Availability and viability of small on-farm biogas plants

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Task 37 – Energy from biogas
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## Context

Estimated feedstock potential for biogas production – EU 27:

<table>
<thead>
<tr>
<th>Origin</th>
<th>Theoretical potential [Mtoe]</th>
<th>Used until 2020 [%]</th>
<th>Realistic potential [Mtoe]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural crops</td>
<td>23.3</td>
<td>100</td>
<td>23.4</td>
</tr>
<tr>
<td>Agricultural by-products (straw, manure, ...)</td>
<td>27.2</td>
<td>28</td>
<td>7.9</td>
</tr>
<tr>
<td>Waste</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodegradable fraction of municipal solid waste (including biowaste), landfill gas</td>
<td>8.6</td>
<td>40</td>
<td>3.4</td>
</tr>
<tr>
<td>Biodegradable fraction of industrial waste (including paper, pallets, ...)</td>
<td>2.6</td>
<td>50</td>
<td>1.3</td>
</tr>
<tr>
<td>Sewage sludge</td>
<td>5.1</td>
<td>66</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Total: 66.8 [Mtoe] Used until 2020: 59 [%] Realistic potential: 39.5 [Mtoe]

*(Based on AEBIOM, 2009)*
Context

Investment costs for biogas plants

![Graph showing investment costs for biogas plants.](image-url)
Objectives

- Illustrate existing technologies for small-scale plants & possibilities to reduce investment costs
- Necessary and favourable framework conditions
- Management and operation to improve economic viability

→ More successful small-scale biogas projects - new agricultural branch, rural development, improved waste and fertiliser management
→ Renewable energy production and reduction of GHG emission - exploitation of the huge agricultural potential
Principal small-scale concepts

CSTR – Continuously Stirred Tank Reactors
Principal small-scale concepts

Garage reactors
Principal small-scale concepts

Plug-flow reactors

(Source: schmack-biogas.viessmann.com/)
## How to choose?

<table>
<thead>
<tr>
<th>Key parameter</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reactor type</strong></td>
<td></td>
</tr>
<tr>
<td>Dry matter content of</td>
<td>CSTR for liquid substrates</td>
</tr>
<tr>
<td>feedstock</td>
<td>Plug-flow or batch digester for solid substrates</td>
</tr>
<tr>
<td><strong>Reactor temperature</strong></td>
<td></td>
</tr>
<tr>
<td>Risk for pathogens</td>
<td>Mesophilic temperature when no risk for pathogens</td>
</tr>
<tr>
<td></td>
<td>Thermophilic temperatures when risk for pathogens (organic house waste)</td>
</tr>
<tr>
<td><strong>Number of phases</strong></td>
<td></td>
</tr>
<tr>
<td>Composition of</td>
<td>One phase systems when no acidification risk</td>
</tr>
<tr>
<td>substrates, acidification risk</td>
<td>Two-phase system for substrates with a high content of sugar, starch or proteins</td>
</tr>
<tr>
<td><strong>Agitation system</strong></td>
<td></td>
</tr>
<tr>
<td>Dry matter content of</td>
<td>Mechanical agitators for high solids concentration in the digester</td>
</tr>
<tr>
<td>feedstock</td>
<td>Mechanical, hydraulic or pneumatic agitation systems for low solids concentration in the digester</td>
</tr>
</tbody>
</table>
Viability of small-scale plants

Framework conditions

Local framework:
- Farm and surroundings

Legislative framework:
- Administrative procedure, state support

Institutional framework:
- Plant constructors, engineering offices, banks

Plant management

Economic viability of small-scale plants

- Feedstock management
- Operation control
- Digestate and energy management
Local framework

...and energy management
Feed-in tariffs

As an effective state support instrument

reserved for small-scale plants (<100 kW)
Example of economics

CHP 45 kWe

Total: 430’000 €

> 9’000 € / kW_{installed}!
Economics – Plant operation

Example - CHP 45 kWel

- Work load
- Interests
- Amortisation costs
- Electricity sales
- Savings heating
- Gate fee

Benefit: 9’000 €/a

Example from Switzerland

- 80% borrowed capital
- 4.5% interest rate
- 60 CHF/t gate fee
- Feed-in tariff: 40 €ct/kWh
Conclusions

Availability

- Vast technological options
- Many new plant suppliers – references must be checked carefully
- Don’t choose the cheapest option, but the most adequate for your situation

Viability

- Good framework conditions are necessary
- Careful evaluation
- Full energy recovery - creative solutions are often beneficial!
Thank you for your attention!