LOW-CARBON AFRICA: SOUTH AFRICA

POVERTY

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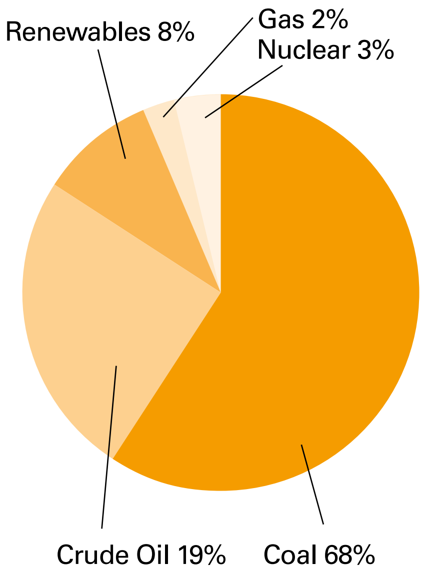
1. COUNTRY CONTEXT

1.1 Brief context of South Africa's energy profile

South Africa's domestic energy sector is dominated by coal, accounting for some three-quarters of the primary energy supply.[4] In South Africa, renewable energy accounts for approximately 7.98 per cent of primary energy supply (See Figure 1). However half the renewable energy comes from wood fuels (biomass) as opposed to renewable energy technology.

Eskom (South Africa's state energy production and supply company) supplies approximately 95 per cent of South Africa electricity, only 1 per cent of whose generation base is renewable.[5] Electricity generated from low-grade coal in South Africa is regarded as 'cheap energy' and South African electricity costs are generally considered to be amongst the lowest in the world. South Africa's reliance on coal has made it a major contributor to carbon dioxide emissions. The country is ranked the 11th largest emitter in the world.[6]

Figure 1: Primary Energy Supply in South Africa



Source: Digest of South African energy statistics 2006 (Department of Minerals and Energy)

In recent years, South Africa has experienced periodic power outages ('blackouts') because the current electricity supply could not meet

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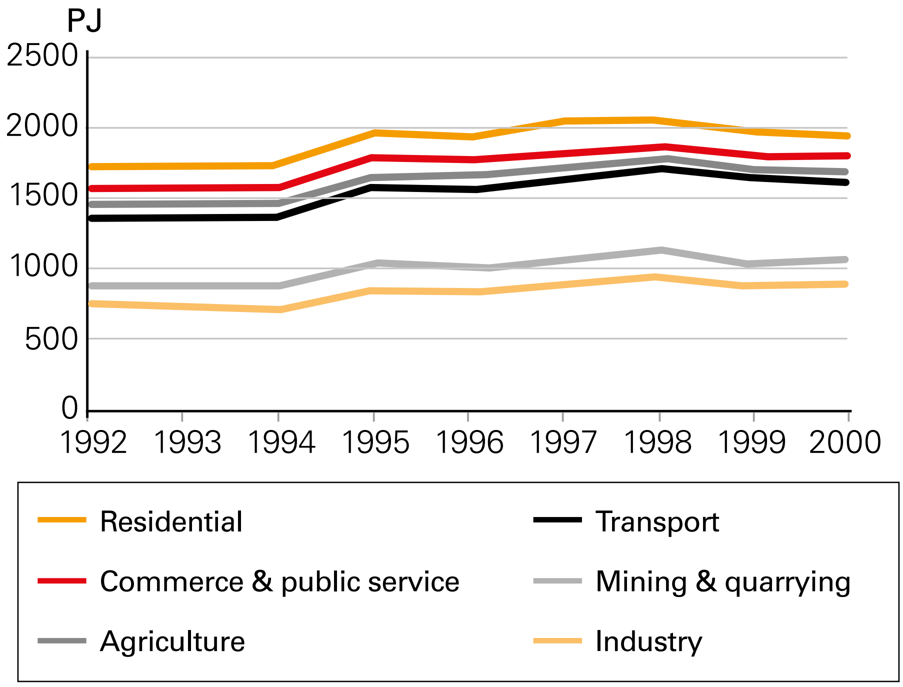
Figure 3: Energy Demand in South Africa



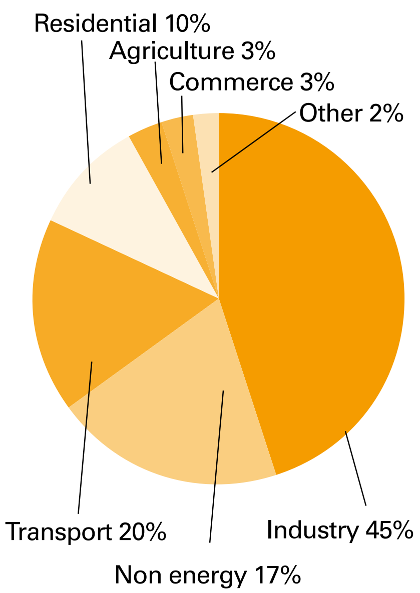
Source: Energy Research Centre, 2006. Energy Policies for Sustainable Development in South Africa: Options for the Future, University of Cape Town.

the current demand. To address the electricity crisis, the government has opted to build new coal power stations and develop further electricity capacity from nuclear energy. Eskom has stipulated that a steep increase in the price is needed to fund the two new coal power stations. It is estimated that the government's New Build Programme could cost around ZAR 1.3 trillion, with less than 1 per cent going to renewable energy.[7] The tariff increase will be 25 per cent per annum over three years.

As mentioned earlier, South Africa's energy is dominated by coal. A small amount of biofuel (ethanol and biodiesel) production takes place. The government has developed a Biofuels Strategy and has plans to expand this sector. South Africa is a net energy exporter in coal but imports large amounts of oil and some natural gas. According to Wakeford (2006), South Africa's economy is somewhat vulnerable to oil price shocks.

The industrial, commercial, transport and residential sectors all consume coal directly. Residential demand for electricity use is 16.4 per cent, much less compared to industry and mining use at 62.7 per cent (Hallowes and Munnik 2007). According to government information, 'much of the energy in this sector is consumed in minerals beneficiation and mining (50 per cent) and manufacturing (20 per cent)'.[8] The information indicates that mining relies heavily on electricity, with 70 per cent of energy consumption on the mines being electricity. (See Figure 2 on energy consumption and Figure 3 on energy demand).

Figure 2: Energy Consumption in South Africa



Source: Energy Research Centre, 2006. Energy Policies for Sustainable Development in South Africa: Options for the Future, University of Cape Town.

1.1.1 Overview of energy poverty in South Africa as well a focus on the privatisation of electricity and its impact on access and affordability for the poor

South Africa faces severe socio-economic challenges. A large proportion of the population is 'energy poor'. About 30 per cent of the population do not have access to electricity and are dependent on biomass and paraffin to meet their energy needs. Government has introduced 'free basic electricity' of an amount of 50kWh per household per month for poor households, however, a study by Earthlife Africa has showed that this insufficient.[9] The study proposes an amount of 200kWh per household per month.[10]

During the 1990s Eskom moved to a policy of 'user pays' cost recovery (meaning that the costs of infrastructure to supply energy needed to be recovered). This policy has affected many poor households, particularly the majority of black South Africans who had no access to electricity during the apartheid era – more than 80 per cent of households living in black townships did not have access to electricity. Although between 1991 and 2000, the government reached its reconstruction and development target of ensuring 2.5 million household have electricity connections – in fact, Eskom made over 3.2 million connections – there was also a high level of disconnections because of non-payment.[11] Greenberg (2006) points out that although infrastructure is rolled out, access is limited to those who can afford the service and lack of payment for services is closely related to the inability to pay. The implications are that these households have to revert to using paraffin and biomass (particularly in rural areas) to meet their energy needs for cooking, heating, lighting and so forth.

1.2 Energy: industrialisation and growth

South Africa's Industrial Action Plan for the 2010 to 2013 period recognises that growth in the productive sector has been relatively low from the period 1994 to 2008. Sectors such as agriculture, mining, manufacturing, electricity and water, and construction grew by only 41 per cent (2.9 per cent annually).[12] Though the plan recognizes that the current growth path is unsustainable and significant emphasis has to be put into building South Africa's productive capacity, the growth path is largely built on expanding the fossil fuel based economy, in particular maintaining the dependence on coal powered stations as well expanding nuclear power.

As indicated in the New Growth Path Framework, released in 2010 by the Department of Economic Development, ecological and social perspectives are divorced from sector priorities. Instead, the 'green economy' is seen as 'seizing the potential of new economies' in parallel with traditional economic system as opposed to changing the economic system, such that it takes into account social and ecological considerations.

Some targets from the Industrial Action Plan and New Growth Path include:

- Supporting 'green and energy saving industries' by committing to the installation of one million solar water heaters (SWHs) by 2014 to meet the Renewable Energy White Paper goal of 10,000GWh.[13]
- Targeting 300,000 additional direct jobs by 2020 to 'green' the economy, with 80,000 in manufacturing, and the rest in construction, operations and maintenance of new environmentally friendly infrastructure. The potential for job creation rises to well over 400,000 by 2030.
- Creating additional jobs by expanding the existing public employment schemes to protect the environment, as well as in production of biofuels.

1.3 Review of renewable energy potential for the country, both decentralised and large scale

Climatic conditions in South Africa present immense renewable energy potential. It is widely accepted that South Africa has amongst the highest solar power potential in the world, estimated at 548GW[14] – an area of 730 square km is required to meet South Africa's total current electricity needs.[15] While attempts have been made in the development of Solar Water Heaters (SWH), the opportunity for solar power has yet to be fully grasped. If adequately deployed at low-mid to high income homes alone, 4,747MW and 1,014MW can be removed from winter peak load and summer standard load respectively. This appears to be the simplest distributed, small-scale intervention that is immediately possible, but various issues, such as unit certification, problems with the subsidy process, and a lack of a vibrant local manufacturing sector are barriers. Similarly, if only 5 per cent of households were to install a 2kW grid connected system that alone would contribute 800MW.[16]

Regarding wind energy potential, the various figures produced by different role players differ markedly. For example, the Eskom wind atlas[17] is seen as flawed, given the low measurement height compared to the Hagemann atlas,[18] which is more credible and provides an upside potential of approximately 56GW of capacity. This is more in line with the 50GW indicated by the Earthlife Africa document.[19] Likewise, hydropower varies – small-scale potential (<10MW) ranges between 69MW and 1,994MW.[20] Wave Power is estimated at between 8,000 to 10,000MW.[21] Tidal current (as opposed to tidal flood) has, as yet, not been adequately quantified, despite two strong ocean currents running off the South African coast – the Benguella and Agulhas Currents – however, besides the fact that it would effectively operate as base load plants, it has been deduced that a workable order of magnitude is about 1,000MW per 10 square kilometres of ocean current.[22] This implies that the base load potential for tidal currents is in the order of 10GW, utilising 15 per cent of the energy.[23]

It is clear that, with the political will, South Africa is able to move towards a 100 per cent renewable energy future, with a concomitant benefit that most of the technologies mentioned above lend themselves to both decentralised and large scale deployment, leading to an energy secure future for all.

1.4 Review of low carbon strategy

South Africa does not have a low carbon strategy as such, but at a national level there are documents that specifically speak to this issue. However, they are inadequate to create the impetus for a low carbon strategy. Two key strategies facilitated by the Department of Environmental Affairs are the National Strategy for Sustainable Development (NSSD) and the Long Term Mitigation Strategy.[24]

The NSSD was developed after South Africa hosted the World Summit of Sustainable Development in response to fulfilling the commitment to implementing the Johannesburg Plan of Implementation. While the document attempts to set a vision for sustainable development in South Africa, the approach is an uncritical economic growth path and instituting sustainable development practice seems to be a catch-all framework for all government policies and programmes, rather than setting the tone to shift policy direction. For example, the focus on energy stresses the risks associated with fossil fuel dependency and makes reference to unsustainable consumption. However, it does not stress that consumption patterns are at the heart of the energy crisis and it fails to critique the current economic growth path largely dependent on fossil fuels and an export driven path leading to an inequitable increase in consumption and production.

Similarly, the LTMS is based on energy modelling that assumes an ever-increasing demand and, therefore, cannot be reconciled with either carbon reductions Required By Science (RBS), nor of declining global oil production following peak oil. Further, a key assumption made by both the LTMS document and the Climate Change Green Paper (2010) is that the development paradigm of South Africa will not shift significantly from its current model,[25] predicated on 'cheap' energy for large scale industrial consumers, in fact, with an expansion of problematic industries such as aluminium smelters.[26]

1.5 Barriers to low-carbon development and energy access in the country

There are a number of barriers in South Africa hindering low carbon development. The key barriers include economic growth largely based on maintaining the minerals-energy complex; an energy strategy committed to coal and nuclear development; the lack of state finance to support renewable energy; continued state energy subsidisation for mining and related large corporations; and the ongoing support for large-scale capital and energy intensive agricultural models, amongst others.

1.5.1 Minerals and energy complex

Historically, the state played a major role in the growth in manufacturing in South Africa. It set up a range of state corporations and entities primarily to support the growth of heavy industry for inputs into the mines and limited beneficiation of mine outputs – known as the Minerals Energy Complex (MEC) (Greenberg 2006, p7). This mineral–energy nexus largely shaped South Africa's energy intensive economy from the apartheid era.[27] South Africa's 'cheap' energy is based on the abundance of coal, with the country estimated as having coal for the next 200 years.[28] This presents a serious structural challenge to government policy, to shift energy generation away from coal.

Coupled with South Africa's economic growth (significantly locked into the minerals–energy complex) are ownership and redistribution issues related to mining. So as to address redistribution of wealth and equity in ownership of the country's resources, institutional capacity has very rapidly been forged and applied in Black Economic Empowerment (BEE). Rio Tinto Zinc, for example, sought to exploit 1 billion tonnes of coal in Limpopo with BEE partner, Kwezi Mining.[29]

1.5.2 The South African government's energy plan committed to coal and nuclear

The announcement of the Integrated Resource Plan 2 (IRP2)[30] in 2010 shows the ongoing commitment to unsustainable energy in South Africa. The 'final' IRP2 shows a commitment to final coal fired electricity in the order of 65 per cent of total generation capacity; a quadrupling of nuclear energy to 20 per cent; only between 7 per cent and 9 per cent from all resources; and hydro between 5 per cent and 6 per cent, in 2030. This is far from the various scenarios sketched by even the conservative UNFCCC, to the more recent confirmation that a 100 per cent renewable powered world is possible by 2050.[31]

Furthermore, the public participation process was deeply flawed. The IRP was produced through a process that privileged industry participation – notably through the technical working group – and discouraged community participation.[32] The result reflects the continued subordination of policy to the interests of energy intensive industry and Eskom.

1.5.3 Lack of State finances to support renewable energy and Renewable Energy Feed In Tariff (REFIT)

Unlike the efforts by the State to obtain resources for the development of the coal power stations, such as having to take out a loan from the World Bank, financial support for renewable energy does not appear to be a priority. The government has introduced the Renewable Energy Feed In Tariff (REFIT) as a basis on which technologies would be deployed, as guaranteed prices to Independent Powers Producers (IPP).

Nevertheless, the uptake has been slow, given that the process of application for the REFIT, as well as access to the grid, are problematic, with Eskom (the energy monopoly parastatal) having a say in the decision-making process. As of May 2011, an announcement was made that the procurement process will follow a tender process, also seen as problematic, given that it will limit competition in the field, as well as being more cumbersome. Further concern is that the entire notion of Independent Power Producers (IPPs) is viewed with suspicion by (particularly) organised labour, as implementing 'privatisation by stealth'.

1.5.4 Subsidisation of large mining and related corporations and inequitable pricing

In South Africa, the electricity produced by burning coal is cross-subsidised, so that it is the cheapest available anywhere in the world for the world's largest mining and metals corporations.

For example, BHP Billiton and Anglo American Corporation, paying less than US$0.02/kilowatt per hour of electricity for smelter consumption through 'Special Pricing Agreement' deals established during the apartheid era. Other large corporations received electricity in 2009 at US$0.05, still below cost, and although prices rose dramatically on average, the lowest increases were imposed on the biggest firms.[33] Currently, a domestic consumer on a pre-paid meter pays approximately US$0.13kWh.[34] Permission has been given to Eskom to increase prices by 25 per cent annually over three years, this being the second year. This will continue to place enormous pressure on the use of electricity in poor households.

1.5.5 The promotion of an energy and capital intensive agricultural model

The 'contribution of the food chain as a whole to climate changing GHG emissions has been estimated to be as high as 20-22 per cent',[35] with the global impact of livestock production measured at 51 per cent of all GHG emissions and 70 per cent of deforestation.[36] Industrial agriculture is the biggest user of water through irrigation in South Africa at about 62 per cent.[37] The current agricultural model is heavily dependent on fossil inputs (energy, pesticides, herbicides, fungicides), and government estimates are that the GHG impact of this sector is in the order of 7 per cent.[38]

However, agricultural development strategies do not seem to consider the impact of food imports or exports, nor of livestock production from a life cycle perspective, which should include value-chain impacts. These include food processing, packaging, long distance refrigeration and massive transport infrastructure systems, which add to the use of fossil fuels. Furthermore, trade distorting agricultural subsidies from developed countries distort the real price of food and its real costs in environmental, social, cultural and political terms, as poor producers cannot compete on the international market and domestic markets are displaced.

Therefore the nature of large-scale capital intensive industrial agriculture coupled with the consequences of the global trade regime presents a huge barrier to shifting to an agro-ecological model that will ultimately result in greater food security and put an end to the fossil-dependent model.

1.6 Links between energy and climate resistance and adaptation

1.6.1 Health impacts

The lack of access to clean and modern energy for the majority of poor South Africans has serious health and safety implications. These communities suffer from respiratory diseases due to indoor pollution from use of paraffin and coal fires for heating and/or cooking. An estimated 20 per cent of South African households were exposed to indoor smoke from solid fuels, exposure to which was estimated to have caused 2,489 deaths, or 0.5 per cent of all deaths in South Africa,[39] and is responsible for the deaths of up to 1,400 children annually.[40]

1.6.2 Water

Energy production and consumption in South Africa uses significant amounts of water in a water-scarce country. Table 1 shows the amount of water withdrawal and consumption for the different energy types.

Table 1: The amount of water withdrawal and consumption for the different energy types.

Energy Type	Water Withdrawal (Gal/MWh)	Water Consumption (Gal/MWh)
Nuclear (steam, once through cooling)	25,000 to 60,000	400
Nuclear (steam, pond cooling/ cooling towers)	500 to 1100	400 to 720
Fossil/Biomass/Waste-fueled Steam (once through cooling)	20,000 to 50,000	300
Fossil/Biomass/Waste-fueled Steam (pond cooling/cooling towers)	300 to 600	300 to 800
Natural Gas/Oil combined-cycle (once through cooling)	7500 to 20,000	100
Natural Gas/Oil combined-cycle (cooling towers)	230	180
Natural Gas/Oil combined-cycle (dry cooling)	0	0
Hydro	4,500	4,500
Solar thermal	1,040	1,040
Geothermal	1,800 to 4,000	1,800 to 4,000
Solar Photovoltaic	30	30
Wind	1	1

Sources: EPRI, 'Water & Sustainability'; NEI, 'Water Use, Electric Power, and Nuclear Energy'; World Economic Forum and Cera, 'Thirsty Energy'; Scientific American, 'Energy versus Water'.

Table 2: Water use by technology type

Power Generation Technologies	Efficiency (L/1,000 kWhrs)
Hydroelectric	260
Geothermal	1,680
Solar Thermal	2,970 – 3,500
Fossil fuel thermoelectric	14,200 – 28,400
Nuclear	31,000 – 74,900

Source: Analysis of Water Consumption for Producing and Generating Power, 2008. Virginia Water Resources Research Centre.

Despite government acknowledging that water constraints are already impacting on the population, it appears that the political will to ensure equitable pricing, and the implementation and enforcement of pollution avoidance measures, is lacking.[41] The water situation is similar to the one that obtains regarding energy in terms of inequitable access, use and pricing of electricity, with bulk users paying low prices and minimal water regulation with regard to pollution. The figures show that the domestic sector (including a 20 per cent share used by small business and small industry) uses only 11 per cent of the water resources of the country; 20 per cent by the environment; and the balance by business and industry, including mining[42] (see Table 2 for water use by technology type).

The inevitable imbalance, and future climate-driven weather events, would suggest that water efficiency would be given the same priority as energy; and that equitable pricing would also be implemented.

1.6.3 Food production

South Africa's food production model is almost wholly commercial, with government prioritising commercial enterprises.[43] This agricultural model is extremely energy, water and capital intensive, and contributes significantly to climate change.

While many adaptation programmes are focused on supporting subsistence farmers, home-based food production, and community food gardens to adapt to climate change, these programmes will amount to very little in the long term if the systemic problems of agriculture and food production are not addressed. The shift towards agro-ecologically based smaller-scale units that are not reliant on fossil fuel inputs and that serve local markets as a priority will prove critical. According to the UN,[44] small-scale farmers can double food production by using ecological methods rather than chemical fertilisers.

1.7 National potential benefits for low-carbon development

1.7.1 Local strategies to promote renewable energy and efficiency energy

Supporting and implementing micro-power and following a localised and distributed generation model will prove most resilient,[45] while also keeping energy costs within limits – the rapidly increasing price of electricity for domestic users is problematic.

An aggressive technology transfer programme is required at the national and local level. There are however problems associated with technology transfer. Some current barriers include World Trade Organisation policies[46] such as the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement, establishes that all inventions are patentable, including inventions based on the exploitation of biological resources.[47] Therefore it is imperative that TRIPS be removed or relaxed to ensure appropriate equitable technology transfer to support strategies for low-carbon development at the local level.

Energy efficiency in South Africa has been inadequate. Though the electricity utility has been appointed to improve energy efficiency, it has proved to be ineffective. It has not been able to regulate effectively such appropriate pricing for all high-end consumers. If measures are put in place for renewable energy development and improved energy efficiency in a range of sectors, this will lead to improved local and localised energy security, with its attendant climate resilience, while enhancing health and well-being.

1.7.2 Local food security

A non-agro-industrial model will prove both climate-resilient (at all scales), as well as lead to improved food security and nutrition (also important in the context of accelerating global food prices), improving health and well-being, and reducing the need for importation of food (both within the borders as well as trans-nationally).

A shift towards agro-ecologically based smaller-scale units, which are not reliant on fossil fuel inputs and large-scale irrigation systems, can improve food security and resilience against climate change. This means spreading agricultural production more widely, including more food production in the cities, where half the population live.

Changing current agriculture production will have a significant impact on stabilising climate change: i) it reduces reliance on the large-scale industrial agriculture system, which is not sustainable, ii) it begins to create an ecologically and socially friendly food production system; and iii) ecological agriculture absorbs large amounts of carbon.

1.7.3 Local benefits of efficient public transport

Low carbon development will significantly improve public transport in South Africa. Transport in South Africa contributes 13 per cent of carbon emissions.[48] South Africa is heavily dependent on long-haul trucks to transport goods and has an inefficient public transport system.

The current transport systems do little to correct the systemic transport issues that are a legacy of Apartheid, where 'townships' were considered 'dormitory' suburbs for the working class.[49] The poor are captive users, who typically spend more than 20 per cent of their income on transport, whereas the acceptable norm is 10 per cent.[50]

Access to public transport is reduced by long walking distances and long waiting times largely due to inadequate service and route coverage, as well as poorly arranged schedules.[51]

Limited progress has been made in this area (such as the Bus Rapid Transport system); however, the focus and expenditure has tended to be towards providing support to tourists (eg, the Gautrain) or events such as the World Cup, where dedicated and premium transport was prioritised.[52] People-friendly (from a safety, dignity and cost perspective) transport will go a long way to improve local stability in commuter patterns, and also reduce the needs for extended infrastructure that are used primarily by the wealthy (the current road system being a case in point).

Similarly improved efficiencies in rail systems for passengers will also reduce the load on the existing road network, as well as reduce the energy utilised per person or per tonne moved, being four times more fuel efficient than heavy vehicles.[53] The average intercity train produces 60 per cent lower CO2 emissions on a per passenger kilometre basis than a car, and about 50 per cent of that of an aircraft.[54]

2. CASE STUDIES

2.1 Household and community

Kuyasa: Thermal Efficiency Upgrade in Low-income Housing

2.1.1 Objective

Kuyasa aims to retrofit existing low-income houses with solar water heaters in order to provide hot water on demand, insulated ceilings to improve the thermal efficiency of the household units and two compact fluorescent light bulbs (CFLs) each to provide energy efficient lighting.[55] The housing units referred to are approximately 2,300 units in Khayelitsha, Cape Town.

2.1.2 Technologies used

The technology used in this project was the installation of Solar Water Heaters. Other aspects included Energy Efficiency Improvement through using specific technologies through retrofitting with CFLs as well as the ceiling insulation. All the technology was supplied by a local company, Genergy.[56]

2.1.3 Development benefits and impact

Some of the socio-economic impact and benefits are:[57]

- Improved energy efficiency, 56 per cent decrease in number of households spending more than R100/month (approximately US$14.29) on electricity was reported and savings of R50/month per household.
- Reduced burning of paraffin for heating; many households used to burn up to 1 litre of paraffin per day in winter at a cost of approximately R11 (US$1.57)/litre, they have now (almost entirely) stopped using paraffin heaters. Benefit of this technology is not just the cost savings, but also the relief on respiratory illness from paraffin fumes and the improved safety – having done away with open flame heaters.
- Reduced health burdens, health cost benefits due to increases in the ambient temperature and reduced reliance on heat sources holding fire-related dangers and negative respiratory health impacts (~800,000 hospitalisation incidents related to fire and ingestion of paraffin).

The installation of technologies and associated infrastructure also resulted in the project creating 100 jobs.[58] There is also significant potential for replication across all low-income housing in South Africa. Furthermore the City of Cape Town (local government) emphasises, 'Building human capacity around various aspects of the project design, most notably around energy efficiency and renewable energy and the development of a social awareness and an understanding of the link between the environment and energy consumption, by drawing marginalised people into a global environmental issue'.

2.1.4 Opportunities/risk of this development

This project presents an opportunity to implement policies and develop regulation for energy efficient as well as 'green' building codes for housing developments and construction. Policies towards sustainable development need to ensure affordability for all sectors of society and avoid creating further disparities between the haves and have-nots.

In South Africa, current government policy, together with restricted investment form barriers to the installation of domestic energy efficient devices, particularly in low-income communities that generally lack of information and available finance when it comes to renewable energy and energy efficiency options.[59] Furthermore, the National Department of Housing's building regulations also does not specify these types of technologies and the once-off National Housing subsidy is only enough to cover basic shelter and some services. For example, ceilings and ceiling insulation are not part of the current low-cost housing delivery, and no houses sampled in Kuyasa have installed ceilings prior to the design of this project.

This project is recognised as a success story for the Cleaner Development Mechanism (CDM) and predicts that the Net Present Value of the income from the emissions reductions will cover 30-40 per cent of the capital costs of the installation of these technologies, based on the current nature of the carbon market.[60] Like other commodity markets, carbon markets will be subject to price volatility. In addition, this market-orientated approach is premised on economic optimisation and is likely to impact on the long term sustainability as well as moving beyond the pilot project.[61]

2.1.5 Types of investment needed

Preliminary calculations indicate that the capital expenditure required for the implementation of the project amounts to approximately R20 million, of which the cost of solar water heaters amounts to R12 million.[62] The capital cost amounts to approximately 60 per cent of the anticipated cost of implementation, excluding the cost of institutional set-up, installation and project management. The project has managed to secure funding from a number of partners, a combined amount from respectively the Provincial Government of the Western Cape (PGWC) and ICLEI (R4.7 million) and the National Department of Environment and Tourism (DEAT) through its Poverty Alleviation Funding (provisional amount of R25 million including VAT). The focus of the latter funding source is to leverage local job creation opportunities through environmental or tourism related project implementation.

The technology-intensive nature of the project, however, places a limitation on delivering the full project (2,309 houses) by means of the Department of Environmental Affairs (DEA) funding. Initially, there was funding for only 620 houses. The Business Plan submitted to DEA indicates that the project still has a shortfall of R23 million, if the installations are to be made on all the proposed 2,309 houses on this basis. The City of Cape Town is currently in partnership with the DEA, investigating the institutional requirements to ensure sustainable maintenance (ie, community development trust), as well as funding options, inclusive of potentially forward trading of certified emission reductions (CERs), for the implementation of the remaining 1,689 households in a manner that is feasible and sustainable.

2.1.6 Other support to the project

At the institutional level many of the local by-laws are outdated particularly in building and construction. These by-laws will need to be revamped to institute building codes and provide the financial support for greater energy efficiency. In other words, installing solar water heaters would have to become part of the norms and standards.

Kuyasa is a pilot project and in a sense provides the impetus and lesson learnt for extensive rollout of solar heaters for low-cost housing. In this case funding has come from a range of sources. Eskom is currently providing rebates to those households making the shift to solar geysers.

2.2 Small business enterprise: integrated biogas system at Three Crowns School

2.2.1 The objective of the project[63]

Three Crowns Rural School in the Lady Frere district of the Eastern Cape has been the recent beneficiary of an integrated biogas system as its primary sanitation system, where it provides a robust, low-maintenance sanitation solution for 170 staff and pupils. The treatment of waste-water and other organic wastes through anaerobic digestion at Three Crowns has the additional benefit of producing methane, which can be used for cooking, water heating and other thermal applications. In the case of the school, the gas is piped to the kitchen facilities to be used for the cooking of school meals.

The project was implemented by Finishes of Nature in partnership with People's Power Africa, AGAMA Biogas and Element Consulting Engineers, and forms part of the 'sustainability commons', an initiative established by the Chris Hani District Municipality whereby sustainable, appropriate and demonstrable technologies are deployed at a learning hub for the benefit of learners and the surrounding community.

2.2.2 Technologies used

Waste water is plumbed from the school ablution facilities directly into the biogas digesters, which also have an opening for the introduction of food and other organic wastes. After about 5 days in the digester, all pathogens requiring oxygen to metabolise are killed off and biogas is produced. The gas is stored safely under low pressure in the digester itself.

After anaerobic digestion, the aerobic treatment process comes into play. This is achieved through a number of settling ponds working in conjunction with two types of algal ponds. The growth of algae in the ponds oxygenates the effluent with additional mechanical aeration achieved by means of wind-powered paddle wheels. The resulting highly oxygenated algal slurry is a hostile environment for anaerobic pathogens whose numbers are greatly reduced. The slurry also constitutes a valuable biofertilizer in the school's gardens.

'Bright water' finally flows from the algal ponds into a maturation pond. The high nutrient content in the pond supports additional algal growth and the growth of various types of zooplankton, which in turn serve as a food source for fish. The fish in turn produce ammonia, one of the inputs of another bacteriological process that ultimately results in nitrate-rich liquid fertilizer, which is also used in the school gardens. From the maturation pond, treated water is gravity-fed back to the school's ablution facilities for flushing and thus the loop is closed.

2.2.3 Development benefits and impacts[64]

Biodigestion is a century old proven technology, which has the potential to:

- supply nutrient rich water and slurry to agri-business projects
- produce methane that could be used for agri-business value-adding and processing, while reducing climate change impacts
- reduce and avoid the load and attendant costs on waste water treatment plants, transport of sludge and the associated negative impacts of dumping, thereby minimising the need for future replacement of infrastructure and avoiding costs and impacts of chemical use
- destroy 99 per cent of all pathogens in sewage and the balance through on-site bio-processing
- provide a sustainable model for replication.

Anaerobic digestion (AD) is a process whereby organic materials are enclosed in a container in the absence of air, leading to the breakdown of the organic material to produce methane and high nutrient slurry.

Anaerobic solid waste biodigestion technology process is a net producer of energy and other valuable materials. It also can transform the problem of biodegradable waste (MSW, yard waste, food waste, wood chips, animal waste, biomass, sewage, activated sludge and agricultural crop residues) into resources (a methane rich biogas as a fuel and valuable digestate as soil conditioner) without production of any noxious odours or pollution. It is a reliable and stable process that is easy to operate with simple procedures. Its operation and maintenance is economical, maintenance free and simple to use.

2.2.4 Opportunities/risks of this development

China is a world leader in the development and application of anaerobic technologies in the production of fuel gas and treatment of wastewater (China Ministry of Agriculture, 2000 and 2001; Li, Zhuang, DeLaquil & Larson, 2001). With individual household-scale biogas digester technology developed in the early 1950s, a programme of technical support and technology dissemination was implemented throughout China. This programme has resulted in biogas digesters being widely used to provide fuel gas for rural household heating, lighting and cooking. By 2003, there were more than 10 million Chinese households with biodigesters and more than 2,000 medium- and large-scale biodigesters which could generate nearly 4 billion cubic meters of biogas annually (Zhang, 2004).

David Oldfield of Finishes of Nature says, 'The implementation at Three Crowns provides a unique opportunity for learners to consciously engage with sustainable technologies in a very real and tangible way. We have no doubt that this will have a profound impact on livelihoods within the surrounding community and, ultimately, a brighter and more sustainable future. It is hoped that we will be able to roll out more of these systems with the Development Bank of Southern Africa as a key partner.'

2.2.5 Types of investment needed

Biodigesters can be scaled to suit the local need – one project at Cottonlands is in the 16 cubic metre range (approximate cost R30,000); one in Cato Manor 288 cubic metre (approximate cost R1.2 million); and companies such as PhilBIO can build a 20,000m3 digester, for one possible reason, because they have to process 9,000 litres of manure plus 80,000 litres of wastewater everyday. Biodigesters in Makati sewage treatment plant handle some 40,000 cubic metres per day.

This makes biodigesters an ideal solution, as they can be scaled up or down to suit the immediate application. Another benefit of biodigesters is that use can be made of local labour, increasing local skills, while keeping money within the local economy. Given the correct design, and mentoring, communities can be trained using basic skills to build community biodigesters.

2.3 Macro-level: Darling Wind Farm

2.3.1 The objective of the project[65]

The Darling Wind Farm is intended to be a learning platform for the development of the wind energy industry in the country by providing a financial, contractual, technical and operational framework for further independent power producer projects. Construction on the project started in September 2007 and the first wind-generated energy was produced in May 2008.

2.3.2 Technologies used

In one year the 4 wind turbines installed (each 1.3MW) produce 8.6 gigawatt hours or the equivalent of the yearly consumption of some 700 average South African households. The turbines rise 50 metres above the ground, (equivalent to a 17-storey building) where the three rotor blades and the nacelle, housing the generator and the gearbox, are located. Their combined weight is 62 tonnes.

The turbines start producing power at a wind speed of 8km/h. They reach their full potential at 54km/h wind speed. The blades rotate slowly at a constant speed of 32 revolutions per minute regardless of the wind speed. The length of the blades is 32 metres, just slightly more than the length of a tennis court. A computer monitors the turbines' condition permanently with over 100 sensors, ranging from wind speed and direction, turbine orientation, temperature, vibrations, the electricity produced etc, in order to optimise the production and efficiency at any time.

Should wind speed exceed 97km/h, the control system will close the system down and initiate braking to stop the blades from turning. Wireless technology allows operation of the Wind Farm to be remotely controlled from anywhere over the internet, allowing for the monitoring of possible alarms, support from the manufacturer (Germany) and swift response action 24 hours a day.

All turbines are connected to small transformer houses built next to their foundations where the current is transformed from 690V to 11,000V. In turn each transformer is connected in series to the main transformer or substation built at the bottom of the hill where the current is transformed from 11,000V to 66,000V. The substation is linked to the national grid and feeds electricity into a 66,000V high voltage line under the control of Eskom.

2.3.3 Opportunities/risks of this development

The project is in line with the Government's vision in respect of climate change and pollution mitigation, efforts to create a new industry and help the local population to benefit economically.

Over 20 years, the Darling Wind Farm is expected to save 142,500 tonnes of coal and 370 million litres of water. A significant reduction in pollutants will also result, namely:

- 258,100 tonnes of carbon dioxide
- 2,200 tonnes of sulphur dioxide
- 1,100 tonnes of nitric oxide
- 58 tonnes of particulates
- 42,200 tonnes of ash

Table 3: Darling Wind Farm[66]

Project investment	R75 million
Construction duration	8 months
Equipment	**Specifications**
Wind generators	4 x 1.3 MW turbine (Fuhrlaender GmbH -Germany), 50Hz
Rotor	Diameter 62 metre, 24.2 tonnes
Hub	Height 50m, 62 tonnes
Tower	Average Diameter 3 metre, length 50 metre
Mini-substation	Transformer 690V – 11,000V
Substation	Transformer 11,000V – 66,000V
Grid connection	High voltage line 66,000V
Power produced per year	8.6GWh
Yearly average wind speed	7.5m/s or 27km/h

Some of the lessons learnt from Darling Wind Farm were that the time delays in obtaining all the necessary permits etc, did delay the project – it was particularly interesting to note that organisations that were part-funded by Eskom, raised objections which were key in causing delays. Off-take agreements with local government takes a lot of time – this needs to be shortened.

2.3.4 Types of investment needed

The Darling Wind Farm, South Africa's first commercial wind farm, currently consists of four 1.3MW wind turbines that provide electricity to the City of Cape Town. In 2006 the mayor of the City of Cape Town signed a PPA with the CEO of Darling Wind Farm. The city became involved in the project by providing financial assurance and carrying the risk as a guaranteed buyer of the electricity that was going to be produced. For the next 20 years the 5.2MW wind farm will supply green electricity to the City of Cape Town, taking the city one step closer to having 10 per cent of its electricity purchases from renewable sources by 2020.

The City of Cape Town is responsible for selling the electricity obtained through the PPA. Willing buyers will pay a premium for this green electricity, which is set at 25c/kWh above current electricity rates. The Darling Wind Farm was officially powered up in May 2008. The wind farm is located 10 km north of the town of Darling in the Western Cape of South Africa, an area that gets strong and consistent winds. The R75 million project was developed by a group of private investors including the Darling Independent Power Producer, the Central Energy Fund, the Development Bank of South Africa, and the Government of Denmark. There are plans to add six more 1.3MW turbines to the farm, bringing the capacity up to 13MW, providing there are no significant impacts found from the existing turbines.[67]

3. LEAPFROG FUND POTENTIAL

Nowhere in current South African policy, not even in the Climate Change Green Paper (recently out for comment), nor in the REFIT approved technologies, is provision made for various funding Renewable Energy Technologies (RETs) such as: Solar Photovoltaic (PV); micro-power; biogas from digesters; wave or any ocean technologies (tidal current, Ocean Thermal Electricity Conversion (OTEC)); bio-diesel from algae, or solar chimneys. At present the main solar technology prioritised are solar water heaters, and plans are in the pipeline for changing building regulations to support energy efficiency. Access to renewable energy technology at community level as well as funding innovative energy efficient technology would require some kind of a 'special purpose vehicle' like a leapfrog fund.

In South Africa, these various forms of funding, i.e. grants, soft loans and micro-credit have been used in one form or the other. First and foremost, it is critical that the South African government ensures that the correct policy frameworks are in place, so that funding can be directed to genuinely support sustainable interventions, not problematic projects such as coal-fired or nuclear power. In general such funding for renewable energy and energy efficient initiatives cannot be developed at the whims of market interest nor should the priorities be on 'bankable' projects. Instead, it needs to enhance public interest and the State's obligation to ensure that the developmental needs of its citizens are met, particularly the poor and vulnerable, through actions that are sustainable, equitable, redistributive and people-centred. Therefore funds for renewable energy and energy efficiency must shift the boundaries to ensure broader systemic changes that address the well-being of all towards a socially and ecologically just society. The change requires the will of all sectors of society, but the onus lies particularly with the government to institute shifts towards socially and ecologically sound policies.

So funding in the form of direct grants is probably the most appropriate for 'leapfrog' projects as opposed to soft loans or micro-credit. These should be designed in such a way that the capital expenditure, design and mentoring costs are included, as well as support for the relevant body or community forum. This could work through exploring current national and/or provincial multi-stakeholder mandatory bodies. For example, in South Africa the National Economic Development and Labour Council (NEDLAC) is a body representing government, labour, business and community groups. NEDLAC broadly engages on social and economic policies, and could set up a special purpose vehicle (SPV) facility to facilitate the implementation of a leapfrog fund at national level to fulfil renewable energy and energy efficiency targets. The main criteria for such an institution are that it should have a broad developmental mandate and an integrated approach to implementing projects. Alternatively the Presidency could possibly set up a SPV and create a multi-stakeholder forum through the National Planning Commission. So, existing institutions should first be explored, before a new institution is set up. Projects will be implemented at the provincial and local level, once the funds are approved and reports to the SPV. Provincial and/or local government will also need to work out the sustainability of the project. A key failure in the 'costing' of projects currently, is the exclusion of externalities – avoided or reduced emissions, health impacts, reduction of waste, and the like. It is critical that Full Cost Accounting be part of the process up-front.

It is important to recognise that a leapfrog fund will not be sufficient to stimulate change without certain conditions that would need to be met, as the South African economy is deeply embedded in the minerals and energy complex (Fine and Rustomjee 1997) and this presents a huge structural challenge to stimulate change.

Institutional capacity is required to administer and generate the ongoing resources needed to perform the functions that stimulate change and innovation, as well as creating democratic and accountable systems. The institutional capacity required to manage a leapfrog fund cannot work in a vacuum, only focusing on technology replacement or energy efficiency. It would need to be coordinated and integrated with the range of sectors, and policy-making structures would need to conform to new national standards. Examples that come to mind include: integration of local resource analysis; re-training of outreach projects by various departments (such as agriculture, water, etc); and general skills development. Therefore, national government will need to provide an overarching policy framework for the evolution of a genuine low-carbon strategy. South Africa has some capacity in research and development, and there are also market opportunities at a national and regional level, considering that 80 per cent of people in Southern Africa do not have access to modern energy sources and are largely dependent on biomass for cooking and heating.

The leapfrog fund will be particularly useful in funding the transition to lower costs in the development and production of alternative technologies, as well as providing mechanisms to generate greater public finance for long-term sustainability.

As for public private partnerships, while the private sector has an important role to play in generating funds for technology or service needed for a low carbon strategy, they have their limitations. These partnerships often adversely affect the poor because, given that private entities are driven by the profit motive, the services they provide are very expensive. The wealthy can afford to pay the 'market' price, but the poor are unable to do so, and therefore often have to forgo those services entirely. The movement across the developing world towards public–private or purely private service providers has created major problems for the poor. Under these arrangements, citizens cannot accuse the state of poor service delivery, and accountability is therefore distanced or diminished (Fakir and Matshiqi 2007).

A leapfrog fund is most likely to succeed if it is grounded in satisfying the needs of communities, where such needs are identified by the community itself, ensuring the 'ownership' of projects required for success. The successful implementation of a leapfrog fund could result in a diversity of solutions being piloted, implemented, and then duplicated widely, given the lessons learnt by such pilots. This approach would be critical in alleviating poverty, while rapidly improving climate resilience, particularly of the poor and marginalised.

3.1 Conclusions

The South African government's energy plan premises South Africa's energy future on a coal and nuclear strategy, with limited renewable energy targets, pegged at 10,000GWh of the final demand by the year 2013. From the research and analysis, it is clear that South Africa's current economic growth path is bent on fossil-fuel dependence with minimal targets toward renewable energy and a low carbon pathway.

Therefore, the following policy considerations in the energy sector need to be advocated for, to put South Africa on a low carbon path:

- Greater public investment in renewable energy so that it is accessible and affordable to all, and not just those who can afford market-related prices. Government should subsidise the local production of renewable energy, because it also creates new livelihoods and jobs to the rural and urban poor, especially women. It is clear that manufacturing has been hit hard by job losses over the last 10 or more years, and that we need these workers' skills to build a sustainable energy future.
- An overhaul of by-laws and regulations that are barriers to energy efficiency targets, as well as building a strong lobby for energy efficiency.
- Obtaining financial resources to encourage systemic changes through public funds and innovative means such as financial transaction taxes, taxing the profits of economic sectors most responsible for climate change (oil, coal, cars, electricity generation, etc), and shifting fossil fuels subsidies, amongst others.
- Broadening the scope of funding to focus on impacts of unsustainable consumption and production patterns, rather than predominantly reducing vulnerability. For example, funding that supports ongoing subsidies for coal power stations as opposed to funding renewable energy.

A leapfrog fund has the potential to initiate a just transition towards requiring a less energy intensive economy, made possible through renewable energy, ecologically-friendly buildings, sustainable agro-ecological agriculture, improved public transport, integrated urban and rural planning, and sustainable infrastructure development. For this transition to take place, a climate response requires a bottom-up approach and needs to be at the core of national development strategies. If this is not done, we risk the status quo remaining, with a few uncoordinated projects in the short term, but ecological and human disaster in the longer term.

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