Development of biomethane production, use and trade in Sweden

Tobias Persson, Energiforsk
Fuels of the Future, 19-20 January 2015, Berlin
Energy usage in Sweden

Total energy use in Sweden (excl. losses) (2012) – 377 TWh

Electricity production 163 TWh
- Hydro-electric power
- Wind power
- Nuclear power
- Industrial back-pressure
- Combined heat and power
- Condensing power
- Gas turbines

Transport fuel 86 TWh
- Petrol
- Diesel
- Electricity
- Fuel oil 2-5
- Aviation fuel
- Natural gas and LPG
- Ethanol
- Biodiesel
- Biogas

Industry – 25 % fossil fuels (oil, coal, natural gas)
Households – 10 % fossil fuels (oil)
**Transports – 92 % fossil fuels**

Source: Energiläget 2014, Swedish Energy Agency
Limited national gas grid

- The natural gas corresponds to approx. 3% of the total energy supply
- Biomethane is injected from 10 of the 55 biomethane plants
Sweden is world leading in transporting gas off-grid

Read more in case story from IEA Bioenergy Task 37: Non-grid biomethane transportation in Sweden
Transportation in gaseous form

- Compressed to 20–25 MPa and kept in flasks
- Suitable for small scale production
- Transport distance up to ~200 km

Transportation in liquid form

- Long distance transportation is economically possible
- New possible markets
- High investment and energy consumption
Local grids

- Two or more biogas plants connected to joint upgrading plant
- Many existing examples such as Biogas Brålanda, similar to Paraná in Brazil
Regional grids

- Connect production units, filling stations and customers to an LNG terminal

Source: Swedegas
Food waste collection in 190 of Sweden’s 290 municipalities

264 biogas plants → 1.7 TWh biogas (2012)

30 000 ton 2005 – 307 000 ton 2013

EU’s prohibit on landfills of organic matter in 2005. National goal on improving the collection of food waste

30 000 ton 2005 – 307 000 ton 2013

Biogas production 2005-2013

Food waste collection in 190 of Sweden's 290 municipalities
The interest for NGVs is increasing

≈ 2 % of the total vehicle fuel

Buses provide a stable market for a long time, important for the dev. of vehicle gas in Sweden

Source: [www.gasbilen.se](http://www.gasbilen.se), SPBI Branschfakta 2014

205 gas filling stations (5 with LNG/LBG)
Biomethane as an automotive fuel

Not only lower emissions of $\text{CO}_2$ but also particles and $\text{SO}_x$ and $\text{NO}_x$

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Present fuel</th>
<th>Liquid bio fuels</th>
<th>Electric</th>
<th>Hybrids</th>
<th>Biogas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>Petrol/Diesel</td>
<td>Yes (%)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (CBG)</td>
</tr>
<tr>
<td>Delivery trucks</td>
<td>Diesel</td>
<td>Yes (%)</td>
<td>No</td>
<td>Yes</td>
<td>Yes (CBG)</td>
</tr>
<tr>
<td>Urban busses</td>
<td>Diesel</td>
<td>Yes (%)</td>
<td>Yes (wired)</td>
<td>Yes</td>
<td>Yes (CBG)</td>
</tr>
<tr>
<td>Heavy trucks</td>
<td>Diesel</td>
<td>Yes (%)</td>
<td>No</td>
<td>No</td>
<td>Yes (LBG)</td>
</tr>
<tr>
<td>Train</td>
<td>Diesel/Electric</td>
<td>Yes (%)</td>
<td>Yes (wired)</td>
<td>No</td>
<td>Yes (LBG)</td>
</tr>
<tr>
<td>Ships</td>
<td>Diesel</td>
<td>Yes (%)</td>
<td>No</td>
<td>No</td>
<td>Yes (LBG)</td>
</tr>
</tbody>
</table>
Hybridbuses (biogas/electricity) in Malmö in Sweden
The Swedish Gas Industry's visions are:
- 100% biomethane in the vehicle gas in 2030
- 100% biomethane in the gas grid in 2050
Swedish visions and goals

• Fossil free vehicle fleet in 2050, through the following measures:
  - ↓ Needs for transports
  - ↑ Energy efficient vehicles
  - ↑ Proportion of electricity and bio-fuels
The realizable biomethane potential for the vehicle fleet in Sweden 2030

- 0.9 TWh biomethane in 2013
- Totally 7 TWh biofuels in 2012

(1) Source: Utredningen av Fossilfri fordonstrafik, Dec 2013
(2) Source: Energiläget 2013, Swedish Energy Agency
Biomethane trade

National trade
• Similar to certificate trading but without third party control.

International trade
• The Swedish Energy Agency claims that imported biomethane has to fulfil traceability on mass balance level. Not possible through the European gas grid. Decision is appealed.
• However: One company (Modity) is certified through REDcert recognized by the European Commission and is allowed to import biomethane to Sweden
Large industrial biomethane productions plants/projects in Sweden
GoBiGas – Bio-SNG plant in Gothenburg

Producing biomethane by gasification
Injection into the transmission gas grid (30 bars)
Feed stock: Forest residues

**Phase 1 - Demonstration**
20 MW\textsubscript{bio-SNG} (160 GWh/yr) + heat
Cost: 160 M€
(24 M€ from Swedish Energy Agency)

**Phase 2 – Full scale**
80 - 100 MW\textsubscript{bio-SNG} (640 - 800 GWh/yr) + heat
Cost: 325 M€
(NER300 support 59 M€ available)

**Status**
Injection into the transmission grid since December 2014
Decision for initializing phase 2 will be taken when phase 1 is proven successful
Bio2G – possible future bio-SNG plant

Production capacity: 200 MW_{\text{bio-SNG}} (1.6 TWh/yr) + heat & electricity

Feed stock: forest residues

Project owner: E.ON

Investment cost: 450 M\(\text{€}\), (NER300 support 203 M\(\text{€}\) available)

Project is awaiting decision on the long-term policy instruments for biofuels

Source: Björn Möller-Fredriksson, E.ON Gasification AB
Lidköping Biogas – The first LBG-plant in Sweden

Production capacity: 60 GWh/yr

Energy for condensation:
≈ 1 kWh per Nm$^3$ biomethane
(Reverse Nitrogen Brayton Cycle)

Investment cost:
160 M SEK (~ 17-18 M€)

Feed stock:
Residues from local food industry
and grain handling

Operational since: April 2012

Project owner:
Swedish Biogas International,
Göteborg Energi AB and the
community of Lidköping

For more information,
http://www.lidkopingbiogas.se/
### Examples of larger co-digestion plants

<table>
<thead>
<tr>
<th>Plant</th>
<th>Production capacity</th>
<th>Operational since</th>
<th>Feed stock</th>
<th>Biomethane injection</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSR Biogas plant</td>
<td>80 GWh/yr biomethane</td>
<td>1996</td>
<td>Household waste, residues from local food</td>
<td>To distribution grid for 10 years</td>
</tr>
<tr>
<td>Tekniska Verken in Linköping</td>
<td>100 GWh/yr biomethane</td>
<td>1997</td>
<td>Household waste and residues from food industry</td>
<td></td>
</tr>
<tr>
<td>Jordberga biogas plant</td>
<td>110 GWh/yr biomethane</td>
<td>2014</td>
<td>Energy crops</td>
<td>To transmission and distribution grid</td>
</tr>
</tbody>
</table>
Thanks for your attention

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Conclusions

• Sweden is world leading of utilizing biomethane as vehicle fuel and in transporting the gas off-grid

• 1.7 TWh biogas production, more than 50 % is upgraded to biomethane

• National vision to have fossil free vehicle fleet in 2050

• The Swedish biomethane potential is estimated up to 22 TWh (2030)

• Great need for a variety of short- and long terms politic-economic incentives so the biomethane (biofuel) potential becomes a reality