The business case for biogas from solid waste in the Western Cape

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Organisation: The GreenCape Sector Development Agency

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Presentation Overview

1. Motivation and scope
2. South African and Western Cape biogas context
3. Drivers and challenges
4. Western Cape case studies
5. Financial viability and sensitivity analysis
6. Conclusions
Motivation

- **GreenCape**
  - non-profit sector development agency that supports and promotes the green economy

- **Biogas business case document:**
  - identify conditions for successful uptake and operation of anaerobic digestion (AD) installations
  - provides insight on factors affecting financial viability and assists stakeholders
    - developers: insight to which clients would be most suitable to approach with their business model / design
    - potential clients: basic understanding of about suitability and financial viability of biogas installation in their contexts
  - current focus: application of biogas for electricity generation or co-generation only; Western Cape
Current South African biogas market

- Innovators: 2.5%
- Early Adopters: 13.5%
- Early Majority: 34%
- Late Majority: 34%
- Laggards: 16%

Rogers, E.: Diffusion of Innovation
Biogas in the Western Cape
Potential for electricity generation

DEA (2015)

<table>
<thead>
<tr>
<th>Residue source</th>
<th>Electricity Potential (MWe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit processing</td>
<td>8</td>
</tr>
<tr>
<td>Brewery</td>
<td>14</td>
</tr>
<tr>
<td>Abattoir</td>
<td>49</td>
</tr>
<tr>
<td>Pulp/paper</td>
<td>268</td>
</tr>
<tr>
<td>Municipal wastewater</td>
<td>281</td>
</tr>
<tr>
<td>Agriculture</td>
<td>533</td>
</tr>
<tr>
<td>Sugar production</td>
<td>1252</td>
</tr>
<tr>
<td>Municipal solid waste</td>
<td>1473</td>
</tr>
<tr>
<td>SA Total</td>
<td>3878</td>
</tr>
<tr>
<td>Western Cape Total</td>
<td>388</td>
</tr>
</tbody>
</table>
## Market potential in Western Cape

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Potential Western Cape benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment</strong></td>
<td>R4 billion – R13 billion (€280 m – €933 mil)</td>
</tr>
<tr>
<td><strong>Job creation</strong></td>
<td>320 – 3 950 direct jobs (389 – 6 300 jobs including indirect &amp; induced)</td>
</tr>
<tr>
<td><strong>Electricity generation</strong></td>
<td>87 – 395 MWe</td>
</tr>
<tr>
<td><strong>Greenhouse gas emission reduction</strong></td>
<td>471 900 - 1 540 000 tCO₂e/yr ⁶</td>
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</table>
Current South African biogas market

<table>
<thead>
<tr>
<th>Market Drivers</th>
<th>Market Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Energy security</td>
<td>• High capital costs</td>
</tr>
<tr>
<td>• Energy affordability and cost savings</td>
<td>• Nascent industry</td>
</tr>
<tr>
<td>• Legislative pressure</td>
<td>– Lack of operational skills and expertise</td>
</tr>
<tr>
<td>– More stringent organic waste management regulations</td>
<td>– Lack of familiarity with biogas</td>
</tr>
<tr>
<td>• Successful, demonstrative plants</td>
<td>• Long payback periods</td>
</tr>
<tr>
<td></td>
<td>• Digestate management</td>
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<tr>
<td></td>
<td>• Grid feeding regulations</td>
</tr>
<tr>
<td></td>
<td>• Low cost of landfill</td>
</tr>
</tbody>
</table>
South African case study examples

Source: Bio-based Hierarchy, Netherlands Study Tour (2015)
## South African case study examples

<table>
<thead>
<tr>
<th>Case study example</th>
<th>Zandam Cheese &amp; Piggery</th>
<th>Uilenkraal Dairy</th>
<th>New Horizons Energy - Athlone</th>
<th>Elgin Fruit Juices</th>
</tr>
</thead>
</table>
| **Process Overview** | • Pig manure feedstock  
  • 75 kWe base  
  • 100 kWth average | • Cow manure feedstock  
  • 500 kWe capacity  
  • 2 x 250 kW CHPs | • MSW feedstock  
  • 500 – 600 t/day of which 200t/day organics  
  • MRF (organics, recyclables & other) | • Mixed organic waste (off spec fruits & veg)  
  • 527 kWe  
  • 500 kWth (at max capacity) |
| **Investment & Financing** | • R 8.5 million (CAPEX) – 1:1  
  • Renting & electricity supply agreement | • R 11 million (CAPEX) – 2:1  
  • Electricity supply agreement with 10 year ROI | • R 400 million (CAPEX) – shared  
  • 30% - gas treating  
  • MRF costs | • R 20 million (CAPEX) by site owner |
| **Challenges** | • Grid feed in  
  • Manure slurry only 6% solids | • Grid feed in  
  • Crusting due to straw in feedstock | • RDF quality  
  • Volume of liquid digestate | • Grid feed in  
  • Odour  
  • Digestate management |
| **Benefits** | • Electricity & heating cost savings  
  • Reduced carbon footprint | • Meets 95% electricity requirements  
  • Animal bedding | • 760 Nm³/h CH₄  
  • 740 Nm³/h CO₂  
  • Recyclables, RDFs & digestate | • 500 kg/h steam at 10 bar  
  • Electricity & heating cost savings  
  • Centralised waste management solution |
What made the business case?

Key conditions (based on case studies)

- Consistent volume of feedstock
- Waste management costs
- On-site use for electricity and heat energy supplementation

Additional factors
- Higher value product – Gas (CH$_4$, CO$_2$) compression and bottling
- Management of digestate stream (cost for disposing or value add product)
- Available skills capacity
## Business Case

### Prefeasibility tool

**Inputs**

- Feedstock type
- Feedstock amount
- Electricity tariff
- Logistics (mass, distance)
- Gate fee
- Financial variables (inflation, loan/equity split, interest rate)

**Outputs**

- Capital cost
- Operating costs
- Electricity production
- Heat production
- Financial indicators (PBP, IRR, NPV, LCOE)
Financial viability assessment and sensitivity

Scenarios

- **Scenario A**: A small-scale, commercial biogas installation
  - Not financially viable, even under optimistic conditions

- **Scenario B**: A medium size, red meat abattoir biogas installation
  - B1: No waste disposal cost
  - B2: High waste disposal cost
  - B3: Lower waste disposal cost, lower electricity price and extent of provision of on-site heat needs
Scenario B: results of sensitivity analysis

<table>
<thead>
<tr>
<th>Size (kW)</th>
<th>Scenario B</th>
<th>IRR</th>
<th>NPV</th>
<th>Required size for viability (NPV &gt; 0, IRR &gt; 15%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>Case B1</td>
<td>11%</td>
<td>-R2.7 million</td>
<td>&gt;575 kW</td>
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<tr>
<td></td>
<td>R1.00/kWh</td>
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<td></td>
<td>Free disposal</td>
<td></td>
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<td></td>
<td>100% electrical and thermal (coal) usage</td>
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<td>125</td>
<td>Case B2</td>
<td>7%</td>
<td>-3.9 million</td>
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<td>R1.00/kWh</td>
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<td>R500/ton gate fee + 30km logistics</td>
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<tr>
<td></td>
<td>100% electrical and thermal (coal) usage</td>
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<tr>
<td>250</td>
<td>Case B3</td>
<td>46%</td>
<td>R28 million</td>
<td>&gt;40 kW</td>
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<td></td>
<td>R0.80/kWh</td>
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<td>R200/ton gate fee + 10km logistics</td>
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<tr>
<td></td>
<td>100% electrical, 50% thermal (coal) usage</td>
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<tr>
<td>125</td>
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<td>34%</td>
<td>R11 million</td>
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<td>20%</td>
<td>R4 million</td>
<td>&gt;140 kW</td>
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<td>14%</td>
<td>-R0.47 million</td>
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Conclusions
Insights from the viability assessments

- Scale and waste management costs play a key role in determining the viability of a biogas installation
- Small-scale commercial biogas facilities (<50 kWe)
  – Not considered financially viable under current landfill disposal costs and energy costs
- Medium size biogas facilities at abattoirs (>50 kWe; <1MW)
  – Financially viable at the middle to higher end of the scale
  – When waste management costs (gate fees, logistics costs) are high
  – Current energy prices and high full utilisation of energy on-site
- Waste management costs could be a stronger driver for biogas installations in South Africa than energy savings
Conclusions

Insights from case studies

- Failure of projects has primarily been due to unfavourable cost-benefit ratio - particularly when electricity generation was not utilised or insufficient scale

- Success drivers a result of a variety of models
  - Feedstock
  - Utilisation of energy for heat and electricity
  - Off-take of products

- Common challenges
  - Waste collection and separation
  - Lignocellulosic contaminants
  - Grid feed-in
  - Odour
  - Digestate management
  - Skills and training
Next steps forward

For document:

- Distribution of biogas business case document to developers and organic residue generators
- Also available from GreenCape’s website.

Further work

- Expand identification of success conditions:
  - alternative value-add products
  - wider South African context
- More in-depth look at financing of biogas installations
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