20

The Utilisation of Renewable Energy Sources to address the security of power supply challenges in South Africa

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Introduction

Mounting evidence of climate change and the concern over the sustainability of deriving energy from finite, carbon based resources that are being consumed at an exponential rate, has focussed the world's attention on energy efficiency and conservation as well as a quest for the large scale utilisation of renewable and regenerative energy sources.

These issues have not escaped the attention of the South African government –

- The white paper on renewable energy (November 2003), set a target of 10 000 GWh renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small scale hydro.
  The renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels.

- Electricity Regulation Act

  Where, amongst others, the objectives of the bill include:

  - The efficient, effective, sustainable and orderly development and operation of the electricity supply infrastructure in South Africa –
  - Promote the use of diverse energy sources and energy efficiency

These initiatives are driven by several important objectives -

- To 'clean-up' the energy environment in terms of CO_2 emissions
- To preserve mineral energy resources for future generations
- To improve the security of the electricity supply

This paper is intended to explore the degree to which renewable energy sources can be expected to contribute to the last objective – electricity supply security, in the South African context

Background

In the electrical energy sector, there are complex, time-related aspects that have an impact on the security of supply – presently the industry is characterised by both generation capacity and distribution network capacity constraints at all levels. This landscape will persist in the medium term as new generation plant and distribution infrastructure upgrades undergo construction, while a continued load growth of 3.2% per annum is expected.

The national generation reserve margin fell to below 7% in 2006, where the international norm to mitigate generation outage risks, considers a margin of 15% necessary. In response to this deficit, Eskom in conjunction with Municipal distributors have implemented load shedding plans to maintain an acceptable reserve margin in the event of generation emergencies.

This drastic measure, even of short duration, has a devastating impact on the economy and is used only as a last resort. It is anticipated that the load shedding plan will be in effect for the next five years.

In order to minimise the economic impact of forced load shedding, it is incumbent on the power distribution industry to execute such load shedding as deep into the network as possible, assigning priorities and discriminating between interruptible, non-essential, industrial, commercial and essential load circuits as far as is practically possible. This process can be automated by SCADA systems where such are installed, and in the eventuality that load shedding is required; such automation investment can quickly be justified.

There is a strong focus on Energy Efficiency and Demand Side Management interventions (EEDSM) in the industry at present, supported by the DSM funding mechanism and targeting load reductions in the order of 3000 MW by 2012.

The scope of this funding, originally focussing on direct electrical efficiency and load shifting interventions has been expanded to include an ambitious Solar Water Heating system, targeting one million installations over a five year period.

Renewable energy sources - part of the SA generation portfolio?

Without a means to store energy in the volumes that is required, the intermittent characteristic of particularly wind and solar energies will always place them at a disadvantage compared to hard, fossil fuel fired sources. In the northern hemisphere, both of these technologies are considered to make an independent average contribution of only 13 to 17% of their installed capacity towards 'reliable' generation capacity.

It is likely that in South Africa, a similar contribution can be expected from wind sources. In terms of solar, the average figure is likely to be significantly better, as we have of the highest solar insolation levels in the world. The problem however, is that there are on average 56 'overcast' days per year, in which case it is still expected that conventional electrical energy will be available to provide supplementary energy for water heating purposes, for example. The worst case scenario would be a large weather front covering the entire SA sub-continent for a few consecutive days.

This would add additional weather sensitivity to generation scheduling, and on these 'bad solar' days, generation capacity more or less equal to the capacity of the solar driven apparatus would be required at least as a 'reserve'.

So, do intermittent renewable sources alleviate or exacerbate reserve margin requirements? A key issue is to ensure that a diversity of renewable sources are included in the mix, and that the renewable plant is geographically well spread out. For example wind sources complement solar sources to a large degree – overcast days are usually accompanied by windy conditions, and in general, overcast conditions in the Cape often do not extend to the Highveld regions.

Experiences of countries with significant renewable resources

Germany has a significant proportion of installed wind turbine plant – a total of some 20 GW, where the national peak demand is in the region of 75 GW. It is not only the lack of wind that determines the intermittency – at the other extreme, too much wind requires that the plant be feathered to avoid damage, or reduce the back feed of power on the limited capacity rural networks opportunistically used to connect the plant to the national grid.

Wind conditions can change drastically within half an hour, and to ensure sufficient backup generation is available, a large proportion of coal-fired spinning reserve has to be maintained, in addition to fast reacting gas-fired plant. When asked about the complexities of generation scheduling in this environment, it was pointed out that the industry was getting very good at short term weather forecasting as a result – down to intensely focussed half hourly predictions when necessary.

New Zealand's approach has been to embrace wind energy to a large extent, strongly complemented with hydro resources, where such sources have sufficient storage capacity.

It has previously been noted that the South African generation portfolio is short of gas turbine peaking plant. Significant investment in OCGT plant is presently under way and, in the context of expanding renewable sources, will not become a stranded investment once additional base load generation is brought on line.

Solar Water Heating Systems – Distributor perspective

Large scale implementation of solar water heaters will inevitably result in significant revenue loss, but will also on average alleviate the load on the distribution network. The issue is that the supplementary energy requirements on bad solar days will still require a network designed for conventional geysers, and these networks will still need to be maintained, less a large portion of the revenue derived from this type of load.

These risks can be mitigated to a large degree by ensuring that limits are placed on the electrical element size, reducing the standing losses by improved insulation, correctly sizing the storage tank and utilising existing, centralised geyser control systems to specifically control the provision of supplementary energy to the mutual benefit of the distribution utility and the end-user.

Revenue loss can only be offset by utilities becoming directly involved in the implementation of solar water heating systems, either directly as a pay for service hot water supply utility or by offering maintenance services coupled with collective application of installed solar plant to earn CDF revenue.

Renewables – challenges

The renewable energy industry is in its fledgling stage at present, and faces several challenges -

- Funding sources and mechanisms
- Capacity to supply and install equipment
- Viability – top-up or feed-in tariffs for renewable energy, based on levies taking into account the production costs of the various sources
- Sustainability - An investment in a coal-fired power station would be specified to have a lifespan of at least 20 years, and the same should apply to renewable equipment, for example solar water heating interventions

Recommendation of the way forward -renewables

A diversity of sources must be considered:

- Wind resources
- Landfill gas opportunities
- Solar street lighting and traffic signals
- Hydro – small and large opportunities
- Wave energy – search for viable technologies

Conclusion –

Is the above sufficient to mitigate security of supply risks?

The answer could be no – then it would be prudent to do a re-examination!

On the other hand, when would be a good time to make a start?