

# Powering the Future

Renewable Energy Roll-out  
in South Africa

GREENPEACE

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The study covers specifically electricity based energy relating to South Africa and its energy needs. It does not include other important energy sources such as thermal or transport which can also be provided by renewable and clean resources. It is founded on desk based research and an extensive literature review. However, the South African case study was supported by a site visit and interviews.



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## Acronyms and abbreviations

<b>AdvE[R]</b>	Advanced Energy [R]evolution (Greenpeace)
<b>BNEF</b>	Bloomberg New Energy Finance
<b>CSP</b>	concentrated solar plant
<b>Danida</b>	Danish International Development Agency
<b>DBSA</b>	Development Bank of South Africa
<b>DC</b>	direct current
<b>DTI</b>	Department of Trade and Industry
<b>EE</b>	energy efficiency
<b>EEA</b>	European Environment Agency
<b>EEG</b>	German Renewable Energy Act
<b>E[R]</b>	Energy [R]evolution (Greenpeace)
<b>EU</b>	European Union
<b>GEF</b>	Global Environmental Facility
<b>GHG</b>	greenhouse gas emissions
<b>GW</b>	gigawatt (1000 megawatts)
<b>GWh</b>	gigawatt-hour (1 billion watts generated or consumed in 1 hour)
<b>IEA</b>	International Energy Agency
<b>IPP</b>	Independent Power Producer
<b>IRP</b>	Integrated Resource Plan (South Africa)
<b>JICA</b>	Japan International Cooperation Agency
<b>JOULE</b>	A measure of energy
<b>kW</b>	kilowatt (1000 watts)
<b>kWh</b>	kilowatt-hour (1000 watts generated or consumed in 1 hour)
<b>LTWP</b>	Lake Turkana Wind Power Project
<b>MCEP</b>	Manufacturing Competitiveness Enhancement Programme (South Africa)
<b>MW</b>	megawatt (1000 kilowatt)
<b>MWh</b>	megawatt-hour (1 million watts generated or consumed in 1 hour)
<b>MYPD</b>	multi-year price determination period (South Africa)
<b>NERSA</b>	National Energy Regulator of South Africa
<b>NGP</b>	New Growth Plan (South Africa)
<b>PJ</b>	10 <sup>15</sup> Joules
<b>PJ/a</b>	PJ per annum
<b>PV</b>	photovoltaic (electron from sun's light)
<b>RE</b>	renewable energy
<b>REBID</b>	nickname for REIPPPP
<b>RETs</b>	renewable energy technologies
<b>REIPPPP</b>	Renewable Energy Independent Power Producer Procurement Programme (South Africa)
<b>R&amp;D</b>	Research and Development
<b>SASGI</b>	South African Smart Grid Initiative
<b>W</b>	watt (measure of energy)
<b>WESSA</b>	Wildlife and Environment Society of South Africa
<b>Wh</b>	watt-hour (measure of energy consumed)

# Foreword

Since the birth of my child in 2012, I have been reminded of the legacy that we will leave all South Africa's children. Will they inherit a country powered by clean, cheap sources of renewable energy – or will they be burdened with a dirty, inefficient debt-ridden energy sector?

Greenpeace believes that the South African government needs to urgently decouple economic development from coal and nuclear-based electricity. These out-dated technologies require energy intensive and polluting mining process and generate a large proportion of South Africa's greenhouse gas emissions (GHG), while creating enormous water shortage.

Current energy planning is dangerously short-sighted, ignoring the vast external costs of both coal and nuclear and which fail to provide electricity for millions of citizens. Greenpeace questions why the government continues to support coal based power plants and the centralized energy distribution supply, when renewable energy is cheaper, provides universal access and creates thousands of jobs.

The Greenpeace Report, Powering the Future: Renewable Energy Roll-out in South debunks the misconceptions

surrounding renewable energy generation; offers solutions to the barriers to its deployment; and presents success stories from across the globe.

In the words of the late Kenyan Nobel Laureate, Professor Wangari Maathari: "We owe it to ourselves and to the next generation to conserve the environment so that we can bequeath our children a sustainable world that benefits all".

We need to act urgently so that we can leave our children a healthy world in which they can reach their full potential. With the right political ambition, South Africa could champion renewable energy expansion on the continent.



**Michael O'Brien Onyeka**  
Executive Director  
Greenpeace Africa



# Executive Summary

## Decoupling South Africa's economic development from fossil and nuclear energy

Currently, a third of South Africa's population does not have energy access; those that do often cannot afford it. The South African government is attempting to meet the electricity demands of a growing industrial sector, along with creating universal electrification. Unfortunately this has promoted the building of two new mega coal powered electricity generation stations in Medupi and Kusile and initiated discussions of a nuclear energy programme.

However, the government's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) is limited to 9% renewable energy (RE) by 2030 with a focus on security of supply as opposed to access to power. This limitation, along with the government's latest energy proposals will not only make curbing the country's CO<sub>2</sub> emissions almost impossible, but it will also create many social problems including health impacts and substantial water wastage and environmental pollution.

Eskom and the government need to be responsible for more RE development than is currently planned. To achieve this, grid transformation is also necessary to ensure meaningful expansion throughout the country. South Africa has the opportunity to leapfrog fossil-fuelled development by embarking on a world-leading ambitious RE and energy efficiency (EE) programme where clean, sustainable, secure, stable, employment-supporting and accessible energy is achieved. This would enable true long-term socio-economic development with reduced emissions but requires strong commitment from government to move towards a clean energy future. The first signs of any commitment are under the REIPPPP but it falls short of an Energy [R]evolution.

## Debunking the Misconceptions

Very often it is argued that renewable energy technology cannot provide the necessary 'baseload' electricity capacity because of its intermittent nature (Van De Putte & Short, 2011). However, old fashioned electricity stations are inflexible, and both economically and energy-wise wasteful. In some grid systems renewable energy plants need to be shut down even though there is an abundance of power so that stations can run at full capacity. However, the European experience shows that RE can make up a large part of the energy mix.

The key to sustaining the energy supply is via smart technology that can track and manage energy use patterns and provide flexible power that follows demand through the

day. A fully optimised smart grid system would be a solution for a climate conscious, job creating, pollution lowering, and sustainable energy system. It is not technology, resources nor economics that prevent this but rather misconceptions of the capability and lack of political will to move to a clean energy future.

South Africa faces electricity price hikes in order to finance the new build programme. If South Africans are to finance Eskom's capacity expansion programme, then Eskom should be investing in renewable energy sources for a sustainable future. The proposed carbon tax in addition to the price hikes should ensure that the true cost of continued investment in carbon intensive industries is reconsidered. The job creation imperative should point towards large scale RE deployment as fossil fuel power has lesser job intensity, carries future expenses due to climate change affects, and has health impacts issues due to pollution. The safety risks and long-term waste storage requirements of nuclear, as well as the cost of new build, are also not affordable. Thus the question is actually: how can South Africa afford not to move to large scale deployment of renewable energy?

## What is holding us back: Barriers to renewable energy

Fossil and nuclear based power is strongly lobbied for and political interests further promote those industries. Less than 4GW of RE have thus far been approved by the South African government. Local governments have not changed their revenue structure to make an Energy [R]evolution possible. Coal and nuclear have been subsidised for many years (Koplow & Kretzmann, 2010), resulting in an uneven playing field, and yet RE is often touted as too expensive (Foster-Pedley & Hertzog, 2006).

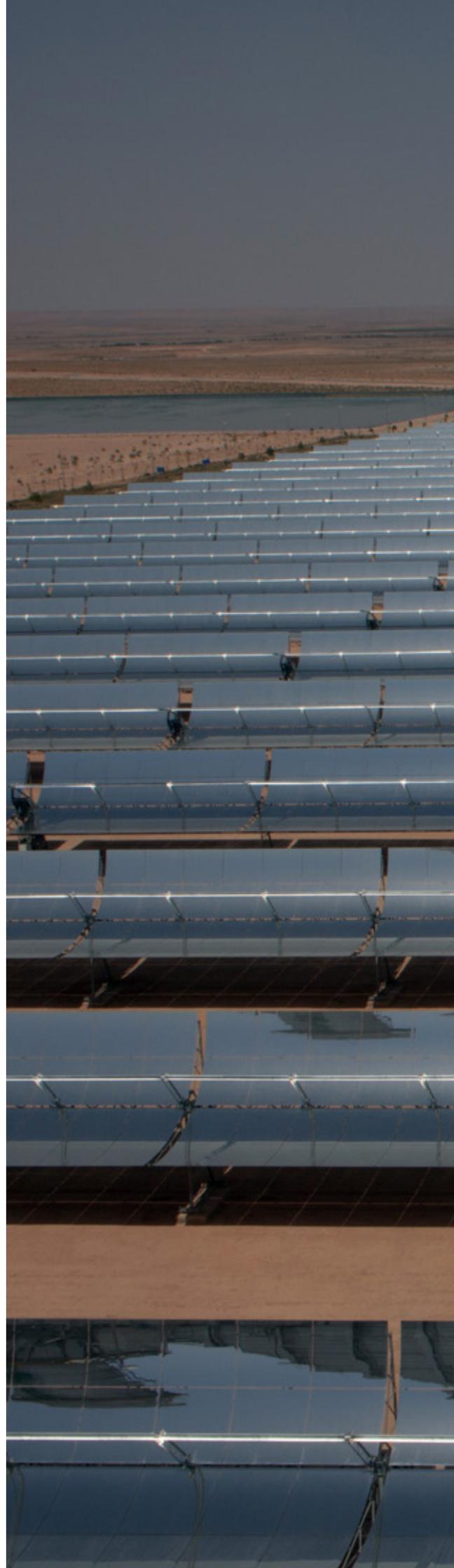
There is also a need to minimise and streamline trading agreements, land access, environmental requirements, licencing and power purchase agreements. Buyers may only purchase electricity if it is part of the REIPPPP but it is complex and expensive – meaning that only large renewable projects with corporate and international funding can participate. Uncertainty in enabling legislation in South Africa has made deployment of significant renewable energy frustratingly slow. The lack of net metering and feed-in tariffs also hampers renewable energy uptake.

In South Africa, the development of the RE Industry is held back by lack of ambitious policy that would encourage investment. Further administrative bottlenecks slow the uptake of RE. There are also issues around grid capabilities.

Ultimately, it is the perception of renewable energy capacity that is the barrier and not practical constraints. Committed political will from the South African government is necessary to set processes and policies in place that would eliminate the barriers and foster the right economic conditions to stimulate a competitive renewable energy industry.

## Recommendations

- Government commitment to energy decisions must show a clear move away from fossil fuels and there must be synchronization of government policy throughout the various departments addressing energy issues.
- Adequate financial and economic incentives need to be in place to allow for stimulating local manufacturing of RE technology equipment and to increase the number of investors in the industry. This must begin with greater RE investment from the state utility Eskom.
- As start-up costs for RE are high it is essential that there is government backing. The use of state funds must be directed towards investment in RE and not coal or nuclear.
- Administrative deficiencies such as those experienced in the REIPPPP process need to be removed.
- Clarity is needed around the grid tie legislation, beginning with a clear net metering programme that allows for the inclusion of the small to medium RE power producers.
- Dedicated and maintained local content drivers must be in place to ensure that local investors, producers and manufacturers, project developers gain experience.
- Improved access to the grid by independent power producers is required with grid priority given to RE.
- Load management also needs to improve through the use of smart grid technology and decentralised energy systems.
- Energy efficiency presents major opportunities for people to be protected from the costs of rising energy prices. Exploitation of existing large energy efficiency potentials as detailed in the Advanced Energy [R]evolution will ensure that primary energy demand decreases - from the 5,500 PJ/a (2007) to 4,095 PJ/a in 2050,
- Government, namely Department of Energy (DoE) and Eskom, need to invest in Research and Development (R&D) for RE beyond current pilot projects and research, as well as storage and cheaper production methods for Renewable Energy.
- Eskom should produce a 20 year road map showing the utilities increased investment in RE and away from coal and nuclear.





# 1. Questioning the development paradigm

The question whether socio-economic development in South Africa can be detached from energy generated using fossil fuel and nuclear sources is critical for government to be asking if it desires a sustainable future. Currently the path taken by government is assuming that large scale coal and nuclear energy is required for such development with little thought for smart and renewable power.

It is commonly understood that economic development requires energy. However, this is often framed by short-term thinking where only immediate and direct economic benefit is considered. Long-term sustainability and external economic costs of energy generation are often ignored, as are the social impacts of that energy.

## 1.1 International socio-economic review

The Greenpeace global Energy [R]evolution (Teske et al, 2012) as illustrated in Figure 1 shows that there is growth over the last decade in the overall capacity of the global power market. This growth is largely due to renewable energy technologies (RETs) coming online.

If China is excluded from the picture the global coal, gas and nuclear station capacity has declined in the last decade. China seems to have linked its steep economic development of the last decade with coal-fired power resulting in 43 billion tonnes of CO<sub>2</sub> in additional emissions. This is in contrast to the USA and Europe (especially Germany) which showed a decline in fossil fuel electrical generation with the implication of a reduction in electricity generating emissions.

The Guardian Online (Harvey, 2012) states that Europe has cut emissions while continuing to grow its economy<sup>1</sup>, research done by the European Environment Agency (EEA) showed that it was possible to cut emissions while boosting economic growth. Connie Hedegaard, EU commissioner for climate action said **“While our economy grew 48% since 1990, emissions are down 18%. These figures prove once again that emissions can be cut without sacrificing the economy.”**<sup>2</sup>

The global trend also indicates that renewables are the modern energy solution of choice. In 2011 the global net investment in renewable energy capacity outpaced that of fossil fuel generation, according to the Corporate Renewable Energy Index Report 2012 (Bloomberg & Vestas, 2012) investment in RE amounted to R2,121 billion (US\$237 billion) compared to R1,996 billion (US\$223 billion)<sup>3</sup> in fossil fuels. Although there are positive global trends, the fact remains that GHG emissions due to coal power generation will continue to contribute to the impacts of climate change globally, in addition to local social and environmental impacts.

For example in Indonesia, the Cilacap coal-fired power plant has severely affected the waters from which local fishing communities make a living. In Shanxi Province-China, heavy pollution from the coal mine, coking factory and power plant in Hanjiashan have lowered crop yields significantly (Bjureby et al, 2008).

In Colombia, the Wayuu community has experienced displacement under threats and unjust treatment due to

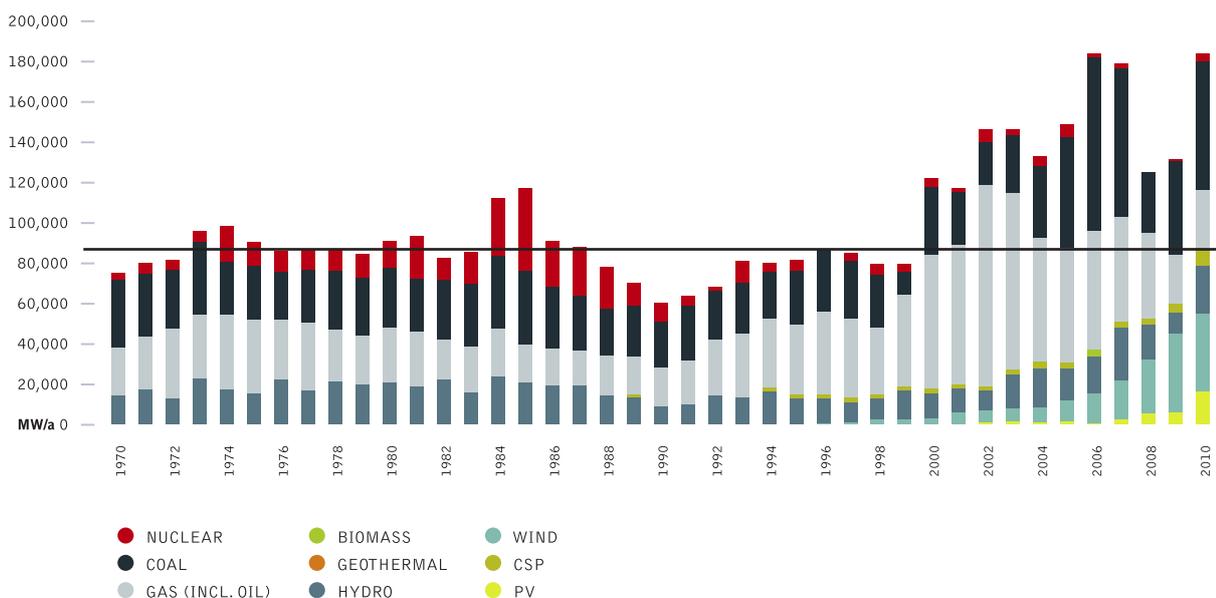


Figure 1: Global Power Plant Market 1970-2010 (Teske et al, 2012)

<sup>1</sup> Note that these include carbon sinks and carbon trading

<sup>2</sup> Author's emphasis

<sup>3</sup> Currencies have been converted into Rand on 28/1/2013 from <http://www.xe.com>

coal mining activities. In 1980 the community of Media Luna was forced to relocate because a coal shipping port was constructed. Some, who refused to leave, were fenced in by the mining company (Bjureby et al, 2008).

The global damages attributed to the supply chain of so-called cheap coal power amounted to about R4,336 billion (€360 billion) in 2007 (Bjureby citing a CE Delft study). The hidden costs of Kusile could be as much as R60.6 billion per year that the new coal-fired power station operates (Steele et al, 2011).

As more safety concerns come to light from accidents such as Fukushima and as the price of nuclear power increases, it is unclear how a full cost benefit analysis can be made for nuclear waste management way into the future.

In contrast to this, these external costs and risks are mostly eliminated, or vastly reduced when moving towards a modern renewable energy power production system which brings South Africa closer to sustainable development. Sustainable development can be described as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Greenpeace & EPIA 2011 citing WCED).<sup>4</sup>

## 1.2 Socio-economic challenges in South Africa

In 2004 almost 30% (WBCSD, 2006)<sup>5</sup> of South Africa's population did not have access to electricity and there is a share of those who do have access but cannot afford it resulting in a large section of the population being, “energy poor”. This contributes to poverty, hunger, water access difficulties, education constraints and health issues where biomass is often burnt in homes with poor ventilation.

For hundreds of years, South Africa has relied almost exclusively on coal (and for decades a small share of nuclear power) to grow its economy and meet the country's industrialisation ambitions. Today, two new mega coal stations (Medupi (4,764MW) and Kusile (4,800MW)) are being built by Eskom while government is promoting a nuclear build programme. The new coal-fired thermal power stations build programme is in theory a response to industrial or productive development needs, but will not touch those without access to the grid or those who are unable to pay a large share of their income on electricity.

According to the South African Industrial Policy Action Plan (DTI, 2011) the New Growth Plan (NGP) of 2010 acknowledges that the “recovery of economic growth between 1994 and 2008 did not lead to an adequate reduction

in unemployment and inequality (n) or mitigate the emissions intensity of growth”. In other words, the current model of utilising fossil fuels for electricity generation, to support economic growth, has not helped curb unemployment and also fails to place the country on a lower emissions trajectory. The plans thus far, in the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), to move away from low-job-potential, high-emission centralised power generating technology is limited – only 9% RE expected by 2030. Energy efficiency is also vital for an Energy [R]evolution. Energy must be produced and used efficiently in order to reduce the need for additional capacity. The energy efficiency uptake in South Africa has been slow because of low levels of awareness of its benefits, lack of available technologies and the alternative priorities of companies (Haw & Hughes, 2007).

## 1.3 South African economic development

South Africa, similar to other developing countries, argues that it should not be denied coal to drive and develop its economy seeing that other countries had the benefit of such power to become industrialised themselves. However, as discussed above economic development using coal and nuclear fuels amounts to regression rather than modernisation, as these have social and economic impacts that negatively cost society, with its poorest members often bearing the brunt of these impacts.

South Africa has higher CO<sub>2</sub> emissions per GDPppp<sup>6</sup> (2002 figures) from energy and cement production than China or the USA (Letete, T et al). Energy accounts for 83% of the total GHG emissions (excluding land use, land use change and forestry) with fuel combustion in the energy industry accounting for 65% of the energy emissions of South Africa (DEA, 2011).

Coal is not the only polluting energy source that is being used. The low and intermediate nuclear waste site, Vaalputs in the desert Namaqualand region, “must mark as one of the most cynical of the dying years of the apartheid regime” – white municipalities were subject to a 50km exclusion zone but the indigenous Nama people were not included in the buffer zone nor consulted (Adam et al, 2011).

Climate change in South Africa is predicted to “increase the distribution and intensity of droughts, reduce agricultural crop yields impacting food security, potential species extinction, and increase growth rates of invasive species, potentially catastrophic coral bleaching, and an increase in the areas affected by vector-borne diseases” (DEA, 2011). It is expected that KwaZulu-Natal and the Eastern Cape will be exposed to more flooding (DEA, 2011).

<sup>4</sup> Our Common Future”, published by the United Nations World Commission on Environment and Development (WCED) in 1987

<sup>5</sup> National Electricity Regulator and Department of Minerals and Energy 71% electrification by 2004 as cited by a World Business Council for Sustainable Development study, (WBCSD, 2006)

<sup>6</sup> Purchasing power parity – taking the relative cost of living and the inflation rates into account

Not only does climate change have environmental impacts on a coal-based economy, it also has socio economic impacts. Acid mine drainage from abandoned mines in South Africa has a damaging effect on water quality and poses the biggest threat to the country's limited water resources. Water sources are contaminated by mining, coal fires and landslides. Huge volumes of water are needed to wash coal and cool operating power stations and often rivers are drained to get coal out of the ground leading to shortages (Bjureby et al, 2008). In fact, Eskom uses an estimated 10 000 litres of water per second, due to its dependency on coal (Greenpeace, 2012).

substantially increase the number of jobs in the energy sector. These are borne from the manufacturing of RE components as well as the installation and operation of RE plants.<sup>7</sup>

Greenpeace reviewed the country's energy job sector up to 2030, publishing an original report and a subsequent update reflecting the Integrated Resource Plan (IRP 2010) targets published by the government shortly thereafter (Rutovitz, 2010 & 2011). In the original publication, the Energy [R]evolution scenario, as presented by the Greenpeace Global Energy [R]evolution series, would generate 5% more

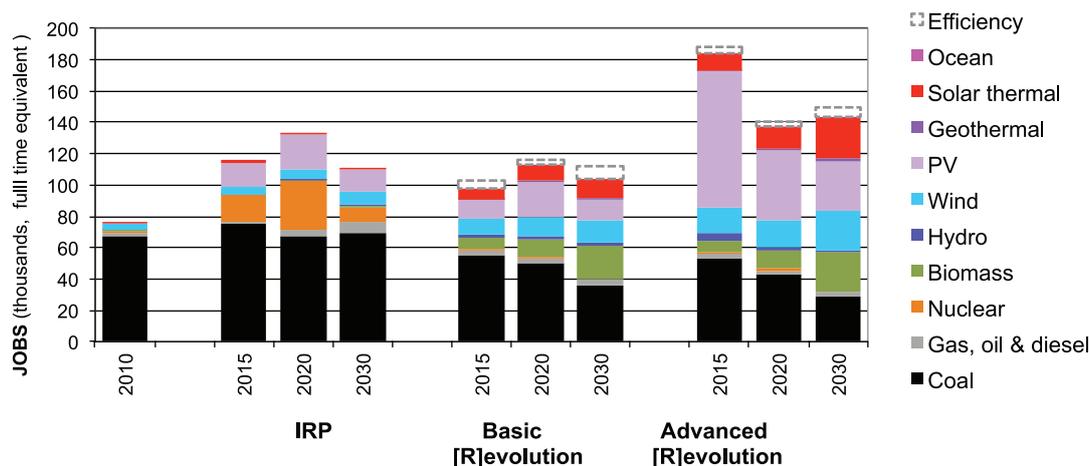


Figure 2: South African electricity sector jobs to 2030 (Rutovitz, 2011)

South Africa's parastatal electricity supplier, Eskom, is focused only on large centralised grid connected coal-based power generation. Recently Eskom and the government have embarked on an efficiency drive through demand reduction programmes and the publishing of the Energy Efficiency Strategy (DME, 2008) but the uptake and effectiveness has not had enough impact and there is still much wastage in the system.

The current energy policy promotes large centralised grid connected power generation. However, this does little to meet the energy needs of the approximately 30% of South Africans who neither have access to the grid nor can afford it (Greenpeace, 2012). A decentralised renewable energy powered dynamic grid, combined with micro grids is a flexible solution to open up power to those who do not have access as yet (Boyle, 2010).

Not only would using more modern grids systems bring energy to the poorest segments of the population, but the renewable energy industry would also promote job creation. In a 2003 South African study, (Austin, 2003) it was concluded that large-scale deployment of RETs would

jobs than the growth without constraint (GWC)<sup>8</sup> scenario, and 27% more than the International Energy Agency (IEA) outlook (taken as a reference case) by 2030. If RE manufacturing is included with installation and operating jobs, then the increase in jobs is 28% and 56% respectively.

The 2011 update to the Green Jobs report compares job numbers to a 2010 baseline with all scenarios showing increases above 2010 levels. The Advanced Energy [R]evolution scenario increases jobs by 149% in 2015 (113 000 additional jobs) and then drops back in 2020 but is still double 2010 numbers (140 000 total) and increase to 149 000 by 2030 and higher than the IRP scenario as shown in Figure 2). Although reduction of energy and demand achieved may be thought to reduce energy jobs, EE and SWH deployment alone would account for about 18% of the energy jobs in 2030 with the advanced scenario. These support the notion that South Africa would increase energy jobs if we embarked on a large-scale RE deployment and an ambitious EE programme.

Currently the first round of REIPPPP has been signed. Figure 3 shows allocation for window 1 and 2. While it is

<sup>7</sup> Mr Austin commented (personal interview, 2012) that the study done was high level and requires updating with new state of the science and new developments within the country. However, its findings are generally true and, as discussed in the paragraph below, are supported by other international studies which also show substantial job creation when moving to a RE economy

<sup>8</sup> Growth without constraint is a SA government energy scenario looking at energy growth where there is no carbon mitigation, no oil restrictions and if no effort were made to internalise externalities. It was considered as the reference case for the country (Rutovitz, 2010)

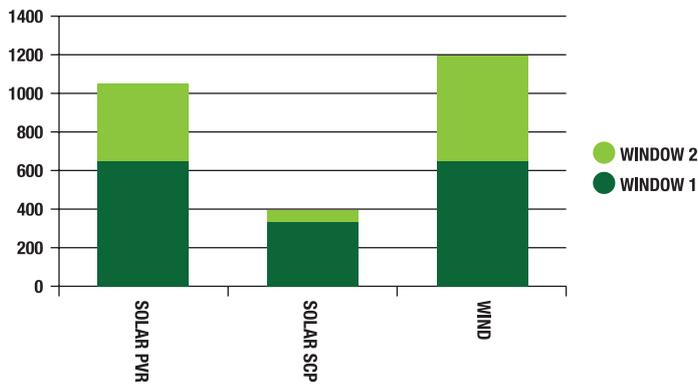


Figure 3: REIPPPP technology share in MW for first two bidding windows

progressive that the REIPPPP is underway, and a great step forward compared to action since the Renewable Energy White Paper was published in 2003, it is still small compared to the coal and nuclear build programme and has been slow to get going. It is also not enough to leave all RE development in the hands of private investors – Eskom and government need to be responsible for more RE development than is currently planned (and not started).

Thus it is possible to say that fossil and nuclear based energy systems result in an economic development path that has negative social and environmental impacts. These impacts are not always immediately apparent, and are often ignored as being external costs while full cost accounting (where these impacts and costs are included) is a far more robust and accurate approach. South Africa has the opportunity to leapfrog fossil-fuelled development by embarking on a world-leading ambitious RE and EE programme where

clean, sustainable, secure, stable, employment-supporting and accessible energy is achieved. This would enable true long-term socio-economic development with reduced emissions.

This requires true commitment from government to decouple development from the current fossil-fuelled and centralised energy system and move towards a clean energy future. It is less about technological barriers but more about lack of political will. The first signs of this commitment are the initiation of the first large RE projects under the REIPPPP within the context of the IRP 2010 but there is a very long way to go for South Africa.



© Greenpeace / Shayne Robinson. Action at Kusile Power Station in South Africa, 2011



## 2. The Truth About Renewable Energy's Capacity

This chapter examines common renewable energy misconceptions and explore how they can be addressed to promote the real capability of renewable energy. Renewable energy resources could provide 94% of the country's electricity needs by 2050 as shown in the South African Energy [R]evolution (Teske et al, 2011).

### 2.1 The Baseload Fallacy

A big centralised grid system is old-fashioned, inflexible and unable to easily follow demand fluctuations. It is said that only coal and nuclear are capable of providing baseload power but more accurately these stations have to run at full capacity so that their business case is fulfilled (Van De Putte & Short, 2011).

Baseload can be described as the minimum level of power required over 24 hours by the collective users – the minimum demand. Graphically, it can be illustrated as a band below the peaks and troughs of demand fluctuations. In a typical hypothetical simple daily demand plot in Figure 4, it is the level that remains unchanged for that day whereas above the line the demand varies as the day progresses. For example when residences draw large amounts of electricity or as factories start up the load increases. The task of the distribution centre is to ensure that the supply feeding the grid is balanced by the demand on the grid.

When the total demand of a country is plotted it tends to be similar day to day and the minimum demand is therefore known. A rule of thumb is that minimum demand is usually

35%-40% of the maximum load during the year (Cardaro, 2008). The load is reasonably constant so this fact is often used as a justification for power stations that run at a steady output such as coal and nuclear. However, the balance required by grid operators to follow the peaks is difficult when only coal or nuclear stations are available. Nuclear stations are designed to run, or (due to safety limitations) often only licensed to run, at full load. Coal stations require 8 hours from cold start-up to full load so switching off and restarting in less than 8 hours cannot be easily met by a coal station. They are designed to operate at full load and are generally only shut-down for scheduled maintenance or emergency repairs (Eskom Fact Sheet GX 0003, 2012). The continuous power supply by these stations keeps their operation costs low and enables the owners to engage in long-term agreements which contribute to the financial stability of the station (Cardaro, 2008).

**It is often argued that renewable energy technology cannot provide baseload capacity to the electricity network and thus a power system based on coal and nuclear is assumed to be essential. However, uninterrupted power supply is possible without new coal or nuclear build.**

Historically, renewable energy technologies have had to adapt to the conditions of the grid. In fact in some grid systems renewable energy plants need to be shut down when there is an abundance of renewable resource (such as sun or wind), combined with a low grid demand, so that baseload stations are able to continue to run at full power.

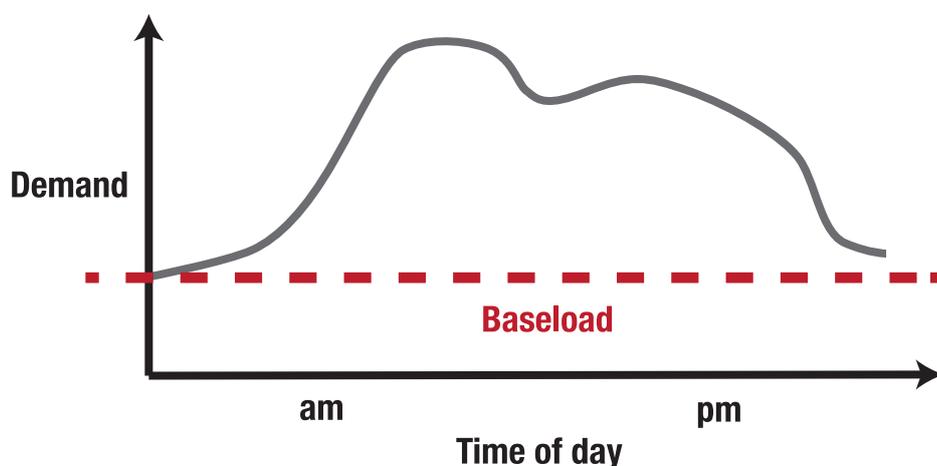


Figure 4: Simple hypothetical power demand curve

## 2.2 Smart power vs inflexible baseload

A big centralised grid system is old fashioned, inflexible and unable to easily follow demand fluctuations. It is said that only coal and nuclear are capable of providing baseload power but more accurately these stations have to run at full capacity so that their business case is fulfilled (Van De Putte & Short, 2011).

As renewable energy technologies increase in the future electricity systems, coal and nuclear plants have less room to operate in baseload mode. If renewable energy plants take priority and baseload plants follow the remaining demand requirements there will be a resulting lowering of their average load factor. This will fundamentally change the economics of nuclear and coal, which are currently based on high load factor operation, (Van De Putte & Short, 2011).

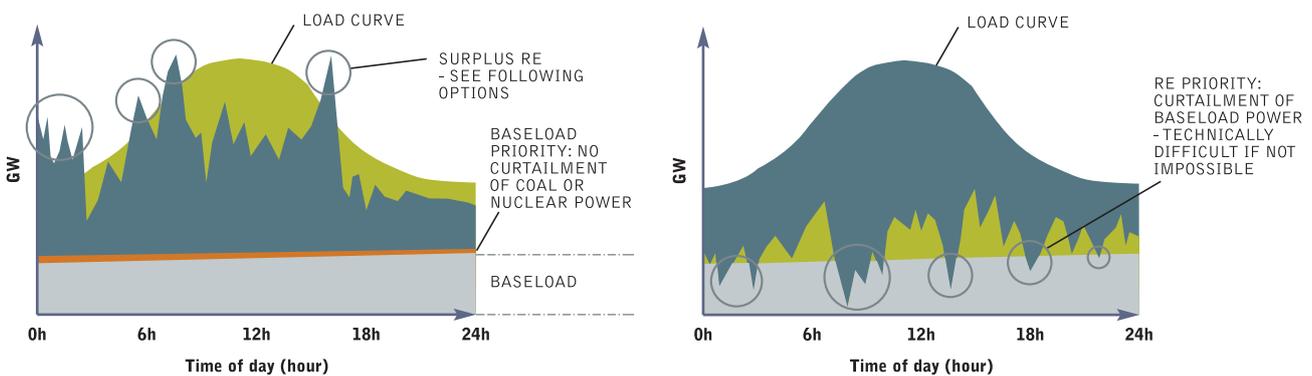
The traditional grid is also vulnerable because a failure at a big centralised station could have a severe effect on the grid whereas a grid with distributed plants is more robust as single plant failures have a negligible effect on the grid as a whole. "With or without renewable energy, there is no such thing as a perfectly reliable power station or electricity generating system. Both coal and nuclear power are only partially reliable" (Diesendorf, 2010).

In contrast, a combination of renewable resources is available most of the time. Smart technology can track and manage energy use patterns and provide flexible power that follows demand through the day. Decentralised smaller renewable energy plants and co-generation can be combined with energy management to balance supply

with demand. Renewable energy 24/7, is technically and economically viable, it just requires the right policy and commercial investment, as well as an interconnected smart grid over a large area. Regardless of the energy source the grid requires upgrading and strengthening. This will give security of supply and economic efficiency (Ackerman et al, 2009).

In the current system, nuclear and coal create room for about 25% variable renewable energy. However, more than 25% RE is needed as a global energy response to the impacts of climate change (Teske et al, 2012). If baseload still has priority and renewable electricity is more than 25% the demand will be exceeded at some times of the day as shown in Figure 5 a. This can be overcome by moving power between areas, shifting demand or shutting down renewables at peak time. However, when renewables exceed 50% this strategy can no longer work. On the other hand if renewables have priority and are more than 25% it "cuts into" the baseload power as shown in Figure 5 b. In this scenario nuclear and coal stations are required to follow these peaks and troughs by turning down or switching off which is difficult for these type of plants.

A grid with over 90% renewables operating with storage, transmission to other regions, demand management and shutting down only when required is fully optimised. A load curve (the change in electricity needed over time) illustrating this scenario is shown in Figure 6. The fully optimised smart grid system could be a solution for a climate conscious, job creating, pollution lowering, and sustainable energy system.



**Figure 5:** System with > 25% RE: a) baseload priority (left). b) RE priority (right) (Teske et al, 2012)

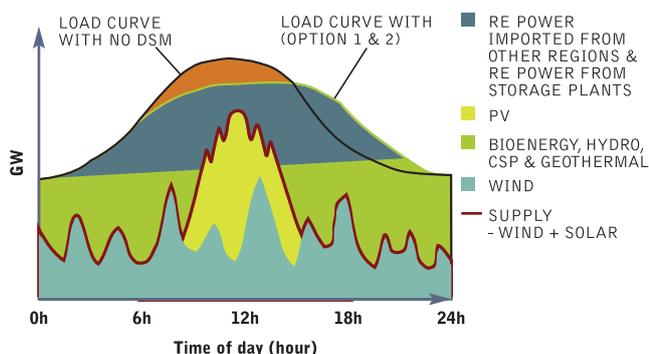


Figure 6: Optimised system with 90% renewable supply (Teske et al, 2012)

## 2.3 Storage of Renewable Energy

Constrained power, as defined above, could be made available for storage. Renewable energy plants that have an abundance of resource during low demand can transfer the power generated to storage instead of being shut down as constrained power (for example a wind farm in a steady wind). Excess power on the grid is stored by pumping water up to high dams which is then released to run through hydro turbines as needed. Fuels can be produced and stored, such as hydrogen from water by using the excess energy for electrolysis processes.

Dispatchable power can be stored and ‘dispatched’ when needed to areas of high demand, e.g. gas-fired power plants (Van De Putte & Short, 2011). In the Greenpeace Energy [R]evolution study (Teske et al, 2012)<sup>9</sup> natural gas is specified as backup and peaking until 2030 when concentrated solar power (CSP), geothermal (although this is limited in South Africa), small hydro, biomass and biogas gradually take over and gas is phased out.

Bioenergy plants can store biomass to load as needed and biogas produced in anaerobic digestions plants can be stored in tanks<sup>10</sup>. Solar thermal electricity plants use techniques such as thermal storage in molten salt.<sup>11</sup> The stored heat can be released after the sun has set and plant continues generating electricity at night.

The large scale distribution of renewable energy plants can collectively smooth out the intermittency often touted as a reason for not moving to a renewable electricity system. For example, several wind farms that are geographically dispersed will be in different wind regimes meaning that intermittency is smoothed out.

As grid penetration of wind energy increases substantially, so do the additional costs of reserve plant and fuel used

for balancing wind power variations. However, the reserve plants do not need to be the same capacity (widely dispersed wind farms need only a fraction of the back-up capacity) and when wind power supplies at least 20% of electricity generation, these additional costs are relatively small (Diesendorf, 2010).

In South Africa there will be a just transition in which coal is phased out while the renewable energy industry grows and storage solutions such as electric car shared storage are developed (Teske, 2011).

## 2.4 Can South Africa Afford Renewable Energy?

The concerns of whether South Africa can afford renewable energy arise out of the perception that RE is expensive while fossil and nuclear technologies are cheap. The premise also ignores life cycle costing of the technologies which is favourable to renewable technologies where the sources of fuel are free or cheap. Perhaps even more compelling is that it ignores the negative economic effects, the external costs discussed in Chapter 1, of nuclear and coal plants. Therefore, the question is surely: How can South Africa afford to not transform towards a renewable energy-based system? The falling cost of renewable plants compared to the rising cost of new nuclear and coal plants means the cheaper investment is renewable energy.

Onshore wind energy costs are expected to drop by 12% since 2011 due to lower cost equipment and gains in output efficiency. According to Bloomberg New Energy Finance, as reported by Renewable Energy Focus online (Williamson, 2011), the average wind farm could reach grid parity by 2016 (for example in the USA wind farms with a 30% capacity factor will reach grid parity in the North East states by 2015). It is likely that this would already be the case had all external costs been included.

<sup>9</sup> This model does not include shale gas.

<sup>10</sup> This does not include; conversion of food crop into fuel. Conversion of land under food crops to fuel crop cultivation

Conversion of agricultural waste into fuel as opposed to being converted into ecological soil nutrients Extending the definition of ‘wasteland’ so that it may be used sweepingly and inaccurately to describe areas with both ecosystem functions and socioeconomic relevance.

<sup>11</sup> Molten salt is thermal storage capability (Spain being the current technology leader) that enables CSP plants to operate after the sun has set – the heat released from the salt at night produces steam that is capable of continued generating operation.

In Australia, unsubsidised renewable energy is now cheaper than electricity from new-build coal- and gas-fired power stations. A BNEF study shows that electricity can be supplied from a new wind farm at a cost of R747.32/MWh (AUS\$80), compared to R1,335.82/MWh (AUS\$143) from a new coal plant or R1,083.06 /MWh (AUS\$116) from a new baseload gas plant, including the cost of emissions under the Gillard government's carbon pricing scheme.<sup>12</sup> "The perception that fossil fuels are cheap and renewables are expensive is now out of date", said Michael Liebreich, chief executive of Bloomberg New Energy Finance. "The fact that wind power is now cheaper than coal and gas in a country with some of the world's best fossil fuel resources shows that clean energy is a game changer which promises to turn the economics of power systems on its head," he said (Paton, 2013).

At the recent NERSA hearings in February 2013, SAWEA made a submission which showed that in the second round of (REIPPPP), the bidding for wind is 89c/kWh. The estimates for nominal new Eskom coal power range from NERSA's 97c/kWh to Standard Bank's estimate that Kusile will cost R1,38/kWh in 2019, when it is commissioned. The inescapable conclusion is that the more wind power we build, the more money we save (van den Berg, 2013). **These trends like many around the world including the case studies below show that the age of coal is over.**

There will, of course, need to be other expenditure in order to move to a renewable energy future. The installation of renewable energy plants and upgrading the transmission network is required. However, this is true even if South Africa were sticking to the traditional power systems of coal and nuclear. Currently huge amounts of money are being spent on building new coal fired stations (Medupi is expected to cost R91.2 billion and Kusile R118.5 billion (Engineering News, 2012 Aug)). In fact, the budgets originally presented have been significantly exceeded and the projects are running behind schedule exposing the South African economy to power constraints and increasing the risk of power outages affecting the economy. And yet it is questioned as to whether South Africa can afford renewable energy?

South Africa faces electricity price hikes in order to finance new build. If South Africans are to finance Eskom's capacity expansion programme, then Eskom should be investing in renewable energy sources for a sustainable future. The 8% increase allowed by The National Energy Regulator of South Africa (NERSA) currently does not include the proposed carbon tax, nor does it include the negative externalities associated with coal-fired electricity generation, including health impacts and water shortages.<sup>13</sup> In addition, investing in nuclear as proposed by the Department of Energy, would drive the price of electricity even higher than the figures included in Eskom's tariff increase application.

The introduction of carbon tax is a step toward tackling carbon emissions in South Africa. However, the proof will be

in the implementation. Further policy change is required to expand the renewable energy sector to ensure a transition to a low carbon economy. Carbon taxes can be an effective economic tool for tackling climate change, by encouraging countries to reach specific carbon intensity reduction targets. Introducing a carbon tax will help to reflect the true cost of carbon intensive industries by internalising the external (hidden costs) associated with fossil fuels. Hidden costs include health impacts, pollution and water shortages. The hidden costs of Kusile alone could amount to R60.6 bn. Crucially, a carbon tax should result in a change of behaviour; a move away from dirty, polluting energy sources to clean energy sources. Revenues generated from such taxation should be used to support energy efficiency technologies, emission reduction projects and further incentivise the development of clean technologies.

Future job creation is another important factor that would influence the answer as to whether SA can afford renewable energy. Chapter 1 illustrated how an aggressive uptake of renewable energy would increase job creation compared to the energy mix proposed by the approved Integrated Resource Plan (IRP-2010) (Rutovitz & Roth, 2011).

## 2.5 Grid Management Problems

In South Africa, Eskom is the primary electricity generator and has full control over the grid. Thus Eskom controls the generation of almost all of the power, as well as the transmission and distribution of that power, resulting in a conflict of interest (McDaid, 2008). The type of generation plants Eskom favours (large centralised plants) dictate how the grid is designed and managed. However, if South Africa is to meet its climate mitigation targets and secure a clean stable future the grid needs to be decoupled from Eskom and become smarter and more flexible with priority given to renewable energy. Continuation on the current path, when climate change mitigation relies largely on increasing the clean energy mix, will lead to a bloated and inefficient grid (Van De Putte & Short, 2011). South Africa needs to overcome this and adopt a modernised energy system by introducing smart grid technology.

A 'smart grid' is a better, cleaner future power system that will use more information technology than currently used to manage the grid. The aim is to deliver lower greenhouse gas and more cost-effective electricity at the right time to the right place. Decentralised renewable energy production and energy management of demand are both fluctuating but can be balanced on a smart grid. Information and communication technology help interconnect large numbers of renewable energy plants to create a flexible power system (Ackerman et al, 2009). A 'super grid' is an extensive smart grid that can transfer energy from areas of large resource to areas of large demand.

Thus far, Eskom, NERSA and local municipalities have resisted net metering and paid lip service to micro feed-in. In

<sup>12</sup> Currencies have been converted into Rand on 8/03/2013 from <http://www.xe.com>

<sup>13</sup> 02/28/2013 Media Statement on Eskom's Revenue Application for the Third Multi-Year Price Determination period 2013/14 to 2017/18 Available: <http://www.nersa.org.za/>



other countries, such as Japan and Germany, home owners can sell roof mounted PV power to the grid and the sheer number of participants creates a significant decentralised system. The benefit to the countries concerned is a reduced need for big power station investment.

The recent signing of power purchase contracts with independent renewable energy power producers in South Africa is the beginning of the need to move to a smart grid. Barry MacColl of Eskom stated: “The introduction of independent power producers to the grid is increasing the need for such a smart system, so that a smelter, for example, can decide whether to use electricity from a solar installation, a wind farm or the grid” (Engineering News, March 2012).

It is often said in South Africa that renewable energy is unaffordable. However, coal-fired power stations have fewer job creation possibilities than RE, carry future expenses due to climate change impacts, and has health expense issues due to pollution – all making the overall cost of fossil fuel unaffordable. The safety risks and long waste storage requirements of nuclear, as well as the cost of new build, are also not affordable. Thus the question is actually: how can

South Africa afford not to move to large scale deployment of renewable energy when all conditions are in place?

This chapter has demonstrated that renewable energy technology can deliver power twenty four hours a day seven days a week. It is not technology, a lack of resources, nor even economics, that prevents this from being accepted but rather misconceptions surrounding the capability of RE and lack of political will to move to a clean energy future. In South Africa, baseload has been cemented into the energy consciousness as being large centralised fossil and nuclear stations. Eskom’s grid is not well aligned to accepting fluctuating renewable energy and its generating stations are not well suited to following these fluctuations if renewable energy had priority. However, with load management, a smart super grid, and a system of net metering and micro feed-ins energy efficient renewable energy would be capable of reaching a dominant share of continuously available power and nuclear and coal could be phased out.



© Greenpeace / Nicolas Fojtu. Solar Installation in South Africa, 2010

# 3. What is holding South Africa back

The following barriers affect the uptake of renewable energy in South Africa and thus hinder low carbon development. This chapter focusses on:

- Political
- Legislative
- Economic and Finance
- Renewable Industry Development and the Grid

These barriers need to be eliminated, reduced or transformed to make way for increased investment opportunities if renewable energy is to reach meaningful deployment in South Africa.

## 3.1 Political

South African coal addiction and vested interests in the fossil and mineral sector (Amerasinghe, 2011), along with the economic weight of the fossil fuel industry are major barriers to the development of renewable energy in South Africa. This is a global issue where there is a strong lobbying sector fighting to keep coal (and nuclear) as the choice of power generation. Coupled with a lack of nationally based expertise in smart energy technology this means that renewable energy sector is not meeting its full potential.

The IRP 2010 sets out 17.8 GW of renewable energy by 2030 (DoE, 2010). However, only 3,725MW of renewable energy has been approved thus far by government under the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP and dubbed “REBID”)<sup>14</sup> running until 2015. Further bids have been announced increasing the allotment of renewable energy in the energy mix by 3200MW. If South Africa is indeed serious about investing in RE then it is critical that state owned utility Eskom urgently begins to shift its investments from coal to RE on a far larger scale. As Eskom is publicly funded, it is the utility’s duty to invest in sustainable methods of energy production such as RE.

While the REBID programme can be (and has been) celebrated it could become a barrier to investment grants trying to increase the renewable energy capacity beyond the allocated approvals. The REBID programme places responsibility of RE uptake entirely with the private sector and thus allows government to reduce its responsibility. The focus is solely on security of supply but RE can increase both access and security of supply. There are only a limited number of socio-economic beneficiaries) which favours multinational corporations and the importation of foreign produced technology. It has also been slow to get off the ground because the process was complicated, lacked transparency and the bidding process was expensive (Dinga, 2012).

Local governments seem to have no intention of investing in renewable energy. Karen Breytenbach, senior project adviser in the public private partnership unit in the Treasury, said municipalities banked on selling electricity as part of their funding model. Unless local government is bailed out, they will not allow rooftop PV electricity generation. “Electricity is basically printing the money which allows them to do their other work,” Breytenbach said. Her personal opinions was that net metering, where consumers could generate electricity and sell it back to the grid, was a good idea (Gosling, 2013). A roof top revolution, where there is widespread small scale solar power, is possible with a strong directive and political will from national government.

## 3.2 Legislative

The IRP 2010 policy-adjusted plan after consultation (DoE, 2010) shows 42% renewable (17.8GW) and 38% coal and nuclear (15.9GW) for new build generation. However, the energy mix in 2030 is still coal and nuclear heavy as shown in Figure 7.

Although trading agreements, land access, environmental requirements, licencing and power purchase agreements

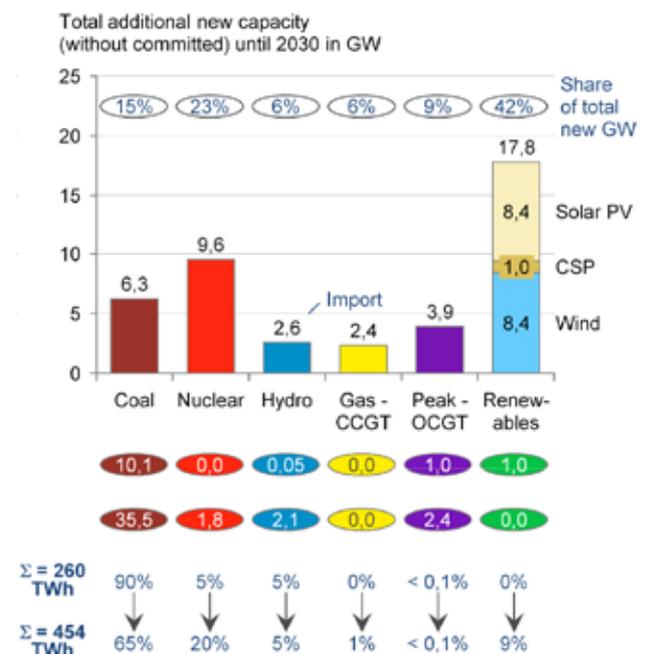


Figure 7: After consultation process – Policy Adjusted IRP (IRP 2010 final report rev2)

are legislative hurdles that need to be cleared there is a need to minimise and streamline these to ensure they do not become barriers to the deployment of renewable energy in South Africa. According to the New Generation Regulations buyers can only purchase electricity if it is part of the

<sup>14</sup> Because it is a bidding process and the dubbed REBID is a play on the original renewable energy feed-in tariff (REFIT) announced by government, where set tariffs for each technology were published.

REIPPPP. Thus any projects outside of this are not cleared by any alternative legislation – these are known currently as ‘unsolicited’ bids. The REIPPPP itself is complex and expensive – meaning that only large renewable projects with corporate and international funding can participate.

Legislative reform is essential to facilitate renewable energy uptake particularly on a small to medium scale of households to municipal projects. The current cost and procedural set up of REIPPPP makes it impossible for small to medium uptake of RE. Legislative barriers are one of the most difficult obstacles that renewables projects, globally, have to face. Uncertainty in legislation in South Africa has made progress of significant renewable energy deployment frustratingly slow. For example the government has delayed Round 3 of the REIPPPP from October 2012 to March 2013<sup>15</sup> (Stromsta, K, 2012). The lack of net metering and feed-in tariffs also hampers renewable energy uptake. Countries like Germany get most of their renewables from the many small projects and households. This too could play a significant role in renewable energy capacity on the grid outside the big REBID projects.

### 3.3 Economic and Finance

For many years, and at values far outstripping renewable energy, coal and nuclear (including mining and related large corporations) have been subsidised. A G20 report (Koplow & Kretzmann, 2010) states that the IEA estimates more than R71.1 billion (US\$8 billion) has been awarded in consumer subsidies, primarily to coal-fired electricity. This uneven financial playing field creates a substantial economic barrier for renewable power. The high capital cost of renewable energy technologies is often cited as the main barrier to their deployment (Foster-Pedley & Hertzog, 2006).

Aversion to risk is also a barrier to diffusion of these technologies. Early project risk sharing and R&D collaboration may help reduce the risk (DEA, 2011) but these arrangements have not surfaced as yet.

However, one proven funding mechanism is the use of a Feed In Tariff System. Fixed FITS means that renewable energy operators are paid a fixed price for every kWh of electricity they feed into the grid. Any initial additional costs of the system is borne by taxpayers or electricity consumers, however over time, when more renewable energy is fed in, the costs decrease (Teske et al, 2011).

In South Africa FITS would aid in establishing the RE market and levelling the playing field for the cleaner technology versus the continued financial leveraging of dirty and

dangerous energy sources. Wide spread participation in a FITS improves energy security through delivering large amounts of local generation and a FITS is necessary to support a new RE sector.

The main benefit of a FIT is that it is simple and encourages better planning. Although the FIT is not associated with a formal Power Purchase Agreement, distribution companies are usually obliged to purchase all the production from renewable installations. Germany has reduced the political risk of the system being changed by guaranteeing payments for 20 years. (Teske et al, 2011)

### 3.4 Renewable Energy Industry development

Two other limitations to substantial RE uptake in South Africa are the lack of national expertise and the national grid system.

Part of the conditions of the REIPPPP is that 30% of the bid scoring needs to be allocated to economic development which includes local content contributions. This percentage could increase in future bids to try and generate local jobs. Unfortunately this is limited by the lack of a long term procurement plan and minimal allocation of capacity per technology that would have enough of a pipeline to promote, for example, the manufacture of wind turbine blades. This is even more pronounced in Concentrating Solar Power (CSP), biogas, biomass, and hydro where the MW allocations are lower.

A limitation to widespread adoption of wind power is the absence of a wind power industry in South Africa of critical-mass and the distance between the areas of high wind potential and the areas of electricity demand (DEA, 2011). The level of government commitment to RE is a barrier to upscaling the industry. More ambitious long term policy is essential to bolster investment in RE manufacturing and installation across the country. Hooking up to the grids is a serious hindrance. Also the amount of renewable energy that is able to be connected to the transmission grid is constrained. The plan to upgrade the grid to handle these inputs is not public knowledge and not listed as approved.

In the 2005 South African Energy Efficiency Strategy the government admitted that solar water heating “is financially viable but the barrier is lack of awareness/information about the technology” (as cited by McDaid, 2008). This is true too for all forms of renewable electricity when all factors are taken into account.

<sup>15</sup> At the time of going to print there were further delays, first from May 2013 to August 19 2013. <http://www.csp-world.com/news/20130116/00712/third-bid-submission-date-delayed-until-august-19-south-africas-reipp>

“There are no real technical or economic barriers to implementing the Energy [R]evolution. It is the lack of political will that is to blame for the slow progress to date” (Teske et al, 2012). This is a reflection on the global situation of the slow deployment of renewable energy but is also true for the South African context. Strong committed political

will from the South African government is urgently required to set processes and policy in place that would eliminate the barriers. A supportive RE policy together with adequate financial incentives such as FIT is crucial to increasing the amount of renewable energy in South Africa.



© Greenpeace / Nicolas Fofu, Solar Installation in South Africa, 2010

# 4. Renewable Energy is possible

Case studies are presented in this chapter to show that renewable energy is a solution with considerable social, environmental and economic benefits.

- **South Africa:** Showing the access to electricity
- **India:** Decentralised energy access supporting community health care
- **Germany:** Investment in renewable energy pays off with decrease in prices
- **Kenya:** Small country with ambitious renewable energy uptake
- **China:** Scale and speed with which renewable energy can be done

The benefits of renewable energy are highlighted by the case studies including: decentralised energy, increased energy access, cheaper electricity, increased number of jobs and stimulation of local industry and environmental protection contributing to mitigation efforts against climate change.

## 4.1 South Africa - access to energy

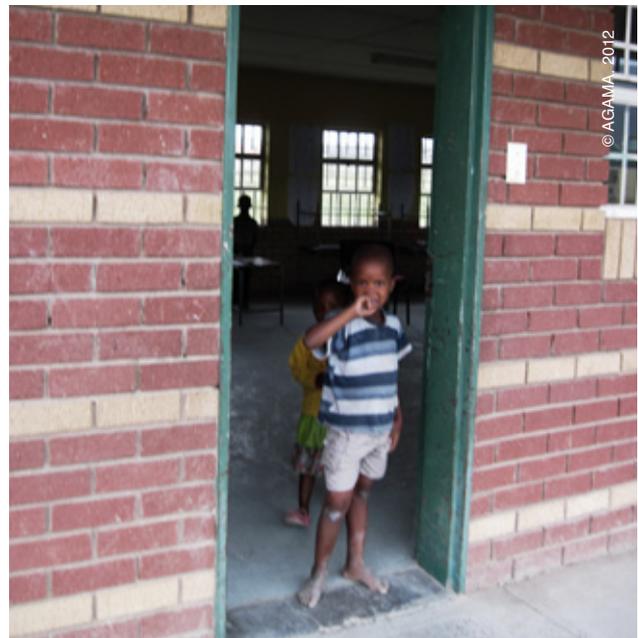
In 2012, according to the Department of Energy (DoE), 74% of households in South Africa were electrified (DoE, 2012). However, this is limited by the affordability of the connected electricity as well as the quality of that supply. A survey by DoE showed that 19% of the households questioned were dissatisfied with the electricity provision. On the quality of electricity 13% stated that it was “poor” and 2% said it was “very poor”. Almost half of the survey group (47%) felt that they paid “too much” for electricity and 27% felt they paid “far too much” (DoE, 2012).

Energy access, does not just affect households, but all aspects of society, including business and community services. According to Ben Sassman of Surplus South Africa, as cited by 25 Degrees online (25degrees, 2012), there are over 3,000 schools in South Africa that are operating without electricity.

Three Crowns Primary School is situated in the Chris Hani District in Khavola village near Lady Frere about 220km from East London in the Eastern Cape. It currently serves 178 children and caters from grade R to grade 6.



Three Crowns Primary School



The school is connected to the Eskom electricity grid but also has a sustainable energy system installed. It is part of the Chris Hani District Municipality School Greening Programme started in 2008 in cooperation with Wildlife and Environment Society of South Africa (WESSA) to install renewable electricity. Through the Eskom Energy and Sustainability Programme, and at the request of the Lady Frere District division of the Department of Basic Education, work was able to begin at the Three Crowns Primary School. Subsequently the project grew into a collection of projects called The Rural Sustainable Villages Programme (CHDM, 2011). Financial support came from the Development Bank of South Africa (DBSA), with project support for the renewable electrical installation from WESSA.

Sustainable energy technologies have been installed at the school. These can be put into two categories, namely renewable electricity and renewable thermal. The electricity is currently provided by a solar photovoltaic system and the thermal heat by a solar cooker and biogas digester. This study focuses on electricity provision.

The electricity is used to power a computer, printer and photocopier as a standalone non-grid tied system, luxuries that many other schools cannot afford in terms of appliances and electricity consumption. The benefits of this system are also shared with the village community when, for example, they need to copy forms for social grants or charge batteries or phones.



© Greenpeace /Markel Redondo. Solnova 1.3.4, PS10 and PS20 Solar Tower Plants, Spain, 2010

The energy project is also used for education and the children at the school have an understanding of the concept, know where the energy comes from and how it benefits them. In fact, they won a prize for a project discussing renewable energy and have presented and demonstrated the system to visiting schools (even high schools). The teachers are better able to teach about renewable energy by having the equipment at the school. The teachers said that because of the copier they are able to hand out important educational material. It helps speed up learning. Copies can be done without worrying about the energy cost and the same goes for using the computer and printer.

The teachers said that they would love to expand the system to light the classrooms. They are keen to extend the capacity of the school up to grade 10 so that the teachers can build on what they have taught. The knowledge can be disseminated by the students to the villages and other schools. They can explain the benefits of renewable energy and environmental protection back at their homes.

The RE system has given the school access to services that they would not otherwise be able to afford using grid electricity. IT can often also be more reliable - during the research for this case study, a storm was raging and at one point the grid connected lights went out while the RE system still functioned.

## 4.2 India - decentralised energy access supporting community health care

In 2010 R61.6 billion (US\$6.8 billion) was invested in clean energy in India. This rose by an impressive 52% to R93.3 billion (US\$10.3 billion) in 2011, according to Bloomberg New Energy Finance (BNEF). "This was the highest growth figure of any significant economy in the world, the country



Solar photovoltaic panels on the roof provide electricity to power lights, fans and computers in the building below. Tripolia Hospital, Patna

accounting for 4% of global investments in clean energy," says Ashish Sethia, Head of Bloomberg's India research. "The large growth was driven by a 7-fold increase in funding for grid-connected solar projects." (Bana, 2012)

The Bihar state of India is one of the poorest with little or no access to energy. At night Bihar is dark and the lack of electricity is starkly illustrated by the lack of electric lights. However, the Tripolia Social Service Hospital remains lit. Tripolia is a charitable private hospital run by the Sisters of Mercy of the Holy Cross with 25 Sisters, 70 staff, 50 supporting staff and 70 students.

Apart from the few with families, all workers and up to 250 inpatients live on the hospital campus, and are supported by its infrastructure. It's a lot of work to run a hospital, requiring a lot of electricity, and a lot of hot water. Yet the electricity deficit in Bihar is one of the worst in India, and so the hospital is increasingly relying on its own methods of energy generation.

Along with a solar powered instrument sterilisation system, Tripolia also has solar on the campus walkways, some solar indoor lights, five hot water heaters for bathing patients and heating medicines, and a laundry sterilisation system that operates on the same principles as the instrument sterilisation system: four huge parabolas on the roof. Both systems are crucial to the health and wellbeing of the patients and are heavily relied upon by the staff, catering to the needs of the 450 people that can stay on campus.

For most of the months of the year, the solar systems create steam for the laundry and sterilisation; but for the monsoon days on which there isn't much sun, the hospital pays for electricity from the main grid to generate the steam. Diesel powered generators are installed as a back-up, though, as grid electricity is not reliable.

To gain independence from the vagaries of grid electricity, the hospital is choosing to invest further in renewable



A nurse tends to a newborn baby delivered by Caesarian section in Tripolia Hospital. Both the medical instruments the Caesarian was performed with, and the clothes the baby is wrapped in, are sterilised by the hospital's steam-generating solar system on the roof.

energy: one year ago Tripolia built a new solar-powered residential unit. Four computers, an office, and the lights and fans of 14 bedrooms are powered entirely by solar photovoltaic; and the hot water of 14 bathrooms entirely by solar thermal. There seems to be an aim to make the hospital campus self-reliant, robust to any variations in supply from the state-provided systems outside.

The force behind these developments is the hospital administrator, Sister Christie Thomas. It was she who persuaded the hospital committee to install the laundry steam system, the solar lighting, and the solar powered residence. Her faith in solar came from her previous post in an unelectrified village in Jharkhand, “a jungle area” where the sisters had used solar energy to power lamps and a water pumping system for their clinic. “I knew it would work,” she says, “and we have an electricity problem.”

This case study illustrates how decentralised electricity production in India can give energy access to rural communities, and could be adapted to the South African context. The information is summarised from the Greenpeace publication “Empowering Bihar” (Boyle, 2010).

### 4.3 Germany - renewable energy pays off

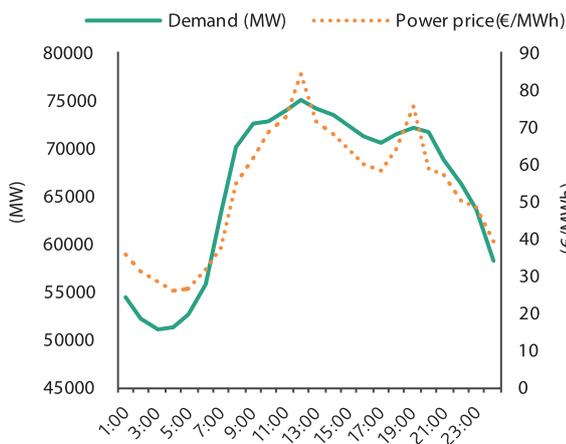
Germany has an electricity generating capacity of 150 GW of which renewable energy has a share of about 38%. When the renewable resources are favorable the proportion of energy produced by renewable technologies can be significant. As an example, in the first half of 2012 the German Association for Energy and Water (BDEW)

estimated that the renewables output was at 25% of the country’s approximate 270 TWh production (Bisset, 2012).

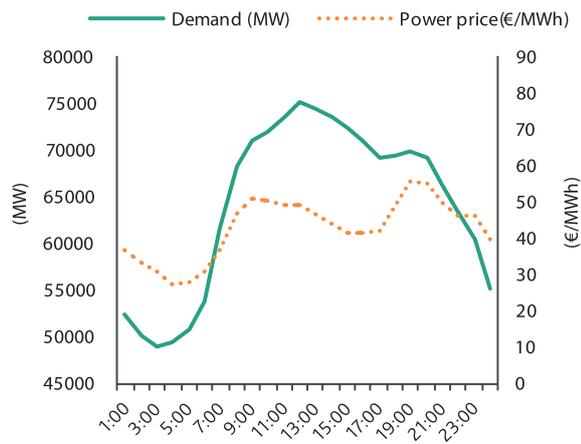
But is this large share of renewables influencing the power pricing market? A Moody report (Phillips, 2012) on European Utilities discusses how wind and solar power will continue to erode the thermal generators’ credit quality. This is because of the large increases in renewable energy providing very low-marginal-cost generation. Germany is considering introducing full-scale capacity payments to incentivise thermal generators to stay online. These are payments per kilowatt, as opposed to per kilowatt-hour, so that earning is possible irrespective of output. However, it will increase thermal power energy prices. Some European utilities are considering electricity storage as a means to manage the impact of increased renewable energy which has the potential to further negatively affect peak power prices and would increase the competitiveness of renewables.

Looking at a day-to-day comparison of the relationship between demand and power prices, an interesting change can be seen between 2006 and 2012 in Germany, as shown in Figure 8. In 2006 there was a distinct match between the demand and the price – when the demand rose more expensive forms of generation were called upon. Now in 2012 the picture changes – although the demand curve is almost identical the prices are not pulled up as much by the demand peaks. This can be attributed to increased low-marginal-cost renewable forms of generation meeting peak demand. The change downwards in power prices is the greatest around midday suggesting that photovoltaic technology is driving down the German energy prices (Phillips, 2012).

Average Demand vs. Average Intra day Power Prices in Germany 2006



Average Demand vs. Average Intra day Power Prices in Germany 2012



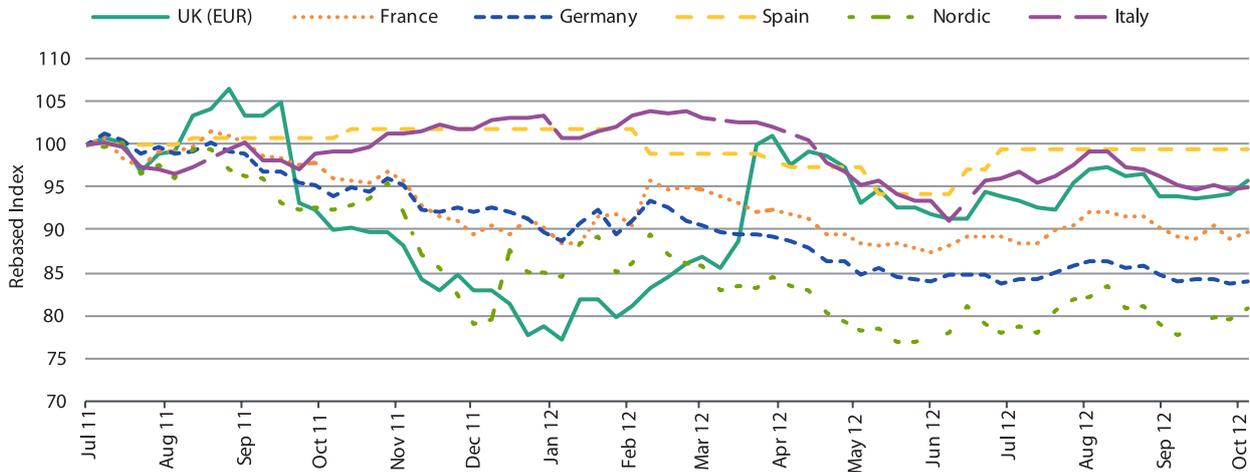
Source: Bloomberg; ENTSOE

Figure 8: Average demand compared to average power prices (Phillips, 2012. p4)

From July 2011 to October 2012 the baseload prices in Germany declined by 9%, as shown in Figure 9. This was partially due to lower coal and carbon prices as well as a wide generation reserve margin<sup>16</sup> but it was also due to the huge increase in renewables on the grid (Bisset, 2012).

This German example shows how increased RE in South Africa, contrary to what many believe, would benefit the consumer by decreasing the cost of electricity and thus making it more accessible to those who may be grid connected but unable to afford the power.

### EU Baseload Power Prices Drift down from Mid 2011



Source: Bloomberg price data (1yr forward prices)

Figure 9: EU Baseload Power Prices (Bisset, 2012. p4)

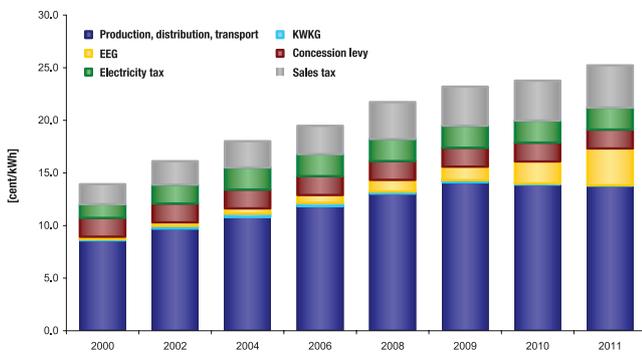
The price of electricity from a German household consumer perspective is shown in Figure 10. In 2011 a kilowatt-hour of electricity cost R3 (€0.253) which was slightly up from 2010. However, note that from 2009 to 2011 the price portion for the production, generation and distribution of electricity declined slightly around R1.8 (€0.14)/kWh (the overall cost increase is due to add-on charges such as taxes and levies – especially the German Renewable Energy Act (EEG) which is in place to encourage cost reductions based on improved energy efficiency and has been a boost of renewables in Germany).

### 4.4 Kenya - ambitious renewable energy uptake

The institutional and regulatory situation in Kenya is promising for renewable energy development. The regulation is independent and transparent, tariffs match the cost of running a profitable generating facility and the cost can be passed on to the consumer enhancing financial stability for the utilities and encouraging lending. There are strong policy and planning documents encouraging large deployment of clean energy. There are already independent power producers active in the country, the utilities are semi-privatized and the financial market is fairly sophisticated and well developed. These support renewable energy development which is driven by good resources, energy security concerns, and a requirement to lower dependency on fuel imports (WEF, 2012).

The above factors have ensured a platform for a renewable energy component industry to establish in Kenya. Ubbink East Africa is the first solar PV panel manufacturing plant in East Africa. They are based in Naivasha, a town 100 km northwest of the Kenyan capital Nairobi and have a production capacity of 30,000 modules per year.

Cost components for one kilowatt-hour of electricity for household consumers



Source: BMU-KI III 1 according to Institut für neue Energien Teltow (IfnE) and Bundesverband der Energie- und Wasserversorgung e.V. (BDEW); Image: Deutsche Bundesbank; as at: July 2012; all figures provisional

Figure 10: Breakdown of German household cost of one kilowatt-hour of electricity (AGEE, 2012)

<sup>16</sup> Reserve margin is generation availability to fill in the energy gaps when stations go into maintenance or demand increases due to unusual circumstances

The cost of solar photovoltaic (PV) panels is seen as an obstacle to decentralised deployment in Kenya as it is out of reach for many getting by on less than R18 (US\$2) per day. However, there are market drivers: solar power has been mandated in new-build homes and tax cuts have been introduced on solar power equipment. Despite the perceived cost barrier, and perhaps due to the drivers mentioned above, East Africa has one of the highest rates of PV installed per capita in the world and uptake of PV is outpacing connections to the electricity grid. Thatched or corrugated roofs in rural Kenya are increasingly seen with a small solar panel. These are used to charge mobile phones and power a few light bulbs helping families save on kerosene costs for lamps. The quality of electric light is better than fuel lamps enhancing home activities, especially for children doing their homework at night.

A 34 year old farmer, Frederick Kaveta, has a solar panel on the corrugated roof of his home in Ukumbani, southwest of Nairobi. He states that having this bit of electricity is a replacement to fuel lighting and has both economic and health benefits. The fuel lamps smoke and made them cough and the R45 (US\$5) he saves per month can buy two or three meals for his family of four. Ubbink East Africa sees PV as a key technology for putting East Africa on a more sustainable and lower carbon development path and hopes to expand sales to Uganda and Tanzania (Eveleens, 2011).

It is not only local manufacture and rural farmers that are benefitting from renewable uptake but large scale renewable utilities as well. Lake Turkana Wind Power Project (LTWP) is the largest wind farm in Sub-Saharan Africa. It has a capacity of 310MW and consists of 365 turbines of 850kW each. It is equivalent to 20% of the current installed capacity in Kenya and is the largest single private investment in Kenya's history (LTWP, 2012). At the proposed 9.9 US cents per kWh it will be cheapest electricity in Kenya (Kernan, 2012).

It is estimated that around R405 billion (US\$45 billion) is needed by 2030 to meet Kenya's ambitious clean energy development plan (WEF, 2012). Kenyan investment in renewable energy amounted to R22.5 billion (US\$2.5 billion) in 2010 possibly making it the most prominent in this field in sub-Saharan Africa. Besides wind energy, another significant contributor is geothermal energy. In 2011 geothermal activity was enhanced by a R 2,969 million (US\$330 million) loan for a 48MW plant in Olkaria (McCrone, 2012).

South Africa is being trumped by Kenya in its clean energy ambitions. Kenya plans to match a large portion of the projected demand through RE with more than ten times its current overall capacity by 2030, however the proof will be in the implementation. The presence of the PV manufacturing plant is also a heads up to the government to promote local manufacturing in South Africa.



© Ubbink. Ubbink East Africa's first solar-panel plant in Navaisha, Kenya.



Hajo Kuper with a Kenyan worker at Ubbink East Africa's solar-panel plant in Navaisha, Kenya.

## 4.5 China - renewable energy at scale and speed

The Chinese State Council has made a series of high-level policy interventions to try and solve grid connection of renewable energy in remote, but well naturally resourced, areas. The policies are also intended to help eliminate curtailment<sup>17</sup> of renewable energy, especially wind, competing against baseload coal and nuclear (Li Shuo, 2012).

Solar in particular has received attention with a policy document, entitled “Soliciting Scale-up Demonstration Project of Decentralized Solar Utilisation” from the National Energy Agency, which also promotes grid access. The 12th Five Year Energy Plan was approved by the State Council in 25 October 2012 and has clear language in support of decentralised energy development. A day later the State Grid Corporation of China published “Guidance on Implementing Decentralized Solar Energy Grid Connection Service”. This grid document states that the solar project owner will be helped with their connection application, that the grid will cover the cost of equipment required for the connection and that no service fee will be charged for this (Li Shuo, 2012).

The speed and scale of renewable energy uptake can be illustrated by the installed wind capacity of 2010 and 2011

totaling an impressive 36.56GW.<sup>18</sup> At a total capacity of 62.4GW China is the global leader in installed wind energy capacity and 2011 produced 1.5% (71.5bn kWh) of the national total electricity output – despite losing 10bn kWh due to curtailment when baseload stations had priority. This amounts to about 10mil tonnes of avoided CO<sub>2</sub> emissions (Greenpeace East Asia, 2012). The two most active provinces in 2011 were Inner Mongolia installing 3.74GW and Hebei installing 2.18 GW. While it can be seen that the onshore wind capacity is huge, offshore wind farms are being planned and currently there are already 38 projects of 16.5GW that are in early stage development (Li Junfeng et al, 2012) This is an impressive programme.

China’s biggest offshore wind farm, the Longyuan Jiangsu Rudong 150MW Demonstration Wind Farm (the first global intertidal-zone farm), is now commercially active. The project is located in the East China Sea offshore from Rudong County in Nantong in the Jiangsu Province, which is on the northern bank of the Yangtze River opposite Shanghai. The sheer scale of RE development in China shows that it is technically possible on such large scale and the South African government, which has only approved less than 4GW of RE thus far, should take note.



Longyuan Jiangsu Rudong 150MW Intertidal Offshore Demonstration Wind Farm (China Longyuan Power Group Corporated Limited)

<sup>17</sup> Curtailment of wind power is the shutting down of wind turbines even if the wind is blowing because baseload stations have grid priority

<sup>18</sup> 17.63 GW in 2011 and 18.93 GW in 2010



© Greenpeace / John Novis. Wind Farm Along the Silk Road. China, 2009

# 5. Key Recommendations

This report clearly demonstrates, renewable energy is possible, “There are no real technical or economic barriers to implementing the Energy [R]evolution. It is the lack of political will that is to blame for the slow progress to date” (Teske et al, 2012). Many issues raised around RE, such as baseload are largely misperceptions propagated by fossil fuel and nuclear bodies. Power production needs to be changed from a producer benefit scenario to one that includes the best interest of the consumer. Currently baseload is used to sustain producer profit margins, fuelled by vested interests in existing dirty energy production. It is not technology, a lack of resources, nor even economics that prevents a transition to RE from being accepted but rather misconceptions of the capability and lack of political will to move to a clean energy future.

Energy efficiency needs to take centre stage as the need for an Energy [R]evolution stems largely from wastage and gross inefficiency in production, distribution and usage of energy. Energy demand curves can be smoothed out if wastage and efficiency in the current process are eliminated. The first step here would be eliminating electrical resistance in water heating.

## 5.1 Financial Recommendations

RE is not expensive. The reality is that the true costs of coal and nuclear are not reflected in their pricing. Primarily coal and nuclear have long benefited from taxpayer funded subsidies. The RE industry has not had the benefit of this leveraging. In addition, the vast external costs of coal and nuclear make them unaffordable. External costs include less job intensity, substantial future expenses due to climate change impacts, and health expenses related to pollution as well as huge water shortage implications, all make the total real cost of fossil fuel unaffordable. The safety risks and long waste storage requirements of nuclear, as well as the cost of new build, are also unaffordable. These factors have not been factored into the financial or social cost of these methods of energy production. A true reflection of the cost of coal and nuclear would be a deterrent. Thus the question is: how can South Africa afford not to move to large scale deployment of renewable energy?

Adequate financial and economic incentives need to be in place to allow for stimulating local manufacturing of RE technology equipment and to increase the number of investors in the industry. As start-up costs are high it is essential there is government backing, estimated costs

from Jefferys Bay wind farm in the Eastern Cape of South Africa are R2.8-billion (Stander, 2013). More importantly government should not be using public funds for dirty and dangerous coal or nuclear power plants.

## 5.2 Policy Recommendations

There needs to be a definite policy and investment shift from coal and nuclear towards renewable energy. The DOE needs to announce more ambitious targets that could see the electricity sector leading the Energy [R]evolution resulting in 49% of electricity produced from renewable sources by 2030, increasing to 94% by 2050 (Teske et al, 2011).

The quality of policy and perceived level of government commitment to policy are essential to bolster investor confidence. Given the lack of technical barriers to the drivers of RE investment, financial attractiveness is subordinate to visible and appropriate RE support mechanisms, which rely on political will.<sup>19</sup> The relationship between the two factors of price and policy requires in many cases that both sets of barriers need to be addressed.

Administrative deficiencies such as those experienced in the REIPPPP process need to be removed. In addition, the grey area around grid tie-in needs to be cleared away, beginning with a clear net metering programme that allows for the inclusion of the small to medium RE power producers. This would include a restructuring of the municipal revenue process removing the dependency on electricity tariffs.

Dedicated and maintained local content drivers must be in place to ensure that local investors, producers and manufacturers, project developers gain experience. The carbon tax should be implemented such that there is a change in behaviour; a move away from dirty, polluting energy sources to clean energy sources. Revenues generated from such taxation should be used to support energy efficiency technologies, emission reduction projects and further incentivise the development of clean technologies.

Government commitment to energy decisions must show a clear move away from fossil fuels and there must be synchronization of government policy throughout the various departments addressing energy issues. An Energy [R]evolution requires inter-departmental coordination including but not limited to the Department of Environmental Affairs Department of Energy and Department of Transport.

<sup>19</sup> Ecofys, Fraunhofer ISI, TU Vienna EEG, Ernst & Young. 2011. Financing Renewable Energy in the European Energy Market by order of European Commission, DG Energy, 2nd of January, 2011, p.148

## 5.3 Structural Recommendations

System intergration and infrastrucutre improvements need to include improved access to the grid by independent power producers. In South Africa, (coal and nuclear stations) have priority on the grid which is owned by the same company that owns these large stations (Eskom). A true Energy [R]evolution requires that RE is given priority grid access rather than forcing RE to assimilate to a currently old and problematic grid.

Load management also needs to improve through the use of smart grid technology. This would include the decentralised energy system. With load management, a smart super grid and energy efficiency, renewable energy would be capable of reaching a dominant share of the energy mix.

The government, namely DoE and Eskom, need to invest in R&D for RE. This needs to go beyond current pilot projects and research needs to look into storage as well as cheaper production methods for RE.

Thus, to thrive, and deliver its full socio-economic benefits, renewable energy still needs greater political support in the form of fundamentally different market regulations: increased grid access, smart and modernised power-market design and to some extent a different infrastructure to achieve an energy market that is 100% renewable energy.



## 6. References

- 25Degrees, 2012. Giving energy to 3000 rural schools in South Africa. 25 Degrees online. <http://www.25degrees.net/index.php/Latest/giving-energy-to-3000-rural-schools-in-south-africa.html> Accessed 19 December 2012
- Adam, F; Fig, D; Gilbert, D; Kantey, M; Muscana, F; Schultz, N; Steele, M, Teule, R; Thomas, S. 2011. The True Costs of Nuclear Power in South Africa. Greenpeace, August 2011
- Ackerman, T; Tröster, E; Short, R; Teske, S. 2009. [r]enewables 24/7, Infrastructure needed to save the climate. Greenpeace and European Renewable Energy Council: Global energy grid scenario, November, 2009. p. 5; 46
- AGEE, 2012. Development of renewable energy sources in Germany 2011, July 2012. Based on statistical data from the Working Group on Renewable Energy – Statistics (AGEE-Stat). Graphics and Tables Presentation, Slide 18
- Amerasinghe, N. It's time to admit there is no future in fossils, 05 December 2011, The Center for International Environmental Law. [http://ciel.org/wordpress\\_211560016/?p=584](http://ciel.org/wordpress_211560016/?p=584) Accessed 18 January 2013
- AMEU, 2012. EJournal, Association of Municipal Electricity Utilities.. <http://www.ameu.co.za/ejournal/2012/8/30/smart-grids-the-south-africa-smart-grid-initiative-sasgi.html> Accessed 20 November 2012
- Austin, G. 2003. Employment Potential of Renewable Energy in South Africa. AGAMA Energy, p.63
- Bana, S. 2012. India powers ahead on renewable energy, Part 1. 14 November 2012. Renewable Energy Focus. <http://www.renewableenergyfocus.com/view/29336/india-powers-ahead-on-renewable-energy/> Accessed 19 December 2012
- Bisset, N. 2012. Industry Outlook, EMEA Electric and Gas Utilities: Negative outlook for unregulated utilities on weak market conditions and rising euro area risks. Moody's Investors Service. Report Number: 146812. 05 November 2012. p. 4 & 11
- Bjureby, E; Britten, M; Cheng, I; Kaźmierska, M; Mezak, E; Munnik, V; Nandi, J; Pennington, S; Rochon, E; Schulz, N; Shahab, N; Vincent, J; Wei, M. 2008 The True Cost of Coal: How people and the planet are paying the price for the world's dirtiest fuel. December 2008, Greenpeace. p. 6, 9, 15, 16, 21, 22, 39, 74
- Blignaut, J; Koch, S; Riekert, J; Inglesi-Lotz, R; Nkambule, N. 2011. The External Cost of Coal-Fired Power Generation: The case of Kusile. Business Enterprises at University of Pretoria prepared for Greenpeace Africa and Greenpeace International. 29 September 2011. P.18
- Bloomberg & Vestas. 2012. Global Corporate Renewable Energy Index 2012, Bloomberg New Energy Finance & Vestas Wind Systems A/S, P.6
- Boyle, G. 2010. Empowering Bihar, Case Studies for Bridging the Energy Deficit and Driving Change. Greenpeace India Society, October 2010. P.24
- Cardaro, M. 2008. Understanding Base Load Power, What it is and Why it Matters, New York Affordable Reliable Electricity Alliance, New York AREA, 7 October 2008
- CHDM, 2011. Chris Hani District Municipality Sustainable Villages Programme, 2011 Programme report.
- CLPGCL, 2012. 50MW Intertidal Offshore Demonstration Wind Farm was Commercially Put into Operation. China Longyuan Power Group Corporated Limited. 26 November 2012. <http://www.clypg.com.cn/en/newscenter/headlinenews/279494.shtml> Accessed 18 December 2012
- COWI, 2012. Zafarana Wind farm. Egypt. Consultancy within Engineering Environmental Science and Economics. <http://www.cowi-africa.com/menu/projects/Industry-and-energy/Pages/zafarana-wind-farm-egypt.aspx> Accessed 17 December 2012
- DEA, 2011. South Africa's Second National Communication under the United Nations Framework Convention on Climate Change. Department of Environmental Affairs Republic of South Africa, Pretoria, November 2011. P. 47, 198, 202
- Diesendorf, M. 2010. The Base Load Fallacy and other Fallacies disseminated by Renewable Energy Deniers. Energy Science Coalition, March 2010. p. 2, 3, 7
- Dinga, S. 2012 Why there is no reason to celebrate the REBID process. Presentation by NUMSA to the WWF NCCRP Implementation Conference
- DME, 2008. National Energy Efficiency Strategy of the Republic of South Africa, First Review Oct 2008, Department of Minerals and Energy
- DoE, 2010. Electricity Regulation Act No.4 of 2006, Electricity Regulations on the Integrated Resource Plan 2010 – 2030, Department of Energy, Government Gazette No.34263, 6 May 2011. p. 15
- DoE, 2012. A survey of energy-related behaviour and perceptions in South Africa: The Residential Sector. 2012. Department of Energy p 2, 3 & 6
- DTI, 2011. South African Industrial Policy Action Plan 2011/12 – 2013/14: Economic Sectors and Employment Cluster, Department of Trade and Industry, February 2011. p.12
- Energici, 2012. Morocco's renewable ambitions. 14 November 2012. <http://www.energici.com/industry-news-mobile/item/5303-morocco%E2%80%99s-renewable-ambitions> Accessed 17 December 2012
- Engineering News, 2012 Aug. <http://www.engineeringnews.co.za/article/medupi-kusile-overruns-should-be-probed-npc-commissioner-asserts-2012-08-21> Accessed 21 January 2013
- Engineering News, 2012 March. <http://www.engineeringnews.co.za/article/business-needs-crucial-for-eskom-smart-grid-migration-2012-03-30> Accessed 20 November 2012
- Eskom Fact Sheet GX 0003, BASE AND PEAK LOAD ELECTRICITY [http://recruitment.eskom.co.za/content/GX\\_0003BasePeakElecRev5.pdf](http://recruitment.eskom.co.za/content/GX_0003BasePeakElecRev5.pdf) Accessed 28 November 2012
- Eskom Fact Sheet TD 0003- TRANSMISSION AND DISTRIBUTION OF ELECTRICITY [http://www.eskom.co.za/content/TD\\_0003TxDxelecRev4~1.pdf](http://www.eskom.co.za/content/TD_0003TxDxelecRev4~1.pdf) Accessed 28 November 2012
- Eskom, 2011. Integrated Report 2011 (annual report 2011) available on [http://financialresults.co.za/2011/eskom\\_ar2011/downloads.php](http://financialresults.co.za/2011/eskom_ar2011/downloads.php). Accessed on 29 November 2012. p. 186
- Eveleens, I. 2011. E. Africa's first solar-panel plant supports Kenya's clean energy push. Alertnet. 23 November 2011 <http://www.trust.org/alertnet/news/e-africas-first-solar-panel-plant-supports-kenyas-clean-energy-push> Accessed 17 December 2012
- EYGM, 2012. Renewable energy country attractiveness indices, Earnest & Young CAI Issue 32, February 2012. p.8
- Foster-Pedley, J & Hertzog, H. 2006. Financing strategies for growth in the renewable energy industry in South Africa. UCT Graduate School of Business and Atlantic Solar. Journal of Energy in Southern Africa, Vol 17 No 4, November 2006. p. 61
- Greenpeace & EPIA. 2011. Solar Generation 6, Solar Photovoltaic Electricity Empowering the World, Greenpeace, European Photovoltaic Industry Association. p. 80, 81, 83
- Greenpeace East Africa, 2012. China Wind Power Outlook 2012. <http://www.greenpeace.org/eastasia/publications/reports/climate-energy/2012/wind-energy-report-2012/> Accessed 18 December 2012

Harvey, F. 2012. UK makes biggest emissions cuts in Europe, The Guardian online, 24 October 2012 <http://www.guardian.co.uk/environment/2012/oct/24/uk-eu-carbon-emission-cuts>. Accessed 7 November 2012

Haw, H & Hughes, A. 2007. Clean Energy and Development for South Africa: Scenarios. Report 2 of 3. Energy Research centre, University of Cape Town funded by the British High Commission, South Africa. 28 February 2007. p. 3-4

Isa, M. 2012. No decision yet on carbon tax – Gordhan. Business Day Live. 27 June 2012. <http://www.bdlive.co.za/articles/2012/06/27/no-decision-yet-on-carbon-tax---gordhan>. Accessed 30 November 2012

JICA, 2012. Zafarana Wind Power Plant Project, Arab Republic of Egypt, Project Design Document, Japan International Cooperation Agency. Prepared by Mitsubishi UFJ Securities, Clean Energy Finance Committee, April 2012. p.4

Kernan, A. 2012. Kenya's Renewable Energy Boom. 23 July 2012. Leonardo Energy. <http://www.leonardo-energy.org/kenya%E2%80%99s-renewable-energy-boom>. Accessed 17 December 2012

Koplow, D & Kretzmann, S. 2010. G20 Fossil-fuel Subsidy Phase Out: A review of current Gaps and Needed Changes to Achieve Success. November 2010. p.9

Letete, T; Guma, M; Marquard, A. Date not given. How do South African emissions compare with those of other countries? Energy Research Centre, University of Cape Town. p.4

Li Junfeng; Cai Fengbo; Qiao Liming; Xie Hongwen; Gao Hu; Yang Xiaosheng; Tang Wenqian, Wang Weiquan, Li Xiuqin. 2012. China Wind Energy Outlook 2012. Global Wind Energy Council.

Li Shuo, 2012. Letter: update on RE development in China. Greenpeace East Asia. Forwarded on 5 December 2012 by Ruth Mhlanga of Greenpeace Africa.

McCrone, A. 2012. Global Trends in Renewable Energy Investment 2012. UNDP Collaborating Centre for Climate & Sustainable Energy Finance, Frankfurt School. Bloomberg New Energy Finance. p.29.

McDaid, L. 2008. Electric Capitalism, Recolonising Africa on the power grid, Ch 7: Renewable energy: Harnessing the power of Africa? p 209, 214, 222

O'Hanlon, L. 2012. HOW MUCH CLIMATE CHANGE WAS IN HURRICANE SANDY? Discovery News, Fri Nov 2, 2012. <http://news.discovery.com/earth/sandy-and-the-record-arctic-sea-ice-melt-121102.html> Accessed 26 November 2012

Parnell, J. 2012. US Oil Lobby outspends green movement by factor of five. 13 February 2012. Responding to Climate Change. <http://www.rccc.org/us-oil-lobby-outspends-green-movement-by-factor-of-five/> Accessed 19 December 2012

Phillips, S. 2012. Special Comment, European Utilities: Wind and Solar Power Will Continue to Erode Thermal Generators' Credit Quality. Moody's Investors Service. Report Number: 146913. 05 November 2012. p. 1, 4-5

polity.org.za. 2012. Eskom seeks yearly increases of 16% to 2018. <http://polity.org.za/article/eskom-seeks-yearly-increases-of-16-to-2018-2012-10-22> Accessed 30 November 2012

Price, T. 2011. African nation sees desert as a renewable power house. 18 August 2011. Renewable Energy Magazine online. <http://www.renewableenergymagazine.com/article/african-nation-sees-desert-as-a-renewable> Accessed 19 December 2012

Renner, M; Sweeney, S; Kubit, J. 2008. Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World, Worldwatch Institute with technical assistance from Cornell University Global Labor Institute for United Nations Environment Programme UNDP/ILO/IOE/ITUC, September 2008. p. 128

Rutovitz, J. 2010. South African Energy Sector Jobs to 2030. Institute for Sustainable Futures, University of Technology Sydney prepared for Greenpeace. p. 2-3

Rutovitz, J & Roth, K. 2011 (assumed). More jobs and progress for South Africa: The Advanced Energy [R]evolution scenario and its impact. Institute for Sustainable Futures, University of Technology Sydney prepared for Greenpeace. p. 5

Singh, V & Fehrs, J. 2001. Renewable Energy Policy Project: The work that goes into renewable energy, November 2001, REPP

Stander, Y. 2013 Wind power blows in R2.8bn. The Herald Online. Available:<http://www.peherald.com/news/article/12092> Accessed 8/03/2013

Steele, M; Teule, R; Schulz, N; Musana, F; Adam, F; Baillie, M; Myllyvirta' L. The True Cost of Coal in South Africa: Paying the price of coal addition, 2011. Greenpeace. p. 6

Steer, A. 2012. Listening to Hurricane Sandy: Climate Change is Here Bloomberg.com. Nov 2 2012. <http://www.bloomberg.com/news/2012-11-02/listening-to-hurricane-sandy-climate-change-is-here.html> Accessed 26 November 2012

Stromsta, K. 2012. Being green in South Africa is not Easy – IPP delays. 25 September 2012. South African Alternative Energy Association. <http://saaea.blogspot.com/2012/09/being-green-in-south-africa-is-not-easy.html> Accessed 18 January 2013

Teske, S; Muth, J; Sawyer, S.. 2012. Energy [R]evolution, A Sustainable World Energy Outlook, 4th edition 2012 (world energy scenario), Greenpeace, GWEC, EREC p. 4; 13, 28; 31-32, 36; 37-38

Teske, S; Adam, F; Smith, B. 2011. Energy [R]evolution: a Sustainable South African energy outlook (national energy scenario) 2011, EREC, Greenpeace International & Greenpeace Africa. p. 41, 44

Van De Putte, J; Short, R 2011. Battle of the Grids. How Europe can go 100% renewable and phase out dirty energy. Based on research report 'Europe Grid Study 2030/2050' by Energynautics commissioned by Greenpeace International. p. 4; 5; 10; 26; 27

WBSCD, 2006. Eskom: Electrifying South Africa, Case Study. World Business Council for Sustainable Development [http://www.wbcsd.ch/DocRoot/M7odEIDrIXhf8jFFaf7e/electrification\\_full\\_case\\_web.pdf](http://www.wbcsd.ch/DocRoot/M7odEIDrIXhf8jFFaf7e/electrification_full_case_web.pdf) Accessed 22/11/2012

WEF, 2012. Unlocking Financing for Clean Energy in Kenya, Workshop, Nairobi, Kenya, 15 May 2012. World Economic Forum. p.1 & 2

Williamson, K. 2011. Onshore wind to reach grid parity in 2016. Renewable Energy Focus. 15 November 2011. <http://www.renewableenergyfocus.com/view/22023/onshore-wind-to-reach-grid-parity-in-2016/> Accessed 30 November 2012

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