Assessing the effectiveness of national solar and wind energy policies in South Africa

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Executive summary

Overview

The report assesses the progress made on renewable energy deployment for the solar and wind technologies over the last 12 years in South Africa. First the report assesses the potential contribution solar water heaters (SWHs), concentrating solar power (CSP), large-scale photovoltaic (PV) farms and wind technology can bring to South Africa's energy demand by 2030. It highlights what the mid-term potential for each is by 2030 and compares this with the deployment of each over the past 12 years. From this a renewable energy policy effectiveness value is calculated based on the method developed in the *Deploying Renewables Report* (IEA, 2008a) and this is critically assessed. Finally, the report assesses the factors involved in renewable energy deployment, or the lack thereof, in South Africa and discusses recent developments in the field.

The compilation of this paper was based on desktop reviews; data interpretation from multiple sources; expert opinion of the authors and peer reviewers; and interviews with experts in the field. A number of interviews were conducted at the ISES International Solar Energy Society Conference in October 2009 and the Energy 2010 Indaba in February 2010. The data used in this report to formulate the projections is from a number of sources and has been independently reviewed.

The South African context

When assessing renewable energy policy in South Africa one has to take certain factors into consideration. For one, Eskom, as the state-owned electricity supplier, dominates the generation capacity. Furthermore, only about 70% of South African households are connected to the electricity supply grid, and overcoming energy poverty still remains a strategic development objective. South Africa also has had a history of supplying cheap electricity due to an over-capacity expansion programme in the 1970s and ample cheap coal, amongst other reasons. In 2008 South Africa was unable to supply the more than 220 TWh of demand even though the country's generating capacity is estimated at 43.5 GW and since then there have been a number of interventions to increase generation capacity.

Prior to the electricity supply crises in 2008 South Africa's electricity was priced on average at R0.25/ kWh. According to Eskom such prices were too low to allow for the recovery of all the prudently incurred costs and the building of reserves to sustain the current asset base, and were unable to support their capital expansion programme. Their expansion programme includes about 10 GW of capacity from coal, 1.2 GW from the Ingula pumped storage scheme, and only about 150 MW of renewable energy (Davidson et al 2010). The National Energy Rergulator has since granted electricity price increases of 31.3%, which incorporated a 2 cents/ kWh environmental levy, and 24.8% for 2010/2011, while another two 25% increases are expected for the following two years. Besides financing Eskom a portion of the revenues incurred is expected to support the deployment of renewable energy projects by IPPs as outlined under the IRP1.

Potential for renewable energy in South Africa

Considering that South Africa is in need of new generation capacity the report assesses the potential for renewable energy generation in 2030. By building on a number of detailed research reports this paper compiled its own projections considering a number of assumptions including technology learning and technology deployment rates. Drawing on IEA (2008a) for guidance, the theoretical, technical, mid-range and economic potential of SWH, CSP, large-scale PV and wind is established.

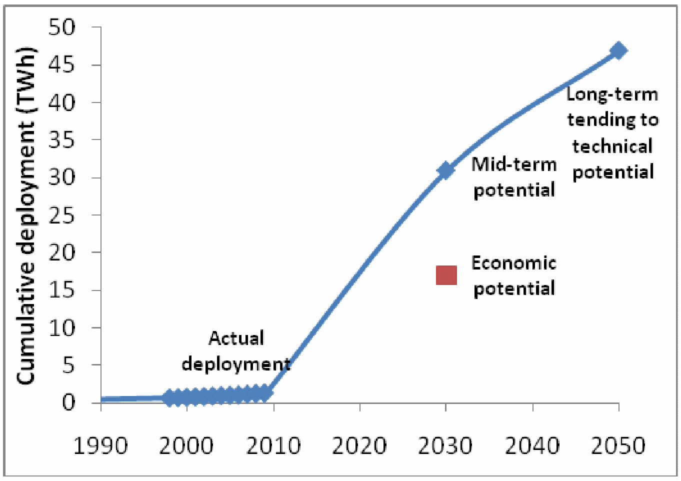
Summary table of potential energy supply from the different renewable energy technology by 2030 (TWh)

	Theoretical potential	*Technical potential*	*Mid-term potential*	*Economic potential*
SWH	70	47	31	17
Wind	184	80	28	23
CSP	2 361 300	1 000	121	52
PV (>1MW)	2 361 300	≈ 1 000	2	0

The theoretical and technical potential for solar is huge, many times the present demand of 220 TWh in South Africa. The technical potential for wind is estimated at 80 TWh and for SWH at 47 TWh. Economic potentials for 2030 are much lower, with large (<1MW) PV farms not being economically viable, CSP estimated at 52 TWh, wind at 23 TWh and SWH at 17 TWh. With effective renewable energy policy it is thought that mid-term potentials of possibly 2 TWh, 121 TWh, 28 TWh, and 31 TWh of renewable energy contribution could be achieved in South Africa.

Deployment in the past 12 years

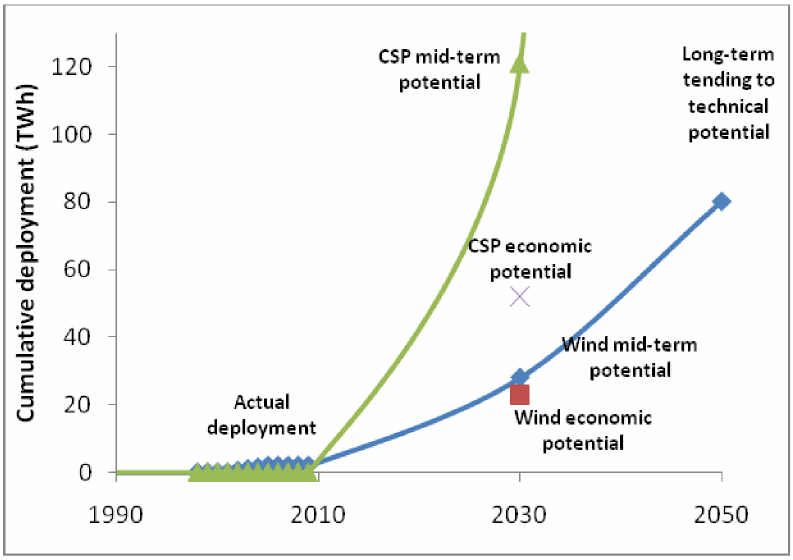
Through a number of interviews and reviewing renewable energy projects in South Africa the deployment of SWHs, CSP, PV and wind was determined for the last 12 years. Of the four technologies, SWHs have contributed the most to South Africa's energy needs. The deployment of unglazed SWHs has been relatively steady, ranging between 40,000 – 55,000 m^2 annually, although in 2007 and 2008 a peak of about 70,000 m^2 of SWHs was deployed. Similarly, glazed SWHs have seen an increase in deployment since 2007 rising from below 20,000 m^2 per year to over 30,000m^2. In total, about 1.35 TWh of energy was being harnessed by SWHs in 2009.



Actual cumulative deployment and potential deployment of SWH in South Africa

Using the policy effectiveness indicator (IEA, 2008a), calculated by dividing the additional renewable energy deployment achieved in a given year by the remaining mid-term assessed realisable potential to 2030, some activity can be seen, although effectiveness levels are still extremely low at 0.003.

As for the solar technologies for electricity generation, PV and CSP, South Africa has seen little deployment of these. No large-scale projects have been developed, only one 25 kW Sterling Dish was built to demonstrate the CSP technology, and PV systems panels have primarily been used to provide electricity for telecommunications, lighting and electronic media in areas that are remote from the grid. According to Mottiar and George (2003) there should be approximately two hundred thousand 'off-grid' installations in the country, which were mainly supplied through the DME concession agreements with private companies in 1999. Nonetheless, the policy effectiveness indicator for PV and CSP is therefore measured at 0.



Actual cumulative deployment and potential deployment of wind and CSP in South Africa

There have also only been two pilot wind projects, which together are estimated to have an output of 18 GWh. Non-electric installations, such as the 30,000 wind-powered pumps, are thought to contribute another 42 GWh. Nonetheless the 0.06 TWh of capacity by 2009 did little to shift the policy effectiveness indicator away from 0.

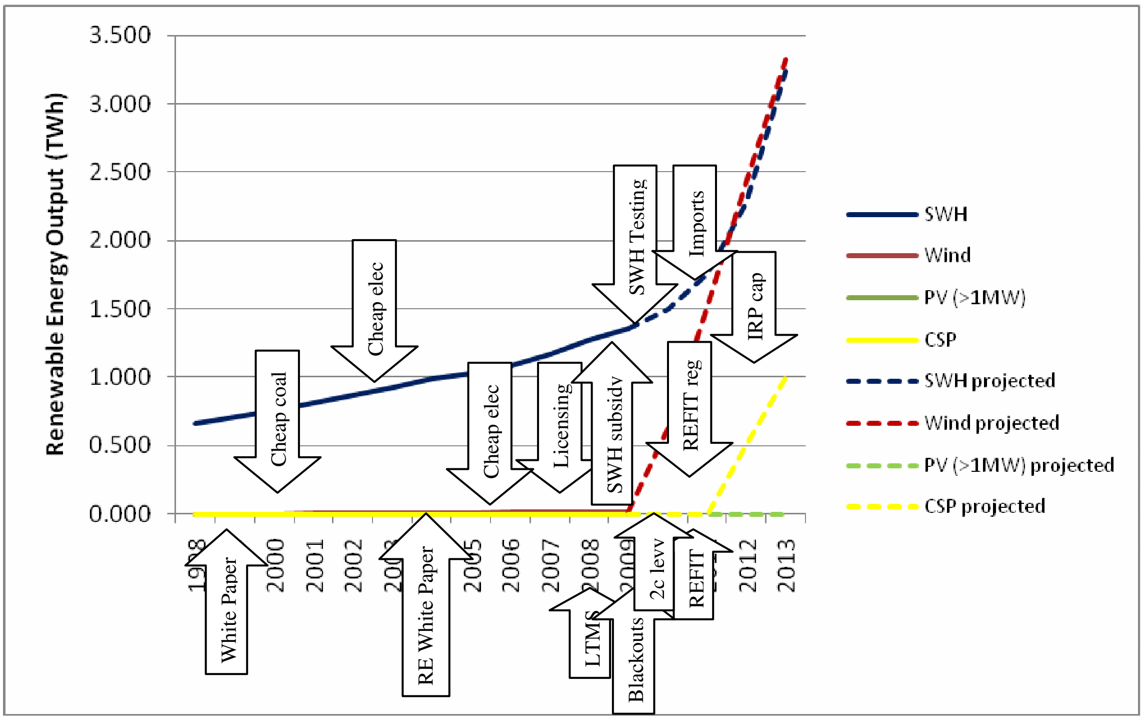
Policy drivers and barriers to renewable energy deployment

Already in the Energy White Paper of 1998 many of the policies presented can be seen as drivers of renewable energy deployment in South Africa. Besides encouraging the inclusion of IPPs in South Africa's electricity generation, it highlighted the areas which needed to be addressed to create the appropriate enabling environment for the promotion of renewable energy, including financial and legal instruments, technology development and awareness raising, capacity building and education.

In the early 2000s there was much research conducted under the CaBEERE project and much of the renewable energy potential in South Africa was identified. This culminated in the publication of the Renewable Energy White Paper with the specific target of achieving 10 000 GWh of renewable energy by 2013. Unfortunately for wind and solar electricity generation, the renewable energy target was expected to be achieved though a mixture of sugar bagasse (59%), landfill gas (6%), hydro (10%), SWH (13%), other biomass (1%) and only 1% wind, and no solar PV or CSP (DME, 2004).

A major barrier to the deployment of renewable energy has been the cheapness of electricity. Renewable energy generating technologies were unable to compete at R0.25/ kWh or less. Even with support from the REFSO the subsidies offered were considered not substantial enough to support the renewable energy technologies analysed in this report. Notably, only R15 million has been handed out, with Darling Wind Farm being the only solar or wind project to have managed to secure funding from REFSO.

Once the Kyoto Protocol was ratified in 2005, carbon financing was hoped to become a major driver of renewable energy in South Africa, but this proved not so, although with increasing climate mitigation awareness in the country, through the publication of the LTMS amongst other things, renewable energy is seen to be given another push. In particular, in 2009 a 2 c/ kWh environment levy was established by government on all electricity generated from non-renewable sources. The revenue gained from this is thought to be enough to finance the required renewable energy deployment to reach the White Paper target of 10,000 GWh by 2013.



The major drivers and barriers for renewable energy deployment in South Africa

Nonetheless, renewable energy projects still face major administrative barriers. Too many agencies are involved, the time taken to process licences has been very long, financers are still hard to come by, and EIAs can be cumbersome processes. Although the publication of the REFIT has promised to largely reduce these barriers, little progress has been seen. More specifically NERSA recently published guidelines for selecting IPPs for the REFIT, which in itself seems to contain a number of administrative barriers.

The publication of REFIT 1 and 2 has certainly given renewables a new driving force. With this policy the financial barrier seems to have been removed, though there still remains much criticism towards how the REFIT will be capped by the IRP and potential IPPs are not willing to make substantial investments until such legislative risks are removed. Under the IRP1 cap IPP developments for wind are estimated to only be 400 MW by 2013, while other renewable energy projects are 325 MW by 2013, of which it is unknown how much may go to CSP or large-scale PV (NERSA, 2010b). Either way, the rising electricity price in South Africa has made the possibility of renewable energy deployment in South Africa more likely, especially since NERSA has allocated some of the revenue to the REFIT programme.

SWHs in particular saw an increase in deployment after the 2008 blackouts and increasingly they are becoming more accessible, with Eskom subsidies already available and DoE subsidies thought to contribute soon too in order to achieve the government-set target of one million SWHs by 2014.

It seems that the renewable energy market in South Africa is set to go, especially since the announcement of the REFIT. More than 1,100 MW of wind capacity are under firm development, as well as 500 – 600 MW of CSP, and possibly 0.5 MW of PV.

Conclusion

To date, South Africa has not shown very effective renewable energy policy, although this may also be a fault of the method of calculating policy effectiveness. Renewable energy may be better understood in the context of the country having other energy priorities, such as reducing energy poverty and making use of its coal resources. Nonetheless, new policies, in particular the publication of the REFIT, have reawakened interest in renewable energy and the next few years may see more effective renewable energy policy. The electricity crisis of 2008 also gave the country a shock, and energy awareness has certainly increased since then, as revealed in the increased interest in SWHs.

If South Africa had been a bit more progressive in its renewable energy policy and had set up a REFIT instead of the REFSO already in 2005 the country could probably have reached their 10,000 GWh target before 2013, possibly by 2011. Nonetheless, the country should now focus on making the REFIT effective without necessarily capping the amount of capacity being deployed under this scheme. On so can South Africa aim to realise the mid-term potential for renewable energy by 2030.

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UNEP

Abbreviations

ACED	African Clean Energy Development
CABEERE	Capacity Building in DME in Energy Efficiency and Renewable Energy
CEF	Central Energy Fund
CERs	Certified Emission Reductions
CO_2	Carbon Dioxide
CSIR	Council for Scientific and Industrial Research
CSP	Concentrating solar power
DME	Department of Minerals and Energy
DNI	Direct normal irradiation
DoE	Department of Energy
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessments
GHG	Greenhouse gases
GW	Gigawatt
GWh	Gigawatt hours
IEA	International Energy Agency
IPPs	Independent Power Producers
IRP1	Integrated Resource Plan 1
IRP2	Integrated Resource Plan 2
KWEDF	Klipheuwel Wind Energy Demonstration Facility
LTMS	Long-term mitigation scenarios
MW	Megawatt
NERSA	National Energy Regulator of South Africa
PPAs	Power purchase agreements
PV	Photovoltaic
R	South African Rands (2009)
REFIT	Renewable energy feed-in tariff
SWH	Solar water heaters
TWh	Terawatt hours
WASA	Wind Atlas for South Africa

1. Introduction

1.1 Scope

This report is the final deliverable for one of the two projects assigned to the Energy Research Centre by the United Nations Environment Programme under its broader project of 'enhancing information for renewable energy technology deployment in Brazil, China and South Africa'. It aims to update the results of a project by the International Energy Agency (IEA) to assess the effectiveness of national renewable energy policies by assessing the level of renewable energy deployment to date with regard to the 'technical and economic' deployment potential by 2030 (IEA, 2008a). The renewable energy technologies being assessed include solar water heaters (SWHs) and electricity generated from wind farms, concentrating solar power (CSP) and large-scale (more than 1 MW) solar photovoltaic (PV) systems. The second project deals with future projections of renewable energy policy in South Africa.

This report assesses the progress made on renewable energy deployment for the solar and wind technologies mentioned above over the last 12 years. Initially the report assesses the potential contribution each technology can bring to South Africa's energy demand by 2030. It highlights what the mid-term potential by 2030 is for each and compares this with the deployment of each in South Africa over the past 12 years. From this a renewable energy policy effectiveness value is calculated based on the method developed in the *Deploying Renewables Report* (IEA, 2008a). Finally the report assesses the factors involved in renewable energy deployment, or the lack thereof, in South Africa and discusses recent developments in the field.

The compilation of this paper was based on desktop reviews; data interpretation from multiple sources; expert opinion of the authors and peer reviewers; and interviews with experts in the field. A number of interviews conducted at the ISES International Solar Energy Society Conference in October 2009 and the Energy 2010 Indaba in February 2010. The data used in this report to formulate the projections is from a number of sources and has been independently reviewed.

1.2 Previous work on deploying renewables

According to the IEA (2008a), renewable energy policy design should reflect five fundamental principles:

- the removal of non-economic barriers, such as administrative hurdles, obstacles to grid access, poor electricity market design, lack of information and training, and the tackling of social acceptance issues – with a view to overcoming them – in order to improve market and policy functioning;
- the need for a predictable and transparent support framework to attract investments;
- the introduction of transitional incentives, decreasing over time, to foster and monitor technological innovation and move technologies quickly towards market competitiveness;
- the development and implementation of appropriate incentives guaranteeing a specific level of support to different technologies based on their degree of technology maturity, in order to exploit the significant potential of the large basket of renewable energy technologies over time; and
- the due consideration of the impact of large-scale penetration of renewable energy technologies on the overall energy system, especially in liberalised energy markets, with regard to overall cost efficiency and system reliability.

As a general principle, less mature technologies further from economic competitiveness need, beyond continued R&D support, very stable low-risk incentives, such as capital cost incentives, feed-in-tariffs (FITs) or tenders (see Figure 1).

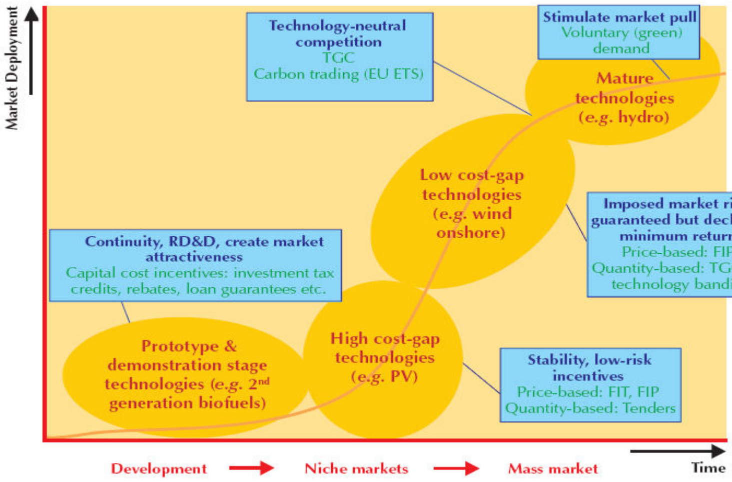

Figure 1: Combination framework of policy incentives as a function of technology maturity
Source: IEA (2008a)

For low-cost gap technologies such as on-shore wind or biomass combustion, other more market-oriented instruments like feed-in-premiums and tradable green certificate systems with technology banding may be more appropriate. Once the technology is competitive with other CO_2-saving alternatives and ready to be deployed on a large scale, and when appropriate carbon incentives are in place, renewable energy technology support systems can be phased out altogether. At that stage, in theory renewable energy technologies will compete on a level playing field with other energy technologies (IEA, 2008a).

For a developing country context, such as South Africa, a market-based approach may not be the most effective renewable energy policy. Renewable energy policy in South Africa would have to take certain factors into consideration. For one, Eskom, as the state-owned electricity supplier, dominates the generation capacity. Furthermore, only about 70% of South African households are connected to the electricity supply grid, and overcoming energy poverty remains a strategic development objective. In 2007 it was estimated that still more than 1.5 million households located in remote areas were unlikely to be connected to the grid in the near future (Lemaire, 2007). South Africa also has had a history of supplying cheap electricity due to a dramatic over-capacity expansion programme in the 1970s amongst other reasons.

1.3 The South African power sector – context for renewable energy

Although South Africa has very good solar and wind resources the deployment of renewable energy technologies has been slow to take off. More than 90% of South Africa's electricity is generated from the burning of coal. Eskom has 27 operational stations in South Africa that make up 40.7 GW of the country's capacity (Eskom, 2009a). Additional capacity is from imports and independent power producers (IPPs), resulting in a national capacity of about 43.5 GW, which aims to supply the forecast peak demand of 36 GW (over 220 TWh). Until recently the country was able to supply the lowest electricity prices in the world at R0.25/ kWh on average or less, although in 2008 demand for electricity outstripped supply and the electricity provider had to resort to load shedding. To alleviate the electricity shortfall Eskom has embarked on a capacity expansion programme which includes about 10 GW of capacity from coal, by return to service mothballed plants and through the construction of Medupi and Kusile, as well as 1.2 GW from the Ingula pumped storage scheme. Furthermore Eskom aims to construct a 50MW CSP plant and a 100 MW wind farm (Davidson et al, 2010).

According to Eskom (2009b) the price of electricity in South Africa did not allow for the recovery of all their incurred costs and the building of reserves to sustain the current asset base, nor did it support the capital expansion programme. Since 2008 the country has seen dramatic price rises, including 31.3% in 2009/10 resulting in an average electricity price of R0.33/kWh, which incorporated a 2 cents/ kWh environmental levy, and 24.8% in 2010/2011 resulting in an average electricity price of R 0.42/ kWh. Furthermore the recent multi-year price determination approved by the National Energy Regulator of South Africa (NERSA) indicates that the 2011/12 and 2012/13 financial years will see price rises of 25.8 % and 25.9 %r espectively (NERSA, 2010a). These price increases in real terms, above inflation, are dramatic and have not been seen before in South Africa.

By 2013 the average standard price for electricity is therefore expected to be about 66 c/ kWh. The revenue incurred will finance Eskom's own primary energy costs, operations expenditure and demand side management activities, while still allowing for some return on its assets. NERSA (2010a) also expects R2.3 million, R4.3 million and R5.8 million of the allowed revenue to be directed at IPPs and co-generation projects for the 2010/11, 2011/12 and 2012/13 financial years respectively. This is thought to cover the costs of funding additional renewable energy and co-generation capacity of 343 MW in 2010, 518 MW in 2011, 284 MW in 2012 and another 300vMW in 2013 as outlined in the Integrated Resource Plan 1 (IRP1) signed off by the Minister of Energy on 16 December 2009 (DoE, 2010).

The process of developing the Integrated Resource Plan 2 (IRP2) is underway and expected to be completed by June 2010.[1] This plan is thought to present South Africa's electricity supply plan beyond 2013 to about 2030. According to a leaked draft, in 2009 future capacity may include up to 5 GW of renewable energy, mainly CSP, and 4.5 GW of hydro and gas, and 10.5 GW of nuclear power (Davidson et al, 2010).

The following report assesses renewable energy deployment in South Africa to date with respect of its potential contribution by 2030. By determining a mid-term potential of renewable energy by 2030, based on economic and technical limits, the deployment to date is assessed in line with the IEA's policy effectiveness calculation (IEA, 2008a). The measure of policy effectiveness is critically analysed and factors driving and barriers to deployment over the past 12 years are critically assessed.

2. Defining renewable energy potential by 2030

By 2030 renewable energy technologies (RETs) are projected to contribute 29% to power generation and 7% to transport fuels globally, according to the World Energy Outlook Alternative Policy Scenario 2007 (IEA, 2007), assuming policies currently under consideration are implemented. By 2050, the contribution of renewables could rise even further to almost 50% of electricity if the ambitious goal of a 50% global reduction in 2005 CO_2 emissions over that time horizon is met, represented by the BLUE scenario in the *Energy Technology Perspective 2008* (IEA, 2008b). While attainable, this objective will require strong political and financial commitment as well as immediate action by all governments and stakeholders.

There is much discussion of the potentials of various energy resources in the literature. Figure 2 shows the breakdown of definitions for renewable energy potential used in this report.

[1] Speech delivered on behalf of Minister of Energy Dipuo Peters, MP at the Energy 2010 Conference, Johannesburg, by Mr TB Maqubela, Deputy Director General, 24 February 2010.

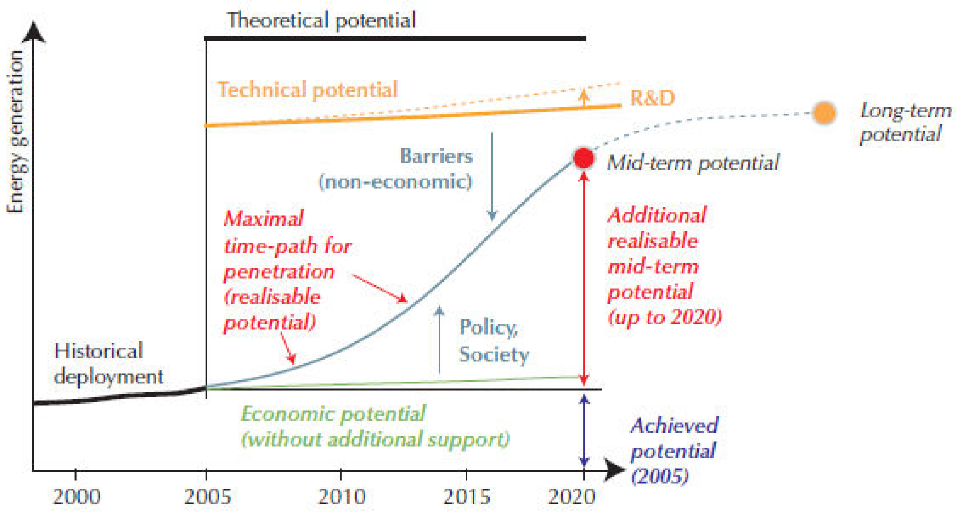

Figure 2: Metrics relating to renewable energy potential
Source: IEA (2008a)

Theoretical potential: This represents the theoretical upper limit of the amount of energy that can be generated from a specific resource, over a defined area, based on current scientific knowledge. It depends on physical flows only (e.g. average solar irradiation on a certain region).

Technical potential: The technical potential can be derived on the basis of technical boundary conditions, eg efficiencies of conversion technologies, or overall technical limitations such as available land area for wind turbine installation. For most resources, the technical potential is dynamic: eg with improved research and development, conversion technologies may be improved, with resulting improvement in the technical potential.

Realisable potential: The realisable potential represents the maximum achievable potential, assuming that all existing barriers can be overcome and all development drivers are active. In this respect, general parameters such as market growth rates and planning constraints are taken into account. It is important to note that realisable potential is also time-dependent: it must relate to a certain year. In the long run, the realisable potential tends towards the technical potential.

Mid-term potential: The mid-term potential is defined as the realisable potential in 2020 – in our report the mid-term potential is estimated for 2030.

Economic potential: The economic potential is defined as that potential which can be exploited without the need for additional support, i.e. whose exploitation is competitive compared with conventional incumbent technologies (IEA, 2008a).

Comparing the deployment of renewables achieved in a certain year, the achieved potential in Figure 2, to the mid-term potential is thought to give an indication of the renewable energy policy effectiveness in that country. Unfortunately this measure does not highlight the barriers to deployment or the conflicting energy needs that may have led to lower deployment rates, such as overcoming access and affordability of the energy, in a developing country. By only focusing on renewable energy deployment, progressive policy interventions may be missed, and factors retarding deployment need to be assessed, as is done in Section 4 of this report.

2.1 The potential contribution of solar water heaters by 2030

2.1.1 Theoretical potential

South Africa has 24% of the world's best winter sunshine area, as well as some of the best annual irradiation (Holm et al, 2008). Upington, for example, has more than 7 kWh/m^2 daily average direct normal irradiation (DNI), which is more than cities in California, Nevada and New Mexico in the US, as well as sun-soaked countries such as Jordan, Morocco, Crete, India and Spain (Eskom, 2007). Some of the large metropolitan areas, where most of the demand for SWHs would be, are in regions with lowest DNI (< 5695 Wh/m^2/d) – the hatched area in Figure 3. Nonetheless, these areas still record DNI values similar to those of values of Spain, and better than Germany.

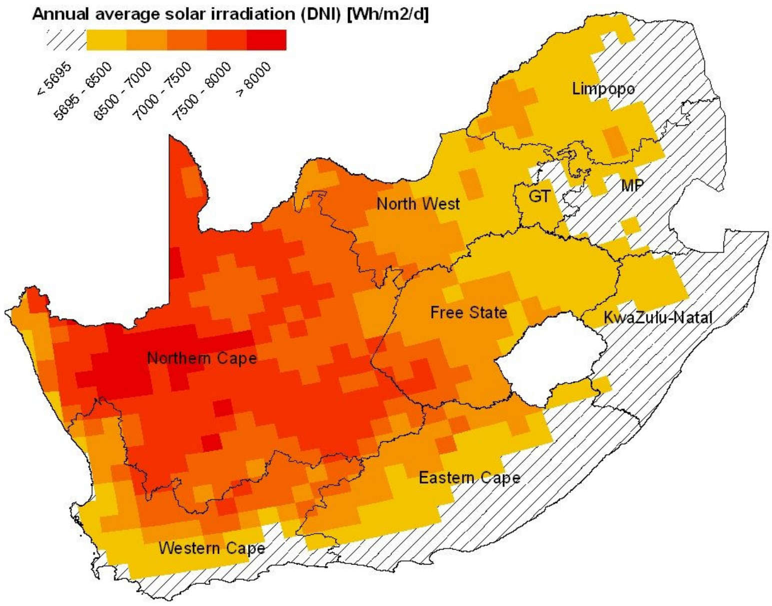

Figure 3: Overview of South Africa annual direct normal irradiation (Wh/m2/d)
Source: Fluri (2009)

SWHs are estimated to cost between R 15,000 and R 35,000, whereas conventional electrical geysers have been costing between R 3,000 and R 6,000, though there are indications that these prices are coming down. The high upfront costs are one of the major barriers to the large-scale deployment of SWHs, though with innovative financing mechanisms, such as Eskom's DSM support grant, carbon credit financing and with soft loans from banks, these could be overcome. According to an optimistic estimate the monthly instalments would only cost a homeowner R18.86.[2] Pay-back periods with electric geysers are well within the lifespan of a SWH, at 4 – 7 years, and therefore it would seem that buying a SWH would make economic sense, though the upfront cost will remain a barrier if no smart financing solutions are established. We therefore estimate the economic potential in line with the mid-term potential for 2030.

The present (2009) theoretical potential of SWH energy has been estimated by Eskom at being 18% of South Africa's total coal generated electricity,[3] which equals about 44 TWh, because that is the amount of electricity used for the country's water-heating needs. By 2030 18% of the projected electricity demand would be about 90 TWh. To assess the future theoretical potential we need to establish the future household and industrial demand. According to Stassen, cited in Holm (2005), total household demand by 2025 may range from 18 – 51 TWh, while other electrified sectors may demand 24 – 48 TWh. By assuming that each household requires 4.96 m^2 of solar water heating to supply all its needs and that there will be about 10 million households in 2025, Holm estimates that 48 TWh will be displaced with SWH.[4] At a 70% penetration rate, assumed by Holm, this drops to 33 TWh by 2025.

To estimate the theoretical potential for 2030 we took the population projection as modeled for the Long-Term Mitigation Scenarios for South Africa (Winkler, 2007), which resulted in aproximately 52 million people divided into 15 million households by 2030. If all these households are to receive

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2 According to Andrew Jarnisch, Sustainable Energy Africa, at the National Solar Water Heating Workshop, February 2009.

3 According to Yaw Afane-Okese, Renewable Energy Market Transformation (REMT) Unit, at the National Solar Water Heating Workshop, February 2009.

4 Holm uses a weighted coefficient of 943 kWh/m^2 to convert SWH area to electricity use equivalent, see his appendix J for more details.

4.96 m^2 of SWHs, as calculated by Holm (2005) to cover all their hot water needs, then the theoretical potential for 2030 will be 70 TWh.

2.1.2 Technical, mid-term and economic potential

Technically, however, not all households can be supplied with SWHs. Cape Town's proposed SWH by-law, for example, indicates that certain buildings may be exempted, including those that are permanently shaded and historic buildings, while multi-storey buildings may also be limited. We therefore estimate the technical potential in line with the number of households able to install SWHs, while the economic potential is the households expected to be able to purchase SWHs by 2030 and the mid-term potential is a percentage half-way between the two (see Table 1).

Table 1: Technical, mid-term and economic potential rates of SWH uptake by households

	Technical	*Mid-term*	*Economic*
New houses			
Rural rich electrified	80%	70%	60%
Rural poor electrified	80%	70%	60%
Rural poor unelectrified	20%	15%	10%
Urban rich electrified	85%	80%	75%
Urban poor electrified	80%	80%	80%
Urban poor unelectrified	25%	20%	15%
Old houses			
Rural rich electrified	60%	35%	10%
Rural poor electrified	30%	17.5%	5%
Rural poor unelectrified	5%	3.5%	2%
Urban rich electrified	70%	40%	10%
Urban poor electrified	50%	27.5%	5%
Urban poor unelectrified	0%	0%	0%

The resultant technical potential for residential SWH in 2030 is 47 TWh, based on 15 million households installing SWHs. The economic potential is thought to be about 17 TWh, while the mid-term potential is estimated at 31 TWh. Lack of awareness and behavioural barriers are noted as the most likely reason for projecting the mid-term potential below the technical potential. The mid-range potential is achievable if SWHs are rolled out to one million units over the next five years and at a rate approaching 400,000 annually, the present estimated rate of electric geyser replacements in South Africa, thereafter.

2.2 The potential contribution of electricity from wind, CSP and PV by 2030

2.2.1 Theoretical and technical potential

All available solar resource assessments for South Africa indicate that the Northern Cape Province has the best solar resource in the country (see Figure 3). The annual radiation sums for the best sites in the Northern Cape are more than 30% higher than for the best sites in Spain. In the Free State, North West, Limpopo and in the interior parts of the Western Cape and the Eastern Cape the solar resource is also excellent. The rest of the country still has a good solar resource (Fluri & von Backstrom, 2009). Howells, cited in Winkler (2005), estimates this theoretical potential at 8 500 000 PJ/yr (2,361,300 TWh). As for technical potential, it is estimated that 547.6 GW of CSP capacity, based on a parabolic trough design, could be built within 20km of the current grid (Fluri, 2009). This would equate to a technical potential of at least 1000 TWh, if not more, by 2030.

There have been no technical estimates for large PV systems, though according to Holm et al (2008) if only 5% of South African households that have a grid supply were to install a 2 kW grid-connected PV system, this would contribute 800MW, and would generate in the order of 1,300 GWh per annum. In addition, with a large-scale rollout of PV farms (larger than 1MW) similar technical potentials to those of CSP could be achieved.

The theoretical wind energy potential for South Africa is difficult to come by, although Mainstream Renewable Power (2009) estimate this at about 70% of South Africa's electricity needs, or 184 TWh. Technically, wind power generation potential is estimated at 80 TWh, according to the realistic projection in Hagemann (2008). This could be realized with an installed capacity of about 30.6 GW of standard Vestas V80 2 MW wind turbine in areas close to road and transmission infrastructure. The best potential is found in the Western Cape and parts of the Northern Cape and the Eastern Cape (see Figure 4). A comprehensive three-year study to define the Wind Atlas for South Africa was launched in June 2009.[5]

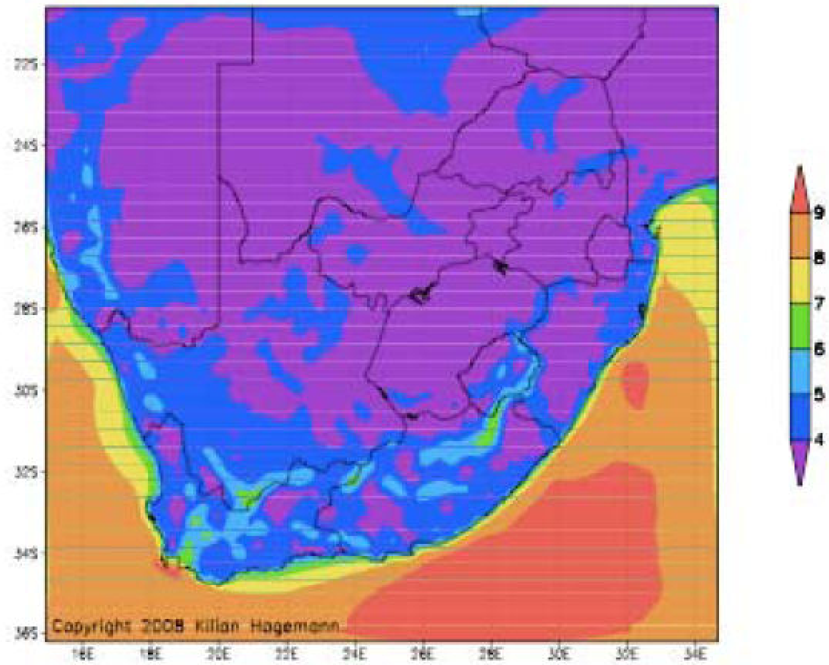

Figure 4: Average wind speeds at 10m above ground (m/s)
Source: Hagemann (2008)

2.2.2 Mid-term and economic potential

To identify the economic and mid-term potential for 2030 for wind, CSP and PV, the MARKAL model developed for the LTMS for South Africa (Winkler, 2007; Hughes et al 2007) was made use of. Based on a number of learning rates cited in the peer-review literature, learning ratios of 19%, 25-35%, 15% and 20% were chosen for wind, PV, CSP parabolic trough and CSP power tower technologies respectively (see Table 2).

5 Presentation by Riso DTU, Technical University of Denmark, introducing the SAWEP Workshop on the Wind Atlas for South Africa (WASA), 4 March 2010, Cape Town.

Table 2: Learning rates for this study and summary of ranges in the international literature
Source: Winkler, Hughes, & Haw (2009)

Energy technology	*Range of learning rates in the literature (%)*	*Learning ratios, this study (%)*
Wind	5–40%	19%
Solar photovoltaic	17–68%	25%
CSP, parabolic trough	2-32%	15%
CSP, power tower	5-20%	20%

The doubling time is assumed to increase by 1.5 for each doubling of deployment, due to the higher amounts of deployment required to achieve the next doubling (Winkler et al, 2009). Such learning rates result in cost reductions for the different technologies under being considered (see Figure 5).

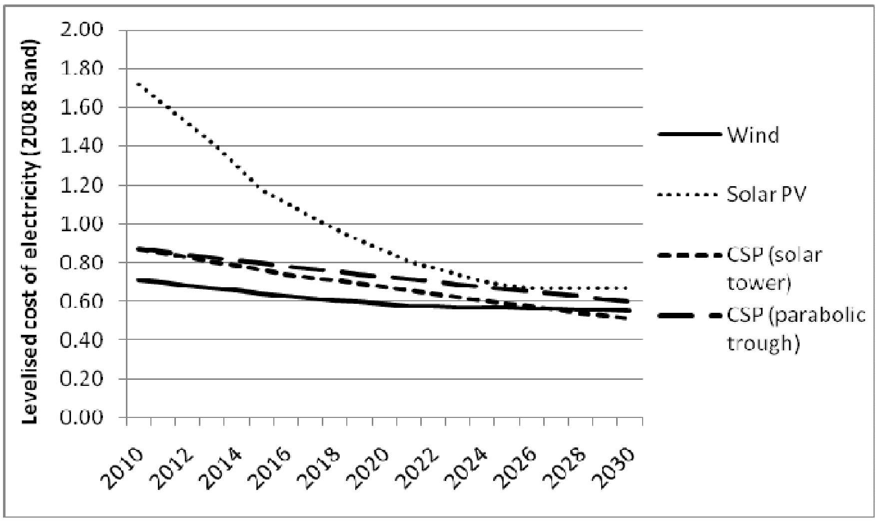

Figure 5: Estimated cost reductions for renewable energy technology
Data source: Winkler et al (2009)

The strength of the MARKAL models lies in the ability to identify the most cost-effective technology solutions for energy systems. Constraints, which temper the drive to least cost, can include environmental factors (eg emissions), limits on resource availability and – relevant to this article – the penetration rates of technologies. The cost reductions shown in Figure 5 were applied in the MARKAL modelling. MARKAL is an optimising model, meaning that, subject to available resources, a set of energy supply and use technologies, and a set of required energy services specified by the modelling team, the model detemines the optimal configuration of the energy system in terms of an objective function, usually to minimise costs subject to constraints. The model ensures that energy system requirements are met, eg that energy demand is equal to supply; that a specified reserve margin is maintained; and that technologies have a limited life.

The optimisation process is based on an assumption that investment decisions in the energy sector are made by all actors in the energy system on a rational economic basis, and thus without careful design, the least-cost option will take over the entire energy market. In this manner the economic potential deployment for the renewable energy technologies was determined (see Figure 6).

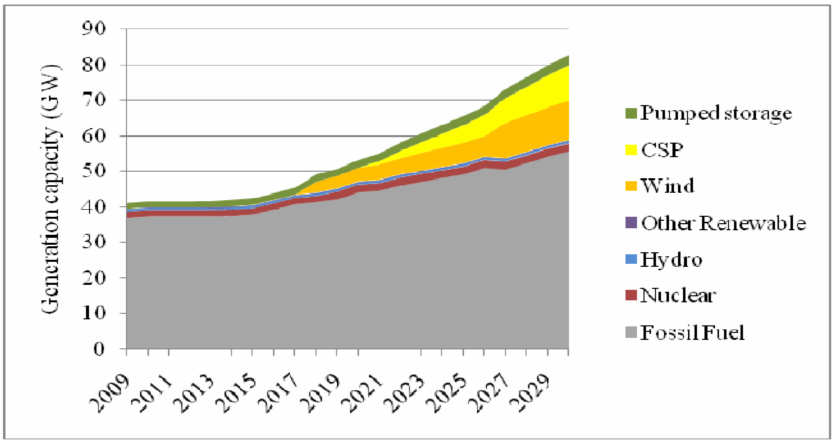

Figure 6: Growth without constraint modelled with technology learning for South Africa's long-term mitigation scenarios depicting the economic potential for renewables
Data source: Winkler (2007)

This projection deviates quite substantially from any official 'business as usual' scenarios presented by the South African government (NERSA, 2004), and even from the most recently drafted Integrated Resource Plan. Largely this has to do with the technology learning new build rates assumed in the modelling. Wind generation capacity already enters the market in 2018, while the first CSP plants come online by 2020. Large PV generation plants are not seen to become economically competitive by 2030, although this would change if the technology experiences even higher learning rates and thereby reduces generation costs. Furthermore, small PV installations, whether building-integrated or off-grid may be more competitive (Holm et al, 2008). By contrast the economic potential by 2030 for wind is 23 TWh and for CSP it is 52 TWh, based on global deployment assumptions as in Winkler, (2007).

Mid-term potentials for wind-, CSP- and PV-generated electricity are thought to be directed by more stringent environmental, in particular climate change, policy. If South Africa is to embrace a target of peaking its greenhouse gas mitigations by 2020-2025, as endorsed by cabinet and modelled by the LTMS for South Africa, then by 2030 at least 27% of the electricity supply would have to come from renewable energy sources (Winkler, 2007). This can be achieved by deploying wind farms from 2011 to achieve a capacity of 14 GW by 2030 and CSP plants from 2015 to achieve a capacity of 24 GW by 2030 (see Figure 7).

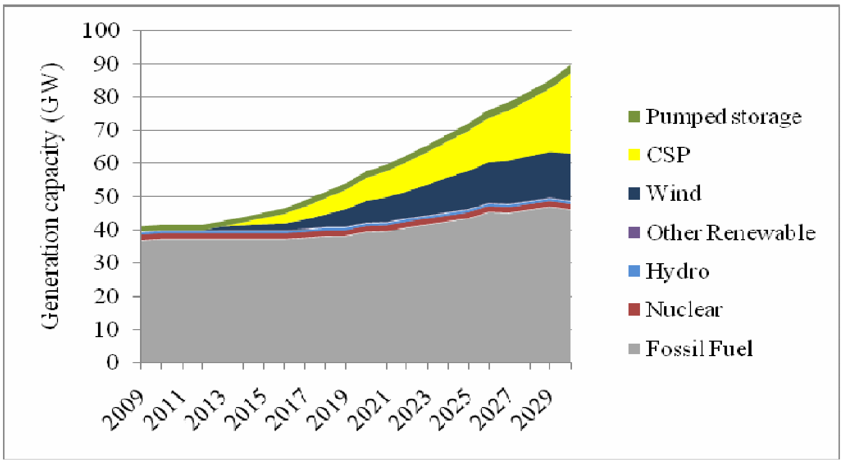

Figure 7: Renewables extended to 27% by 2030 modelled with technology learning for South Africa's long-term mitigation scenarios depicting the mid-term potential for renewables
Data source: Winkler (2007)

Large-scale PV farms are still not considered economically competitive prior to 2030, although smaller scale off-grid or building integrated PV may become competitive, and if PV systems for large-scale farms experience more dramatic technology learning rates then some farms may be deployed, and with increased interest in diversifying the supply mix one could possibly expect 2 TWh of electricity potential from PV farms. The mid-term potential for wind and CSP translates into about 28 TWh of wind electricity and 121 TWh of CSP-generated electricity in 2030, assuming generation capabilities as in the LTMS (Winkler, 2007).

2.3 Summary of theoretical, technical, mid-term and economic potential for renewable energy in South Africa

Each technology has very different deployment potentials for 2030, as shown in Table 3. The mid-term potential is greatest from CSP with 121 TWh, followed by wind with 28 TWh, and then SWH with 17 TWh. Unfortunately, grid-connected PV does not feature by 2030, unless policy incentives are designed to encourage their deployment. The combined mid-term potential of 166 TWh renewable energy generation is quite ambitious considering that the total electricity demand in South Africa is only about 220 TWh. Furthermore the potential for renewable energy in South Africa was estimated at 87 TWh by the DME CABEERE Study (2004), which is more in line with the combined economic potential this study has defined.

Table 3: Summary table of potential energy supply from the different renewable energy technology by 2030 (TWh)

	Theoretical potential	*Technical potential*	*Mid-term potential*	*Economic potential*
SWH	70	47	31	17
Wind	184	80	28	23
CSP	2 361 300	1 000	121	52
PV (>1MW)	2 361 300	≈ 1 000	2	0

3. Policy effectiveness indicator sheets

3.1 Solar water heaters

The market for SWHs in South Africa went through a growth spike between 1979 and 1983, averaging about 42% growth per year. Similarly in the last three years the market has again seen increased growth, averaging about 72% per year (Theobald & Cawood, 2009). The industry's growth spurts coincided with marketing efforts by the CSIR during the late 1970s and early 1980s and by Eskom and the CEF during the period 2005-2008. Some industry players saw sales expanded by up to 400% during the first four months of 2008 during the load shedding period in South Africa (Theobald & Cawood, 2009).

Eskom's DSM plans to rollout one million SWHs over the next five years, which could save as much as 578 MW. According to some estimates this would equate to about 2.3 TWh per year (Nano Energy & SESSA, 2009). By August 2009 only a total of 1,612 SWHs had been supported under the scheme, with 138 in the last month (Eskom Distribution, 2009).

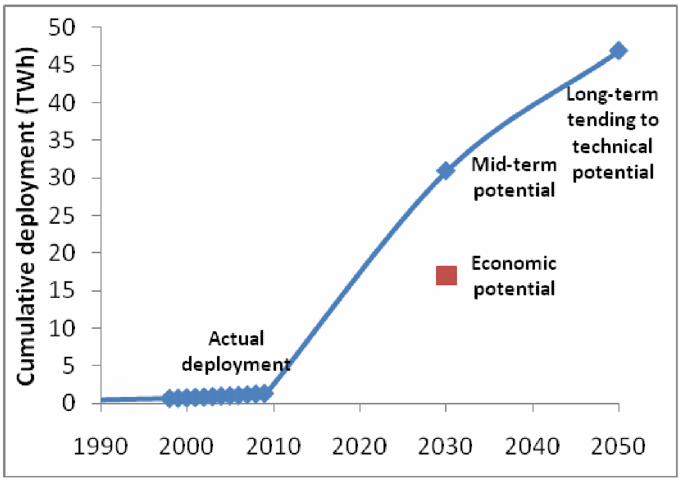

Figure 8: Actual cumulative deployment and potential deployment of SWH in South Africa

Deployment estimates to date, as shown in Table 4, are largely based on Holm (2005) and Theobald & Cawood (2009), who have been studying the market closely. With the growth in glazed units sold from 2005 to 2008 the deployment levels are thought to have spiked in 2008 and are currently estimated at 33,000 m^2. Of the glazed units deployed almost all are flat plate units, with barely 2,000 m^2 and 2,500 m^2 of evacuated tubes entering the market in 2008 and 2009 respectively. Since the lifespan of SWHs is estimated at 20-25 years we assume all systems installed since 1998 are still running today. Translating this into TWh with the conversion factors of 940 kWh/m^2, 943 kWh/m^2 and 1,015 kWh/m^2 for unglazed, flat plate and evacuated tubes respectively developed by Holm (2005), the cumulative contribution from SWH by the end of 2009 is estimated at 3.4 TWh (see Figure 8).

Table 4: Estimated amount of glazed and unglazed SWHs deployed

	1998	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Total glazed (1000 m^2)	11	10	9	12	13	14	15	11	17.5	19	34	33
Total unglazed (1000 m^2)	39	40	43	45	47	49	51	35	39	70	72	55
Total (1000 m^2)	50	50	52	57	60	63	66	46	56.5	89	106	88
Cumulative (1000 m^2)	700	750	802	859	919	982	1048	1094	1151	1240	1346	1434
Total (TWh)	0.66	0.71	0.76	0.81	0.87	0.93	0.99	1.03	1.08	1.17	1.27	1.35
Policy effectiveness indicator	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.002	0.003	0.003	0.003

The additional realisable potential to 2030 therefore is 27.6 TWh. The IEA *policy effectiveness indicator* (IEA, 2008a), calculated by dividing the additional renewable energy deployment achieved in a given year by the remaining midterm assessed realisable potential to 2030, indicated the last three years have shown a minor increase, though deployment levels are still extremely low at 0.003 (Table 4).

3.2 Solar PV, CSP and wind policy effectiveness

There have been no CSP or large (>1MW) PV plants built to date, which would imply very ineffective solar policy. Though considering that the mid-term potential for large grid-connected PV is also very low, it is rather difficult to establish the policy effectiveness indicator, as determined by dividing the present deployment by the mid-term potential (Table 5).

Table 5: Policy effectiveness indicators for wind, PV and CSP

	1998	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*
Total wind (TWh)	0.04	0.04	0.04	0.045	0.045	0.045	0.045	0.045	0.06	0.06	0.06	0.06
Wind effective-ness indicator	0	0	0	0	0	0	0	0	0	0	0	0
Total PV (TWh)	0	0	0	0	0	0	0	0	0	0	0	0
PV effectiveness indicator	-	-	-	-	-	-	-	-	-	-	-	-
Total CSP (TWh)	0	0	0	0	0	0	0	0	0	0	0	0
CSP effective-ness indicator	0	0	0	0	0	0	0	0	0	0	0	0

Note: The findings presented here are based on the IEA policy effectiveness calculations, which compare actual deployment of renewable energy projects to mid-term deployment potentials. This may not be the most effective way of assessing renewable energy policy. The national context must be considered, in particular the other energy policy objectives, such as energy access and affordability.

Smaller-scale PV installations do exist in South Africa, although these too have had quite a limited deployment rate. PV panels are primarily used to provide electricity for telecommunications, lighting and electronic media in areas that are remote from the grid. There are already approximately two hundred thousand 'off-grid' installations in the country, which were mainly supplied through the DME concession agreements with private companies in 1999 (Mottiar & George, 2003). A 2002 review found only ten grid-connected PV installations in the entire country (Banks & Schaffler, 2006).

As for wind energy there have been two pilot projects, namely the Eskom Klipheuwel Wind Energy Demonstration Facility (KWEDF), which consists of three units with a total capacity of 3.2 MW and the Darling Wind Farm with an initial capacity of 5.2 MW, with a present estimated output of 18 GWh (Table 5). When it comes to non-electric wind installations there are an estimated 30 000 wind powered pumps installed in South Africa, (Banks & Schaffler, 2006), which raise the estimated wind energy supply to 60 GWh once added to the pilot wind farms (Holmet al, 2008).

In summary, the policy effectiveness indicator for PV, CSP and wind ranks 0 for all of the last 12 years (see Table 5). Although electricity generation capacity from renewable energy sources has been very little (Figure 9), this is projected to grow in the next few years. The announcement of a renewable energy feed-in tariff has resulted in increased interest by IPPs to invest in generation capacity in South Africa.

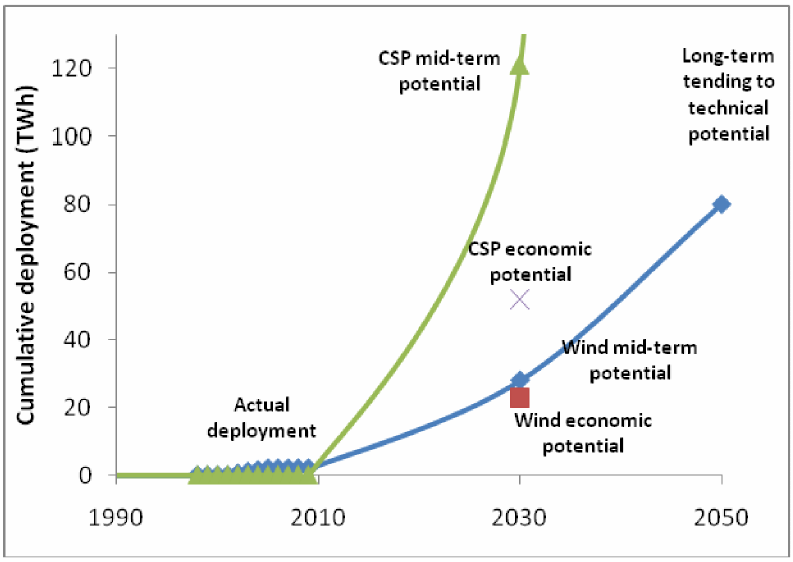

Figure 9: Actual cumulative deployment and potential deployment of wind and CSP in South Africa

4. Factors affecting renewable energy deployment

This final chapter of the report aims to give some insight into the low renewable energy policy effectiveness indicators presented above. A number of policies have been put in place in the last 12 years to incentivize renewable energy deployment. Various factors encouraging deployment can be identified as well as barriers that still need to be overcome. See Figure 10 below for a summary of some of the major drivers and barriers of renewable energies deployment in South Africa.

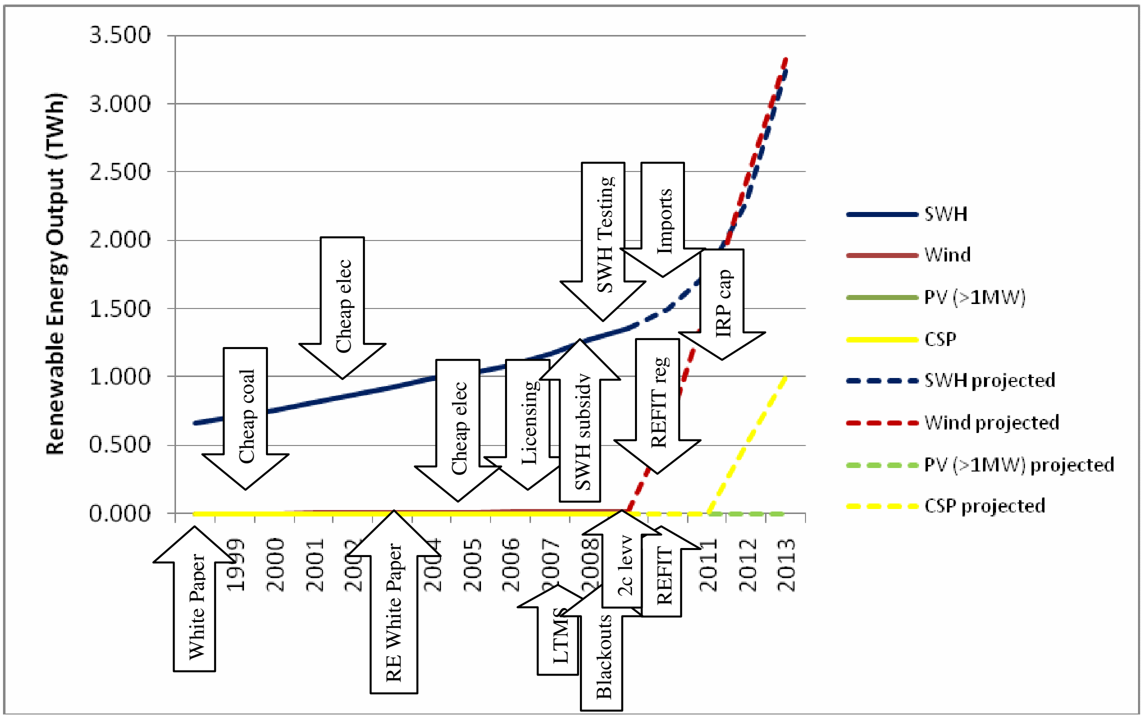

Figure 10: The major drivers and barriers for renewable energy deployment in South Africa

4.1 Renewable energy drivers and barriers

4.1.1 Energy Policy Papers

Early support for renewable energy generation in South Africa can be seen in the White Paper on Energy Policy of 1998, the overarching document that established the government's official policy on supply and consumption for the next decade. One of the main goals in the White Paper is to create energy security by diversifying the energy supply, thereby giving support towards the deployment of renewable energy supply. Another key feature of the White Paper is the recognition that not all of South Africa's power needs should be met by Eskom, the single operator, but rather that 30% of the power should be met by independent power producers (DME, 1998). Liberalizing the market would allow for renewable energy IPPs to contribute to South Africa's energy mix.

The White Paper furthermore identifies four strategic areas that need to be addressed to create the appropriate enabling environment for the promotion of renewable energy, including financial and legal instruments, technology development and awareness raising, capacity building and education. Although there has been much progress on this in the last few years, a number of barriers still need to be overcome.

As a result of a dialogue between the DME and Danida over the years 1999 to 2001 the Capacity Building in DME in Energy Efficiency and Renewable Energy (CaBEERE) project was formulated. This gave the renewable energy deployment agenda in South Africa a boost by culminating in the Renewable Energy White Paper with the specific target of achieving 10,000 GWh of renewable energy in 2013. Unfortunately for wind and solar electricity generation the renewable energy target was thought to be achieved though a mixture of sugar bagasse (59%), landfill gas (6%), hydro (10%), SWH (13%), other biomass (1%) and only 1% wind, and no solar PV or CSP (DME, 2004).

In 1999 the South African government also launched the solar household concessions programme, which really started implementation in 2002 with the aim of electrifying 300,000 off-grid households. The concessions were awarded to Solar Vision for rural areas in the Northern Province, Nuon RAPS and Electricité de France-Total for rural areas in KwaZulu-Natal, Renewable Energy Africa for rural areas in the Eastern Cape, Transenerge for rural areas in the Eastern Cape and the North West Province and, the subject of this case study, Eskom Shell for rural areas in KwaZulu-Natal and the Eastern Cape (Mottiar & George, 2003).

4.1.2 Undervalued electricity price

Nonetheless, the cost of electricity generation from coal in South Africa was still very cheap. Until the last price hikes South Africa was able to supply the cheapest electricity globally, estimated at a financial cost of R0.25/ kWh (DME, 2004). Renewables, with high upfront investment costs were unable to compete with such low coal prices and no IPPs were attracted to the South African market. Even though the state established the Renewable Energy Fund and Subsidy Office (REFSO), the subsidies offered were considered not substantial enough to support the renewable energy technologies analysed in this report. In particular, project developers could only qualify for the REFSO subsidy if the project is less than R100 million and the subsidy would not exceed 20% of the project costs (Fakir & Nicol, 2008). Only the Darling Wind Farm managed to secure funding under REFSO, and by 2009 only a total R15 million was allocated to renewable energy projects under REFSO.[6]

4.1.3 Climate change as a driver

After the ratification of the Kyoto Protocol the potential for additional finance through the Clean Development Mechanism was thought to give renewable a boost in South Africa. To date this has not been the case, with less than 1% of Certified Emission Reductions (CERs) being sourced from Africa. Nonetheless some of the new wind farms being proposed under the REFIT are also applying for CER crediting, such as the Caledon Wind Farm proposal (Arcus Gibb, 2009).

A greater potential boost for renewable in South Africa is with the increasing awareness that climate change mitigation actions will have to be taken. In particular the Long Term Mitigation Scenarios publication by the Department of Environmental Affairs and Tourism (Winkler (ed), 2007) highlighted the need for renewable energy deployment as a strategy to mitigate South Africa's GHG emissions. The South African government is currently engaged in defining the country's climate change policy and increasingly the electricity sector is taking carbon targets into consideration (Davidson et al, 2010)

4.1.4 2c/ kWh environmental levy

The government introduced a 2c/kWh environmental levy on non-renewable generation effective from 1 July 2009. Eskom expects the total revenue derived from this to be about R 19 billion over the next three years (Eskom, 2009b). This could in theory finance the R 12.4 billion expected to be needed for the 1595 MW of IPP and cogeneration projects under IRP 1 (NERSA, 2010a). Having instated an environmental levy is certainly a push for the deployment of renewable energy, but the use of its revenues still needs to be seen.

4.1.5 Administrative barriers

In South Africa, obtaining approvals and licences is cited by developers as being the biggest hurdle and most time-consuming project activity (Fakir & Nicol, 2008). The Darling Wind Farm and the Bethlehem hydro-projects took several years to get off the ground. These drive up development costs, and delays also add to the cost of finance if the cost of capital increases due to inflation. Construction cost can also be affected because both labour and material costs go up the longer the project takes to get approval. The time-delay factor, where there is no streamlined process of approval and uncertainty in the policy environment as to how to deal with a new technology, affects the financial sustainability of renewable energy as an option. Table 6 indicates a number of hurdles renewable energy developers face in South Africa.

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6 Renewable Energy Summit Speaking notes of the Director General DME 20 March 2009, Swan Lake Conference Centre, Centurion

Table 6: Barriers facing renewable energy developers in South Africa (Fakir & Nicol, 2008)

Category	*Barriers*
Institutional	• Too many agencies involved in approvals (DME, DEAT, DME and NERSA, the Department of Water Affairs andnForestry (DWAF), the provincial and local authority). • Time taken to process approvals for licenses, EIAs or negotiation of PPA. • Identifying the right public sector finance partner. • CDM process is expensive and long. • Approval of the right tariff.
Legal	• EIA laws, planning legislation, the Public Finance Management Act (PFMA), MFMA, wheeling rights and power purchase agreements (PPAs). • Rights of access to property or resource.
Financial	• Identifying institutions that offer development grants. • Identifying suitable lenders (soft and commercial). • Securing equity partners. • Insurance.

Environmental impact assessments also take long to complete, which may further add to the cost of an IPP project. Furthermore, power purchase agreements (PPAs) take time to be negotiated. With the publication of the renewable energy feed-in tariff this may become less of a burden, because generic PPAs will be made available (NERSA, 2009a).

4.1.6 REFIT overcoming the financial barrier

The major financial barrier was overcome in South Africa with the publication of the REFIT in 2009. Renewable energy generators are assured a rate per kWh for electricity fed into the grid for specific technologies. The REFIT was part of a number of energy actions implemented in the wake of the load-shedding experienced in South Africa in 2008. The REFIT regulatory guidelines published in 26 March 2009 present tariffs of R 1.25 per kWh for wind and R 2.10 per kWh for concentrating solar power, in addition to tariffs published for small hydro and landfill gas (NERSA, 2009a).

In October 2009 NERSA approved the addition of tariff for CSP without storage (R 3.14/ kWh), large-scale (>1 MW) grid-connected PV systems (R3.94/ kWh) and CSP Tower with storage of six hours per day (R 2.31/ kWh) (NERSA, 2009b) (see Table 7).

Table 7: REFIT tariffs published by NERSA

REFIT Phase	*Technology*	*R/ kWh*
Phase I	CSP	2.10
	Wind	1.25
	Small hydro	0.94
	Landfill gas	0.90
Phase II	CSP trough without storage	3.14
	Large-scale grid-connected PV systems (≥1MW)	3.94
	Biomass solid	1.18
	Biogas	0.96
	CSP tower with 6 hours per day storage	2.31

4.1.7 Rising electricity prices

On 30 September 2009 Eskom applied for a 146% tariff rise over a three-year period to raise the price of electricity to what they consider a more appropriate level in the range of R 0.80 – 0.88 per kWh. This multi-year price application was revised on 30 November to an average price increase of

35% per annum for 2010/11, 2011/12 and 1012/13, which would have resulted in Eskom revenue of R 98 billion, R 132 billion and R 180 billion per year (NERSA, 2010a).

On 24 February 2010 NERSA approved an allowed revenue of R85 billion for 2010/11, R109 billion for 2011/12 and R141billion for 2012/13, which will result in the average standard price of R 0.42/kWh, R 0.52/kWh and R 0.66/kWh for the 2010/11, 2011/12 and 2012/13 financial years respectively. Such an increase will result in a percentage price increase of 24.8% on the average standard tariff from 1 April 2010 followed by another average increase of 25.8 % from 1 April 2011 and a further price increase of 25.9 % from 1 April 2012 (NERSA, 2010a).

The revenue incurred is intended to finance Eskom's own primary energy costs, operations expenditure and DSM activities, while still allowing for some return on its assets. NERSA (2010a) also expects R 2.3 billion, R 4.3 billion and R 5.8 billion of the allowed revenue to be directed at IPPs and cogeneration projects for the 2010/11, 2011/12 and 2012/13 financial years respectively. Finance for the REFIT programme is therefore being made available, but how much deployment will be seen still remains questionable.

4.1.8 Capping deployment

NERSA recently presented its 'Rules on selection criteria for renewable energy projects under the REFIT Programme' in terms of Regulation 7 of GN R. 721 GG No. 32378 of 5 August 2009. These are presented for public comment until 18 March 2010. The rules related to the selection criteria for renewable energy or cogeneration IPP that qualify for a license are based on the following considerations:

(a) compliance with the integrated resource plan and the preferred technologies;

(b) acceptance by the IPP of a standardized power purchase agreement;

(c) preference for a plant location that contributes to grid stabilisation and mitigates against transmission losses;

(d) preference for a plant technology and location that contributes to local economic development;

(e) compliance with legislation in respect of the advancement of historically disadvantaged individuals;

(f) preference for projects with viable network integration requirements;

(g) preference for projects with advanced environmental approvals;

(h) preference for projects demonstrating the ability to raise finance;

(i) preference for small distributed generators over centralized generators; and

(j) preference for generators that can be commissioned in the shortest time (NERSA, 2010b).

These regulations present a specific barrier to renewable energy deployment in South Africa. The amount of capacity deployed is determined by the IRP and capped once the targets have been reached. The IRP1 was signed off by the Minister of Energy on 16 December 2009 (DoE, 2010) stating additional renewable energy and co-generation capacity from IPPs of 343 MW in 2010, 518 MW in 2011, 284 MW in 2012 and another 300 MW in 2013. Under this cap IPP developments for wind are estimated to only be 400MW by 2013, while other renewable energy projects are 325 MW by 2013, of which it is unknown how much may go to CSP or large-scale PV (NERSA, 2010b). In addition Eskom aims to only build its 100 MW Sere wind farm and its 50 MW CSP plant with support of the World Bank loan (Davidson et al, 2010).

Beyond 2013 no further incentives for renewable energy deployment can be identified. There is uncertainty regarding for how long and how much the REFIT programme will finance. Until 2013 IPPs face the uncertainly of whether they will be chosen for the programme according to the guidelines set out above. The preference for generators that can be commissioned in the shortest time proves to be a rather obstructive barrier to the larger projects in planning, specifically CSP projects. They also face more difficulty completing the IEAs and finding suitable sun-blessed sites that have viable network integration requirements. By the specific statement that small distributed generators will be preferred over centralised generators, CSP, wind and large-scale PV farms are thought to be disadvantaged.

4.2 SWH specific drivers and barriers

Energy conservation received much attention since the blackouts, as highlighted in 'National Response Strategy to South Africa's Energy Shortage' published in January 2008 (DME, 2008), where a power conservation programme was presented as the recommended option for dealing with the crisis, aimed at achieving an overall savings target of 10 – 15%. Eskom's Demand Side Management (DSM) programme was also touted as being one of the options for alleviating electricity demand. Specific targets include the rollout of compact fluorescent lights with the aim of reducing demand by 750 MW by 2010 and a one-million SWH rollout programme aimed at reducing the demand for electricity capacity by 650 MW (DME, 2008). Eskom subsidies for SWHs are dependent on the efficiency of the collectors and can range between R 3,000 and R 12,000.[7] In the IRP 1 the Department of Energy (2010) states that the one million SWHs by 2014 DSM programme should commence from 1 March 2010.

Consequently, 2008 saw a dramatic increase in the number of SWH companies operating in South Africa, from 20 to more than 200, resulting in the deployment of more than 100,000 m^2 of SWH surface area (0.1 TWh) that year (see Figure 10). In particular glazed SWH saw an increased from about 10000m^2 deployment per year to about 30,000 m^2 (Theobald & Cawood, 2009). Nonetheless the immediate barrier is one of supply: at 10,000 in 2008 it is estimated that not enough SWHs are being produced in the country and it is expected that increasing supply would come from imports (Fakir & Nicol, 2008). Furthermore for a SWH installation to receive the Eskom subsidy the technology must be SABS approved. The SABS testing facility is yielding very slow results with waiting periods of some six months to test equipment. The restriction that SWH installations can only apply for an Eskom subsidy once SABS approved is therefore a further barrier.

4.3 Projecting renewable energy deployment

In 2008 a rough estimate of investments in renewable energy was close to R1 billion (Fakir & Nicol, 2008), although with the number of feasibility studies for large-scale renewable energy projects underway this figure may well be more. Figure 10 shows a possible projection for renewable energy projects in South Africa, estimated from the achievement of a one million SWH target, deploying 200 MW of wind in 2010, and 300 MW in the years thereafter, and deploying 50 MW of CSP in 2011 and 100 MW thereafter.

The SWH industry has received further support through the publication of the latest Industry Policy Action Plan (IPAP2) in February 2010 by the Department of Trade and Industry (DTI, 2010). In it the SWH milestones are:

- By the second quarter of the 2010/11 financial year (ending March 31, 2011), the DoE will introduce a subsidy programme covering one million units by 2014.
- By the end of December 2010, the DTI and the National Regulator for Compulsory Specifications will publish amended national building regulations to make it compulsory for new buildings and upgrades to homes to install SWHs and other energy efficiency building requirements, from March 2011.
- By the end of September 2010, the DTI will ensure that legislation is enacted to make it compulsory to install a SWH when an existing geyser is replaced.
- Between 2010/11 and 2012/13, DTI incentives and Industrial Development Corporation (IDC) industrial financing will be leveraged to support investment and increasing manufacturing and installation capacity in the SWH value chain.

[7] Eskom website, http://www.eskomdsm.co.za/?q=swh_supplierslist, accessed: 10/03/2010

Table 8: IPP wind projects under development in South Africa

Site	*Province*	*Owner*	*MW*
Cookhouse	EC	ACED (Macquarie)	300 MW
Flagging Trees	EC	ACED (Macquarie)	100 MW
Hopefield	WC	African Infrastructure Investment Fund	100 MW
Jeffrey's Bay	EC	Mainstream/Genesis Eco-Energy	50 MW
Brand-se-Baai	WC	Exxaro	100 MW
Tsitsikamma Community Wind Farm	EC	Consortium including Exxaro, Tsitsikamma Development Trust & Watt Energy (46%). Balance by DANIDA & Danish IPP, European Energy (54%).	40 MW
Coega IDZ	EC	Electrawinds	57.5 MW
40km SW of PE	EC	Central Energy Fund	25 MW
Caledon Wind Farm	WC	Epipspan (Pty) Ltd – trading as Caledon Wind.	300 MW
Eastern Cape Wind Project	EC	Red Cap Investments	50 MW

Besides Eskom's 100 MW Sere plant there are a number of wind developers who have publicly announced projects they are developing, in the order of about 1 100 MW (see Table 8). African Clean Energy Development, a joint venture between Macquarie and Old Mutual, has a pipeline of seven wind farms that would have an estimated capacity of 1500 MW.[8] Furthermore, a recent study showed the integration of 2800 MW in the Western Cape was generally feasible, though more detailed studies are required to confirm this,[9] though the IRP 1 indicates that wind developments, besides the Eskom 100 MW project, will be capped at 400MW (DoE, 2009).

As for solar electric developments currently underway, besides Eskom's 50MW demonstration plant, the SKA MeerKAT radio telescope array programme collaborated with the University of Stellenbosch on a feasibility study for a 100 MW CSP plant and a 0.5MW PV system.[10] The Clinton Climate Initiative is partnering with the Department of Energy to set up a solar park in the Northern Cape, which could add up to 5 GW of capacity to South Africa's electricity generation (*Engineering News*, 2009). Siemens is also currently conducting a feasibility study on a possible 210 MW CSP plant in the Northern Cape to possibly come online by 2014 and the Industrial Development Corporation is also investigating a CSP demonstration plan (DTI, 2010). In total there seem to be about 500 – 600 MW of CSP currently undergoing pre-feasibility and feasibility stages of development, with 75% of these able to deploy by 2013.[11]

4.4 What if REFIT had been implemented earlier?

Since there has been very few renewable energy projects deployed in South Africa to date and the REFIT has created a great interest in developing renewable energy projects in South Africa immediate question that comes to mind is: What if the REFIT had been implemented earlier in South Africa?

After the establishment of the 10,000 GWh renewable energy target by 2013 South Africa could have pro-actively set up a feed-in tariff as early as 2005. Since the renewable energy target then was thought to mainly come from biomass (59%), landfill gas (6%), hydro (10%), and SWH (13%) (DME, 2004), the first technologies to be considered to fall under a feed-in tariff would have been biomass (sugar bagasse), landfill gas and hydro. This could have been instead of the renewable energy subsidy offered by the REFSO. Furthermore, if the South African government had followed the dramatic growth of the wind market internationally, this technology would probably also have

8 Email communication, Mary Waller, Macquary 9 March 2010.

9 Presented by Riaan Smit, 24 July 2009. Eskom/DIgSILENT/GTZ.

10 Wikus van Niekerk & Tom Fluri presentation 'Solar Power for SKA', 17 February 2009, Centre for Renewable and Sustainable Energy Studies, Stellenbosch University.

11 Presented by Pancho Ndebele, 9 March 2010, DBSA 'Promoting a CSP Industry in Southern Africa' Workshop.

been considered. Feed-in tariffs for PV and CSP could then have been added in 2007, in line with international developments for these technologies.

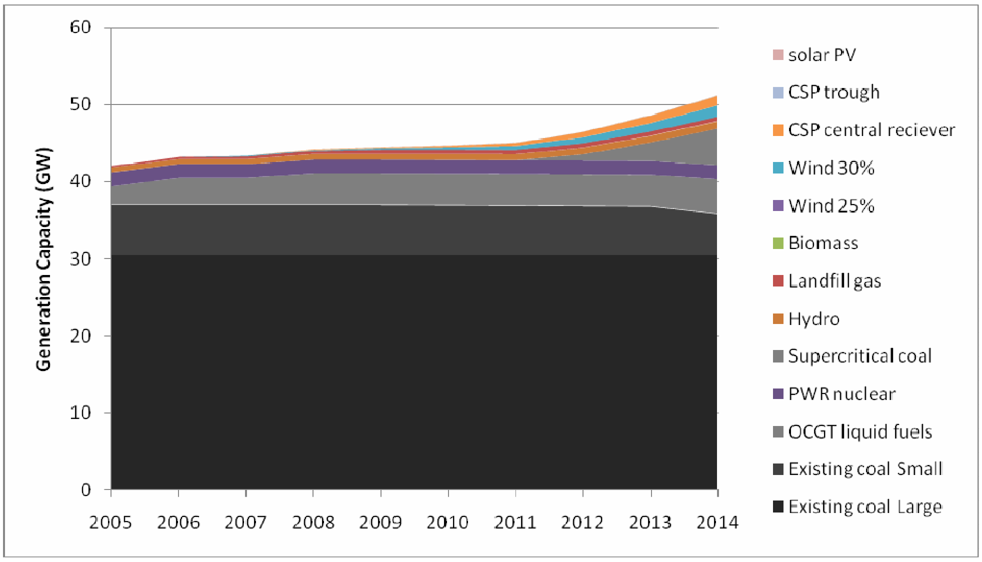

Figure 11: Possible projection of South Africa electricity generation capacity had been implemented in 2005.

This could have encouraged the deployment of renewable electricity generating technologies in South Africa. A possible deployment projection is presented in Figure 11, whereby landfill gas and biomass electricity generation capacity comes into the mix in 2007 and wind and CSP from 2008. Small scale hydro and PV projects are also implemented with generation capacity expected to come online by 2009. According to this projection, based on the assumption that South Africa implemented a REFIT in 2005, the renewable electricity target of supplying 10,000 GWh by 2013 (DME, 2003) would already have been reached in 2011 (Figure 12).

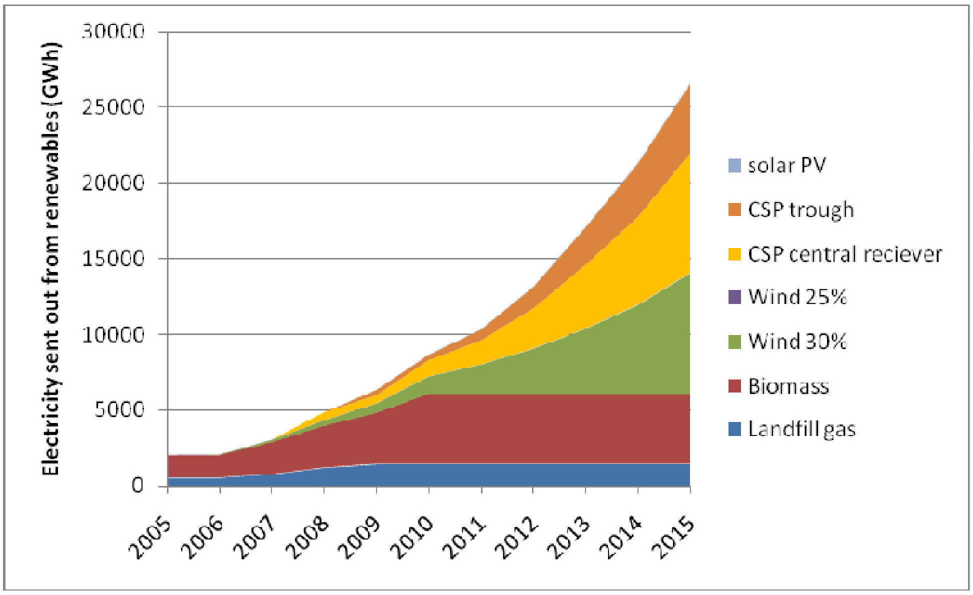

Figure 12: Possible electricity production from renewable energy sources had a REFIT been implemented in 2005

According to this projection 4,700 GWh could have been supplied from biomass, 1,400 GWh from landfill gas, almost 2,000 GWh from wind, 2,300 GWh from CSP and about 100 GWh from PV and small Hydro each in 2011 (Figure 12). Such a renewable energy policy intervention would probably also have helped with reducing the risk of blackouts due to lack of generation capacity within the country, as was the case in 2008. Furthermore, implementing the REFIT in 2005 would probably have cost little more than R 50 billion per year by 2011 – an upfront investment cost that could have been provided by the private sector with government paying it off over 20 years or so.

In conclusion it seems that South Africa could have encouraged much greater rates of deployment than those seen for renewable to date if an effective REFIT had been implemented earlier.

5. Discussion

The deployment of renewables in South Africa has been less than impressive, though there has been a shake up in the market since the blackouts in 2008; with the establishment of the REFIT, the interest in deploying renewable energy projects in South Africa has been given a boost. Encouraging actions lie in Eskom's support for SWHs, as well as interventions at the city level towards supporting the rollout of SWHs. On the renewable electricity front encouraging policy is seen with the announcement of the REFIT and the redrafting of the Renewable Energy White Paper that is due to be presented in 2010.

A number of drivers for renewable energy deployment have been identified, although to date the barriers facing the industry have largely outpaced these, and the deployment of solar PV (large-scale), CSP and wind projects has been minor. Renewable energy effectiveness indicators for the last 12 years have therefore been practically zero. Only the SWH industry has seen some progress, having achieved an estimated 1.35 TWh in 2009. Nonetheless the potential for renewable energy deployment is high, with mid-term estimates of 121 TWh, 28 TWh, and 17 TWh for CSP, wind, and SWH respectively. The next years may yet show more effective renewable energy policy in South Africa.

In must be kept in mind that South Africa is a developing country characterised by an energy-intensive economy reliant on coal as the main energy source. Although it has seen impressive electric grid expansion, still about 30% of the country goes without electricity. By only focusing on the amount of renewable energy deployed, as was prescribed by the IEA policy effectiveness measure, little progress has been seen for CSP, large PV, and wind installations. Nonetheless there has been some progress in the deployment of household PV, biogas and SWH to provide off-grid energy services. These interventions must be noted in the South African renewable energy policy context, where a notable policy aim is to alleviate energy poverty.

Although the PV concessions programme under the DME has seen a number of problems, including loss of PV panels due to theft, and slow and inefficient technical support to the households (Mottiar & George, 2003) the scheme did result in the deployment of about 200 000 solar home systems (Banks & Schaffler, 2006). Of the six concession agreements the Kwazulu-Natal scheme managed by NuRa is considered the most successful even though it met only half of its deployment target by 2006 due to lack of government subsidies (Lemaire, 2007). The customers also expressed dissatisfaction with the limit of the system provided, comprised of a 50 W panel with four lights and a socket for a radio or a black/white TV only.

Similarly PV systems aimed at small-scale business enterprises in off-grid areas showed that 24 V, as opposed to 12 V, systems proved to be more effective in offering social, environmental and economic positives (Hajat et al, 2009). Furthermore, mini-grid installations, such as the Hluleka 11 kW and Lucingweni 86 kW, have proven to be effective in providing off-grid electricity services. Small-scale off-grid developments such as these and other renewable energy projects, including solar passive housing designs and biomass and biogass digesters all can contribute to effective renewable energy policy in South Africa.

Nonetheless, strong renewable energy policy interventions will have to be established to encourage the deployment of large-scale renewable projects. South Africa is in need of electricity, and wind, PV and CSP have the potential to contribute. The cap on South Africa's REFIT should be removed to allow for large-scale deployment. SWHs also have great potential to supply South Africa with a renewable energy service, and a number of incentives are already in place. In particular Eskom-funded rebates are alleviating the upfront installation costs, although the behavioural or market barrier still need to be overcome to see the large-scale rollout of this technology.

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