Sustainable Energy Briefing 17:
Costs of Renewable Energy

With Eskom negotiating with the World Bank for a US$5 billion dollar loan to finance a part of its planned R1 trillion expansion plan, there is an urgent need to assess Eskom's current build plan in the sober light of financial long-term health. Eskom's current plans are for increased investment in coal-fired power stations and nuclear plants. These plants have life expectancies of between 40-60 years.

This Sustainable Energy Briefing will summarise recent research into the costs of renewable energy versus fossil fuel energy. This research indicates that the cost of building renewable energy is cheaper (or at par) with that of fossil fuels and without the consideration of externalised costs.

In addition, the unit cost of electricity will be examined. In the next 15 years or less, the unit cost of renewable energy will be less than that of conventional energy. This statement (perhaps one of the most important statements in the energy sector today) has the logical consequence that Eskom's continued reliance on coal will result in higher than necessary energy prices. Once again, these calculations do not include externalised costs such as carbon emissions, poor air quality, waste storage, and acid rain.

Finally, this issue will outline the faulty economics of nuclear power. Simply put, nuclear power may be the altar upon which this country bankrupts itself.

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I. Eskom's New Build

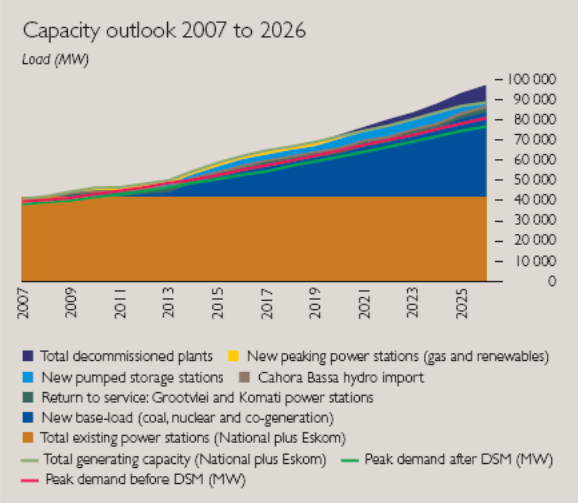
Eskom is embarking on a capital-intensive programme to increase its generating capacity. Its current plans are almost entirely based upon expansion of its fossil fuel base. According to Eskom literature, Eskom is currently planning to bring three mothballed stations back into production, build two open-cycle gas turbines (OCGT), three new coal-fired power stations, two pumped storage schemes, and a single wind farm. The Table below outlines these plans.

Table One: Eskom's New Build Programme 2008 to 2016[i]

MW	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
Camden (coal-fired)[1]	400									400
Grootvlei (coal-fired)[1]	590	585								1 175
Komati (coal-fired)[1]	120	240	310	285						955
Ankerlig (OCGT)[2]		740								740
Gourikwa (OCGT)[2]		296								296
Arnot (coal-fired)[3]	90	60	30							180
Medupi (coal-fired)					798	1 596	798	1 596		4 788
Bravo (coal-fired)						803	1 606	803	1 606	4 818
Ingula (pumped-storage)						1 352				1 352
Lima (pumped-storage)								375	1 125	1 500
Wind farm (renewable)			100							100
Annual total MW	1 200	1 921	440	285	798	3 751	2 404	2 774	2 731	16 304

This new build programme is set to cost, according to Eskom R343 billion. The capital costs of the build programme have already increased from an initial R97 billion to R150 billion to R343 billion in the span of two years.[ii]

In addition, Eskom plans to reduce demand (Demand Side Management) to the tune of 3000MW by 2012 and 8000MW by 2026. This is, by far, the cheapest way of increasing reserve capacity. This is equivalent to two coal-fired power stations.



The contribution of renewable energy to Eskom's build plans to 2016 is negligible at a mere 100MW for a single wind farm. This strongly indicates that Eskom has no meaningful plans to use renewable energy as a resource.

Eskom's build beyond (worth roughly R750 billion) is best illustrated in the graph[iii] to the right. As this graph shows, Eskom has no meaningful plans to increase the percentage of renewable energy in the next two decades. There are, however, significant aspirations of a major increase in nuclear power stations from 2011 onwards, to a planned capacity of 20,000MW.

Eskom's own documentation clearly indicates it has no meaningful programme to invest in renewable technologies, and, instead, is relying upon coal, natural gas and nuclear power. This could be a costly economic mistake.

II. Renewable Energy Build Costs

With R1 trillion in projected new build costs, there has been scarce public and political debate on how that money should be spent. The prevailing opinion has been to leave that issue up to Eskom; even the National Energy Regulator of South Africa, at this year's public hearings into electricity price rises, refused to delve into this issue. This is surprising, as the electricity build programme dwarfs the 2010 World Cup and various arms purchases. This R1 trillion represents the taxable earnings of individual citizens, and should be invested wisely and only after full examination of the facts.

Liziwe McDaid, in cooperation with Sustainable Energy Africa, has crunched the numbers on Eskom's expansion plans up to 70,000MW of capacity at 2030, and then compared them with a build programme based upon progressive renewable energy strategy (45,000MW of renewables plus fossil fuels and energy efficiency).[iv] The results are startling; the renewable strategy and the fossil fuel strategy result in the same price tag. In other words, we can have wind and solar energy in place of coal-fired power stations for the same amount of money. This is not a choice between "expensive" and "cheap" energy, but between two alternatives; the first dependent on fluctuating fuel prices and causing environmental pollution, the other clean and with zero fuel costs.

Table Two compares the fossil fuel build programme with the progressive renewable build programme. As with all of the calculations in this SE Briefing, these figures exclude externalised costs. Table Two also predicts the cost of the fossil fuel programme if current CAPEX figures rise. This is a possibility that must be explored as the CAPEX figures for Medupi power station have already risen from R60 billion to R80 billion.

Table Two: Fossil Fuel vs. Renewable Build
Note: All costs in millions of Rand

	Business as usual scenario	Renewable energy and energy savings scenario	Business as usual with increased costs	Renewable Energy and Energy savings with decreased costs
Total MW capacity required to meet peak demand	70 000MW	56 000MW	70 000MW	56 000MW
Leftover existing capacity hydro and coal	23 762MW	23 762MW	23 762MW	23 762MW
New approved fossil	7 595MW	7 595MW	7 595MW	7 595MW
Extra fossil and nuclear requirements	49 143MW		49 143MW	
Renewable Energy New Build		45 630MW		45 630MW
Energy Efficiency Savings		14 000MW		14 000MW
Renewable Energy Costs (Millions of R)		R816 028		R718 105
Fossil and Nuclear Costs (Millions of R)	R1 058 188	R136 710	R2 846 459 952	R273 420
Energy Efficiency Costs (Millions of R)		R48 412		R48 412
Total Costs (Millions of R)	**R1 058 188**	**R1 001 150**	**R2 846 459 952**	**R1 039 937**

III. Unit Costs of Electricity in 2020

Establishing costs for energy into the future is a somewhat risky business; for example, the current oil price was not expected by most analysts two years ago, and, hence, has surprised the world. With this disclaimer stated, the table below summarises the estimated cost data known in South Africa for renewable energy by civil society. Two key texts are required reading for interrogation of these figures. They are:

1) D. Banks, et. al. 2006. “The Potential Contribution of Renewable Energy in South Africa”, available from Earthlife Africa Jhb

2) D. Holm, et. al. 2008. “Renewable Energy Briefing Paper”, available from Earthlife Africa Jhb

Table Three outlines costs by type with projected capacity reasonably possible. As Table Three indicates, the capital and running costs for most renewable energy sources will dip below that of fossil fuel costs by or before. This is an important consideration, as Eskom is currently building coal-fired plants with 60-year lives, and has yet to make any meaningful investment in the alternatives.

Table Three: Electricity Generation Costs Comparison

Note: Excludes Nuclear Power

Note: Projects Based on Progressive Renewable Strategy

Note: Fossil Fuel Peaking OCGT using diesel

Note: Excludes Externalised Costs

Type	Installed Capacity (MW) 2006	% of Total Install Capacity 2006	Installed Capacity (MW) 2020	% of Total Install Capacity 2020	Capital Costs (2006) in R/kWh	Est. Capital Costs (2020) in R/kWh	Unit Costs (R/kWh) 2006	Est. Unit Costs (R/kWh) 2020
Fossil Fuel Existing (Base), Coal	38209	92.66	35523	60.33	0	0	0.12	0.16 to 0.18
New Fossil Fuel (Base), Coal	0	0	5423	9.21	9600	9942	0.25	0.31 to 0.36
Fossil Fuel Existing (Peak)	660	1.6	0	0	0	0	1.6	
New Fossil Fuel (Peak)	0	0	3360	5.71	4500	4660	1.6	1.81 to 2.14
Pumped storage	1580	3.83	4910	8.34	8000	10000	0.18	0.23
Hydro (small, medium and large)	668	1.62	2422	4.11	site/type specific 3400-9000		0.34	0.31
Wind	0	0	3208	5.45	7700	8000	0.49	0.29
Solar Thermal	0	0	2000	3.4	15000	9390	0.4	0.25
Solar PV	12.1	0.03	580	0.99	32500	15849	1.5	0.73
Wave	0	0	100	0.17	15000	9390	0.4	0.29
Biomass (incl. Bagasse)	105	0.25	989	1.68	site/type specific 4820-40000	4042 to 33541	0.06 to 0.89	0.05 to 0.75
Landfill Gas	0	0	363	0.62	site/type specific 4886-10000	4244 to 8687	0.03 to 0.15	0.03 to 0.13

This latest research into pricing of electricity in the South African context clearly demonstrates this. The current cost of generating electricity from new coal-fired stations (such as Medupi) is

R0.25/kWh, set to rise to R0.36/kWh by 2020. The cost of solar thermal is currently at R0.40/kWh, and is set to decline to R0.25/kwh by 2020. The cost of wind is presently R0.49/kWh and will fall to R0.29/kWh in 2020. Solar thermal technology can provide base-load power, making it a viable alternative to coal, and there is no real limit to its usage in South Africa.

On this analysis, renewable technologies are the cost-effective alternative.

IV. An Overview of Nuclear Economics

The costs concerning nuclear power have four distinct elements: 1) Construction Costs, 2) Operating Costs, 3) Decommissioning Costs, and 4) Waste Storage Costs. All of these elements can prove to be perilous to South Africa's future, considering that the current plan is to increase nuclear power generation to 20,000MW, translating into 11 new Koeburg-type power stations. This is a large bill in and of itself, considering a new pressurised reactor could cost up to R100 billion to build alone. Fuel costs have doubled since 2005.

The only current nuclear build programme underway in South Africa is the build programme for the Pebble Bed Modular Reactor (PBMR) and the costs involved in this are illustrative of the financial risks inherent in nuclear power. In 1999, the PMBR (165MW) construction costs were budgeted at R2 billion rand. By 2005, these construction costs had risen by a factor of seven, to R14 billion without a single PBMR being constructed. These costs do not include the decommissioning costs. The costs for the PBMR are not efficient as Eskom is seeking finance of R5 billion to build a concentrated solar plant (100MW) in the Northern Cape; R14 billion for 165MW or R5 billion for 100MW, economic sense favours the solar plant.

In regards to traditional reactors being built in other countries (of which there are very few) the cost overruns of nuclear power are legendary. Areva, who built Koeburg and is bidding to build additional reactors in the Cape, is trying to build a new pressurised reactor in Finland. Last month, Areva announced that costs for that reactor have soared from €3 billion to €4.5 billion and the finish date has been pushed back from 2009 to 2011. The recurring trend within the industry in considerable cost overruns; in the USA, 75 reactors had combined initial construction budgets of US$45 billion, actual construction costs ran to US$145 billion. In India, the last ten reactors built averaged construction cost of 300% above budgeted costs.

Based upon the EIA for the PBMR Demonstration Reactor and the decommissioning costs for of the predecessor to the PBMR (German AVR), the costs to decommission a single PBMR range from R1.5 billion to R70 billion. It is nearly impossible, due to the lifespan of the reactor and the variable rates of contamination, to be more exact than this. Hence, the decommissioning costs of the PBMR are uncertain and could incur a heavy burden on future. The decommissioning costs for traditional pressurised reactors have the same uncertainty with estimates ranging from €290 million to €1.5 billion. The decommissioning of a plant takes up to 135 years.

And, then there are the waste storage costs, which are impossible to calculate due to the long-term nature of storing waste; uranium-235 has a half-life of 704 million years, plutonium-239 a half-life of 24,110 years, caesium a half-life of 30.2 years. These kind of timeframes defy economic planning.

Nuclear power is the most expensive option for power generation, and, worst of all, it is hard to nail down the exact costs due to a large number of variables. By perusing the nuclear option, the Department of Minerals and Energy and Eskom will be gambling with our economic future.

V. Concluding Remarks

This Sustainable Energy Briefing has attempted to outline the economics involved in the current expansion of the electricity sector. If there ever was a time for economic analysis in state expenditure, this is it.

In a way, we have three competing economic scenarios based on a mixture of practise, results and research. The first is to continue down the familiar path of coal-fired power stations. This is Eskom's current plan, and based on market costs this will be an increasingly expensive option. Coal will so no longer be the cheapest energy source.

The second path is to mix coal with nuclear technologies. This path, certainly favoured by ex-Minister Erwin, is fraught with dangers and could be, by far, the most expensive decision taken post-1994. As the outline of nuclear economics shows, the true costs of nuclear energy are virtually impossible to calculate, given that these costs will stay with us for thousands of years. Further, the cost overruns of nuclear energy are legendary.

The third path is a massive investment in renewable technologies. Not only will fuel costs and carbon emissions drop radically, this will be the cheapest form of energy available. However, this will require effort from all sectors of society. There is the additional benefit of positioning South Africa as the world leader in these technologies, with predictable economic benefits. Why shouldn't we be exporting solar thermal plants to the rest of world instead importing expensive equipment from France and America?

"The main constraints [to renewables] are neither resource availability nor techno-economics but a limiting mindset focussed on the supply-side, partial energy costing, low (indirectly subsidised) energy prices and short-term thinking favouring low initial costs. Dominance of the state-controlled power monopoly and the influence of vested interests (particularly of the minerals sector) on key stakeholders are exacerbated by a lack of awareness and informed leadership as well as a real shortage of person power. It is concluded that the most important constraint is not money, men, machines, materials or management, but the motivation, the inspired political will."—Jason Schaffler, 2008

Date of Publication Nov. 2008

[i] Table from Eskom's 2008 Annual Report, pg. 66.
[ii] Eskom Holding Ltd, "NEW BUILD PROGRAMME: REVISED CAPITAL EXPENDITURE FOR THE PERIOD 2007/8 TO 2011/12", 2007.
[iii] Graph from Eskom's 2008 Annual Report, pg. 70.
[iv] Liziwe McDaid, "How to ensure energy security for a future South Africa?", 2008, Draft Format, Sustainable Energy Africa