Biogas Utilization

..more than CHP

Berry de Jong (CCS)
Small scale gas utilization techniques
Content

1. Energy on the farm
2. Combined Heat & Power
3. Heat
4. Biogas
5. Biomethane
   1. Fuel
   2. Grid
6. Other

BioEnergy Farm
## Energy use on the farm

<table>
<thead>
<tr>
<th>Energy use per animal</th>
<th>Electricity (kWh)</th>
<th>Electricity (MJ)</th>
<th>Natural Gas (m³)</th>
<th>Natural Gas (MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milking cows</td>
<td>456</td>
<td>1634</td>
<td>16,7</td>
<td>525</td>
</tr>
<tr>
<td>Sows</td>
<td>182</td>
<td>654</td>
<td>43,5</td>
<td>1375</td>
</tr>
<tr>
<td>Pigs for meat</td>
<td>37</td>
<td>136</td>
<td>3</td>
<td>94</td>
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<tr>
<td>Laying hens</td>
<td>3,1</td>
<td>11</td>
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<td>0</td>
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</tbody>
</table>

Source: based on *Energiebesparing en – benchmark in de agrarische sector*’ AgentschapNL 2011
## Energy use on the farm (2)

<table>
<thead>
<tr>
<th></th>
<th>Farm size</th>
<th>Electricity (kWh)</th>
<th>Electricity (MJ)</th>
<th>Natural Gas (m³)</th>
<th>Natural Gas (MJ)</th>
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</thead>
<tbody>
<tr>
<td>Milking cows</td>
<td>100</td>
<td>45,600</td>
<td>163,400</td>
<td>1,670</td>
<td>52,500</td>
</tr>
<tr>
<td></td>
<td>300</td>
<td>136,800</td>
<td>490,200</td>
<td>5,010</td>
<td>157,500</td>
</tr>
<tr>
<td>Sows</td>
<td>500</td>
<td>91,000</td>
<td>327,000</td>
<td>21,750</td>
<td>687,500</td>
</tr>
<tr>
<td></td>
<td>1,000</td>
<td>182,000</td>
<td>654,000</td>
<td>43,500</td>
<td>1,375,000</td>
</tr>
<tr>
<td>Pigs for meat</td>
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<td>37,000</td>
<td>136,000</td>
<td>3,000</td>
<td>94,000</td>
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<tr>
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<td>5,000</td>
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</tr>
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<td>Laying hens</td>
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<td>165,000</td>
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</tr>
<tr>
<td></td>
<td>30,000</td>
<td>93,000</td>
<td>330,000</td>
<td></td>
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</tr>
</tbody>
</table>

Source: based on *Energiebesparing en – benchmark in de agrarische sector* AgentschapNL 2011
# Energy use vs energy potential on the farm

<table>
<thead>
<tr>
<th>Farm size (# animals)</th>
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<th>Farm size (# animals)</th>
<th>Farm size (# animals)</th>
</tr>
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<td>Farm size (# animals)</td>
</tr>
<tr>
<td>Milking cows</td>
<td>100</td>
<td>300</td>
<td>45,600</td>
<td>107,500</td>
<td>1,670</td>
</tr>
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<td>136,800</td>
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<td>375,000</td>
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<td>5,010</td>
</tr>
<tr>
<td>Sows</td>
<td>500</td>
<td>1,000</td>
<td>91,000</td>
<td>63,000</td>
<td>21,750</td>
</tr>
<tr>
<td></td>
<td>182,000</td>
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<td>145,000</td>
<td></td>
<td>43,500</td>
</tr>
<tr>
<td>Pigs for meat</td>
<td>1,000</td>
<td>5,000</td>
<td>37,000</td>
<td>60,000</td>
<td>3,000</td>
</tr>
<tr>
<td></td>
<td>185,000</td>
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<td>400,000</td>
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<td>15,000</td>
</tr>
<tr>
<td>Laying hens</td>
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<td>46,500</td>
<td>75,850</td>
<td>500</td>
</tr>
<tr>
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<td></td>
<td>93,000</td>
<td>180,000</td>
<td>1,000</td>
</tr>
</tbody>
</table>
Energy use vs energy potential on the farm (2)

Electricity

Small scale gas utilization
Energy use vs energy potential on the farm (3)

Heat

Small scale gas utilization
Energy use vs energy potential on the farm (4)

- Only for sows the potential production of energy equals the use of energy on farm
- Electricity is 2 to 3 times higher production
- Heat (Gas eq.) is 10 to 50 times higher production

→ Energy has to be sold
Experiences co-digesters

Situation in the Netherlands, but also relevant for other countries

• Digesters were primarily designed for electricity production

• Changing markets
  – Decrease of electricity price
  – Increase price of co-substrates

• Bankruptcy of digesters
  ... With no heat valorization
Options for gas utilization

There are multiple options for gas use:
1. Combined Heat & Power (CHP)
2. Heat
3. Biogas
4. Biomethane
5. Other
Option 1: CHP

- Most used for large scale digestion
- Production of electricity and process heat
  - Heat for own use
  - Electricity partly for own use, partly sold
- For small scale heat valorization is difficult
- Electricity feed-in is subsidized → money
Option 1: CHP

Small scale gas utilization
Option 1: CHP

Pros:
- Simple technique
- Proven technology
- Easy offset of energy
- Heat for free on farm

Cons:
- Only electricity
- If electricity price drops, BC drops
- Difficult heat valorization
- Low energy efficiency
Option 1: CHP

- Especially small scale low electric efficiency
- Part of heat used for process

![Diagram](image-url)

Small scale gas utilization
Option 1: CHP

- Efficiency drops fast for small scale CHP
Option 2: Heat

Heat production by boilers or CHP

(Related to option 3: Biogas)

Heat delivery to:
- On farm processes
- District heating
- Industry
- Swimming pool
- Etc.

In most countries heat delivery not subsidized → topic for lobby work
Option 2: Heat

Pros:
- Simple technique
- Proven technology
- High energy efficiency
- Low costs (investment & maintenance)

Cons:
- Heat demand not (always) stable over year
- Depended of end user(s)
- In most countries not subsidized
- Heat pipes only usable at short distances
Option 2: Heat

- Low energy losses
- Only possible at short distances

Small scale gas utilization
Option 3: Biogas

Direct sales of (un-treated) biogas
• Transport via:
  1. Biogas grid or
  2. Biogas tank transport

Delivery to:
• Industry
• Swimming pools
• District heating

Possibility with satellite CHP
Option 3: Biogas

In most countries biogas sales not subsidized →
1. Option with satellite CHP
2. Selling of the heat
3. Lobby for subsidy scheme for raw biogas
Option 3: Biogas

Pros:
- No upgrading needed
- No CHP needed
- Proven technology
- High energy efficiency
- Low maintenance costs
- Possible at longer distances

Cons:
- Biogas often not subsidized
- Depended of end user(s)
- New infrastructure needed
Option 3: Biogas

- Dutch example biogas grid
- 20 dairy farms
- 3 end users
- 14 km gas grid
Option 3: Biogas

- High energy efficiency when used in industrial burners
- Minimal energy losses
Option 4: Bio Methane

Sales of bio methane as:

1. Natural gas substitute
   – Grid injection

2. Transport fuel
   – Feed-in in natural gas grid
   – Selling via tank station
   – Off set with tank transport
Option 4: Bio Methane

Upgrading options
1. Farm scale
2. Centralized
   (farms connected via biogas pipes and one central upgrading system)
Option 4: Bio Methane

Pros:
• High energy efficiency
• Higher revenues
• 24/7 feed-in
• Savings on transport fuel

Cons:
• Complex technique
• High operational costs
• Not in every country subsidized
• For fuel high pressure is needed
Option 1- 4: energy efficiency

Small scale gas utilization
Option 5: Other options

Combinations of techniques:
• CHP & Biomethane
• Biomethane and dual-fuel tractor
• CHP & digestate treatment
  – Pasteurization of thick fraction
  – Chemical-like fertilizer production
General remarks

• All presented options are feasible at farm-scale (in the Netherlands)
  – CHP >100 dairy cows
  – Heat >100 diary cows, but depending on heat use close by
  – Biogas >90 dairy cows, but depending on heat use close by
  – Bio Methane > 250 dairy cows
  (numbers based on our own experiences and feasibility studies)

• Geographical details important in choice of technique

• Lobby work needed in countries with no biomethane or sustainable heat subsidies
Decision making

Some steps in doing a FS:
1. What is the own energy use, electrical & heat
2. Is there heat use close by <1 km
3. Is there large heat use close by <5 km
   – industry with steam production,
   – swimming pool,
   – piggery
   – etc.
4. Are there other large energy users close by <5 km
   – elderly houses,
   – hospitals,
   – district heating
5. Is Biomethane feed-in possible at site
6. Are there other processes thinkable that may use the produced energy
Decision making

Some steps in doing a FS

1. What is the own energy use, electrical & heat
   Yes? → CHP or boiler

2. Is there heat use close by <1 km
   Yes? → CHP or boiler & heat network

3. Is there large heat use close by <5 km (industry with steam production, swimming pool, etc.)
   Yes? → Biogas grid (& satellite CHP)

4. Are there other large energy users close by <5 km (elderly houses, hospitals, district heating)
   Yes? → Biogas grid & satellite CHP or boiler

5. Is bio methane feed-in possible at site
   Yes? → Biogas upgrading & grid feed-in

6. Are there other processes thinkable that may use the produced energy
   Yes? → Expertise of the experts is tested to the max!
Conclusion

1. There is more (and better) than CHP

2. Details will make or break the case

3. Sometimes subsidy schemes have to be adapted

4. Farm scale digestion has a huge potential, and it is our job to help farmers (and other stakeholders) recognizing that!
The use of the offline expert feasibility calculator for small scale digestion
Other outputs of the BioEnergy Farm 2 project

- Leaflets with case studies
- Market overview
  - Microscale digestion in Europe
- Policy guideline
  - What policymakers should know about small scale biogas installations
- Implementation Guideline
  - From idea to implementation
- Tools
  - Business plan and Calculation tool
  - Manuals
- Training sessions
  - Slides from presentations
The use of the offline expert feasibility calculator for small scale digestion
Information for:
- Policy makers
- Benefits of MSD
- Emissions
- Sustainable energy
- Social aspects
- Etc.

The use of the offline expert feasibility calculator for small scale digestion
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The use of the offline expert feasibility calculator for small scale digestion is available in 6 languages and for 7 countries:

- English (7 countries)
- Germany (German)
- Netherlands (Dutch)
- France (French)
- Belgium (Dutch & French)
- Poland (Polish)
- Italy (Italian)
- Denmark (Danish)
Thank you for your attention

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Small scale gas utilization