The Swedish biogas roadmap

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LINKÖPING UNIVERSITY

Biogas Research Center

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- 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/

Swedish Energy Agency | LINKÖPING UNIVERSITY | SLU Swedish University of Agricultural Sciences … *and 21 participating organisations* | Biogas Research Center

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.

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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

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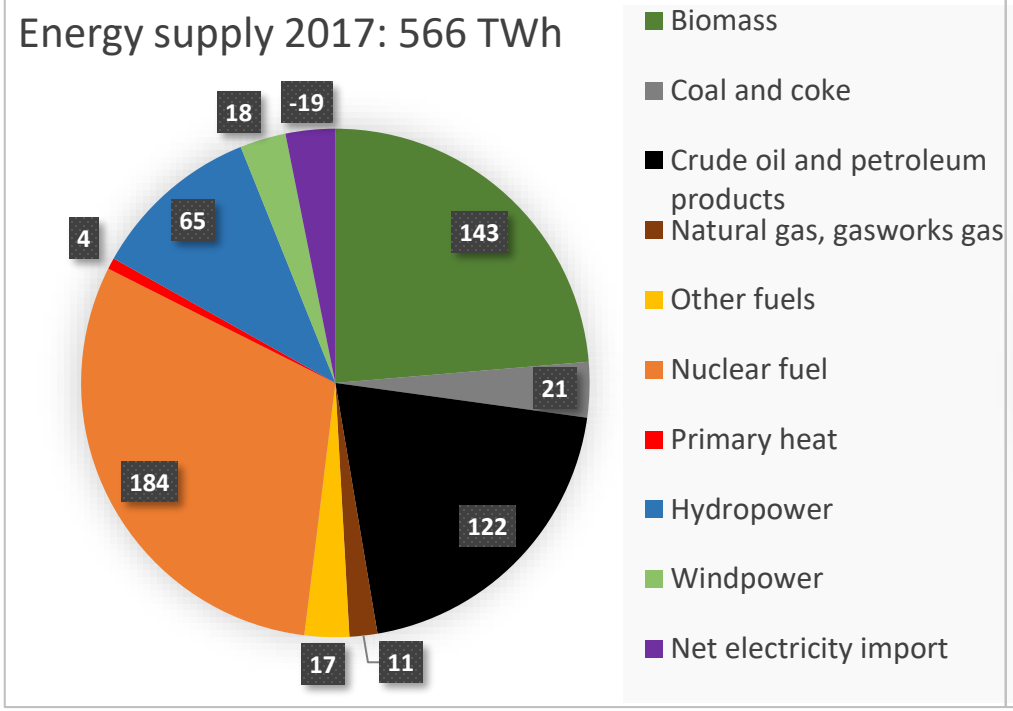
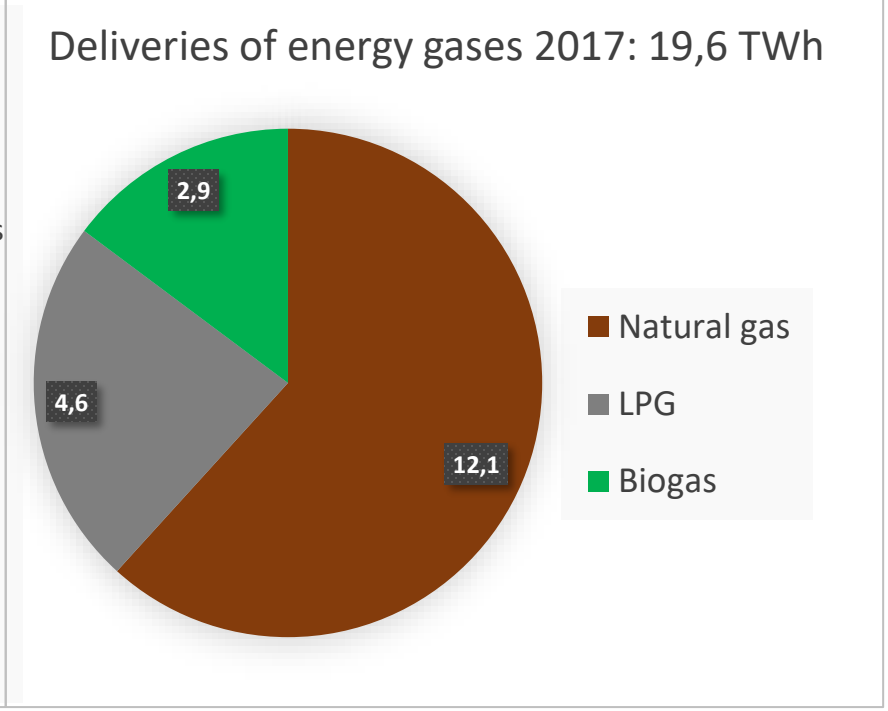
Energy supply & deliveries of energy gases, 2017



Source: Swedish Energy Agency, 2019. Energy in Sweden 2019



Source: Statistics from the Swedish Gas Association, 2018

Less than 30% fossil energy

Low share/levels of gas

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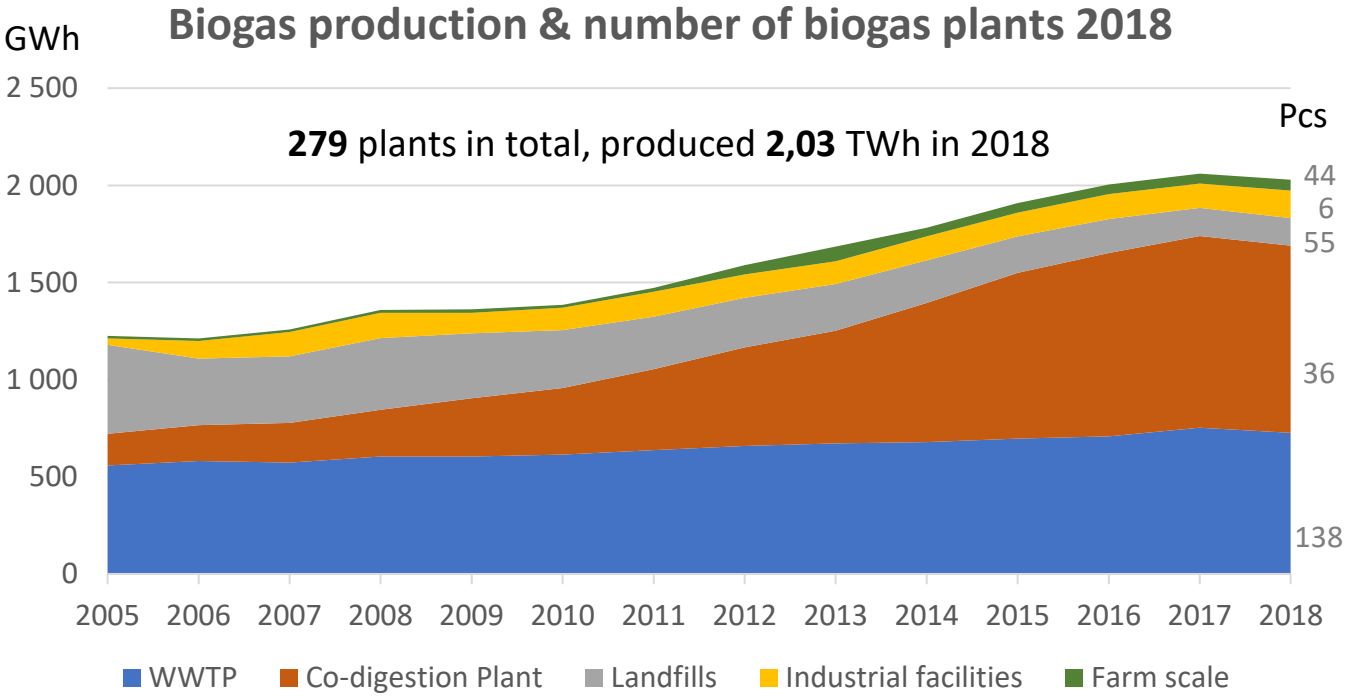
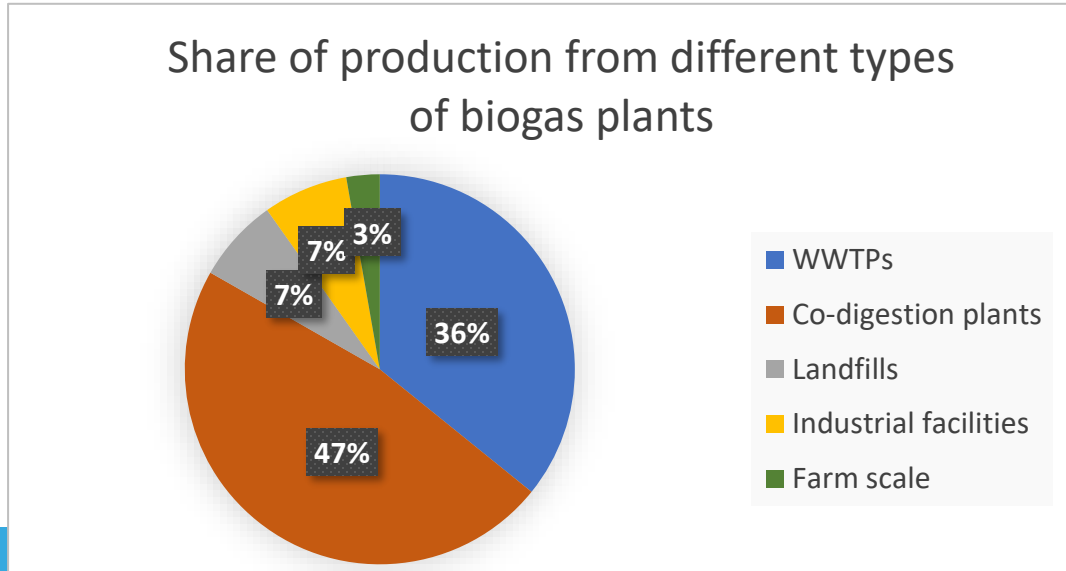
Production of biogas, 2018



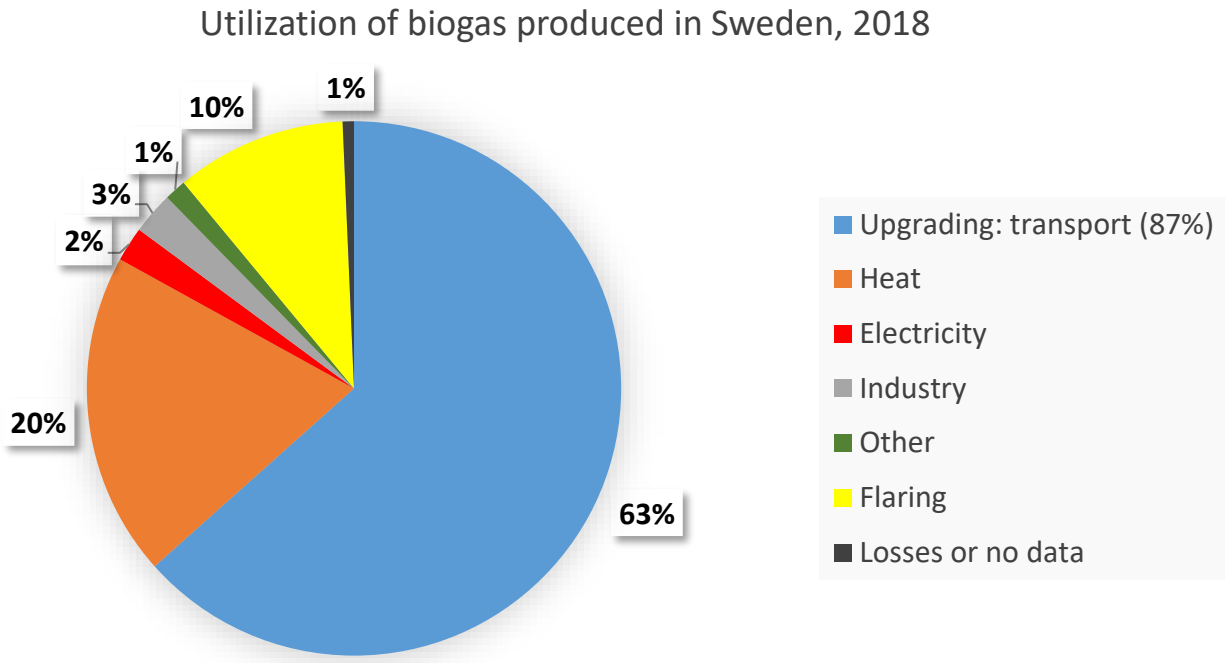
Excluding 1 pilot gasification plant

In addition: about 2 TWh/y imported from Denmark



Source: Swedish Energy Agency & Swedish Gas Association

Utilization of biogas, 2018



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

Source: Swedish Energy Agency and Swedish Gas Association

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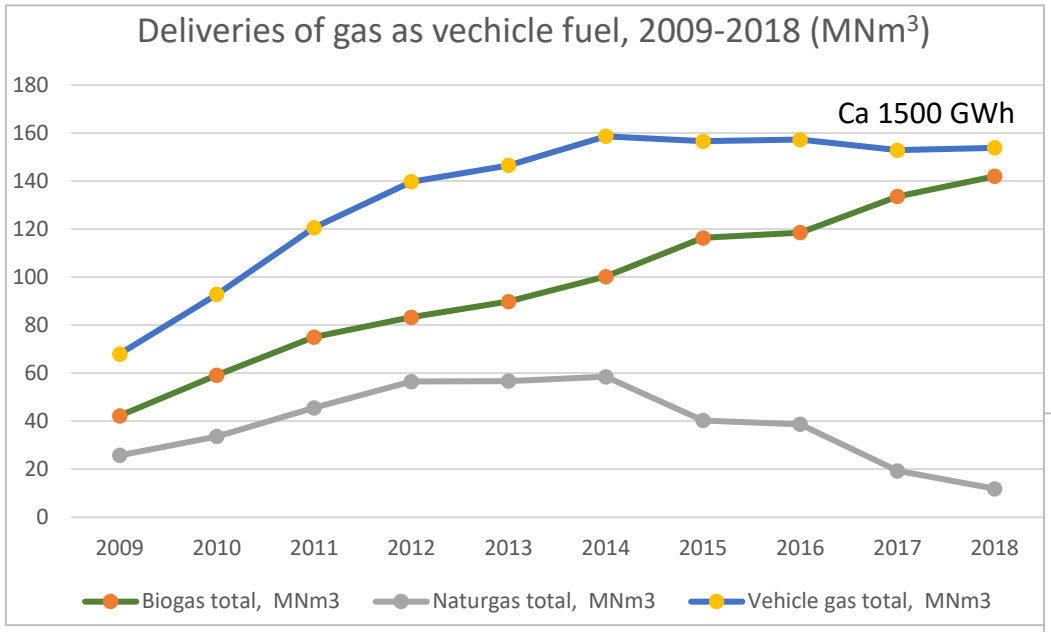
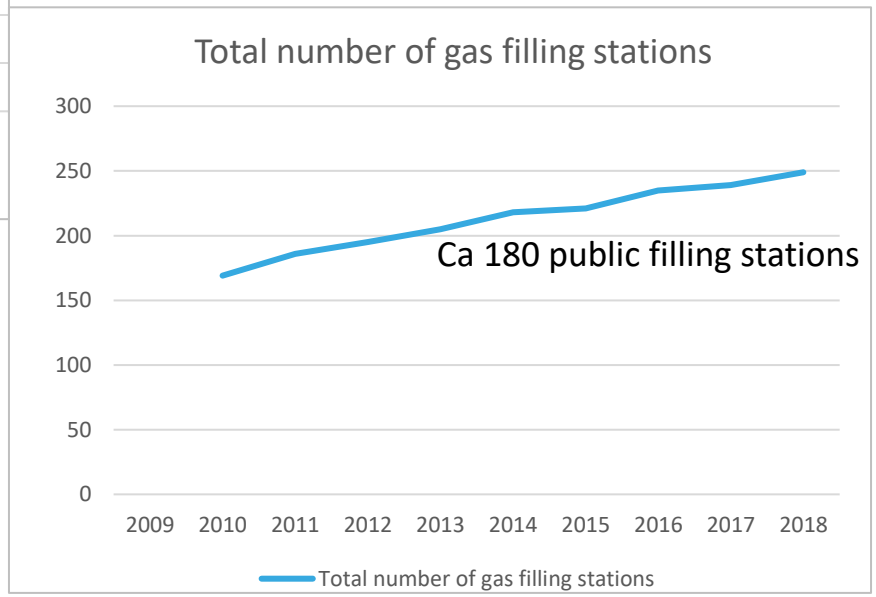
Development regarding gas as vehicle fuel





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

Source: Statistics Sweden (SCB)

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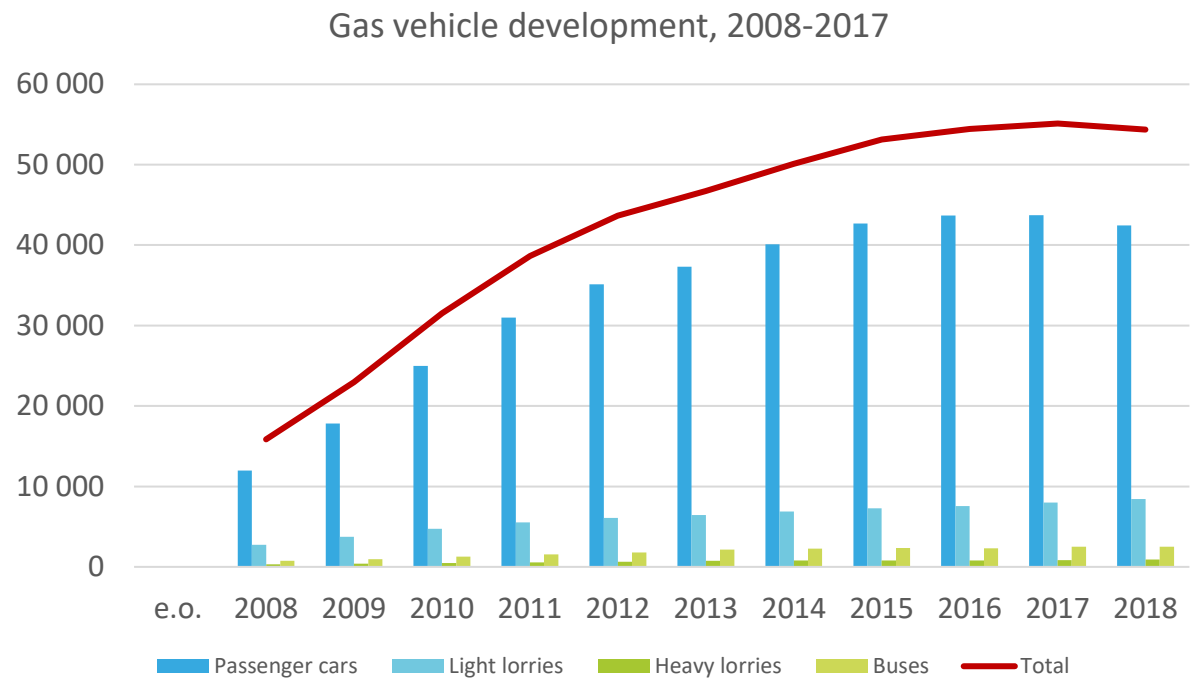
Development regarding gas vehicles



Sources: Statistics Sweden (SCB) & Transport Analysis

- 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

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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

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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

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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

https://biogasresearchcenter.se/order-book-biogas-in-the-sustainable-society/?lang=en (english version)

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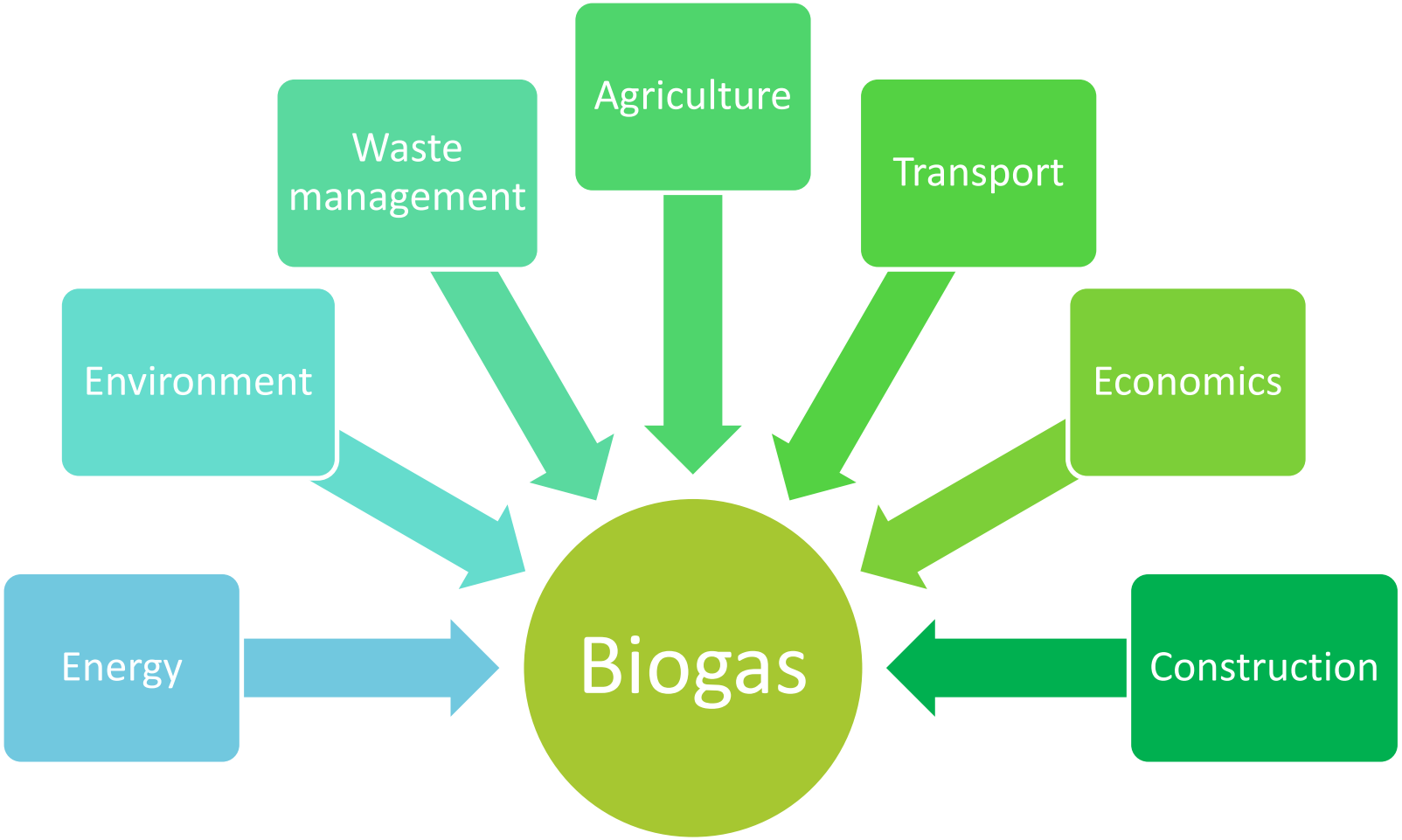
The institutional conditions for biogas



Source: Marcus Gustafsson

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Policy

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

- Examples of financial support systems:
  - High CO_2 tax and energy tax on fossil energy and tax exemption for renewables
    - ✓ E.g. CO_2 tax and energy tax exemption for biomethane for transportation
  - Production support for manure-based biogas; ~ € 0.043/kWh
  - 40% reduction of income tax for use of company gas vehicles
  - Norway and Sweden have a joint electricity certificate market

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Policy

- New policy:
  - 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)
  - Municipal environmental zones – gas vehicles allowed in the most restricted zones (zone 3)
  - Quota obligation for biofuels in gasoline and diesel from July 1st, 2018

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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***:
  - 676 pages!
  - New legal texts suggested → hoping for a rapid implementation
  - Investigation of the most suitable long-term policies for biogas and biomethane after 2020
  - Focus on the production side

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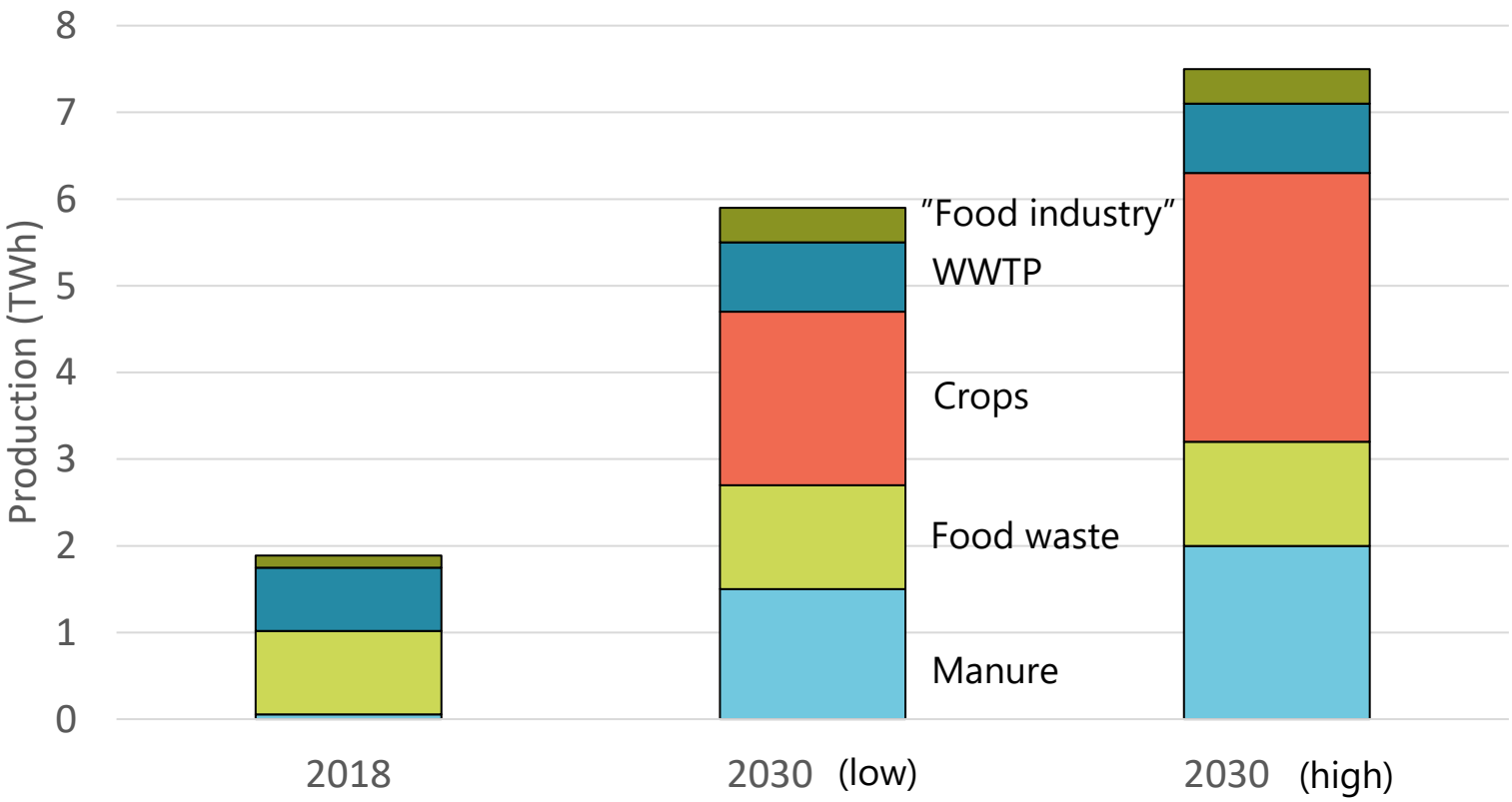
Production target

7 TWh/y 2030 from anaerobic digestion



Source: Marcus Gustafsson

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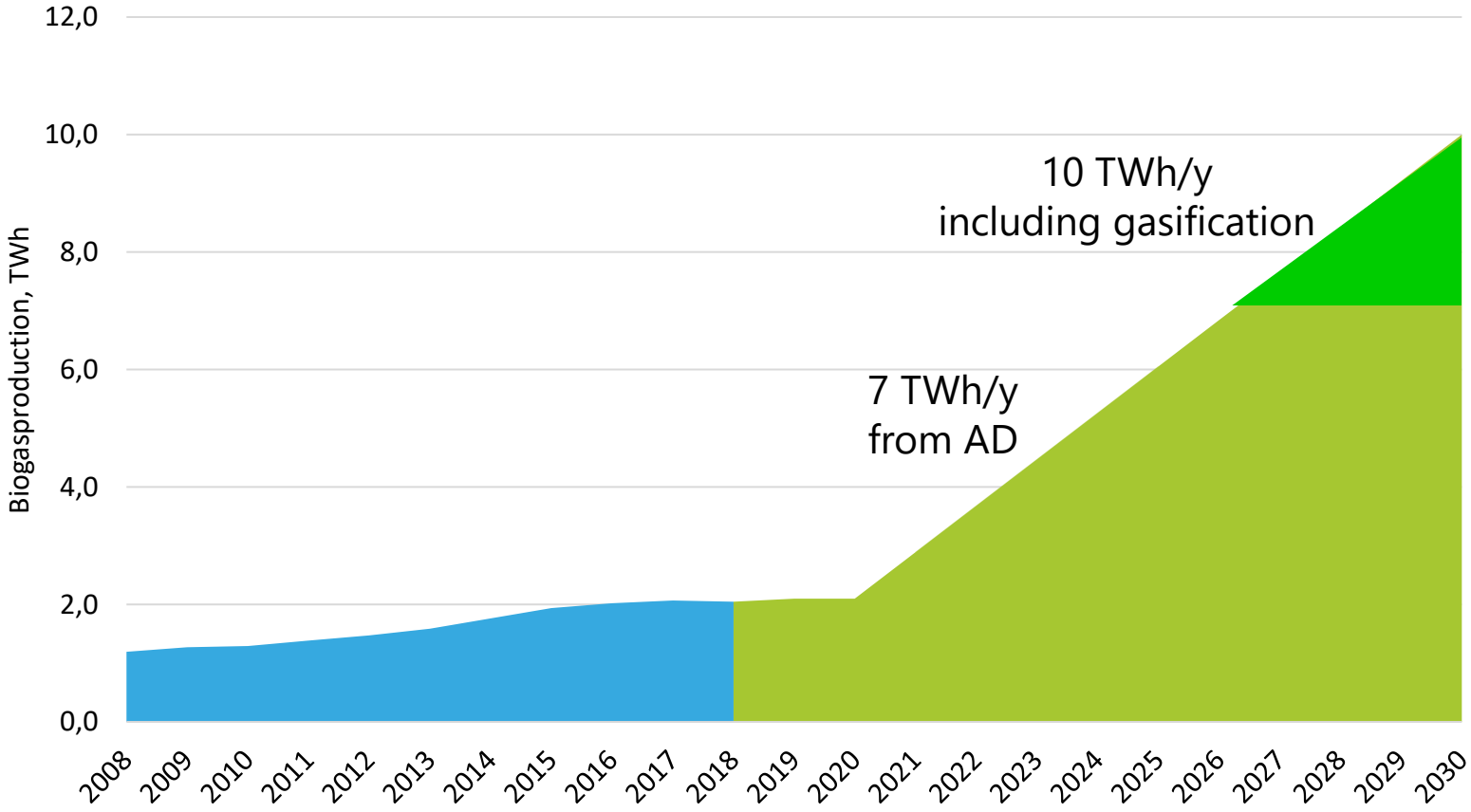
Production target perspective



Source: Marcus Gustafsson

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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

Upgrading - biomethane for transport & industry!

Package II:

- Beneficial financial instruments (loans, guarantees)
- Some kind of production support (other energy gases/technologies, i.e. not AD)?

- Ten years support period

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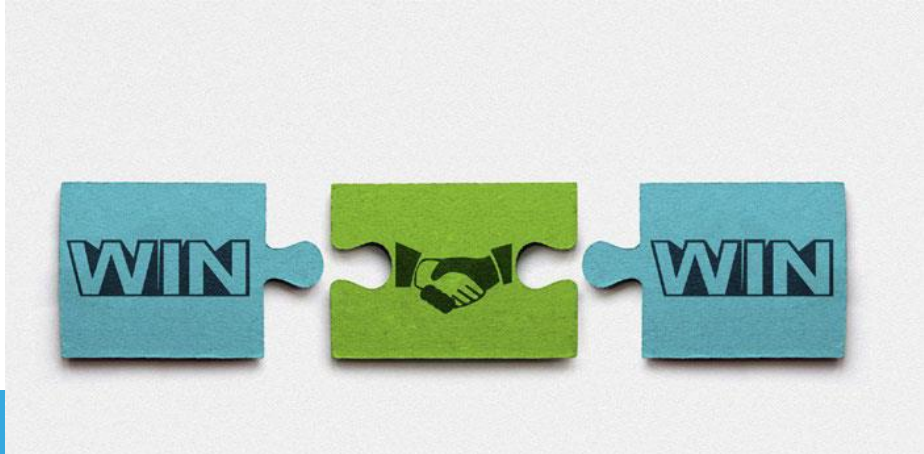
Socio-economically beneficial

- 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.



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