CSIR Energy Autonomous Campus Biogas Project

Presented at Crowne Plaza Hotel, Nairobi Kenya

2 March 2018
The CSIR is South Africa’s multidisciplinary research council

- The CSIR’s Executive Authority is the South African Minister of Science and Technology

In numbers:

- 72 yrs: 1945 - 2017
- Total staff: 2,668
- SET base with PhD: 350
- Publication equivalents: 490
- Total operating income: ~$200 m
- Total in SET base: 1,980

Based on 2015/16 forecast
Content

• What is biogas
• Benefits of biogas
• Current S.A. bioenergy market
• Biogas installations in S.A.
• Current installed capacity
• Market drivers and barriers in S.A.
• Status Qou: Promoting biogas development
• Overview of CSIR EAC projects
• Potential partnerships
What is Biogas

• Biogas is a renewable source of energy that belongs to the category of biofuels.
• It is made by the natural fermentation process by using organic materials.

• Biogas can be used to:
  ➢ Light homes and buildings
  ➢ Cook
  ➢ Run generators and make electricity
  ➢ Vehicle fuel
Benefits of Biogas

- Sustainable Waste Management
- Stimulates Local Manufacturing
- Skills Transfer
- Job Opportunities
- Carbon Mitigation
- Thermal Energy
- Digestate as Fertilisers
Current S.A. bioenergy market

- Limited potential for bioenergy.
- Most attractive sources are organic waste and invasive alien plants (IAP).
- IAPs can be supplemented by agricultural, plantation and sugar cane field residues.
- Paper and pulp mill residues, sawmill residues and sugar cane bagasse are already used to generate power.

*source: Bioenergy Atlas for South Africa*
Biogas Installations in S.A.

- 300-500 digesters country wide
- Domestic/residential digesters: Cooking, lighting and sanitation.
- Small scale/medium-commercial digesters: use of gas directly and generation of electricity.
- Large scale digester: for industrial purposes
- ~10 biogas installations larger than 1MW
Current Installed Capacity

Approximate total current installed capacity = 15 MW

*source http://www.biogasassociation.co.za/biogas-info-hub/projects-map
Market drivers and barriers in S.A.

- Energy Security
- Energy affordability
- Cost Savings
- Legislative Pressure
- Successful, demonstrative plants

- High capital costs
- Marginal financial viability
- Prohibitive perceived risk from financiers
- Restrictive legislation (licences, EIA, etc.)
- Lack of operational skills
- Lack of familiarity with biogas
- Long payback periods
- Digestate management
- Grid feed-in regulations
Status Qou: Promoting biogas development

- Creation of South African Biogas Industry Association (SABIA)
- Active marketing/raising awareness of biogas
- National biogas platform plus working groups
- Discussions with Independent Power Producer (IPP) office
- Proposed amendments on restrictive legislation
CSIR Energy-Autonomous Campus in Pretoria: Real-world implementation of a least-cost, renewables-based microgrid
Real-world research platform for cost-efficient future energy systems based on renewables, the CSIR “Energy-Autonomous Campus”

**Potential future of CSIR’s energy mix**

**Demand**
- **Load:** 24 GWh/yr → 20% reduction through energy efficiency (today: 30 GWh/yr)
- **Load mgmt.:** Flatten residual load, peak shaving, incl. eCars

**Supply**
- **PV:** All CSIR rooftops, 1-2 ground-mounted plants
  - Total of 8 MWp → 12-13 GWh/a
- **Wind:** 1 or 2 MW-class wind turbines
  - Total of 3 MW → 5-6 GWh/a
- **Biogas:** Municipal solid waste and/or organic waste from surrounding supermarkets/restaurants
  - 5 MW @ 1,000-1,200 h/a → 5-6 GWh/yr
- **Im-/export:** Trading with other CSIR campuses

**Storage**
- **Power-to-H2:** For long-term storage and fuel production
- **Batteries:** For short-term peak shaving
- **Heat storage:** For flattening of heat/cold demand

Sources: CSIR analysis
Pre-feasibility study outcomes

- Maximum of 6MW.
- Combined Heat Power (CHP).
- Approximate footprint size of 16 000m²
- 100 000 t/a of mixed waste.
- ~65% organic content.
- Produce 21 000 t/a of dry organic compost & 39 000t/a of RDF.
- Significant amount of wet commercial waste available.
- Location: CSIR campus
Biogas Plant Location
Feedstock Study Boundary

Gauteng Province

Study boundary for the CSIR biogas feedstock availability study

- Urban Commercial 2014
- Urban Industrial 2014
- Urban residential 2014
- Cultivated commercial pivot 2014
- Cultivated commercial fields 2014
## Study Boundaries for CSIR waste sources

<table>
<thead>
<tr>
<th>Included in the study</th>
<th>Excluded from the study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agriculture-derived (dry and wet waste)</strong></td>
<td>Non-agriculture-derived (food, drink and processing residues)</td>
</tr>
<tr>
<td>Fruit and vegetable farms</td>
<td>Food manufacturing facility/factory (food processing facilities, breweries, bakeries)</td>
</tr>
<tr>
<td></td>
<td>Zoological facilities</td>
</tr>
<tr>
<td>Animal and chicken farms</td>
<td>Retail facilities (shopping centers, food department stores, fresh produce markets)</td>
</tr>
<tr>
<td></td>
<td>Hospitality facilities (hotels and restaurants)</td>
</tr>
<tr>
<td></td>
<td>Garden waste collected from estates and other sources</td>
</tr>
<tr>
<td></td>
<td>Waste from abattoir</td>
</tr>
<tr>
<td></td>
<td>Sewage waste</td>
</tr>
<tr>
<td></td>
<td>Waste source that the CSIR biogas project would compete with other biogas projects around</td>
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</tbody>
</table>
Biogas Feedstock Outcomes Challenges

Waste Management
- Volumes of waste not always kept in track.
- Lack of capacity to sort at source or intermediate site.

Agricultural Waste
- Waste does not get disposed to landfills.
- Waste utilised on farm for composting.
- Waste provided to third party.
- Small scale farms do not generate significant volumes.

Food Manufactures
- Strict food regulations.
- Contracts with waste management service providers.
- Zero to landfill initiatives or recycling.
- Insignificant waste volumes.

Retail Facilities
- Volume is dependable on size of store.
- Waste available is food that have reached sell date.
- Waste picked by waste collection company.
- Organic waste streams were larger at fruits & vege outlets.

Zoological & Botanical
- 90% of organic waste goes towards composting.
- Carnivore droppings are sent to incinerators.
- Some compost sold.
- Insignificant volumes of organics are generated from onsite restaurants.

Schools & Hospital
- Waste collected by waste management service providers.
- Recycling initiative for other waste.
Volumes of waste are accessible not necessary available.
## Potential volume of organic feedstock

<table>
<thead>
<tr>
<th>Name</th>
<th>Comments/explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>Food waste and garden waste</td>
</tr>
<tr>
<td></td>
<td>• Suitable, available and sustainable</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>All suitable sources</td>
</tr>
<tr>
<td></td>
<td>• All waste sources that are suitable, available and sustainable, regardless of the costs associated with acquisition</td>
</tr>
</tbody>
</table>
## Potential volume of organic feedstock cont...

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1</th>
<th>Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary – supply per annum (t)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anchor sources</td>
<td>14,915</td>
<td>42,275</td>
</tr>
<tr>
<td>Secondary sources</td>
<td>2,490</td>
<td>2,490</td>
</tr>
<tr>
<td>Tertiary Sources</td>
<td>587</td>
<td>648</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>17,992</strong></td>
<td><strong>45,414</strong></td>
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</tbody>
</table>

|                       |            |            |
| **Summary – breakdown per primary, secondary and tertiary sources** |            |            |
| Anchor sources        | 82.9%      | 93.1%      |
| Secondary sources     | 13.8%      | 5.5%       |
| Tertiary Sources      | 3.3%       | 1.4%       |
| **TOTAL**             | **100%**   | **100%**   |

|                       |            |            |
| **Summary – per day (t)** |            |            |
| Anchor sources        | 40         | 114        |
| Secondary sources     | 7          | 7          |
| Tertiary Sources      | 2          | 2          |
| **TOTAL**             | **49**     | **123**    |
Unit costs per scenario

**Scenario 1**
- Unit cost about R1.06/kWh
- Operating expenses could further increase the cost of electricity generated

**Scenario 2**
- Unit cost about R4.75/kWh
- Higher unit costs per tonne
- Potential to increase the electrical energy capacity
- Not financially feasible
Environmental Impact Assessment Process

Purpose: to identify, investigate, assess and report the impact and consequences of the biogas project on the environment.

• Specialist studies completed i.e. air quality, traffic, heritage etc.
• Background Information Document (BID) completed.
• Opportunity and constraints analysis requirements draft report completed.
Purpose: to design and determine the viability of the proposed project by providing a high level business model.

- Technical design of the plant
- Support the development of the EIA.
- Funding model
- Construction of plant planned for 2020 and commissioning in 2021.
CSIR Biogas

1MW

Peaking plant, 6h/day

Sell by-products

Heat

Sell gas
Potential Partnerships

Funding

• Donor funding for feasibility studies
• Capital funding for developing projects (preferential rates)

Skills transfer

• Collaboration with British biogas companies
• Formal training programmes
• Provide Biogas expertise as the UK is one of the leading countries in the Biogas technology
• Assistance in advancing biogas research in SA
THANK YOU