Advantages and synergies in the biogas pathway

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Danish Biogas Association
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- **Members:**
  - Biogas plant owners, constructors, consultants, suppliers, energy sector, waste sector, agriculture, research etcetera.

- **Mission:**
  - Promote framework conditions for production and use of biogas contributing to meet societal challenges: Climate change, eutrophication, circular economy, etc.
Biogas in Denmark

Livestock manure
Liquid slurry/Deep litter
Organic catch crops

Organic residues
Agriculture, households, industry, servicesector

Improved fertilizer & environment
Recirculation; N, P, K and carbon
Nutrient supply (organic)

Reduced greenhouse gas emissions (agriculture, transportation and energy)

Renewable energy
Stabilising energy system
Supplementing wind power

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Energy crops: No thanks!

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Danish Biogas Model is based on residues and livestock manure
Biogas in Denmark

2014:
1537 GWh / 5.5 PJ

Production

- Sewage sludge
- Biowaste
- Agriculture
- Industrial
- Landfill
Utilisation

2014

77%
15%
7%
0%
1%

El
Heat
Gas grid
Industry
Transportation
Flaring

Production

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Recent development

New since 2012 Energy agreement

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<table>
<thead>
<tr>
<th>Year</th>
<th>Production (PJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>4.1</td>
</tr>
<tr>
<td>2013</td>
<td>4.6</td>
</tr>
<tr>
<td>2014</td>
<td>5.5</td>
</tr>
<tr>
<td>2015</td>
<td>6.4</td>
</tr>
<tr>
<td>2016</td>
<td></td>
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</tbody>
</table>

Production has increased:
- 12% from 2012 to 2013
- 34% from 2013 to 2014
- 56% from 2014 to 2015
- 100% from 2015 to 2016
New markets

- Gas grid
- CHP
- Industry
- Transport
- Heat

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Biogas potential

Livestock manure

Tonne dry matter
5 km square grid

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From: AgroTech for Nature Agency
Biogas potential

Straw

Tonne dry matter
5 km square grid

Livestock manure

From: AgroTech for Naturstyrelsen
BioGas potential

Grass from natural habitats

Tonne dry matter
5 km square grid

Livestock manure
Straw

From: AgroTech for Naturstyrelsen
Biogas potential

Household / service sector waste

Tonne dry matter Municipalities

- 100,000 till 253,000 (4)
- 30,000 till 100,000 (24)
- 20,000 till 30,000 (24)
- 10,000 till 20,000 (29)
- 1,000 till 10,000 (17)

From: AgroTech for Naturstyrelsen

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Biogas potential

Nm$^3$ methane per year

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From: AgroTech for Naturstyrelsen

Livestock manure

Straw

Grass/natural hap.

Waste

Turn residues into biomethane
Methanisation of CO₂ content with hydrogen from surplus wind power.
Gassystem: high storage capacity

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Kilde: Energinet.dk
Production & potential

Current production

- Sewage, landfill, industry
- Manure based

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Production & potential

Projection 2016

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Production & potential

Projection 2020

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Production & potential

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Production & potential

Projection 2035

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Production & potential

Projection 2040
100 % green gas supply possible

From fossil to green gas

Natural gas consumption

Biogas production

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## GHG reduction husbandry

- **MCF** = methane conversion factor: Part of methane potential that is emitted

- New MCF lower for cattle – they have a smaller problem than expected until now
  - New MCF higher for pigs – they have a bigger problem than expected until now

- Biogas is an efficient climate tool (cattle: 7,9 and pigs 15,3 kg CO$_2$-eq./tonne)

- Collection of **1 week old pig slurry** increase the GHG reduction and biogas production
  - Cooling of slurry will also increase the biogas yield and effect as climate tool

### Table: MCF Comparison

<table>
<thead>
<tr>
<th></th>
<th>Old MCF Slurry covered</th>
<th>New MCF Biogas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cattle slurry</strong></td>
<td>- 17/10</td>
<td>+ 4,95/2,92</td>
</tr>
<tr>
<td><strong>Pig slurry</strong></td>
<td>- 17/10</td>
<td>+ 13,96/10,53</td>
</tr>
</tbody>
</table>

- 41% reduction
- 25% reduction
- 70% increase
Biogas – the best climate fuel

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Kilde: Danish Energy Agency 2016
Biogas saves soil carbon

Using all straw for biogas with recirculation of digestate gives same long term carbon storage in soil as direct incorporation.

- Straw incorporated directly in soil
- Digestate incorporated in soil

From: Julie Houge, SDU
Improved fertilizer and environment

- Anaerobic digestion of livestock manure in biogas plants
  - improves the value as fertilizer: 5-8 kg more N available per LU*
  - Reduces leaching of nitrate with 2 – 4 kg per LU*

* Livestock unit
1 LU: 100 kg of N

- 100 % pig slurry
- 100 % cattle slurry
- 25 % deep litter 75 % cattle slurry
- 25 % fish industry waste 75 % pig slurry

From: Aarhus University 2015
Greenhouse gas reduction

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Reduced GHG emission

- Gas substitution (other)
- Gas substitution (slurry)
- Slurry

400,000 tonnes manure-based biogas plant
Biogas – a flexible fuel

- Fits into the energy system in many ways
  - Decentralised co-generation
  - Distribution in gas net (biogas/mixed/natural gas)
  - Individuel or district heating
  - Process fuel in industry
  - Transportation fuel
- Engines, boilers, fuel cells
  - Mobile
  - Stationary
Synergies and advantages

- Supply security in future fossil free society
- Stabilising windpower based energy system
- Reduced GHG emissions (agriculture/energy)
- Environmental protection (eutrophication, smell)
- Recirculation of nutrients from residues and waste
- Bioenergy combined with carbon storage
- Excellent transportation fuel
- Turns livestock manure into better fertilizer
- Export of food and technology
- Jobs

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Thanks for the attention!

Questions?

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