The Swedish biogas roadmap

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Biogas Research Center
- advancing resource-efficient biogas solutions -

A transdisciplinary competence center where co-production of knowledge is generated by 21 different biogas actors and ten research groups at Linköping University and Swedish University of Agricultural Sciences, Sweden

http://www.biogasresearchcenter.se/

... and 21 participating organisations
Research areas

**Societal research**
Focus on how the development of biogas solutions is influenced by public/private actors and institutional conditions.

**Systems research**
Focus on structured, qualitative analyses as well as quantitative methods for handling of critical factors and uncertainty handling for improving economic and environmental performance of biogas solutions.

**Process and technology research**
Focus on improving profitability in existing biogas production and making new substrates available for biogas production through developing intervention based on characterization of undigested substrate.
Swedish biogas history

• 1930s →: WWTPs
  – Initially focus on waste treatment (volume reduction, hygienization, stabilization).
  – Initially used for heating or flared
  – Municipalities key actors

• 1970s →: manufacturing industry
  – E.g. sugar and pulp & paper industry

• 1970s →: agriculture, farm-scale

• 1980s →: landfills
  – Very small amounts of organic material landfilled since 2005 due to legislation

• 1990s →: codigestion plants
  – Source separated food waste, slaughterhouse waste, etc.
  – Municipalities key actors

• An off-grid market to a large extent; some local or regional grids
Energy supply & deliveries of energy gases, 2017

Energy supply 2017: 566 TWh

- Biomass: 143 TWh
- Coal and coke: -19 TWh
- Crude oil and petroleum products: 21 TWh
- Natural gas, gasworks gas: 122 TWh
- Other fuels: 18 TWh
- Nuclear fuel: 17 TWh
- Primary heat: 11 TWh
- Hydropower: 184 TWh
- Windpower: 65 TWh
- Net electricity import: 18 TWh

Deliveries of energy gases 2017: 19.6 TWh

- Natural gas: 12.1 TWh
- LPG: 4.6 TWh
- Biogas: 2.9 TWh

Source: Statistics from the Swedish Gas Association, 2018

Less than 30% fossil energy
Low share/levels of gas
Production of biogas, 2018

**Biogas production & number of biogas plants 2018**

- **279** plants in total, produced **2,03** TWh in 2018

**Share of production from different types of biogas plants**

- WWTPs: 47%
- Co-digestion plants: 36%
- Landfills: 7%
- Industrial facilities: 7%
- Farm scale: 3%

*Excluding 1 pilot gasification plant*

*In addition: about 2 TWh/y imported from Denmark*

Source: Swedish Energy Agency & Swedish Gas Association
Utilization of biogas, 2018

Utilization of biogas produced in Sweden, 2018

About 30% of the imported gas from Denmark (443 GWh/y) is used as vehicle fuel.

Source: Swedish Energy Agency and Swedish Gas Association
Development regarding gas as vehicle fuel

- More than 90% is biogas.
- Liquified biogas (LBG, or bio-LNG) is entering the market (vehicles & fuels)

Source: Statistics Sweden (SCB)
Development regarding gas vehicles

- Ca 55,000 gas vehicles:
  - 44,000 pass. cars
  - 8,000 light lorries
  - 2,500 buses
  - 850 heavy lorries

- A shift in focus to electric vehicles (EV):
  - Policy best for (EV), but ok for gas
  - Fewer good gas pass. vehicle models
  - Promising regarding HDV and LBG

- A large share of second-hand gas vehicles sold to Finland & the Czech republic

Sources: Statistics Sweden (SCB) & Transport Analysis
Digestate management

• About 2.8 Mtonnes of digestate in 2018:
  – 86% as biofertilizer in agriculture

• Almost 100 % as biofertilizer from co-digestion plants and farm-scale plants.

• About 40 % as biofertilizer from WWTPs

Source: Swedish Energy Agency & Swedish Gas Association
Development

- Examples regarding new plants:
  - E.ON in Högbytorp – dry digestion of food waste, ca 60 GWh/y (Hitachi Zosen Inova). Similar plant is built in Jönköping
  - Rena Hav in Sotenäs – biogas in marine biorefinery context
  - Stora Enso in Nymölla – biogas at a paper mill, 75-90 GWh/y LBG per year (Gasum)
  - Most development on the larger level

- Interest in liquefied biomethane (LBG, bio-LNG) – the high energy density can be distributed over longer distances despite the absence of a national gas grid:
  - New LBG plants; Nymölla (above) and Linköping (also Örebro, Mönsterås & Västerås)
  - New gas lorries (Scania and Volvo, +400 hp, with different techniques (otto, diesel))
  - LBG investments (production and filling stations). Drive LBG; will act to collect, demonstrate and increase the knowledge, innovation and development opportunities in sustainable solutions for LBG
  - About 40-50 LBG filling stations in 2020
Development

- The Swedish Biogas Research Center released a book in 2019 on the role of biogas in a sustainable society, comprising examples of innovative biogas projects in Sweden and in Norway.

The institutional conditions for biogas

- Waste management
- Agriculture
- Transport
- Environment
- Economics
- Construction

Source: Marcus Gustafsson
Policy

• Examples of long-term climate and energy goals:
  o Climate neutral energy sector 2045, with at least 85% GHG emission reduction in Sweden. From 2045 negative emissions.
  o 100% renewable electricity production 2040
  o 63% GHG emission reduction in non-EU ETS sector in 2030 and 75% 2040 compared to 1990
  o 70% GHG emission reduction in domestic transport (excl. aviation) 2030 compared to 2010. Climate neutral 2045

• Examples of financial support systems:
  o High CO₂ tax and energy tax on fossil energy and tax exemption for renewables
    ✓ E.g. CO₂ tax and energy tax exemption for biomethane for transportation
  o Production support for manure-based biogas; ~ € 0.043/kWh
  o 40% reduction of income tax for use of company gas vehicles
  o Norway and Sweden have a joint electricity certificate market
Policy

• New policy:
  o Bonus-malus (cars with low CO$_2$ emissions get a bonus, while cars with high CO$_2$ emissions get a punitive tax. EV highest bonus)

  o Municipal environmental zones – gas vehicles allowed in the most restricted zones (zone 3)

  o Quota obligation for biofuels in gasoline and diesel from July 1st, 2018
Policy – future

• About 30% increased use of biogas 2017 and 2018, mainly due to imported gas from Denmark:
  – Sweden has tax exemption for users, while other EU countries have production support → double subsidies → prices similar to natural gas for heating/industry

• Enquiry into market conditions for the Swedish biogas sector; *More biogas! For a sustainable Sweden*:
  o 676 pages!
  o New legal texts suggested → hoping for a rapid implementation
  o Investigation of the most suitable long-term policies for biogas and biomethane after 2020
  o Focus on the production side
Production target

7 TWh/y 2030 from anaerobic digestion

Source: Marcus Gustafsson
Biogas production targets perspective:

- **10 TWh/y** including gasification
- **7 TWh/y** from AD

Source: Marcus Gustafsson
Main support suggested

Package I:
• Continued production support for manure-based biogas: ~ € 0.040 per kWh
• Upgrading support: ~ € 0.020–0.030 per kWh
• Liquefaction support: ~ € 0.010–0.015 per kWh

Package II:
• Beneficial financial instruments (loans, guarantees)
• Some kind of production support (other energy gases/technologies, i.e. not AD)?
• Ten years support period
Socio-economically beneficial

• Support package I → reduced CO$_2$ emissions corresponding to 4% of Sweden’s total emissions

• The socio-economic benefits are greater than the costs, just based on these climate impacts
  – Positive even if no other biogas related benefits included; such as lowered emissions of particles, reduced noise levels, nutrient recycling, reduced eutrophication, improved waste management, improved energy security, etc.