CHAPTER 7

Renewable energy: Harnessing the power of Africa?

Liz McDaid

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 to moving away from polluting coal and nuclear energy and 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 electricity generation and distribution monopoly now operative suits the current industrial powers, while government commitment to renewables has thus far been limited to paper statements, or pilot demonstrations.

The conclusion of the chapter is that 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 in the energy sector.

What differentiates renewable 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 which can be converted into forms of energy. Renewable energy is commonly understood to be energy from ongoing, natural processes; examples would be sunshine, wind, moving water and geothermal energy. Biomass is also regarded as a renewable energy source; plants can be grown over weeks or years, the wood burned directly or plant material turned into gas or biofuels. The South African Department of Minerals and Energy (DME) has produced a White Paper on Renewable Energy which 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' (DME 2003: v).

In South Africa, while we have an abundance of renewable energy in various forms, estimates differ as to how much of this is useable. Eskom estimates that there is only about 1 000 megawatts (MW) of wind power available around the coast (Eskom 2006a: 40). However, based on DME figures for 2004, Banks and Schäffler (2005: 23) provide an estimate of 50 gigawatts (GW).

Our solar resources are among the best in the world, with solar radiation levels of between 4.5 and 7 kilowatt-hours per square metre (kWh/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 75 m^2 per person would be sufficient (Banks & Schäffler 2005: 14).

While there are many different types of renewable energy, for the purposes of this chapter I focus largely on electricity generation options using solar photovoltaic (PV), solar thermal and wind power.

Solar photovoltaic options

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

Solar thermal options

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 electrical system for use in inclement weather (Ubushushu Bendalo 2006).

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 (DME 2003).

Wind options

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 in the coastal regions and along the escarpment. Banks and Schäffler (2006: vii) predict that wind energy could provide up to 80 terawatt-hours (TWh).

Why renewable energy is important for South Africa

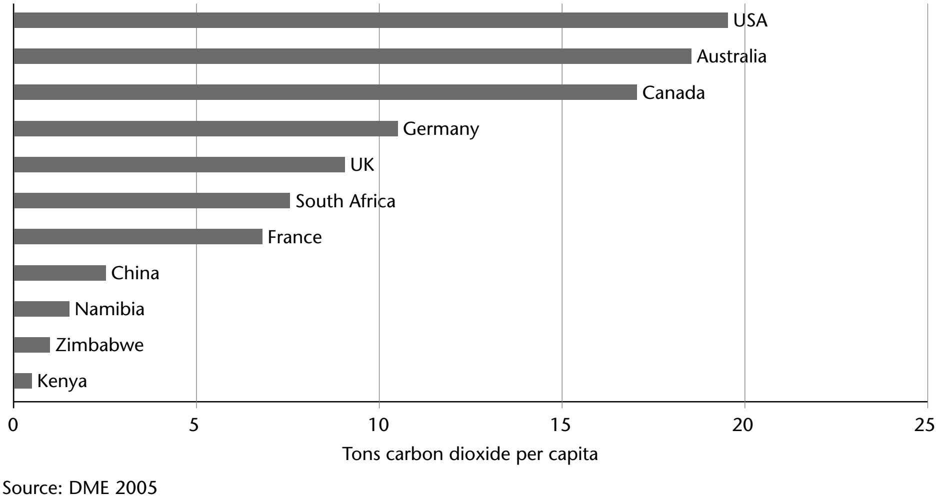
Over the last decade, there has been an enormous expansion of renewable energy use across the world. For example, in Germany installed wind capacity was 68 MW in 1990; by 2000, installed capacity was 6 095 MW and by 2004 it was 15 000 MW (Meixner 2003).

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 generated by the burning of fossil fuels has resulted in a change in the world's climate. As stated by Bond (2002: 179) in his critique of the New Partnership for Africa's Development (NEPAD), South Africa is one of the leading greenhouse gas producers in the world, if figures are 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 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 (Midgley et al. 2005). The report produced by Midgley et al. argues that the west coast of South Africa is becoming hotter and drier, for example, with severe resultant impacts on biodiversity and sustainable livelihoods in this region.

The implementation of renewable energy technologies (RETs) provides an opportunity to address climate change. By replacing 30 000–40 000 MW of fossil fuel with renewable energy, a considerable reduction in greenhouse gases can be achieved within the relatively short time frame of 25 years, while continuing to provide a high-quality electricity supply.

Health and social benefits: reducing air pollution and creating jobs

Many poor South Africans rely on solid or liquid fuels for energy in poorly ventilated homes. This results in high levels of indoor air pollution with huge resultant health costs. Where households located close to each other are all using paraffin or wood stoves, this results in increased air pollution outside as well as inside the houses (Hallowes & Butler 2004). In her foreword to the White Paper on Renewable Energy, Deputy Minister Susan Shibanga raised the issue 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' (DME 2003: i).

Renewable energy at the household level could mean using the energy of the sun, rather than paraffin, to heat water. Localised 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' (DME 2003: i).

Job creation

South Africa is a developing country experiencing 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 potential within the two sectors (Table 7.1); the unit of measurement used is jobs per MW.

According to Agama Energy (2003: 12), if all RETs are included a total of 36 400 direct jobs alone could be created in the South African economy, with additional spin-off employment potential. Such a model assumes a government commitment to a target of 15 per cent of total electricity generation capacity in 2020 through RETs. A key finding from the Agama Energy study was that the development of large-scale RETs will sustain and substantially boost the numbers of jobs in the energy sector, particularly because of the development of manufacturing industries that would take place.

Table 7.1: Job-creation potential of renewable and non-renewable energy technologies

Renewable energy technologies	**Total jobs/MW**
Solar thermal	5.9
Solar PV	35.4
Wind	4.8
Biomass	1.0
Landfill	6.0
Non-renewable energy technologies	
Coal – current	1.7
Coal – future	3.0
Nuclear – pressure water reactor	0.5
Nuclear – Pebble Bed Modular Reactor	1.3
Gas	1.2

Source: Adapted from Agama Energy 2003: 6–7

It is important to note that while massive employment gains can be made quickly in the solar water heater 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.

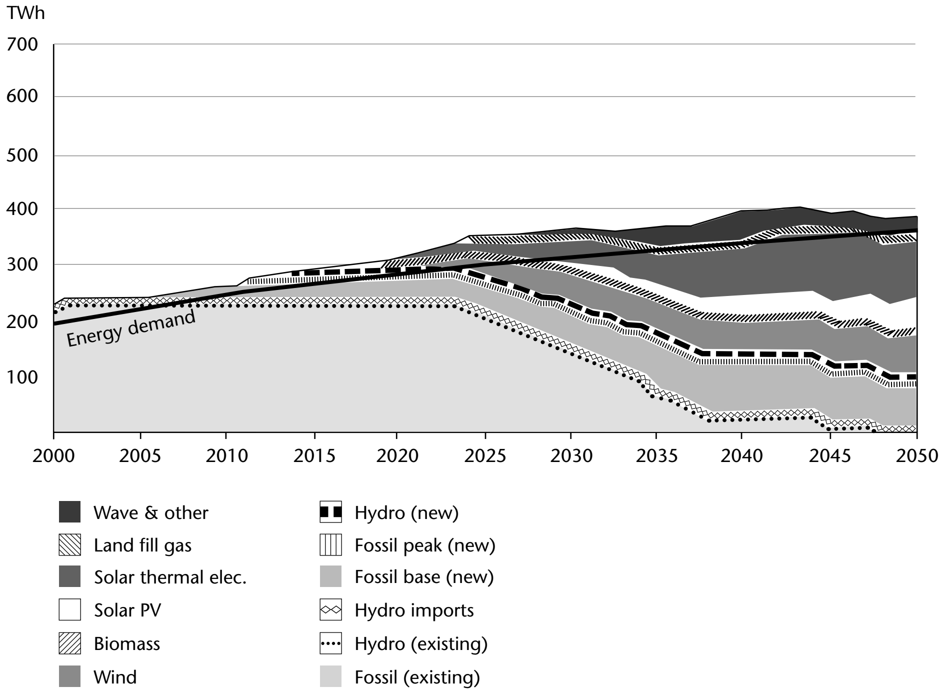
How much energy could we supply using renewables?

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. The discussion in this section draws largely on the report by Banks and Schäffler, which argues that it would be possible to provide up to 70 per cent of South Africa's electricity needs by 2050 using RETs (Banks & Schäffler 2006: xii).[1] Figure 7.2 presents findings from this report.

If we accept that South Africa must grow its economy, doing so in a way that meets the goal 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 cent per annum translates into electricity demand growth of 4.4 per cent per annum, requiring generating capacity of 47 252 MW to be built between 2005 and

Figure 7.2: Renewables scenario, 2050: how electricity demand would be met



Source: Banks & Schäffler 2006

2025. Eskom's capacity planning programme is based on a 4 per cent growth in GDP, which translates into 2.3 per cent electricity demand growth (Eskom 2006b).

Learning from renewable energy projects in southern Africa

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, to meet their energy needs.

And yet, a report produced by the US Energy Information Administration (US EIA) (US EIA 2005) on the current status of renewable energy in various Southern African Development Community countries only highlighted a bagasse plant and a solar power station.[2] While Tanzania, Swaziland and Mauritius have shown interest in a bagasse plant, it was only Mauritius which, in 2001, built a 70 MW plant. Plans for the others have either stalled or are in the feasibility stage. According to the US 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 12–30 watts, but they 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).

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

In 2005, the Forum for Energy Ministers of Africa (FEMA) was formed. A paper commissioned by the forum focused specifically on energy and the Millennium Development Goals in Africa. The paper analyses the provision of energy, including electricity, gas and biofuels. While acknowledging that the continent is rich in renewable resources, it fails to describe any particular strategy for the development of these resources (FEMA 2006), apart from one weak example of PVs, which 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 FEMA priorities. In fact, the 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' (FEMA 2006: 38).

NEPAD has a policy on energy which clearly states that 'Africa should strive to develop its solar energy sources which are abundantly available' (NEPAD 2001: 27). 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 hydro-power is included as a major component of the energy objectives, and action to be taken to give expression to this commitment is identified – to establish a task force to recommend priorities and implementation strategies for regional projects (Bond 2002).

The FEMA paper also provides a number of case studies and examples of energy services provision in Africa. Two case studies, of 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 in terms of its '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' (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' (FEMA 2006: 29; italics added).

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

Hathaway (2005b) also raises the issue that many African governments are already seeking funding for billions of dollars' worth of large hydro-power dam proposals, with little regard 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, Chapter 5 in this volume).

The Southern African Power Pool

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

The 2006 SAPP *Annual Report* acknowledged that the SAPP was becoming increasingly unable to meet electricity demands and that measures needed to be put in place to address this shortfall. 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 hydro-power in the DRC and Angola (SAPP 2006).

There is no meaningful reference in SAPP planning to the role of renewable energy. It can therefore be concluded that, like South Africa, the SAPP 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.

The current status of renewable electricity

The South African state-owned electricity utility Eskom has embarked on a number of pilot projects with various partners, as part of a research programme on renewable energy. Called the South African Bulk Renewable Energy Generation programme, it is aimed at 'large scale generation options'. These projects include:

- solar – the 'power tower', in which sunlight is concentrated onto a focal point where it is then used to produce steam and power a turbine to produce electricity;
- solar – the 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 at Darling in the Western Cape. 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 (Eskom 2006a).

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

Individual municipalities have also taken some action. The City of Cape Town's (CCT) *Energy and Climate Change Strategy* (CCT 2006) identifies a target of sourcing 10 per cent of its energy from renewable sources by 2020. In Darling near Cape Town, the Darling Independent Power Producer, the Central Energy Fund (CEF), the Danish government, the South African government and the Development Bank of Southern 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 (GWh) of electricity will be generated using four turbines (each generating 1.3 MW). The CCT 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 subsidise 50 per cent of the costs. This is necessary as this 'green electricity' is more expensive to produce than Eskom-generated electricity, for reasons highlighted later in this chapter.

CCT residents will be asked to pay extra for this wind-generated energy, 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 700 MW while the wind farm is expected to deliver a maximum of 5.2 MW (CCT 2006). However, it is hoped that the Darling initiative 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 65 MW. This amounts to approximately 5 per cent of the metropole's electricity demand (Chown interview).

In Jeffrey's 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 10 MW of wind energy with 5.5 MW of pumped storage. The total demand for the area is 15 MW. 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 use the financial mechanism of willing buyer/willing seller; the details are currently under negotiation. Customers are expected to pay a premium of R0.25/kWh for their green electricity (CCT 2003–2008; Chown interview).

Contribution of renewables by 2020 and 2050

The electricity demand predicted by Eskom for 2025 indicates that an extra 47 252 MW is required in addition to the current capacity (Eskom 2006b). Banks and Schäffler (2005) examine a number of different scenarios, with varying degrees of renewable energy in the mix. Their report examines the growth potential of different RETs and provides some indications of cost.

While there are a number of non-solar RETs such as biomass, landfill gas, waves and ocean currents, Banks and Schäffler (2005) identify solar thermal and solar PVs as large potential electricity producers for the future. They have found that because renewable technologies start from a very small base, even modelling a 10–20 per cent 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 (see also Table 7.2):

- 'Business as usual': This scenario envisages the current fossil and nuclear plants being replaced with more of the same; renewables would only contribute a negligible 4 per cent. The growth required would mean the equivalent of building a 3.6 GW power station every 30 months. Obviously, there would be severe environmental impacts if such a path were followed.
- The 'progressive renewable' scenario: This scenario sees about 13 per cent of total electricity coming 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 emphasises 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 Schäffler (2005) 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 Schäffler attempt to model a scenario in which not only is a very large proportion of electricity generated from renewables, but there is a greater use of electricity to replace fossil fuels, for example in the transport sector.

Whereas these scenarios show a limited amount of renewables available by 2020, they change dramatically by 2050. Table 7.2 shows the total amount of renewable energy provided by this date (as a percentage of total demand), as well as the contributions of wind, solar PV and solar thermal electricity to this total.

Table 7.2: Comparative contribution of renewables to total energy demand (percentage), 2050

Scenario prediction for 2050	Total contribution of all renewables (%)	Solar thermal contribution (MW)	Solar PV contribution (MW)	Wind contribution (MW)
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 & Schäffler 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 and increasing environmental safeguards applied to fossil fuel generation would contribute to this increase (Banks & Schäffler 2006). 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 (Salgado 2006).

Banks and Schäffler (2005) have included a suite of complexities in their analysis and prediction of the costs of electricity production into the future. The 'progressive scenario' outlined above would have a unit cost of energy of about R0.28/kWh by 2050. Compared to current costs of about R0.11/kWh, this appears high, but it is important to remember that Eskom is in a unique position because of 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 R0.25/kWh (peak load is predicted to cost R0.70/kWh) (Banks & Schäffler 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' renewables scenario developed by Banks and Schäffler, 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 & Schäffler 2006).

Using solar thermal as an example, the starting costs for a large plant are estimated to be R0.40/kWh and predicted to decrease to such an extent that by 2012, the costs could be lower than new baseload fossil fuel plants (approximately R0.25/kWh). By 2022 solar thermal could be the lowest-cost option (Banks & Schäffler 2006: 19).

Wind electricity generation costs presently range from R0.27 to R0.70/kWh, depending on the wind regime, which enables it to compete internationally with conventional fossil fuels. According to the International Energy Agency (as cited by Banks and Schäffler 2006: 22), wind energy costs are predicted to decline by 40–50 per cent over the next 15–20 years, making it a very attractive option for grid contribution. According to Davin Chown of Ecogenesis Energy, the recently approved Darling wind farm will produce electricity at a cost of R0.47/kWh (Chown interview). The wind farm is predicted to start generating power from late 2008.

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 provide an example of the implications of such an energy demand management approach. According to the CCT (2003), the heating of hot water in middle- to high-income electrified households constitutes 43 per cent 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: Comparison of solar water heaters and the 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 billion	R10 billion
Creation of jobs	13 440 jobs	135 jobs

Source: Ubushushu Bendalo 2004

It is clear that the installation of solar water heaters 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 Osman Asmal, Environment Department Head in the CCT, the reason that solar water heater technology was not implemented on a large scale throughout the city was partly the upfront financial costs involved, which are already committed towards existing infrastructure.[3] But another reason is that the city has not been convinced of the economic savings that would result from pursuing this option. It appears that the city has yet to conduct its own cost/benefit analysis which would show the savings to be made. Despite this, the CCT is drafting a by-law which would make installation of solar water heaters compulsory in all new houses.

Challenges to the implementation of renewable energy

It is clear that RETs offer significant benefits to South Africa, yet renewable energy currently makes 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 to 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).

Generating electricity when the sun doesn't shine or the wind stops blowing

As wind and solar power are intermittent energy sources, there is a need 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 available 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 350 MW 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 solve the problem of 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 at night (Agama Energy 2003).

Within South Africa currently there is about 1 580 MW of pumped storage capacity (Banks & Schäffler 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 current demand of approximately 40 000 MW 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 1 000 km^2 would yield 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 et al. 2003).

Pilot projects

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 has been to put forward projects to assess the viability of the technology for South Africa. Examples include the Klipheuwel (Darling) wind farm project in the Western Cape, the testing of solar water heaters, and 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 the 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 levelled against the project include that the turbines are at the wrong height, and that the project is in a sub-optimal site (Morris interview). 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 then likely to be forthcoming for renewable energy technologies.

This use of pilot projects 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 that of wind or solar technology (see Fig, Chapter 6 in this volume). While wind and solar technologies are established throughout the world, the pebble bed technology is 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 will use 6 000 mirrors and span a 4 kilometre 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* 20 July 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), the investment analysis tools for energy have not changed in 100 years. This might have been appropriate if we had to compare one centrally-based fossil fuel power plant with another, but is less useful when faced with the diverse range of energy resource alternatives available today. If we use solar PVs as an example, the costs of PV are almost all upfront 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 on Renewable Energy as the main barrier to implementation on a large scale (DME 2003). According to Awerbuch (2000) 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 cash 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 announced that it planned to build a solar panel production facility with a capacity of 215 MW in 2007, and thereafter producing 430 MW annually. The investors included Google's two founders, and the price quoted was

US$100 million. The first panels were shipped to Germany in December 2007. The exciting impact of this technology is that it will bring the cost of PV to or below the level of 'delivered electricity' in a large part of the world (Freeman & Harding 2006).

Oil companies have also started to show an interest in renewable energy. According to Reuters (*Business Report* 4 April 2007), Royal Dutch Shell has invested US$1 billion in renewables over the past five years while BP invested US$500 million in solar between 1999 and 2005, and US$300 million in wind generation in 2005–2006.

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

Factoring in the hidden external costs of fossil fuels and nuclear energy

Awerbuch (2000) 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 from sources such as the sun, ocean currents and the wind can be factored into long-term financial equations as a fixed cost – e.g. zero – while there is huge uncertainty related to the oil price which must be factored into conventional electricity generation (e.g. to transport nuclear fuel to the reactor and convey waste to a dump site). To illustrate, the petrol price in South Africa rose from R3.81 per litre in 2003 to R7.23 per litre in December 2007, an increase of almost 100 per cent over four years.

These risks are ignored in conventional financial models, and the comparative benefits of renewables are not apparent (Awerbuch 2000).

Government policy and the challenges of renewable energy

In her foreword to the White Paper on Renewable Energy (DME 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 identify a government target of 10 000 GWh renewable energy by 2013, which amounts to 4 per cent of total electricity demand in South Africa (DME 2003: i).

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

- Financial and legal instruments: One of the deliverables under this heading 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 (Salgado 2006). In 2004/05, the CEF commissioned a study to investigate subsidies for solar water heaters. There appears to be some progress in this regard but it is dishearteningly slow.
- Legal instruments: Deliverables under this intervention include 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: A key deliverable here is the inclusion of research and development in the scope of the South African National Energy Research Institute. This institute will be housed at the CEF and the plan appears to be to invest R100 million in its work over the period 2006–2009 (Hanekom 2006). Unfortunately, it is impossible not to contrast this with the R14.5 billion estimated allocation for the nuclear demonstration pilot (Cokayne 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 (DME 2003) admirably states that it 'will not reinvent the wheel' with regard to established technologies. It also states that the National Energy Regulator of South Africa (NERSA) will be able to determine the price at which power generators can sell their energy, and regulate electricity tariffs. It is therefore unfortunate that 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 (Hamlyn 2006).

According to the DME (DME 2004), there are two strategic options available to facilitate the uptake of renewables onto the grid. The first is *direct capital subsidies*, which the DME believes are the answer for near-commercial projects. This appears to be an attempt to level the playing fields by subsidising capital investments, but the control of the price renewable energy suppliers would receive for their generated power remains unsubsidised.

However, in the longer term, the DME views the second option, *feed-in tariff,* favourably. A feed-in tariff would regulate the price that suppliers can charge 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), German suppliers were able to reduce the cost of wind-generated electricity by 60 per cent 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 68 MW in 1990 when the feed-in law was introduced. By 2000, installed capacity was 6 095 MW and by 2004 it was 15 000 MW (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 (Austin interview).

Another mechanism involves forcing the distributor to buy a certain percentage of power from a renewable supplier but allowing this to occur at market prices. However, the 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).

The willing buyer/willing 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), and has used a system of tradeable renewable energy certificates (TRECs). These certificates can be obtained for producing a certain amount of renewable energy, and can then be sold. They 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 – 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 that fail 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. In this section I briefly review some of these organisations and discuss the extent to which renewable energy is championed by them (or not).

The CEF is a state-owned company, controlled by the minister of minerals and energy, which is responsible for 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. This division pursues 'commercially viable' investments in renewable energy. According to the CEF website, the Energy Development Corporation 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.'[4]

The front cover of the CEF's 2007 *Annual Review* shows a wind farm at sunset. While progress appears slow, the strategic objectives for 2007/08 include solar water heaters, the Darling wind farm and exploring landfill gas, but also include continuing focus on biofuels research and implementation. The CEF is also investigating a PV panel production plant for South Africa. CEF investment is given as approximately R7.8 million whereas PetroSA (part of the CEF group) showed a net after-tax profit of R36.4 million (CEF 2007: 6, 8–9, 63).

The CEF also established the South African National Energy Research Institute (SANERI) in 2006, as a result of a ministerial directive. The SANERI received a R2 million start-up grant from the Department 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, the SANERI might research the best sites for wind farms within South Africa. Such research, conducted by the state and available to all, would help to guide investment decisions regarding the best sites for wind farms, without each potential wind farm owner having to undertake similar, costly research.

The NERSA is also an important player. It has not provided information on its stance on regulating renewables, but according to press reports it has been involved in the following activities:

- Two gas turbine power plants were to be built at a cost of R3.5 billion. These plants (with a total capacity of 1 050 MW) were scheduled to come online by 2007, at Atlantis and Mossel Bay respectively (Gosling 2005).
- In March 2006 the NERSA announced that it had called for bids to build two open cycle gas turbine power plants. These were to have a combined capacity of 1 000 MW (Faniso 2006).
- It was also reported that a private company, Independent Power Southern Africa, planned to build an 800 MW combined cycle gas turbine plant in Port Elizabeth (with a cost estimate of about R1.9 billion) as well as a 400 MW coal-fired power plant near East London (cost estimate not provided). It appeared from the reports that these power plants would apply for licences

within the next two years, and that the NERSA would look favourably on their application (Faniso 2006).

The NERSA has a policy position that stipulates that electricity prices must be based on the lowest-cost option for generating new capacity (*Business Report* 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 NERSA position also contradicts the White Paper on Renewable Energy, which states that power generators would 'base their tariffs on full cost accounting, including environmental externalities' (DME 2003: 40).

In April 2007, a press report indicated that the NERSA would be asked to approve an electricity price increase of 18 per cent despite inflation figures of 3–6 per cent (Williams 2007). In a press statement released by the NERSA in December 2007, it announced that 'given Eskom's capital financing needs' there would be a 14 per cent increase in electricity prices (NERSA 2007).

As for Eskom, its R97 billion capital expansion programme (increased to about R150 billion in early 2007) contains no significant plans for renewables. It is sobering to see that of a planned potential increase of 47 000 MW of new capacity envisaged by Eskom to meet South Africa's electricity needs over the next 20 years, less than 0.2 per cent 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). Its energy strategy, as presented on its official website, includes a reference to '[e]nsuring 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, from which it is clear that 'high quality, low cost' electricity is Eskom's primary aim.[5]

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. Decisions aimed at achieving this are unlikely to take account of externality costs such as toxic emissions unless forced to do so by government. If Eskom makes decisions based 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.

Such a strategy cannot be read in any other way than as a firm commitment to the continuation of traditional capital-intensive energy generation projects such as coal-fired power stations, with the addition of further fossil fuels such as gas, and hydro developments in the region.

Challenging 'business as usual': returning 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 need to be put in place in order for South Africa to move beyond the fossil age into the solar age? This section provides some general suggestions for such systems.

Transforming the grid

As pointed out by the DME (2004), 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 transmission losses from Mpumalanga to Cape Town are presently about 10–20 per cent (Dobbins 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 Guterl 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 blackouts 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 R0.11/kWh but paid out approximately R1.70/kWh to these consumers) (Chown interview). 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 (Guterl & Romano 2004: 36–37):

- In Japan, Hitoshi Iokawa installed solar panels on his roof in 1997. It cost him the equivalent of US$33 000 of which the government subsidised a third. By 2004 he was generating an income of $460 per year selling electricity back to the grid – enough to offset his electricity bills. Japan started its programme of solar power in 1993. In 2004, 170 000 homes were feeding into the grid.
- In California in 2004, Ignacio Vella was powering the fridges in his cheese factory with 234 solar panels, and was able to sell leftover energy back to PG&E, the local power company.
- In 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, 500 MW of power is being produced per year, some of which is then sold back into the grid.

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 mobilised *against* the nuclear industry, but little has been done to mobilise *for* renewable technologies.

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. The South African Faith Communities Environmental Institute is a recent initiative amongst faith-based groups which focuses on environmental sustainability, including renewable energy. In the press, Bishop Davies, the chairperson of the institute, 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 at both city and provincial levels and has been selected by the CCT to assist with the rollout of solar water heaters in the metropole (CCT 2006).

There is some research being done on the renewables sector (e.g. the work of Agama Energy and the DME; see also Banks & Schäffler 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 to be taken which would encourage the development of RETs. These could include:

- government passing laws making certain RETs mandatory, for example solar water heaters (such as the CCT's draft regulation which would make it mandatory for all new buildings to have solar water heaters);
- fiscal measures such as taxes on fossil fuel-derived electricity that would assist in levelling the playing fields as well as giving life to the principle of 'the polluter pays', which already exists in law;
- transformation of the grid to allow power to be fed into it as well as drawn off it;
- a government mandate to Eskom to direct 20 per cent of its current investment into RETs;
- government ensuring that the poor are protected from increased electricity tariffs.

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 renewables uptake is only 4 per cent by 2013 (DME 2003), and the underlying government assumption is that RET is relegated to use by the rural poor and for small-scale applications, while mainstream electricity generation will be via 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 using these technologies, sufficient to satisfy even the needs of the greedy captains of industry.

The real problem is not, therefore, the economic or technical issues related to RETs, but the absence of *political will* to take the lead. Former British Prime Minister Tony Blair's response to the challenge of climate change summarises the political dilemma: 'There is a mismatch in timing between the environmental and electoral impact' (Blair cited in Monbiot 2006: 22). 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 terms of five-electoral cycles.

RETs are beneficial to a developing nation; they are sources of clean electricity, safe energy and an increase in jobs. The economics are sound, providing that 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 per cent of South Africa's electricity and therefore must be transformed. The only way that renewables will become mainstream in South Africa is if Eskom is instructed by Cabinet to plough significant resources into implementation of RETs, not in the form of pilot research but as a rollout of large-scale power supply.

Eskom appears to have taken what it believes to be a low-risk route of sticking to technologies that it knows. Committing the country to a centralised grid also ensures that it maintains an income stream, either through charging for access to the grid by independent power producers, 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* 6 February 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. It can choose to follow the dirty, heavily polluting technologies which are being dumped on the continent by the countries of the First World, including large fossil fuel 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 demand at the least cost. But in this case the calculation of least cost includes the impact on 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, and 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 to start on this path is a leader!

Notes

1 Banks and Schäffler do include small/micro hydro of up to 9 900 GWh per annum in their progressive scenario (Banks & Schäffler 2005: 26). These figures have been included in the arguments in this chapter. However, large hydro-power schemes face a number of social/environmental and political challenges which are discussed elsewhere, and their inclusion in the renewable energy mix is not supported by this author.

2 Bagasse is plant material waste left behind after sugar is extracted from sugar cane. It can be used as a fuel in an electricity-generating plant.

3 Osman Asmal, personal communication

4 www.cef.org.za

5 www.eskom.co.za

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