring in the hidden external costs of fossil fuels and nuclear

Awerbuch (2000, 16,17) argues that the relative costs of RETs to fossil fuels can change over time due to uncertainties such as the increasing price of oil, the decreasing costs associated with improved efficiencies of evolving newer RETs, and the increasing cost of meeting constantly improving environmental standards.

The implications of Awerbuch's conclusions are that the costs of fuels such as sun, ocean currents and the wind can be factored into the long term financial equations as a fixed cost – eg. zero – while there is huge uncertainty in the oil price which must be factored into conventional electricity generation (for example to transport nuclear fuel to the reactor and to convey waste to a dump site). To illustrate, the petrol price in South Africa has risen from R3.81 per liter in 2003 to R5.66 per litre in December 2006, an increase of almost 50% over three years. These risks are ignored using conventional financial models and the comparative benefits of renewables are not apparent (Awerbuch 2000, 18).

Does South African government policy acknowledge the challenges of renewable energy?

In her foreword to the White Paper on Renewable Energy (2003), deputy Minerals and Energy Minister Susan Shibanga states that the policy document is there to give a much needed boost to renewables. She goes on to outline a target of 10 000GWh by 2013, which amounts to 4% of total electricity demand in South Africa (White Paper on Renewable Energy 2003, i)

How does government policy propose to achieve these goals? The White Paper identifies five areas of strategic intervention each with a number of goals, objectives and deliverables:

- Financial and legal instruments - One of the deliverables under this topic is to identify barriers to renewable energy and to investigate fiscal instruments which could stimulate renewable energy development. In 2006, Treasury released a paper looking at financing mechanisms including taxing polluting industry (Business Report, April 7, 2006). In 2004/05, the Central Energy Fund (CEF) commissioned a study to investigate subsidies for solar water heaters. There appears to be some progress but it is dishearteningly slow.
- Legal instruments - Deliverables under this intervention included regulations which would increase access to the grid, stimulate the uptake of renewable energy and force power generators to base their tariffs on full cost accounting, including environmental externalities. Unfortunately, there have been no regulations passed in this regard.
- Technology development - In this intervention, a key deliverable is the inclusion of R&D in the scope of the SA National Energy Research Institute. This institute will be housed at the Central Energy Fund and the plan appears to be to invest R100 million over the next 3 years. (Address by Deputy Minister Hanekom on the occasion of the 2006 Science and Technology Budget Vote in the National Assembly 26 May 2006). Unfortunately, it is impossible not to contrast this with the R14.5 bn estimated for the nuclear demonstration pilot (Business Report, January 23, 2006).
- Awareness raising, capacity building and education - Education and awareness raising amongst all stakeholders through campaigns, a key deliverable, have yet to become visible. Although the DME political heads do speak of renewables in the press to some extent, it is also difficult for the public to understand the mixed messages from different cabinet ministers, sometimes promoting renewables, and sometimes ignoring them and supporting the nuclear industry.

The White Paper on renewable Energy (2003) admirably states that it “will not reinvent the wheel” with regard to established technologies. It also states the National Energy regulator (NERSA) will be able to determine the price which power generators can sell their energy, and regulate electricity tariffs. It is therefore unfortunate that the NERSA should find itself at the centre of a constitutional battle over whether it has the right to interfere in the local authority mandate of providing electricity (Business Report, September 21, 2006).

According to the Department of Minerals and Energy (2004, 2) there are two strategic options to facilitate the uptake of renewables onto the grid. The first is that DME believes that *direct capital subsidies* are the answer for near commercial projects. This appears to be an attempt to level the playing fields by subsidizing the capital investment but the control of the price renewable energy players would receive for their generated power remains unsubsidized.

However, in the longer term, DME views the second option, *feed-in tariff,* favourably. A feed-in tariff would regulate the price that suppliers receive for their renewable energy, in effect guaranteeing their viability. This would enable renewable energy suppliers to prepare their business case and look for investment on the basis of a known return. It is a system which has been implemented in other parts of the world, for example in Denmark and Germany.

According to Lackmann (2003), Germany was able to reduce the cost of wind-generated electricity by 60% over just 12 years. They achieved this through the application of a feed-in tariff, which stimulated enormous advances in wind turbine technology. The results are startling and South Africa needs to take note. In Germany, installed wind capacity was 68MW in 1990 when the feed-in law was introduced. By 2000, installed capacity was 6095MW and by 2004 it was 15000MW (Meixner, 2003). In the South African context, the feed-in tariff is regarded as the most effective system to promote the rapid uptake of renewables (Greg Austin, Agama Energy, pers. Comm. 2006).

Another mechanism includes forcing the distributor to buy a certain percentage of power from a renewable supplier but allowing this to occur at market prices. However, DME admits that this system raises problems in that renewable suppliers cannot survive on such arrangements and other subsidies must then be put in place (DME 2004,14).

The willing buyer-wiling seller approach allows the renewable energy supplier to negotiate with the buyer in order to come to an arrangement for a fixed tariff. This is the approach that has been adopted for the Darling wind energy project.

Australia has taken the route of mandating renewable energy targets legally, with penalties for non-compliance (DME 2004, 20) and has used a system of tradable renewable energy certificates (TRECS). These certificates can be obtained for producing a certain amount of renewable energy, and can then be traded and sold. These TRECS provide a further source of income to the renewable energy suppliers, and are one of the ways to supplement renewable energy supplier income which is dependent on subsidies. TRECS arise out of the global threat of climate change and are based on the idea that industries can continue business as usual and then buy their way out of changing themselves by financing other businesses that generate renewable energy. Such 'greenwash' systems are attractive to renewable energy lobbyists as they provide a practicable means of offsetting the current initial high investment costs of renewables. But they fail to address one fundamental problem – i.e. the need for *existing* industry to switch from dirty and energy wasting power production to clean energy in order to reduce the climate change impacts on the planet.

While it is ideologically correct to reject TRECS and carbon trading systems failing to address the impacts of climate change in any meaningful way, it is my view that these financial tools could play a role in ensuring that RETs hit the global spotlight, thereby contributing to the uptake of renewable energy globally. Such uptake of renewable energy should replace current polluting industries such as nuclear and coal over time, thereby contributing to overall sustainable development goals.

Institutional Support for renewables

There are several state agencies tasked with the responsibility of investigating renewable forms of energy in South Africa. I will briefly review of some of these organizations and discuss the extent to which renewable energy is championed at these institutions (or not).

The Central Energy Fund (CEF) is a state owned company controlled by the minister of Minerals and Energy which has a number of wide ranging activities in the energy field. One of its portfolios is renewable energy. In 2004, the CEF established the Energy Development Corporation (EDC). This division pursues "commercially viable" investments in renewable energy. According to the CEF website (www.cef.org.za) EDC is "close to the policy makers, [and] able to lobby the relevant government departments and institutions for support when necessary. At the same time it operates as a fully commercial entity ".

According to the CEF annual report (2005), the Energy Development Corporation's involvement in renewables included solar cookers, biodiesel investigations, solar water heating as well as their involvement in the Darling wind farm. CEF's investments in renewable electricity generation are small compared to their proposed investment in biofuels and their continued support of the fossil fuel industry, however. CEF has invested R19.3m in the Darling wind farm (5.3MW), whereas their biodiesel project is worth R520 mill, and CEF is proposing to take a 20-30% stake in the project (CEF 2005).

CEF also established SA National Energy Research Institute **(**SANERI) in 2006, as a result of a ministerial directive. SANERI received a R2 million start up budget from the Deptartment of Science and Technology. At the time of writing, the CEF website contained one tender issued by SANERI, for oil and gas, not renewables. However, such a research body could play a decisive role in the exploitation of renewable resources. For example, SANERI might research the best sites for wind farms within South Africa. Such research, conducted by the state, and available to all, would help investment decisions regarding the best sites for wind farms, without each potential wind farm owner having to undertake similar, costly research.

The National Energy Regulator of South Africa (NER) is also an important player. The NER has not provided information on its stance on regulating renewables, but according to the press reports it has been involved in the following activities:

- Two gas turbine power plants are to be built at a cost of R3.5 billion. These plants (total capacity 1050MW) are scheduled to come on line by 2007, and will be built at Atlantis and Mossel Bay respectively (Gosling 2005).
- In March 2006, the National Energy Regulator (NERSA) announced that it had called for bids to build two open gas cycle gas turbine power plants. These were to have a combined capacity of 1000MW (Faniso 2006).
- It was also reported that a private company, Independent Power Southern Africa (IPSA) planned to build a 800MW combined cycle gas turbine plant in Port Elizabeth (cost estimate about R1.9bn) as well as a 400MW coal fired power plant near East London (cost estimate not provided). It appeared from the reports that these power plants would apply for licenses within the next two years, and that the NERSA would look favourably on their application (Faniso 2006).

NER has a policy position that stipulates that electricity prices must be based on the lowest cost option for generating new capacity (Business Report, January 12, 2006). While this may be good news for consumers and communities, the cheapest form of electricity may hide a number of externalities such as toxic emissions. The NER position also contradicts the White Paper on Renewable Energy (2003, 40) which states that power generators would “base their tariffs on full cost accounting, including environmental externalities”.

In February, 2006, NERSA announced that there would be a 5.1% increase in electricity prices to allow Eskom to “expand its power generation capability through its capital expansion programme”. A recent press report indicated that NER will be asked to approve electricity prices increases of 18% despite inflation figures of 3-6% (Die Burger, April 20 2007).

As for Eskom, its R97 billion capital expansion programme (increased to about R150 in early 2007) contains no significant plans for renewables. It is sobering to see that of a planned potential increase of 47000MW new capacity envisaged by

Eskom to meet South Africa's electricity needs over the next 20 years, less than 0.2% will be in renewables.

Eskom controls almost all of the country's electricity generation, all transmission and some distribution (most of the latter is the mandate of local authorities). Eskom's energy strategy includes a reference to "Ensuring the sustainability of the business through balanced financial, social and environmental decision making". This is translated into a number of descriptive points on how the core strategy would be achieved. It is clear that "high quality, low cost" electricity is Eskom's primary aim (www.eskom.co.za).

It could be argued that ensuring Eskom's "sustainability" as a business is not necessarily going to ensure the most effective energy services for South Africa. Eskom's financial sustainability is linked to generating the largest income (from electricity sales) in order to generate profits for Eskom. Such decisions are unlikely to include externality costs such as toxic emissions unless forced to account by government. If Eskom makes decisions purely on conventional cost comparisons, with no political incentives to change to renewables, coal-fired power stations are likely to remain the "lowest cost option" in the short term.

The above cannot be read in any other way but a firm commitment to the continuation of traditional capital intensive energy generation projects such as coal, with the addition of further fossil fuels such as gas, and hydro developments in the region.

Challenging Business as usual - How do we return the power to the people?

In order for renewable energy technologies to play a major part in the future of South Africa, some radical changes are necessary. What types of systems would be in place in order for South Africa to move beyond the fossil age into the solar age? The following provides some general suggestions:

Transforming the grid:

As pointed out by the DME (2004, pg 25), a utility such as Eskom, which controls generation, transmission and distribution finds itself in a conflict of interest when facilitating access to the grid for renewable power. If the grid were "smarter", it would be more decentralised, improving efficiencies by reducing the distances between the energy producer and the user (in South Africa presently transmission losses from Mpumalanga to Cape Town are about 10-20% (Dobson 2006)). A decentralised system would also increase the security of power supply and be less vulnerable to power disruptions. The future scenario would see a flexible, dynamic grid that can accept power as well as push it out.

According to Guerl and Romano (2004), one of the challenges to such a system change would be the number of standards and specifications that would need to be developed. Obviously, there is a cost attached to this but it would be possible to draw on international best practice for assistance. Some perspective can be gained by considering the 2006 electricity black outs in South Africa. Eskom was forced to pay customers with the ability to generate their own electricity to keep them from drawing power off the grid (Eskom generates electricity at 11c/kWh but paid out approximately R1.70 /kWh to these consumers) (Davin Chown 2006. pers comm.). It seems logical to assume, therefore, that a system which allows customers to feed back electricity into the grid, rather than paying inflated prices to keep customers off the grid, would be of benefit to all.

International experience clearly shows that where the systems are in place, renewable energy will flourish (Guteri and Romano, Newsweek, September 13, 2004, 36-7):

- In Japan, Hitoshi Iokawa, installed solar panels on his roof in 1997. It cost him the equivalent US$33,000 of which the government subsidised a third. He now generates an income of $460 a year selling electricity back to the grid - enough to offset his electricity bills. Japan started its programme of solar power in 1993. Now 170,000 homes feed into the grid
- In California, Ignacio Vella , powers the fridges in his cheese factory with 234 solar panels, and is able to sell leftover energy back to PG&E, the local power company (Guteri and Romano, Newsweek, September 13, 2004, 36)
- Countries like India, where, similarly to South Africa, power supply lags behind demand, local power producers have emerged. Sugar mills are producing their own electricity from bagasse. In Karnataka and Maharashtra, 500MW of power are produced per year, some of which is then sold back into the grid (Guteri and Romano, Newsweek, September 13, 2004, 37.)

The role of civil society:

The role of civil society within the energy sector has been mostly reactive to date. Organisations such as Earthlife Africa and the Environmental Justice Networking Forum, as well as some faith communities, have mobilized *against* the nuclear industry, but little has been done to mobilize *for* RETs.

Groups such as the Civil Society Energy Caucus have been formed to lobby on energy related issues and some of their work has focused on renewable energy. I am aware of some discussion about founding a renewable energy caucus but such a body is not in existence yet. There is also the South African Faith Communities Environmental Institute, a recent initiative amongst faith-based groups which focuses on environmental sustainability, including renewable energy. In the press, Bishop Davies has called on Eskom to spend money on renewable energy, to open up to other power producers and to “move resources from the control of giant and multinational corporations into the hands of the people” (Davies 2006).

One civil society initiative, the Ubushushu Bendalo campaign, has raised the profile of solar water heating and concentrated on this technology as one solution. Ubushushu Bendalo has lobbied government leadership in the Western Cape province at both city and provincial levels and has been selected by the City of Cape Town to assist with the roll out of solar water heaters in the metropole (City of Cape Town 2006, 41).

There is some research being done on the renewable sector (e.g the work of Agama, DME, Banks and Schaffler 2005). However, the level of lobbying and advocacy is poor and, in general, civil society campaigns lack capacity to use the available information effectively.

Civil society lobbying strategies could focus on advocating for a number of concrete institutional steps which would encourage the development of the renewable energy technologies. These could include:

- Government passing laws, making certain RETs mandatory, such as solar water heaters (such as the city of Cape Town’s draft regulation which would make it mandatory for all new buildings to have SWHs and is expected to be passed before the end of 2007).
- Fiscal measures such as taxes on fossil fuel derived electricity would assist in leveling the playing fields as well as giving life to the principle of the polluter pays which is already in law.
- The grid must be transformed to allow power to be fed into the grid as well as drawn off.
- Government must mandate Eskom to invest 20% of its current investment in renewable energy technologies.
- Government must ensure that the poor are protected from increasing electricity tariff hikes.

Conclusion

There is no doubt that renewable energy has a place in the energy equation for South Africa and the rest of Africa. However, the target set for the South African Renewable uptake is only 4% by 2013, and the underlying prevalent government assumption is that renewable energy technology is relegated to use by the rural poor and for small scale application*s,* while mainstream electricity generation will be traditional, grid based technologies.

And yet, renewable technology is viable in areas of the world that are much poorer in renewable resources than South Africa. Renewables are economically viable and it is technically possible to produce large amounts of reliable electricity, sufficient to drive even the greedy captains of industry.

The real problem is not, therefore, the economics or technical issues around RETs, but the *political will* to take the lead. Tony Blair's response to climate change (quoted by Monbiot 2006, 22) summarises the political dilemma: "There is a mismatch in timing between the environmental and electoral impact". In effect the full horror of the harmful environmental impacts of our current dirty electricity generation path may only be felt in 25 years' time whereas politicians only operate in five year electoral cycles.

Renewable energy technologies are beneficial to a developing nation – clean, electricity, safe energy, and an increase in jobs. The economics are sound, providing a full cost/benefit analysis is performed. However, what is beneficial for the state may not be the best option for the parastatal company, Eskom. Eskom will continue to generate at least 70% of South Africa's electricity and therefore must be transformed. The only way that renewables will become mainstream in South Africa is for Eskom to be instructed by cabinet to plough significant resources into implementation of renewables, not pilot research but the roll out of large scale power supply.

Eskom appears to have taken what it believes to be a low risk route of sticking to technologies it knows. Committing the country to a centralized grid also ensures that it maintains an income stream, either through charging for entry on to the grid by IPPs, or by generating electricity directly into the grid using established technologies.

Is this the wisest strategy for a country where more than half of the children live in households with an income of less than R3 per day (Cape Times, Feburary 6, 2007)? Government has a responsibility to provide energy security to all citizens irrespective of their ability to pay. Sustainable energy security will be found in a diversity of energy sources.

Energy is necessary for development and Africa stands at a crossroads. She can choose to follow the dirty, heavily polluting technologies which are being dumped on Africa by the first world, including large fossil fuelled power plants, nuclear energy and large scale hydro. Alternatively, Africa can take a visionary approach, the high road to sustainable development, leapfrogging over the dirty technology development phase that the rest of the world has experienced (which has led to the current crisis). This high road is not business as usual, it puts people first. It provides the most suitable energy source to meet the demand at the least cost. But in this case the calculation of least cost includes the impact on the natural resources, the impact on human health, and the impact on future generations.

To choose such a path will allow African countries to take full advantage of the current climate change crisis to start down the visionary road. Such a growth trajectory cannot be held back or stifled by pollution taxes, will not be held to ransom by declining and ever more costly fossil fuels but will use the best available technology internationally, producing clean electricity forever. All that is needed is a leader!

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