

# **2<sup>nd</sup> National Biogas Conference 2015**

**Effective exploitation of the real value of biogas  
generated electricity due to its full  
dispatchability.**

Willem du Preez  
BBEnergy



# Dispatchability of Biogas generated power

- The biogas power generation industry is currently developing at such a slow pace, that it is unlikely that the potential of the resource will be exploited to a meaningful extent in the foreseeable future.
- The current electricity pricing levels for biogas do not reflect its most valuable component, which is the fact that biogas generated power is fully dispatchable
- This inherently higher value should be exploited by allowing it to compete for applications where its full dispatchability is a definite requirement, such as morning and evening peaking power.
- Biogas could be used to generate a large portion of the peaking power required and thereby effect very large cost savings for the country.
- A Time-of-day tariff for biogas generated electricity is required with a rate for peaking hours that is
  - sufficient to attract investors
  - substantially lower than the current rates during peaking hours for CSP with storage and OCGTs.



# Biogas generated electricity compared to CSP generated electricity

- CSP combined with Thermal Energy Storage (TES) enable CSP power stations to supply electricity even when there is no sun.
- For CSP this ability is limited, for technological and cost reasons, to the supply of electricity during the evening peak time. CSP technology does clearly not have the potential to provide a truly dispatchable renewable energy supply that is economically viable.
- In contrast to this, biogas generated electricity is a truly dispatchable renewable energy supply, since it can supply electricity on demand at any time of the night or day (i.e. 24/7).
- The energy is stored in the form of chemical energy of the biogas produced by anaerobic digesters and stored in gas holders, from where the gas is fed to the engine-alternators according to the load electricity demand.



# Cost of electricity generation at Eskom's diesel fuelled OCGTs

- The average cost of the diesel used to generate electricity is about R3.00/kWh. This is only the cost of the diesel. It does not include other production cost elements such as operating cost, maintenance, amortization and corporate overheads.
- During a briefing on 6 March 2014, former Eskom CEO Brian Dames stated that the diesel-fuelled power plants cost Eskom more than R10-billion to operate the previous year and were run at costs that were between 16 and 18 times more expensive than its coal plants.



# Time-of Day (TOD) tariff for CSP generated electricity

- To encourage CSP with storage to generate energy during peak time, the Department of Energy (DoE) introduced an incentive in the form of a Time-of-Day (TOD) tariff. A base tariff applies during the day and a higher tariff will be applied for supplying energy during peak.
- A generator supplying energy during the peak time between 16h30 and 21h30 will get 270% of the base tariff, while there is no payment for supplying energy at night.
- Prices for the CSP projects awarded during the latest bidding round was R1.46/kWh (fully indexed, April 2011 base year). Fully indexed to October 2014 the price is about R1.80/kWh. The price for power delivered during the peak demand hours will be R4.85 /kWh.



# Utility scale generation during both morning and evening peak hours

- To be useful to Eskom, the scale of the power delivered during the peak times must be large enough (utility scale).
- It is not the size of the individual energy storage units that is decisive, but the scale of the generation during both morning and evening peak hours.
- Whether the energy is stored in large chunks in a few remote locations (using very complex and expensive technology) or whether it is stored in a relatively large number of smaller units distributed over the Eskom network and using simple, inexpensive and very well proven technology, is not the issue.
- It is the dispatchability, cost and scale of the generation that determines the inherent value of the generation for Eskom. >

6

# Potential for biogas electricity generation in South Africa

- According to a recent study by the Energy Research Group at UCT, the total biogas generated electricity potential for the country is about 2300 MWe (continuous generation, 24/7)
- The combined total nominal capacity of Eskom's Ankerlig and Gourikwa open cycle gas turbine power plants is 2067 MWe)
- If the South African biogas industry has to deliver 2000 MWe only during the morning (07h00–10h00) and evening (17h30-21h30) peak demand hours, i.e. 35 hours per week, the equivalent continuous generating capacity required would be 417 MWe which is only 18.1% of the 2300 MWe available.
- If the 2000 MW had to be delivered only during the morning peak hours (15 hours per week), the equivalent continuous generation capacity required will be 179 MW or 7.8% of the available potential.



# Distributed generation and grid stability

- Large scale biogas power generation as contemplated above, is a very good example of distributed generation. It has the advantage of lower transmission costs compared to CSP generation in a few remote locations
- The distributed generation factor coupled with the truly dispatchable nature of biogas electricity, will also help to improve network stability.
- With fluctuating capacity, inherent to most renewable energy technologies, addressing grid stability will become a very high priority concern.
- The TOD tariff introduced by the DoE for CSP recognizes the intrinsic value of storage for shifting generation in order to meet demand.
- The fact that biogas electricity generation, in contrast to CSP, is fully dispatchable, gives it a higher intrinsic value than that of CSP generation.



# Plant capital cost and economic performance as a function of generation capacity

<b>Methane production per day by digester (Nm<sup>3</sup> CH<sub>4</sub>/d)</b>	<b>1013</b>	<b>2026</b>	<b>4052</b>
<b>Continuous net power generation potential (kW)</b>	<b>100</b>	<b>200</b>	<b>400</b>
<b>Generation capacity during 35 hrs peak generation per week only, during weekdays (kW)</b>	<b>480</b>	<b>960</b>	<b>1920</b>
<b>Digester cost (Rmillion)</b>	<b>4.4</b>	<b>6.6</b>	<b>10</b>
<b>CHP house cost (Rmillion)</b>	<b>10</b>	<b>17</b>	<b>30</b>
<b>Gas holder cost (Rmillion)</b>	<b>2</b>	<b>4</b>	<b>8</b>
<b>Total plant cost (Rmillion)</b>	<b>16.4</b>	<b>27.6</b>	<b>48</b>
<b>Specific capital cost of generation ( R / kW)</b>	<b>34167</b>	<b>28750</b>	<b>25000</b>
<b>Debt ratio (%)</b>	<b>50%</b>	<b>70%</b>	<b>70%</b>
<b>Loan term (yrs)</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>Peak time electricity tariff (c/kWh)</b>	<b>380</b>	<b>320</b>	<b>280</b>
<b>IRR (%)</b>	<b>17.3%</b>	<b>31.7%</b>	<b>40.2%</b>



# Sustainability of electricity generation in South Africa

- The country needs environmentally sustainable ways of generating electricity, without long term dependence on burning of fossil fuels with its associated carbon emissions.
- The country is seeking ways to ensure that 'the lights stay on' (security of supply) while managing growing demand and old generating capacity shutting down, which can be exacerbated by the intermittency of renewable generation.
- Affordability of electricity is crucial since increasing electricity prices have the potential to disrupt economic growth.
- Renewable and low carbon forms of generation have a vital role to play in the sustainability effort, and in security of supply. Of the renewable technologies, hydro-powered and geothermal resources are effective, but in South Africa their application is limited by geographical constraints. The key focus for renewables deployment in South Africa in a 2030 timeframe is wind and solar generation.



# Integrating intermittent sources of power generation into the grid

- » Wind and solar forms of energy are intermittent in nature – their output fluctuates as a result of weather conditions.
- » Electricity storage technologies are either not yet commercially developed, or are not available in all areas (such as forms of hydropower), so levels of generation output need to be actively balanced with levels of consumption on a second-by-second basis. At present this is mostly achieved by flexing the output of controllable sources of electricity generation (such as coal, gas, etc)
- » System operators hold flexibility in reserve to cover disturbances in the balance of supply and demand such as surges in demand, or for back-up in case of the failure of a large plant.
- » The impact of large amounts of intermittent renewables on systems will need to be handled in a similar way, though it is widely accepted that the task of balancing wind and solar generation will be far more significant in future.
- » Flexible forms of energy must be able to ramp their output at the same rate that wind and solar output fluctuates, so that a balance can be maintained.

# Part loading conventional power plants to ensure that they can provide flexibility

- At present many systems rely on CCGTs, or existing coal plant, to provide flexibility. As these plants cannot typically provide flexibility from standstill, they often need to be ‘part-loaded’.
- However, while this may have been practical in the past for providing small amounts of flexibility from existing generating resources, it is questionable whether such practices will be efficient for integrating renewable generation in the future.
- The practice of part-loading conventional power plants to ensure that they can provide flexibility is inefficient and therefore costly.
- The renewables back-up generation capacity, which is required in addition to the normal grid reserve capacity, is also very expensive and under utilized.



# Smart power generation

- Instead of focussing on part-loaded conventional generation to provide the increased flexibility requirement in the future, the electricity markets are likely to embrace new forms of flexible generation, such as forms of Smart Power Generation (SPG).
- SPG is a set of requirements that future generators must be able to deliver to enable the transition to a modern, sustainable power system. These are:
  - The need for very high efficiency,
  - The need for outstanding operational flexibility, and
  - The need for multi-fuel operation.
- For today's emerging low-carbon power systems, these requirements allow balancing of large fluctuations of wind and solar power.
- They also provide for high efficiency baseload, peaking, and load-following power, as well as super-fast and versatile grid reserves on a national power system level.

# Commercial power plant technologies developed to meet SPG requirements

- There are commercial power plant technologies available today that have been developed to deliver against the SPG principles to enable sustainable, reliable and affordable power systems.
- They are a form of highly flexible and efficient power plants based on reciprocating engines, covering a capacity range of about 1 to over 500 MW.
- They can run on the best buffer fuel available : hydrocarbon gas under pressure in pipelines and storage systems. The two predominant gasses used for this are natural gas and biogas.
- Biogas, unlike natural gas, is a renewable fuel. It is carbon neutral and have zero net emissions of carbon when combusted with air.
- While less than that of coal, natural gas produces significant carbon emissions when combusted with air.
- Another factor in favour of biogas in the South African context, is that the country has virtually no indigenous natural gas resources. Importation of natural gas, whether by gas pipeline from Mozambique or Namibia, or as liquefied natural gas in LNG tanker ships or trucks, is very expensive.

# Biogas enables the large scale use of wind and solar

- It was mentioned that the potential in South Africa for electricity generation from organic wastes in biogas plants exceeds 2000 MW continuously.
- Such an amount of flexible power generation will make a large contribution to the integration of intermittent renewables into the national grid.
- It seems inevitable that policy makers will come to realize the importance of this role and set prices for biogas at a level that reflects its real value.
- By enabling the large scale use of relatively low cost intermittent renewables, i.e. wind and solar, the biogas industry will make a very important contribution to improving the affordability of electricity in South Africa.

# Conclusion

- **Biogas power generation can provide peaking power at a reduced cost compared to CSP with storage and OCGTs.**
- **Biogas power generation will enable the large scale use of low cost intermittent renewables**
- **As a result it will contribute to keeping the price of electricity lower.**
- **Large scale use of biogas resources will contribute substantially to economic development and job creation, also in the rural areas**
- **Biogas power generation is a prime example of distributed power generation with its many advantages**
- **It is a challenge to set up appropriate legal, regulatory, licensing, grid access , etc. procedures. But that is a much smaller challenge than the challenge of actually designing, constructing ,operating and maintaining the potential dispatchable generating capacity provided by biogas.**