3.7.3 Cost indications

The estimated total capital cost of large multi-megawatt wind-based electricity generation plants range from R8 million to R11 million per Megawatt[7]. Electricity generation costs would range from about R0.40 to R.70c/kWh per unit depending on the wind regime in which the turbine operates (DME 2004a). International experience indicates a cost of less than US$0.04 per kWh (IEA, 2003, p. 25). This cost indication makes wind one the most financially viable renewable energy based generation technologies, and in favourable conditions wind can compete directly on commercial terms with conventional energy options. These costs are also projected to decline by as much as 40 to 50 percent over the next 15 to 20 years (see IEA, 2003, p. 18). Cost estimates used for this study are listed in Table 16.

3.8 Wave and ocean energy

3.8.1 Wave energy

The ocean breakers crashing onto our shores have an average energy intensity that is good to excellent on an international standard. Several parties including Eskom, University of Stellenbosch and private sector role players are actively exploring the potential for establishment of wave power plants at various points along the Western Cape Coast (see project list in Appendix A). There are a number of different technologies under investigation, and it is clear that it will be some time before optimum strategies have been determined or detailed cost information derived.

[7] Some of the magnitude of this range can be attributed to these prices usually being cited in foreign currency and therefore of exchange fluctuations. It is certainly also a function of there not being sufficient data upon which to base projections.

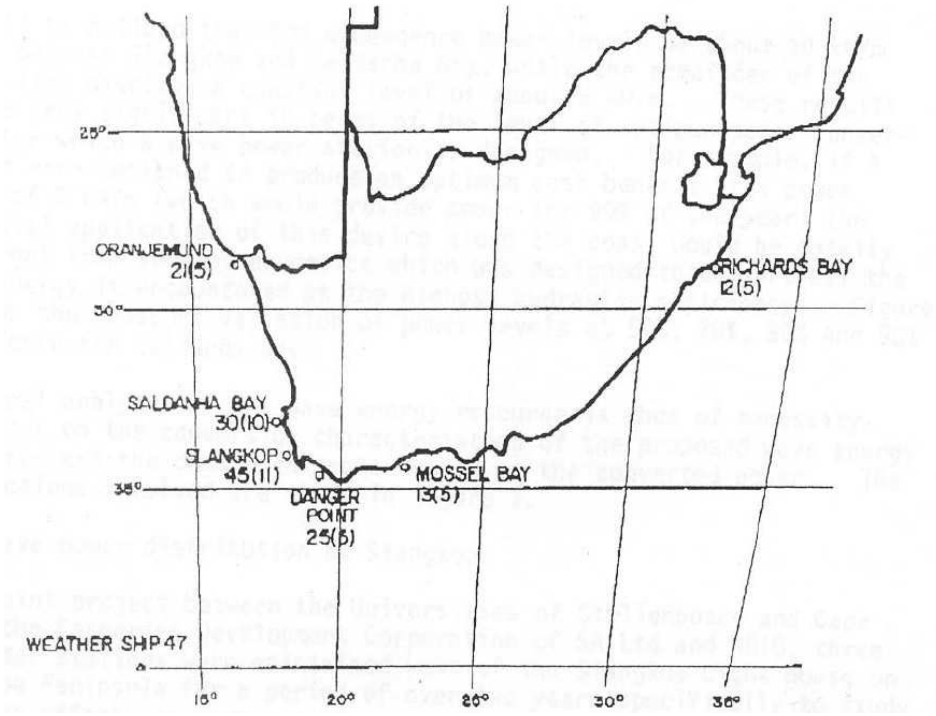


Figure 17 Wave power distribution along the South African coast: kW/m mean annual (90% exceedence) [Retief 1982][8]

Table 12 Adapted wave power potential for five measurement stations in the Western Cape region.

Location	Annual median wave power potential [kW/m]	Power potential exceeded 25% of the time [kW/m]	Power potential exceeded 50% of the time [kW/m]	Power potential exceeded 90% of the time [kW/m]
Saldanha Bay+	31.6	n/a	25.0	10.5
Duynefontein°	11.0	22.0	n/a	n/a
Slangkop°	33.0	55.0	n/a	n/a
Slangkop+	39.3	n/a	28.4	10.7
Gansbaai+	29.2	n/a	16.9	4.4
Mosselbay°	13.0*	21.0*	n/a	n/a
Mosselbay+	21.4	n/a	17.3	6.8

Key: *estimated values, +Geustyn report, °VanWyk report

Mueller (2007) (quoting a Stellenbosch University, Oelsener Group New Energy Projects study) lists the South African coastline potential as having a total generating capacity of 18 000 MW, with an average of 8 000 MW realizable energy.

Based on the above data in Figure 17 and Table 12, the following estimate of the broad potential for wave energy in the Western Cape is presented.

[8] Although more recent data has been gathered by the CSIR, and reported to Eskom, this is not yet available in the public domain

Table 13 First pass estimate of the potential wave energy resource in the Western Cape

Region	Length of coast (km)	Energy kW/m (Ave)	Theoretical Potential
Hoekbaai to Cape Columbine	280	30	8398
Cape Columbine to Marcus Islan	54	45	2420
Marcus Island to Mouille Point	252	40	10071
Moiuille Point to Cape Point	85	40	3389
Cape Point to Kaap Hangklip	128	40	5100
Kaap Hangklip to Danger Point	110	25	2756
Danger Point to Northumberland	110	20	2204
Northumberland Point to Bloukr	525	13	6820
Total			**41158**
Assume that practical limitations limit access to 10% of this			**4116**

From the above it seems quite feasible to consider that more than a 1000 MW of wave power plant could be installed. Note that there are already concept plans for up to 600 MW of wave power plant in the project listing below.

3.8.2 Cost indications

Figure 18 illustrates the reported costs of wave energy, as compared to wind energy in the European Union. It will be noted that wave energy costs are still significantly higher than wind, but show a more rapid rate of decline. This reflects the current status of the industry – which is has even lower installed capacity than Concentrating Solar Power. Nevertheless, significant government and private sector investment continues to be made to try and reduce the costs. Furthermore, a high proportion of wave converter components could be manufactured in the Western Cape (as in the case for many other renewable energy conversion technologies).

Preliminary information on wave plant feasibility in the Western Cape (Ocean Power Delivery, Genesis Eco Energy, personal communication), indicates costs of the order of R18 000/kW installed. Given that wave power plants would have high costs for connection to the grid – we have adopted a more conservative base cost of R25 000/kW for wave power plant (2007 figures). Note that these are expected to reduce (see section 3.13).

Cost of power of course depends on the capacity factor, and assumptions regarding cost of capital. For the purposes of the scenarios we have assumed operational costs will be 50% higher than used for on-shore wind, and the same discount rate as for other technologies (8%). Wave plant life has however been set at 20 years (shorter than for some other technologies given the harsh environment). A capacity factor of 45% has been used, although this will strongly depend on the specifics of the wave resource as well as the particular technologies chosen. Wave energy is somewhat more consistent than wind energy, and there is a high degree of predictability associated with wave patterns, which assists in network management.

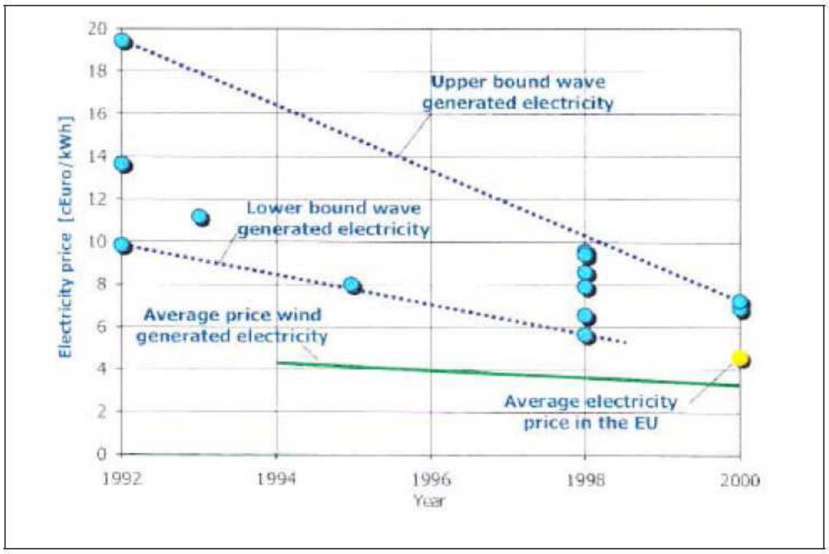


Figure 18 Predicted wave energy costs (EESD, 2002, p 14)

3.8.3 Ocean Current energy

The Western Cape has two strong ocean currents which flow past, the Benguela on the West, and the Agulhas on the Southern/Eastern coast. Eskom is currently investigating the potential of the ocean current resource. See Nel 2007 which indicates that the Agulhas current reaches speeds up to 2.7 $m.s^{-1}$. This is well within the range being considered for ocean current turbines. In an ocean current moving at this velocity, the power density would be above 4 kW/m^2 ([9]) (Meuller, quoting Fraenkel, 2007). It has not been possible to obtain an assessment of the potential energy that could be extracted from the Agulhas (or the Benguela) currents. An indication of the order of magnitude of resource can be deduced from the following:

- Assume that Marine Current Turbines could be deployed, at a density such that they extract 10 MW/km^2 (Mueller).
- At this energy density, an array of marine current turbines over a front of 10 km, could deliver 100 MW per running km of the resource that they tap into.
- Ten such installations would yield 1000 MW and occupy a sea area of 10 x 10 km.

The resource is likely to be significant. However, for present purposes it is included in the "Ocean Energy" resource in the scenarios below.

3.9 Waste Management Systems

3.9.1 Sewage

There is some potential for processing of sewage waste from large urban plants in a manner that releases a net energy output. This will have a relatively small energy output (in terms of provincial demand), but is nevertheless and important contributor. The process also has important benefits for water saving, as well as reducing the need for large capital intensive plant expansion as existing city sewage treatment plants need expansion. The research team have not been able to obtain estimates of the potential methane (and hence

[9] For comparative purposes, solar radiation has a power density of about 1 $kW/m^{2,}$

energy recovery that could be achieved. It is likely to produce less than 10 MW electricity, and will thus not significantly affect the scenarios below.

3.9.2 Landfill gas

Landfill sites generate methane gas, which is normally vented to the atmosphere. As methane is a severe 'greenhouse' gas, it is important to try and utilize this, or at least to flare it (converting the methane to Carbon Dioxide and water). The DME commissioned a detailed landfill gas study – see Lombard, de Mattos & Associates 2004.) This identified a number of sites in the Country. Following a long process, the first of three Durban (eThekwini) electricity generation from landfill plants has finally started generation in March 2007. The plants will generate revenues of the order of R400 million from carbon credit and electricity sales.[10]

Production costs for landfill gas-based electricity generation are estimated to range from 17 to 30c/kWh (DME, 2004a). Costs depend primarily on the size of the generating unit, which range from 'micro', with a capacity of approximately 500 kWe, to 'large', with a capacity of 4 MW.

Table 14 shows the current estimates of energy production potential. It will be noted that the net energy output is relatively small in comparison to overall provincial energy needs. . As urban populations grow and more people move into the middle or upper income bracket, so waste streams will grow. Furthermore, if waste resource streams are separated, there can be improved energy return. There is thus a potential for the landfill gas resource to grow over time

Table 14Landfill Gas Potential by Landfill Site(Lombard de Mattos & Associates 2004)

Probable Power MW e	**Province**	**Year**		
Landfill		**2005**	**2010**	**2015**
Vissershok CMC	**WC**	3	9	5.5
Bellville South	**WC**	2	2.5	1.5
Coastal Park	**WC**	1	2	2
Swartklip	**WC**	1	1.5	2
Brackenfell	**WC**	0	1	0.5
Faure*	**WC**	0	0.5	0.5
Total MWe potential		**7**	**16.5**	**12**
GW h		**61.32**	**144.54**	**105.12**

Ongoing investigations are underway to characterise the methane outputs from key waste sites in the Western Cape. The technology and methodologies for extraction and utilization are well developed internationally (with South African experience building through projects such as the eThekwini one mentioned above). We therefore anticipate a fairly repaid implementation of landfill to energy projects – provided that the process is given the necessary planning and financial support.

[10] Mail and Gaurdian, 21 March 2007

3.9.3 Waste gasification

A recent presentation at a City of Cape Town workshop on "Alternatives to Landfilling of Waste" (Droste, T, 2007) discussed options for establishment of a plant that could treat 500 000 tons/annum, (assumed to be generated by 290 000 households and 15 000 businesses). This could generate 3.56 Million GJ of syngas, which could be used directly for thermal applications. If it were used to generate electricity at 35% efficiency, the output would be 346 GWh, or equivalent to a 40 MW electrical generator running at 100% capacity factor.

Costs for this power are not available at present, and are of course strongly dependent on the fee paid to the plant for the waste processing service that it renders. However, power costs are expected to be similar to that for gas turbine power plant (as the syngas produced would be sold by the waste treatment plant at similar prices to natural gas prices). Note that syngas from municipal waste production plants have already been established on a significant scale in Japan and other countries.

It is also necessary to note that there are several concerns regarding thermal treatment of waste, in particular related to the emissions from such plants, as well as a tendency for people to see this as an alternative to recycling. Minimisation of waste streams, re-use and re-cycling should be prioritised.

For the purposes of this study it has been assumed that an additional 40 MW electricity generation could be achieved through thermal processes (over and above the 12 MW of electricity generation from land-fill discussed in section 3.9.2). For the high renewable scenario, a total yield by 2035 of 92 Mw is assumed for land fill, waste gasification and sewage. The cost of power generated is assumed to be the same as for land fill gas, and the plant is shown entering the *progressive renewables* scenario in 2016.

3.10 Geothermal

In regions of volcanic activity, places where aquifers reach deep into the earth's crust and along fault lines, conditions can be suitable for the extraction of geothermal energy from the earth. Currently Kenya, with more than 100 MW of geothermal generation, has Africa's largest installed capacity (Engineering News, 2003a). Kenya and ten other East African states have committed to installing 1 000 MW by 2020 (Engineering News, 2003b).

Geothermal resources have not been reviewed in the recent DME renewable energy strategy development processes, or in the series of Danida funded CaBEERE resource assessments. Little is thus known of the true potential. However, the Southern Cape Fold Mountains hold subterranean reservoirs of superheated water that some argue could be a source of cheap 'green' energy (Engineering News, 2003c). Geothermal has not been formally included in the scenarios below. If economically viable resources are found, this could obviously substitute any of the other planned generation technologies listed below.

3.11 Building design – passive solar

Although passive solar design of buildings to optimise natural heating and cooling is primarily considered a demand side/EE issue, it should be noted, in considering renewable energy contributions (both electrical and non-electrical), that some elements of passive building design result in a net contribution of renewable energy to the energy mix. It is however difficult to measure and monitor. For example the heat gain through properly orientated north facing windows can be estimated through simulations, but is difficult to measure. It is far easier to monitor the net saving in electricity or heating fuel (which results from solar heat gain, better insulation etc.)

Accounting for changes in total energy consumption after inclusion of solar energy in the system however, requires very careful baselining. In the case of passive design and the building envelope in particular, baselining methodologies are less well developed than for example those for electricity or liquid fuels. The issues are is similar to the accounting required for solar water heating. Monitoring systems for water heating with electrical co-supply can deliver an indication of relative solar contribution to the water heating energy mix.

Specific energy impacts of passive solar design have thus not been included in the renewable energy component of the scenarios below – although they are effectively implied in some of the recommendations made in section 7.

International trends highlight the move to ensuring that new building stock is capable of generating 10% of its own energy consumption on site. Such a requirement would be a strong driver to reduce overall demand. Achieving this is linked to the need to (a) implement building codes as developed in the Sustainable Energy Strategy and (b) ensure the uptake of technologies such as Combined Heat and Power solutions, small scale fuel cell technologies, Solar Water Heaters and Photovoltaic Systems. This area does hold significant promise, and existing work on building guidelines needs to be carried forward.

3.12 Renewable Energy, Peak Power management and energy storage

The Western Cape region has a peak demand of the order of 4200 MW at present (Eskom, Western Cape Recovery Plan, 2006). If this is compared to the average load of 2.26 GW[11], this gives a load factor of about 57%. The country as a whole has a load factor of about 57% as well. Available generation capacity in the Western Cape is of the order of 2500 MW (see Appendix A for a summary of generation plant in the Western Cape). The transmission network from Hydra can bring in 2400 MW to 2800 MW (although its capability is reduced as Keoberg output increases). Eskom 2006 indicates total supply capacity of 4700 (if all plant and transmission lines are available).

The transmission line is being upgraded at present, and new plant is under construction (see Appendix A).

The above highlights the critical importance of seeing the Western Cape as an integral part of the larger electricity supply network in South Africa. A consequence of this is that it is not (within the resource constraints of the process to produce this plan) possible to investigate the interplay between transmission capacity (from national generators located outside of the province), peak load power plant, base load plant, renewable resources and the need for storage technologies (such as pumped storage) in significant detail.

[11] Reference Demand scenario has annual production of 19.8 TWh. Eskom Supply stats for 2002 have national peak energy sent out as 40.44 MW, average load is 204 Twh/8.76 = 23.2 GW

It is important to distinguish between energy carriers and energy resources. Determining the magnitude of storage needed in the Western Cape electrical energy supply system as increasing amounts of intermittent generators, as opposed to dispatchable devices, are brought into the energy supply mix, represents a significant study, and the first of several required beyond this study. Suffice it to say that it is not a forgone conclusion that there is a one-to-one or perhaps even proportional relationship between additional storage capacity requirements and capacity of non-stock resource based electricity introduced to the system. In many ways, the benefit which has been derived from fossil fuels, stock resources, stems from their ability to be utilised at will as demand fluctuates.

3.12.1 Storage technologies

Pumped Storage capacity in the Western Cape has been discussed in section 3.3.2. There are other emerging technologies which can help meet short- and longer-term storage needs. The technologies can be roughly divided into relatively fast storage types with high output (e.g. capacitors, flywheels, superconductors) and slower types with high energy content (e.g. pumped storage hydroelectric plants, compressed air tanks, electrochemical storage). To keep costs down, pumped storage hydroelectric plants are most often used to provide large-scale grid support for mid- to long-term energy storage. Redox systems, especially those using Hydrogen, are being developed as future storage systems.

Given the concerns raised above regarding detailed modelling of storage requirements, storage technologies have not been explicitly included in the LEAP scenarios discussed below, although:

- A portion of the solar thermal capacity has been listed as including short term storage
- Existing pumped storage capacity is by default included in the categories “Existing Base” and “Existing mid and peak”.

3.12.2 Fuel Cells and the hydrogen economy

Fuel cells, and hydrogen as an energy carrier have not been dealt with in detail in this energy strategy for the province – in part because they are expected to contribute a relatively small portion to electricity generation and storage (in the medium term). However, fuel cell technologies are receiving increased national and international attention and are likely to play more and more significant role over time. The Province should actively monitor national development in this regard – in particular noting that the Department of Science and Technology is developing a fuel cell and hydrogen energy research and development thrust – and two of the research hubs established have Western Cape ‘homes’.

3.13 Technology development – new options, learning curves and increasing costs

The price of energy generated by different technologies changes over time. Factors which influence this downwards include:

- Technical developments – gradual improvements in technology that allow for gradual cost reductions
- Significant technical innovations- from time to time there are significant technical innovations that can result in large cost reductions

- Global economies of scale- as the industry grows, and the installed capacity grows, so a range of design, manufacturing, financial and distribution efficiency improvements bring down costs.
- Local economies of scale – particularly relevant if the technology or large portions thereof can be manufactured in South Africa.

On the other hand, some aspects of energy technology costs are likely to increase. Steel (and some other commodities) have recently shown a positive increases in real terms. Fossil fuel prices are likely to increase, both on account of increasing fossil fuel scarcity (with higher extraction costs), as well as increased environmental loading, and requirements to make fossil fuel plants significantly cleaner.

The effect of local economics of scale is particularly important for the Western Cape. If the province can establish a position of leadership with regard to certain key technologies, and establish a local manufacturing base – this will create a competitive market advantage, as it will be difficult for other regions that have little experience with the specific technologies to compete.

Learning curves are typically used to model cost reductions. These have been shown to match past reductions in technology cost fairly well, and can be used to try and predict future cost reductions. These are typically expressed as an exponential relationship which models future costs of energy in terms of current costs, a learning rate and the so called Progress Ratio, and projects capacity increases. Technologies that have lower progress ratios will have more rapid future project cost declines. Technologies that are experiencing significant growth will tend to have more rapid future cost declines. The Long Term Mitigation Scenarios study (ERC 2007) sets out possible approaches to learning curves, and proposes learning rates for a number of different technologies. Also highlighted in the ERC study is the significant range of future cost reduction potential quoted in the literature. The study has however not yet released final results. Banks & Schäffler (2006) also provides information on learning rates for a number of different technologies.

Also note that this area is subject to significant debate and uncertainty. Historically, it is known that costs for new renewable energy technologies have come down – but predicting future cost changes is an uncertain science!

Informed by these studies, we have used a relatively simple, but transparent approach to include technology learning (and price increases) in the scenarios below. This uses the annual price changes shown in Table 15 below for Capital, fixed operational and variable operational costs.

Table 15 Annual cost changes used for the scenarios

Technology	Capital Expenditures						Fixed OM						Variable OM					
	2006 - 2009	2010 - 2014	2015 - 2019	2020 - 2024	2025 - 2029	2030 - 2035	2006 - 2009	2010 - 2014	2015 - 2019	2020 - 2024	2025 - 2029	2030 - 2035	2006 - 2009	2010 - 2014	2015 - 2019	2020 - 2024	2025 - 2029	2030 - 2035
Biomass cogeneration	-1.5%	-1.5%	-1.5%	-1.0%	-0.5%	-0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hydro	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Municipal Waste	-1.5%	-1.5%	-1.5%	-1.0%	-0.5%	-0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Pumped storage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Solar PV off-grid	-5.0%	-5.0%	-5.0%	-3.0%	-3.0%	-3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Solar PV grid-connected	-5.0%	-5.0%	-5.0%	-3.0%	-3.0%	-2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Solar thermal electric no storage	-4.0%	-4.0%	-4.0%	-3.0%	-3.0%	-2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Solar thermal electric storage	-4.0%	-4.0%	-4.0%	-3.0%	-3.0%	-2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ocean Energy	-4.0%	-4.0%	-4.0%	-3.0%	-3.0%	-2.0%	-1.0%	-1.0%	-1.5%	-1.5%	-1.5%	-1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wind High CF	-3.0%	-3.0%	-1.5%	-1.5%	-1.0%	-1.0%	-1.0%	-1.0%	-1.5%	-1.5%	-1.5%	-1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Wind Medium CF	-3.0%	-3.0%	-1.5%	-1.5%	-1.0%	-1.0%	-1.0%	-1.0%	-1.5%	-1.5%	-1.5%	-1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Imported Renewable Energy	-3.0%	-3.0%	-1.5%	-1.5%	-1.0%	-1.0%	-1.0%	-1.0%	-1.5%	-1.5%	-1.5%	-1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
New nuclear conventional	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
New fossil fuel peak	2.0%	1.5%	1.0%	1.0%	1.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
New fossil fuel base	2.0%	1.5%	1.0%	1.0%	1.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Existing Peak Load	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Existing Base Load	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%

The following figures show the resultant levelized cost of energy generated from *new installations* by year (using the assumptions above). Base capital cost, operational cost and variable operational costs are given in Table 16. Note that the energy generated from say wind energy in 2020 will include power generated from more expensive plant installed prior to 2020, thus in the case of wind energy, the average cost of all wind generated power in the province does not decrease as rapidly as the levelized cost for *new installations* by year.

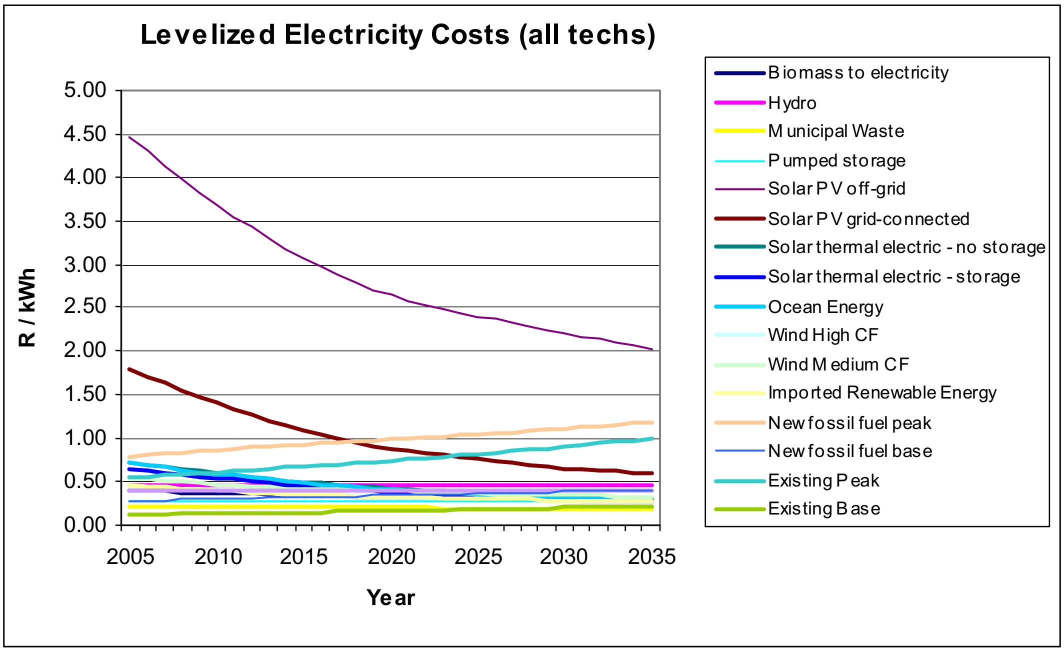
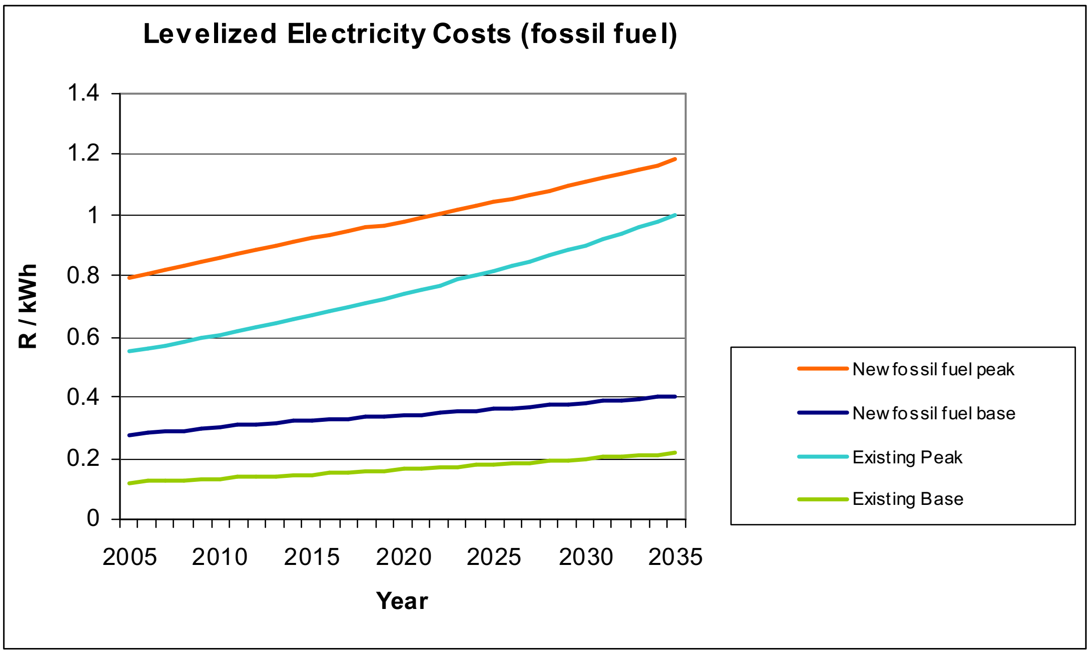


Figure 19 Levelized costs of energy (taking into account capital and operational costs) for new plant installed by year



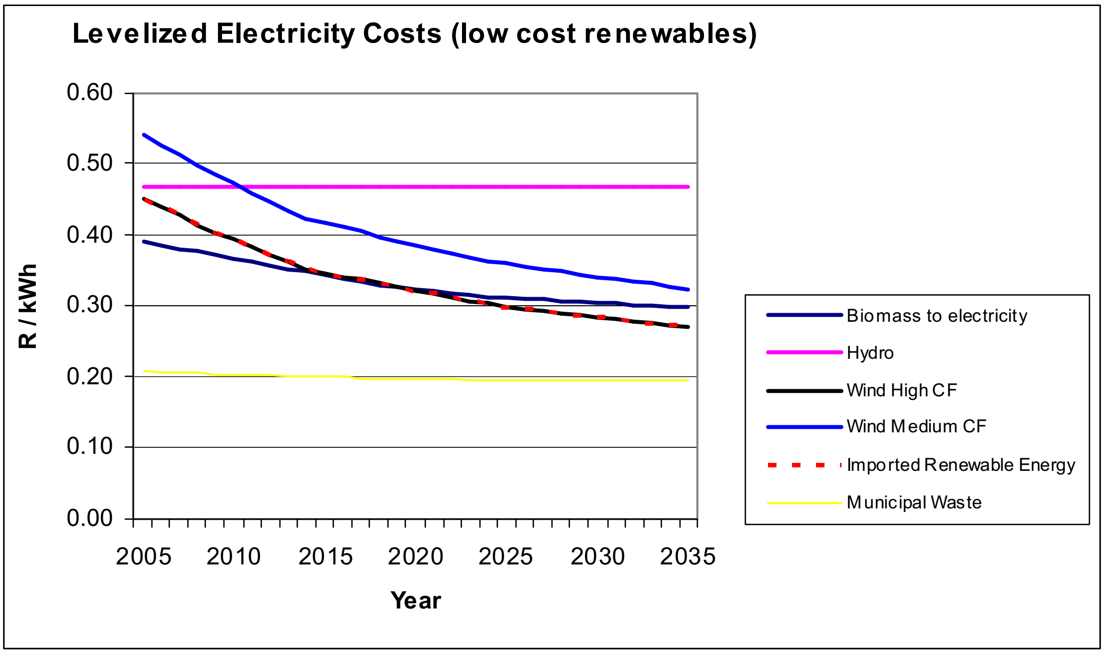


Figure 20 Levelized costs of lower cost renewables

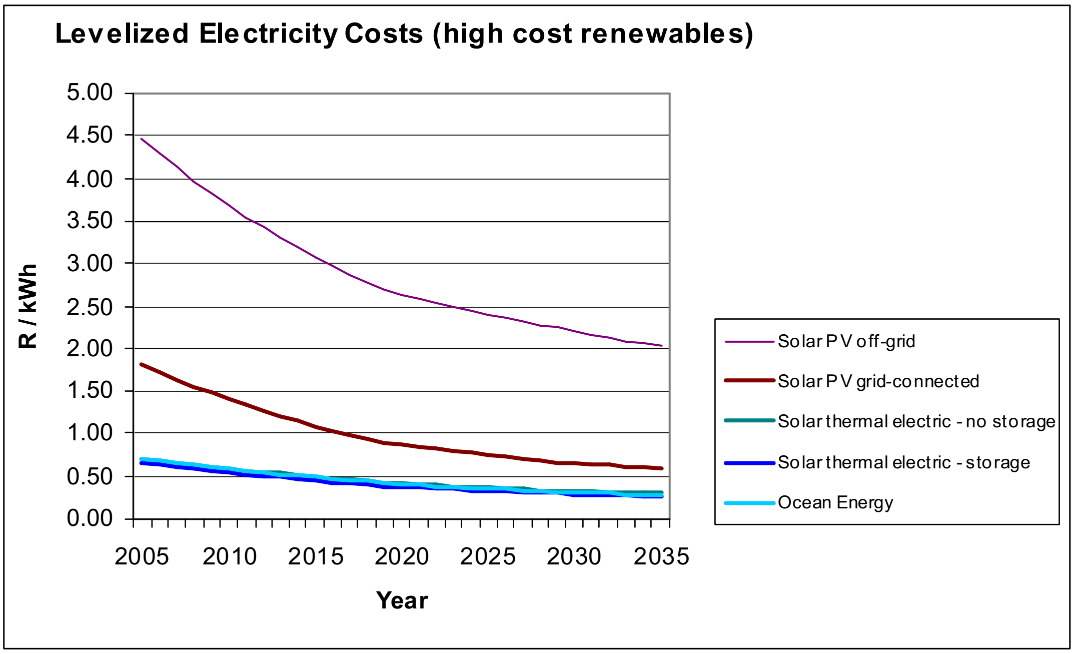


Figure 21 Levelized costs of a range of medium cost renewable conversion technologies

3.14 Resource Summary

Table 16 provides a summary of the renewable energy resource assessment results. Also included are the assumptions used for both renewable resources and fossil fuel options for the scenarios. Fossil fuelled generation is discussed in chapter 5.

Table 16 Resource Assessment Summary

Name	Short Description	Practical Resource limits (MW)	Used in Progressive Scenario (MW)	Used in High Scenario (MW)	Capital cost / kW (R 2005)	Fixed OM, R/kW/yr	Vaiable OM, R/kWh	Plant life (years)	Cap. Factor	CoE (R2005)	CoE (2010)	CoE (2015)	CoE (2020)	CoE (2030)	Comment
Biomass cogeneration	Electricity production from forest waste or similar	20 - 50	30	50	23000 [3]	154 [3]	22.9 [3]	30	68 [3]	0.39	0.37	0.34	0.32	0.30	Forest waste potential. Direct biomass production for energy not yet considered
Hydro	Small hydro opportunities	25 -100	50	100	10938 [3,5]	202 [3]	0	25	30 [3]	0.47	0.47	0.47	0.47	0.47	Limited identified potential in WC
Municipal Waste	Landfill and waste gasification	< 100	12	92	4287 [3]	156 [3]	135.6 [24]	25	89 [3]	0.21	0.20	0.20	0.20	0.19	
Pumped storage		3000	0	0	4822 [3,6]	49 [3]	9 [3]	40	20 [3]	0.27	0.27	0.27	0.27	0.27	Not included in LEAP model
Solar PV off-grid	Stand alone or isolated grid PV	N/A	2	6	60000 [20]	2000 [20]	0 [3]	15	23	4.47	3.68	3.08	2.64	2.21	Signigican existing installed base. Key uncertainty is grid expansion
Solar PV grid-connect	Small or large scale PV power generation	N/A	69	241	40000 [20]	69 [3]	0 [3]	30	23	1.80	1.40	1.09	0.87	0.66	Although expensive, easy to apply on small scale
Solar thermal electric - no storage		N/A	400	400	21900 [19]	178 [3]	0.1 [3]	30	34 [19]	0.71	0.59	0.49	0.42	0.33	Although good potential in WC, may be applied in better resource area further north
Solar thermal electric - storage		N/A	200	1000	32850 [17]	178 [3]	0.1 [3]	30	54 [3]	0.65	0.54	0.45	0.38	0.29	As above
Ocean Energy	Wave, possibly ocean current	5000	750	1000	25000 [18]	250.5 [18]	0	20	45 [18]	0.71	0.59	0.49	0.41	0.31	WC has good resource
Wind High CF		>700 +1 500	750	1000	10000 [20]	167 [3]	0 [3]	20	30 [20]	0.45	0.39	0.35	0.32	0.28	Significant potential -even for export (on and off-shore)
Wind Medium CF		>2 400	500	2000	10000 [20]	167 [3]	0 [3]	20	25 [20]	0.54	0.47	0.42	0.39	0.34	
Imported Renewable Energy		unknown	333	40	10000	167	0 [5]	20	30	0.45	0.39	0.35	0.32	0.28	See discussion on TRECs
New nuclear conventional		unknown	180	180	25920 [23]	507 [3]	25 [3]	40	86	0.38	0.38	0.38	0.38	0.38	Significant concenrs re cost of waste/decomissioning
New fossil mid merit/p	A catch all for non-base general plant	N/A	N/A	N/A	3949 [22]	110 [3]	247 [21]	25	10	0.79	0.86	0.92	0.98	1.11	
New fossil base	A catch all for national fossil generation plant	N/A	N/A	N/A	17500 [12]	227 [3]	47.3 [21]	35	86	0.28	0.30	0.32	0.34	0.38	
Existing mid-merit/pea	Represents national mix	N/A	N/A	N/A	0	[25]	550 [25]	25	10	0.55	0.61	0.67	0.74	0.90	Variable costs adjusted so that LEAP derives reasonable CoE (as capital already paid)
Existing Base	Represents national mix	N/A	N/A	N/A	0	[25]	120 [25]	35	86	0.12	0.13	0.15	0.16	0.20	Variable costs adjusted so that LEAP derives reasonable CoE (as capital already paid)

Notes for Table 16

[2] NER 2004, p. 7: 8600 GWh transmission losses (incl. int'l trading); 5208 GWh; 208310 GWh sold. This number could increase if more electricity is generated locally.

[3] LTMS (2007), p. 4

[4] Own estimate

[5] LTMS has three classes of imported hydro: Cahora Bassa at R 92.2 / MWh, Mepanda Uncua at R 161.3 / MWh, and Inga at R126.7 / MWh.

[6] LTMS has two classes of pumped storage: Generic and Braamhoek. Generic is slightly more expensive, and this study assumes Generic. *Note that pumped storage is not included in the LEAP model calculations.*

[10] LTMS has two solar thermal technologies: Central Solar Receiver with molten salt and Parabolic Trough with oil storage. This study assumes Central Solar.

[12] Recently Eskom announced a 4000 MW plant with a R70 billion budget. CapEx = 17,500 = R70 billion / 4000 MW / (1000 kW / MW)

[13] Used LTMS costing for natural gas

[14] Used LTMS "Super Critical coal"

[17] von Heerden, 2007, developing 100 MW in South Africa

[18] See section 3.8.2

[19] See section 3.6.1

[20] See section 3.7.3, 3.5.1

[21] ISEP 10, quoted in [3]

[22] NIRP 2, quoted in [3]

[23] The information available on Nuclear power from NIRP2 and LTMS indicates fairly low costs. However, indications from recent international study are that nuclear costs are likely to be significantly higher. This capex is from Harding 2007

[24] Landfill waste costs are reported as very low in LTMS, however, given that much of this would be from thermal gasification, we have taken Variable O&M as the average of landfill and peak plant

[25] Existing base and peak load plant are costed so as to give a current average price of 18c/kW

4 Accounting for renewable energy

In setting a target and plotting progress towards a renewable energy target achieved through strategic provincial policy and participation, guidelines for qualification of facilities converting renewable energy resources must be clear and must be set from the outset. They must draw from a firm definition of renewable energy.

It is also necessary to be clear as to the circumstances in which renewable electricity generated with in the Western Cape can be credited to Western Cape targets. For example, if a nationally owned plant is established, then it is probable that only about 10% of the energy it generates could be credited to the Western Cape renewable energy targets (in line with the Western Cape proportional share of Eskom's electricity production). The rules or guidelines will in turn be the interface with project developers for determinations on what is considered renewable and what is not.

The process of data collection, analysis and reporting of the response to measures to stimulate uptake, similarly, must proceed according to strict, transparent rules. Monitoring is discussed further in Section 7.5

In the scenarios below we have postulated that some of the renewable energy consumed in the province could be purchased from sources outside of the province. Accounting for such purchase or sale would most readily be undertaken through a renewable energy certificate mechanism. A recommendation to the Department of Minerals and Energy flowing from a study commissioned by that Department into the feasibility of establishing a TREC (Tradable Renewable Energy Certificate) system nationally, indicated that establishing such a system would indeed be feasible. The study indicated that a TREC