Biogas in Scandinavia

Skandinavisk Biogaskonference, Skive, 7. november 2017, Knud Boesgaard, FREMSYN
Setting the right perspective

Gedsermøllen (1957)
24 m wingspan

Tvindmøllen (1975)
54 m wingspan

Vestas V164 (2017)
164 m wingspan

710,000 tonnes of biomass
# Biogas status in Scandinavia

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of biogas plants</th>
<th>Number of upgrading plants</th>
<th>Production Nm3</th>
<th>Production TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>165</td>
<td>12</td>
<td>333,000,000 Nm³</td>
<td>3,3 TWh</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>80,000,000 Nm³</td>
<td>0,8 TWh</td>
</tr>
<tr>
<td>Sweden</td>
<td>282</td>
<td>61</td>
<td>202,000,000 Nm³</td>
<td>2,1 TWh</td>
</tr>
<tr>
<td>Norway</td>
<td>40</td>
<td>9</td>
<td>80,000,000 Nm³</td>
<td>0,8 TWh</td>
</tr>
<tr>
<td>Finland</td>
<td>84</td>
<td>10</td>
<td>80,000,000 Nm³</td>
<td>0,8 TWh</td>
</tr>
</tbody>
</table>

### Flare Distribution

- **Denmark**: 01% Flare
- **Sweden**: 19% Flare
- **Norway**: 20% Flare
- **Finland**: 09% Flare

### Direct to Heat and Power Distribution

- **Denmark**: 46% Direct to heat and power
- **Sweden**: 50% Direct to heat and power
- **Norway**: 40% Direct to heat and power
- **Finland**: 76% Direct to heat and power

### Grid Injection, Other Distribution

- **Denmark**: 15% Grid injection, other
- **Sweden**: 26% Grid injection, other
- **Norway**: 20% Grid injection, other
- **Finland**: 11% Grid injection, other

### Grid Injection to Transport Distribution

- **Denmark**: 0% Grid injection to transport
- **Sweden**: 0% Grid injection to transport
- **Norway**: 20% Grid injection to transport
- **Finland**: 0% Grid injection to transport
## Biogas incentives

<table>
<thead>
<tr>
<th></th>
<th>Denmark</th>
<th>Sweden</th>
<th>Norway</th>
<th>Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Taxes</strong></td>
<td>Full energy and CO2 tax on biomethane</td>
<td>40% company tax reduction for using NGVs</td>
<td>Biomethane exempt from fuel taxes</td>
<td>CO2 tax exemption for biogas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Biomethane exempt from fuel taxes</td>
<td></td>
</tr>
<tr>
<td><strong>Subsidies</strong></td>
<td>Feed-in-premium: biomethane to power</td>
<td>Fund for climate projects (163.5 million € in 2019-2020)</td>
<td>€1,65 / m³ manure</td>
<td>Feed-in-premium: biomethane to power</td>
</tr>
<tr>
<td></td>
<td>biomethane to grid</td>
<td></td>
<td>Investment grant for biomethane plants</td>
<td></td>
</tr>
<tr>
<td><strong>Other measures</strong></td>
<td>Biotickets</td>
<td>Target of 75% environmentally friendly vehicles in public sector</td>
<td>Pump law: large tank stations (more than 1000m³ capacity must sell one alternative fuel)</td>
<td>Investment subsidy</td>
</tr>
<tr>
<td></td>
<td>Minimum of 0.9% advanced biofuels in 2020</td>
<td></td>
<td></td>
<td>Construction subsidy</td>
</tr>
<tr>
<td></td>
<td>Free parking</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
## Status of NGV deployment

<table>
<thead>
<tr>
<th></th>
<th>NGV cars</th>
<th>NGV buses</th>
<th>NGV vans and trucks</th>
<th>Total NGV’s</th>
<th>Filling stations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>%</td>
<td>#</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>93</td>
<td>0.00%</td>
<td>73</td>
<td>0.54%</td>
<td>197</td>
</tr>
<tr>
<td>Norway</td>
<td>126</td>
<td>0.00%</td>
<td>624</td>
<td>3.84%</td>
<td>522</td>
</tr>
<tr>
<td>Sweden</td>
<td>42.675</td>
<td>0.90%</td>
<td>2.357</td>
<td>16.97%</td>
<td>8.079</td>
</tr>
<tr>
<td>Finland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Biogas for transport in Denmark

Gas stations in Denmark
Existing and planned gas stations – January 2016

Development of gas consumption for transport in Denmark

Trends
• Transition to bio nature gas
• Sales of CBG almost exclusively runned by local offers in the municipalities
Interessefællesskabet for biogas til transport

*Interest community for biogas in transport

• Investigation of opportunities barriers for biogas in heavy transport
• Report series
• Send an e-mail to: knud@fremsyn.net

Lots of potential ...

Cleaner than the alternatives ...

And it’s cheaper ...
Danish biogas potential in transport

Calculations for busses are based on numbers from The Danish Transport, Construction and Housing Authority. Numbers City-transport og renovation are based on The Danish Energy Agency’s “Rammevilkår for gas til tung transport.”
Emissions from biogas for transport

Greenhouse gas emissions

NOx emissions

Particle emissions

Modelærskier

Kørselsemissioner fra leverandøreroplysninger
Biofuels in Denmark

- Biofuels used in Denmark:
  - Biodiesel
  - Ethanol

- Sources:
  - Palmeolie (1G)
  - Rapsolie (1G)
  - Canola (1G)
  - Korn (1G)
  - Sukker (1G)
  - Andet
  - Animalsk fedt (2G)

- Graph showing biodiesel and ethanol production from 2013 to 2016.
From 2020, Denmark introduces a requirement for advanced biofuels of 0.5%

- The EU Commission currently discuss raising this requirement to 3.5% by 2030

- Økonominotatet (the financial note) examines the socioeconomic and state-financial effects of 3 alternatives to fulfillment of the requirement; Bio nature gas, Advanced Bioethanol and Advanced Biodiesel
### Socio-economic net present value 2017 - 2030

<table>
<thead>
<tr>
<th></th>
<th>Biogas</th>
<th>Bioethanol</th>
<th>Biodiesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel gains</td>
<td>+953</td>
<td>-1.192</td>
<td>-1.688</td>
</tr>
<tr>
<td>Infrastructure costs</td>
<td>-602</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Additional costs for gas vehicles</td>
<td>-308</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Externality gains</td>
<td>+834</td>
<td>+64</td>
<td>+372</td>
</tr>
<tr>
<td>Cross border trade</td>
<td>+435</td>
<td>+306</td>
<td>+118</td>
</tr>
<tr>
<td>Tax distortion</td>
<td>+136</td>
<td>+92</td>
<td>+8</td>
</tr>
<tr>
<td><strong>Total socio-economic gains</strong></td>
<td><strong>+1448</strong></td>
<td><strong>-731</strong></td>
<td><strong>-1189</strong></td>
</tr>
<tr>
<td>Total government revenue, present value million. kr.</td>
<td>+513</td>
<td>+345</td>
<td>+29</td>
</tr>
</tbody>
</table>
100,000 km in a bus

Infrastructure and vehicle cost estimates
### Scandanvian policy developments

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<tr>
<td>EV's are heavily favoured over NGV's.</td>
<td>Public fleets are dominantly biomethane when possible</td>
<td>Oslo has a target of 100% renewable energy in public transport</td>
<td>Focus on double counting towards 2GA in Renewable energy directive</td>
</tr>
<tr>
<td>Increasing taxes on NGV cars</td>
<td>Regions Skåne, Halland and Västra Götaland actively promoting biomethane for NGV's.</td>
<td>Expects to implement toll-roads, where toll is based on CO2 and NOx emissions</td>
<td>Positive attitude towards biogas in heavy transport</td>
</tr>
<tr>
<td>Tax system doesn't differ between natural gas and biomethane</td>
<td>70% of gas for transport is biogas</td>
<td>Green vehicle strategy review in 2017</td>
<td></td>
</tr>
<tr>
<td>No environmental requirements for public transportation</td>
<td></td>
<td>New green vehicle strategy in 2018</td>
<td></td>
</tr>
<tr>
<td>No strategy for alternative fuels</td>
<td></td>
<td>16% of gas for transport is biogas</td>
<td></td>
</tr>
<tr>
<td>100% of gas to transport is biogas due to bioticket system</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
First ship will have small propellant plant, which will be expanded over time

Effectively unlimited supplies of carbon dioxide and water on Mars
- 5 million cubic km ice
- 25 trillion metric tons CO2

2H₂O + CO₂ → 2O₂ + CH₄
Potential for biogas in busses

Biogas potential in traffic companies’ supplies

- Movia
- BAT
- Fynbus
- Sydtrafik
- Midttrafik
- NT

Akkumuleret forbrugskurve

Gasforbrug [mio. Nm³]

0 20 40 60 80 100 120 140 160


Potentielle biogasbussers udbud

Gasforbrug [mio. Nm³]

0 20 40 60 80 100 120 140 160


Movia BAT Fynbus Sydtrafik Midttrafik NT
**Project developing**

- Development of consortias
- Applications
- Implementation and reporting

**Fleet analysis**

- Consumption Needs
- TCO (Total Cost of Ownership)
- Assisting and support of implementation

**Environmental and climate analysis**

- Climate scenarios
- Emission inventories
- Socioeconomic calculations
Technoeconomic parameters

Range

Socioeconomic gain goal achievement with advanced biofuels 2017-2030 (DKK million)
Biogas in Scandinavia

EBA has XX biogas plants

Finland:
https://wiki.uef.fi/display/BIOMAP/Piia+Ikonen%2C+biogas+in+Finland