Injecting biomethane into the grid

Dutch example – How to deal with capacity limits of the DSO grid?

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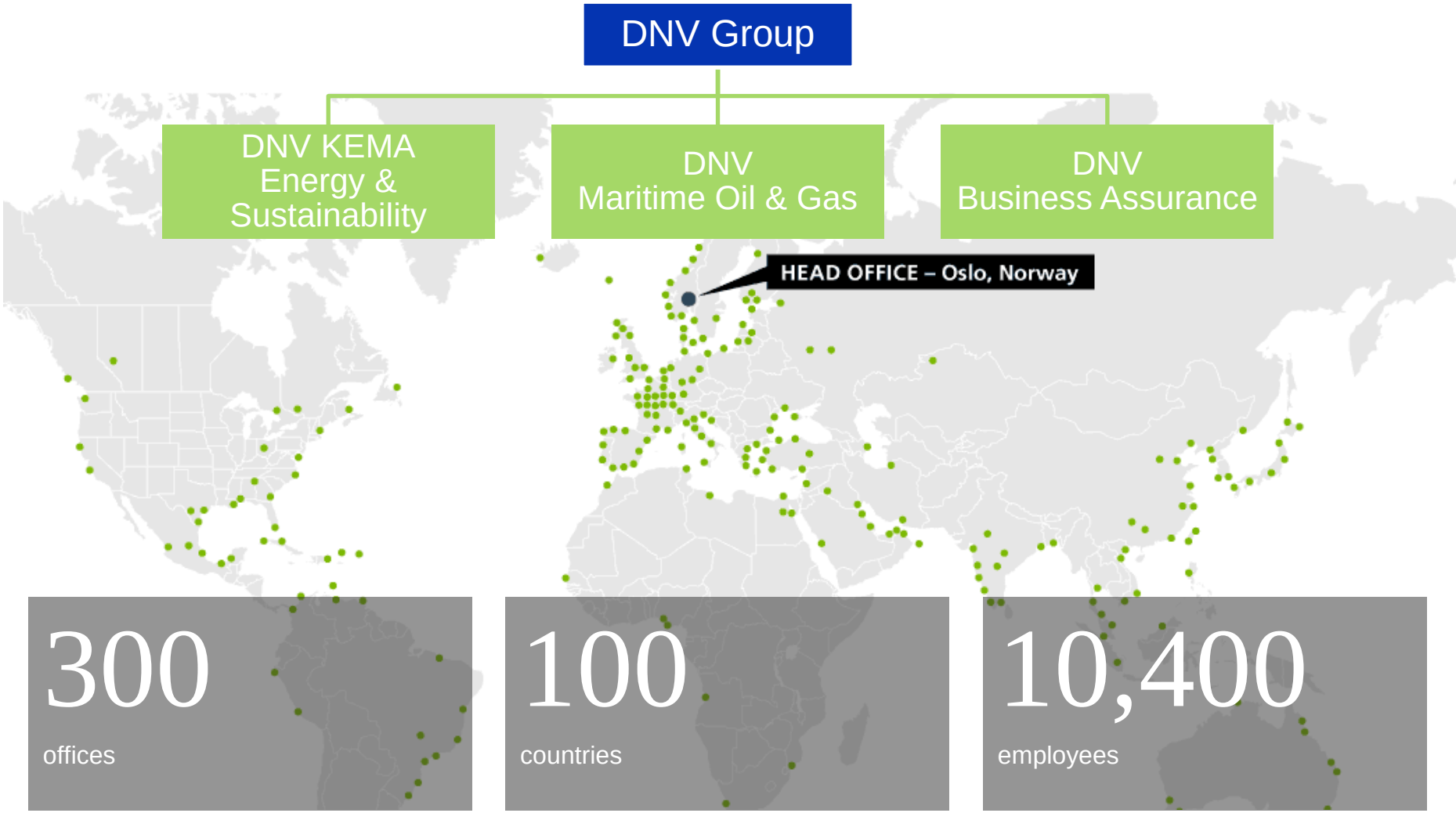
Outline

- Introducing DNV KEMA Energy & Sustainability
- Renewable energy, biogas and biomethane in the Netherlands
- Biomethane grid injection
- Options for accommodating biomethane in the grid
- Conclusion

The DNV Group



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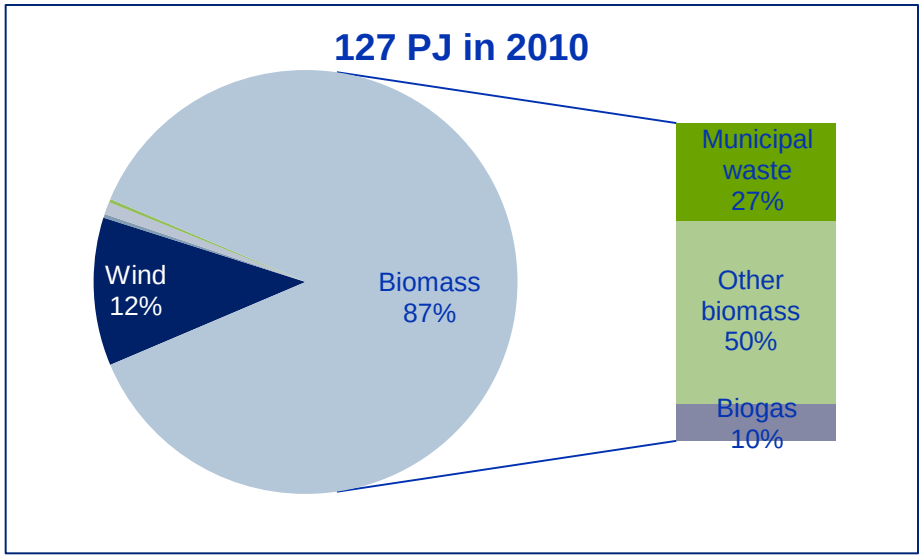
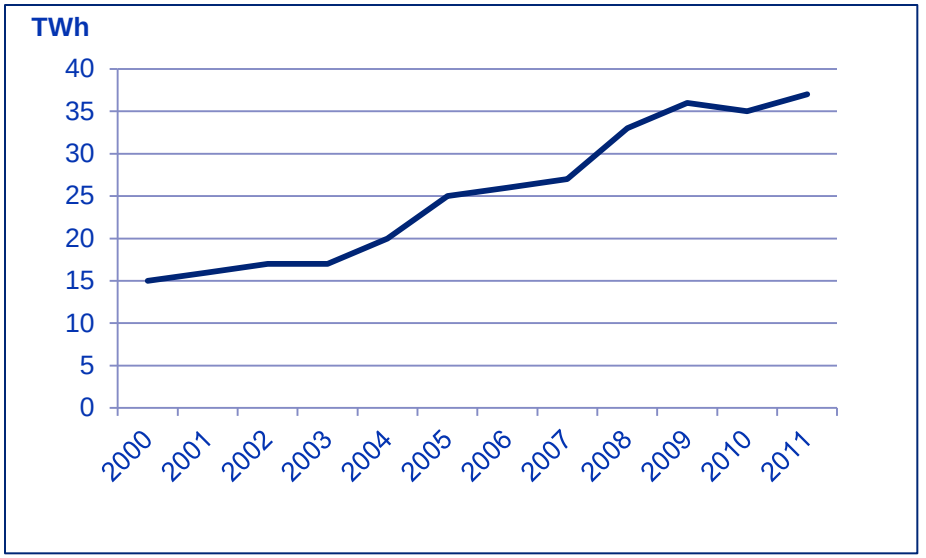
- DNV KEMA Energy & Sustainability is commited to **driving the global transition** toward a **safe**, **reliable**, **efficient**, and **clean energy** future
- **2,300+ experts** in over **30 countries** around the globe
- KEMA and DNV combined: a heritage of nearly **150 years**
- Specialized in providing **world-class, innovative solutions** in the fields of **business** & **technical consultancy**, **testing**, **inspections** & **certification**, **risk managment** and **verifcation**
- As an **objective** and **impartial** knowledge-based company, we **advise** and **support organizations along the entire energy value chain**: producers, suppliers & end-users of energy, equipment manufacturers, as well as government bodies, corporations and non-governmental organizations

Renewable energy supply in the Netherlands

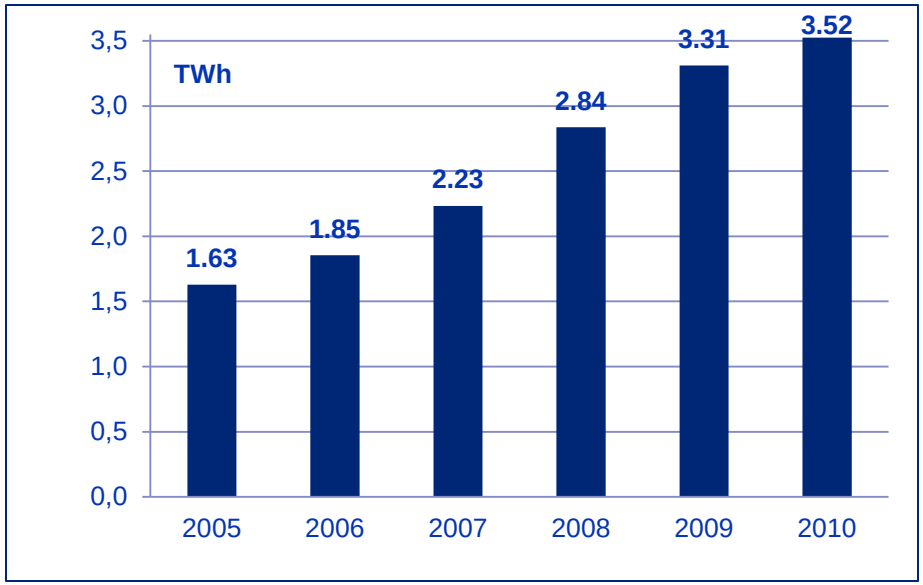
- Renewable energy has been steadily increasing to around 4.2% of final energy use in 2010 (~130 PJ)
- The national target is set at 14% of final energy use in 2020 (~310 PJ)
- Biomass represents more than 80% of the renewable energy mix (~111 PJ), of which only ~13 PJ (3.5 TWh) is used in the form of biogas



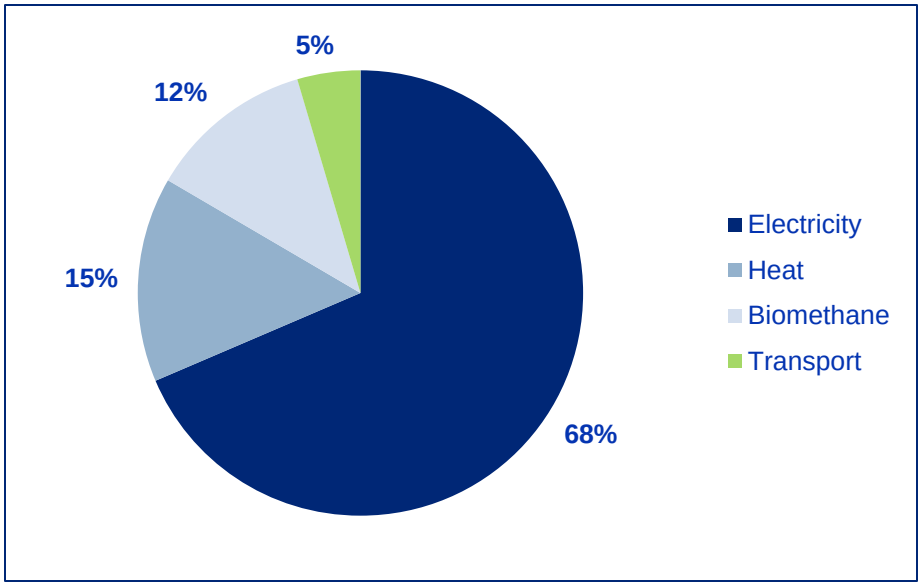


Raw biogas production and utilization

Biogas production 2005 - 2010



Biogas utilization 2010



- In 2010 around 3.5 TWh of biogas was produced in the Netherlands
- The number of biogas production plants in operation increased to 209 in 2011, from 130 plants in 2010
- The majority is used in power and heat production
- 17% of all raw biogas produced (0.58 TWh) was upgraded to biomethane quality and injected into the grid or used as transport fuel

Biomethane production

- First upgrading started in 1987 with landfill gas. In 2011 landfill represented one-third of all upgraded gas
- The share of organic waste and co-digestion has increased in recent years
- Currently approximately 17 biomethane plants are in operation
- Individual biomethane production, but also cooperation in ‘green gas hubs’
- In 2010 some 50 mln m^3 of biomethane was produced, representing 0.1% of natural gas supply in the Netherlands
- The target is to inject 24 PJ or ~760 mln m^3 in 2020

Source: www.malmberg.se

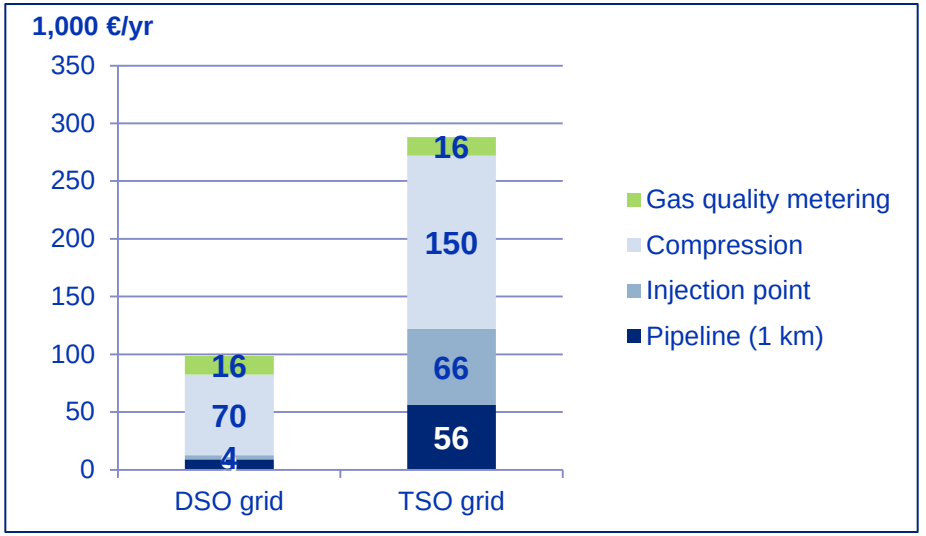
Biomethane grid injection - Overview

- Raw biogas is upgraded to L-gas quality
- Injection is possible both into the distribution (max. 8 bar) and into the transmission grid (max. 40 bar)
- Due to lower costs and proximity, injection into the distribution system is the default choice for producers
- Currently only one project in the Netherlands is injecting into the transmission grid on an experimental basis

Source: www..hvcenergie.nl

Source: www.flotech.com

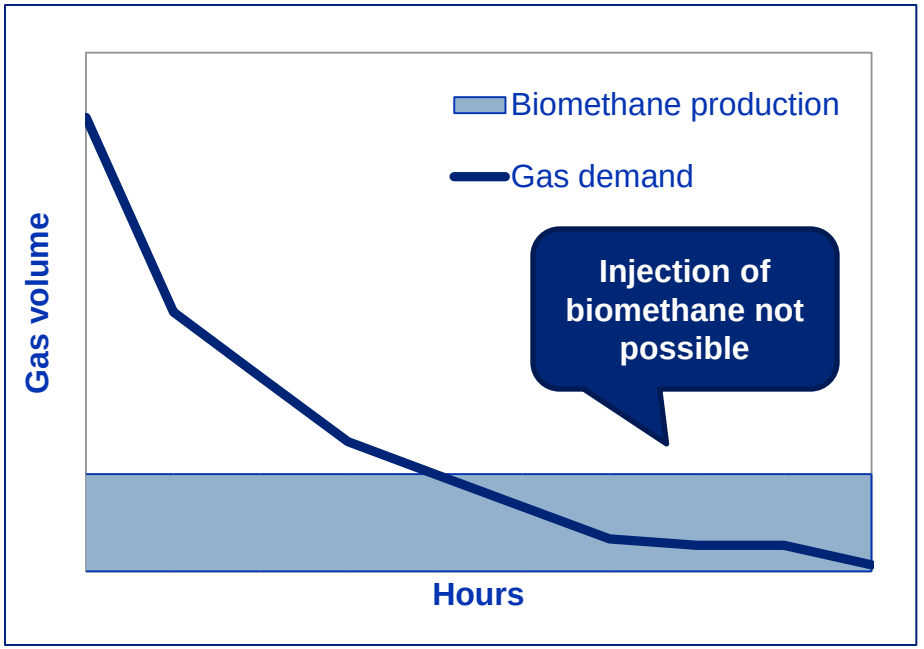
Indicative costs of injection



Biomethane grid injection – Available capacity

- Factors that affect available injection capacity in the distribution grid are
  - Maximum grid capacity
  - Gas pressure and gas flow rate in the grid
  - Gas demand
  - Number of biomethane producers in the area
- These factors could lead to the situation where biomethane producers have more gas available than they can inject into the grid

Illustrative relationship between demand load (annual basis) and maximum injection capacity



Options for accommodating biomethane in the grid (1)

FLARING

- Financial loss of commodity and costs associated with flaring itself
- Leads to high emissions
- Only attractive when the volume of biomethane that cannot be injected is very insignificant

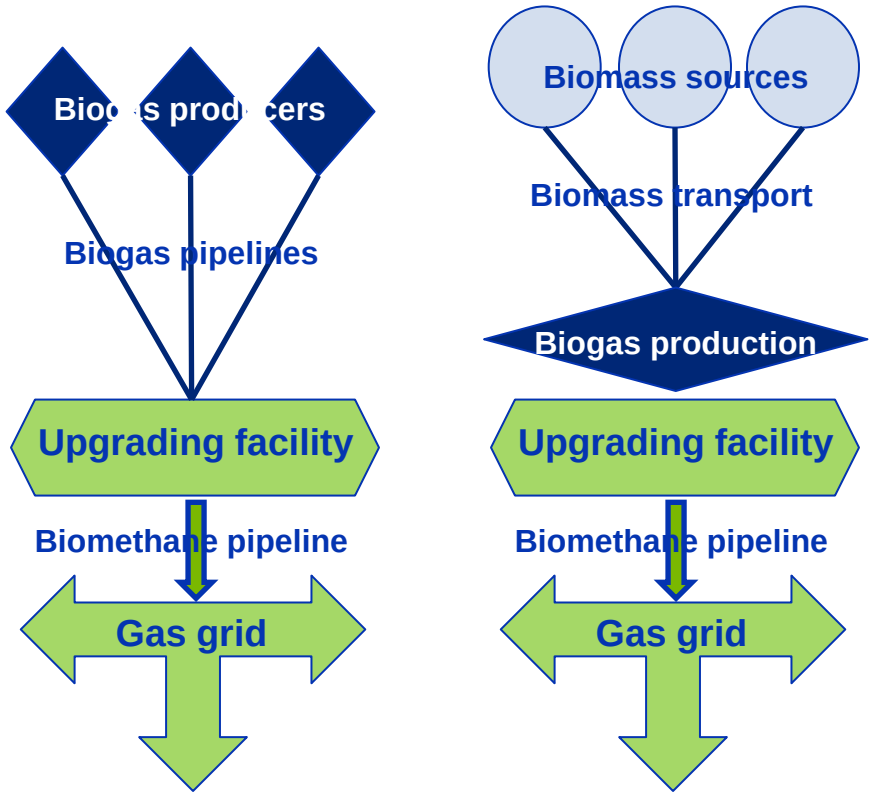
DIRECT USE BY THE PRODUCER

- Not all producers have the need or the possibility to use the gas for own purposes
- Producing and commercializing electricity and/or heat, however this is not always possible
- The subsidy for biomethane injection would be lost

Options for accommodating biomethane in the grid (2)

BIOMETHANE HUBS

- Upgrading biogas to ‘natural gas’ quality is highly sensitive to economies of scale
- Cooperation between small scale biogas producers and upgrade their biogas jointly in the hub
- Two main design options
  - decentralized digestion and centralized upgrading
  - both digestion and upgrading centralized
- A hub producing more gas than it can inject would have to find other solutions



Options for accommodating biomethane in the grid (3)

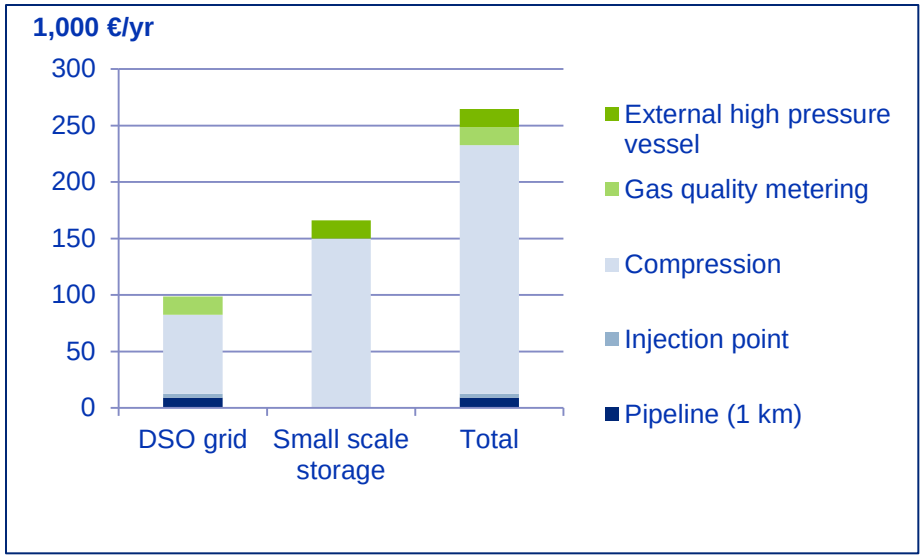
SMALL SCALE STORAGE

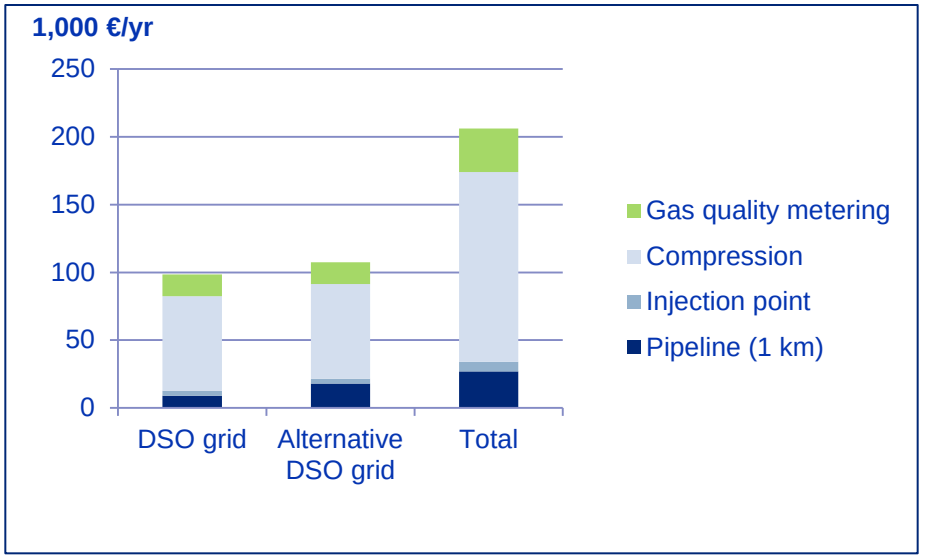
- Storage of excess gas in a small scale facility, bridging the time gap between the production and available injection capacity
- Simple compressed gas storage requires a compressor and a pressure vessel

ALTERNATIVE DSO GRID

- Injection in an alternative grid when the nearest grid cannot accommodate all biomethane production
- The alternative grid should have sufficient spare injection capacity

Indicative costs





Options for accommodating biomethane in the grid (4)

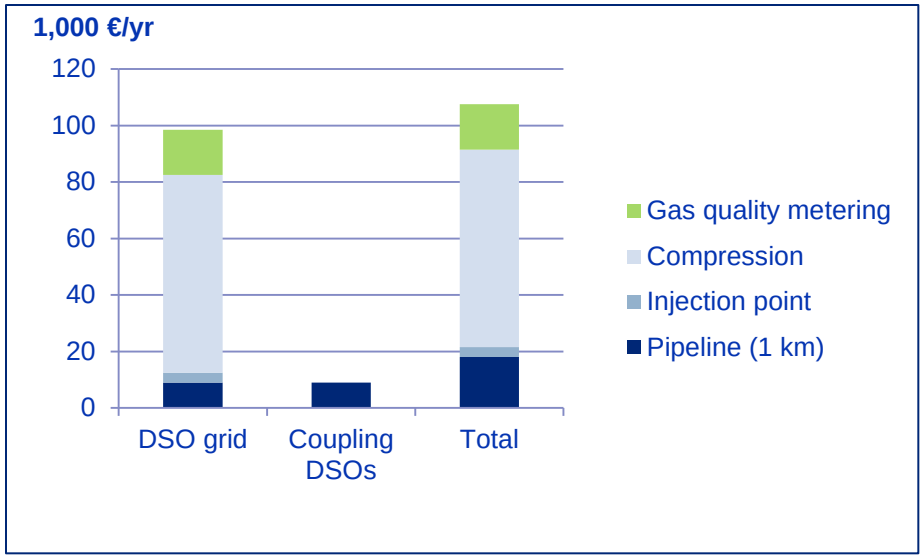
COUPLING DSO GRIDS

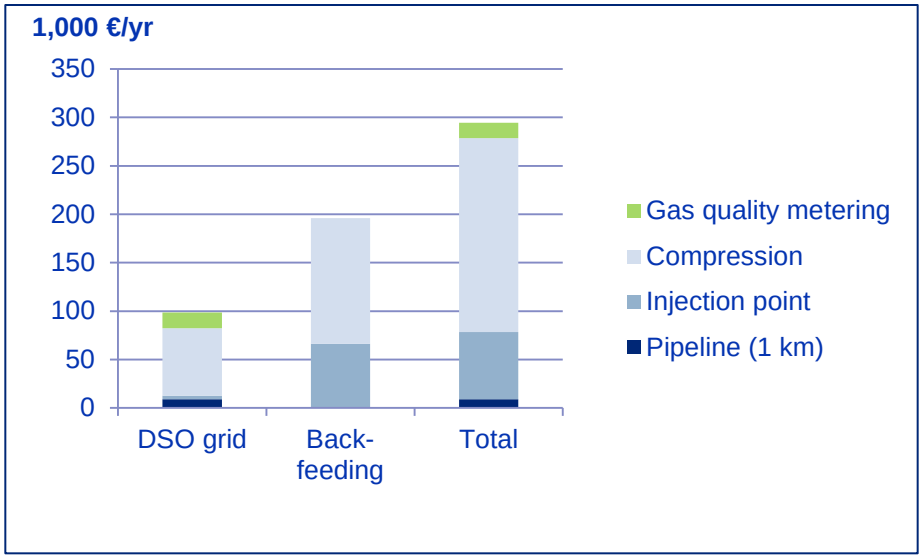
- Via a linking pipeline
- The alternative grid should have sufficient spare injection capacity

BACK-FEEDING INTO TSO GRID

- The DSO would feed the compressed excess gas into the TSO grid as a reverse flow
- Only attractive with sufficient demand from TSO customers

Indicative costs

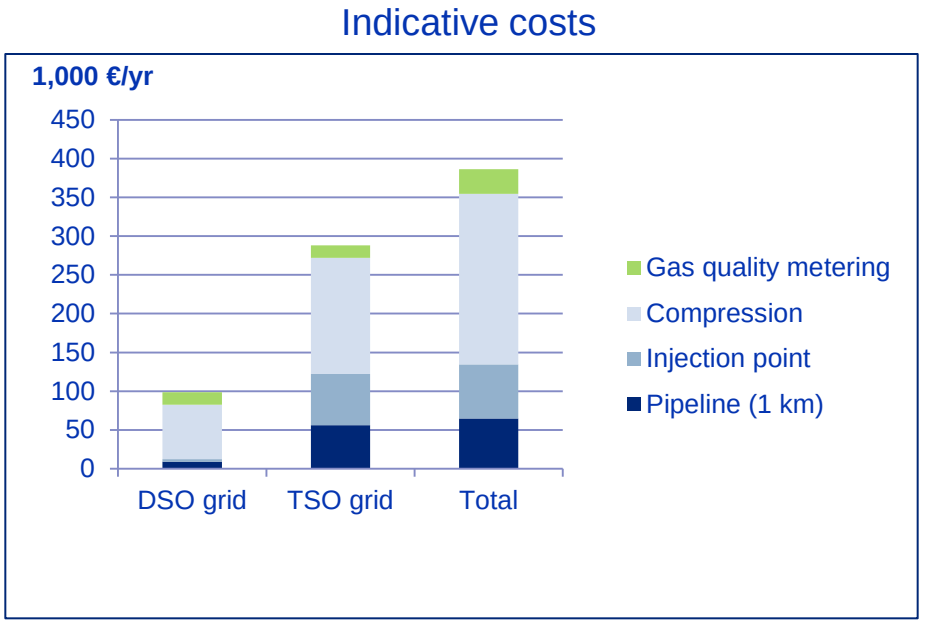




Options for accommodating biomethane in the grid (5)

DIRECTLY INJECT INTO THE TSO GRID

- Injection into a TSO grid is only attractive when demand of the TSO customers is higher than that of the DSO customers
- The costs of a connection to the DSO grid in addition the costs of a connection to the TSO grid amount to an expensive solution
- Therefore this solution is only potentially attractive to the green gas producers who have significant volumes of excess green gas



Options for accommodating biomethane in the grid (6)

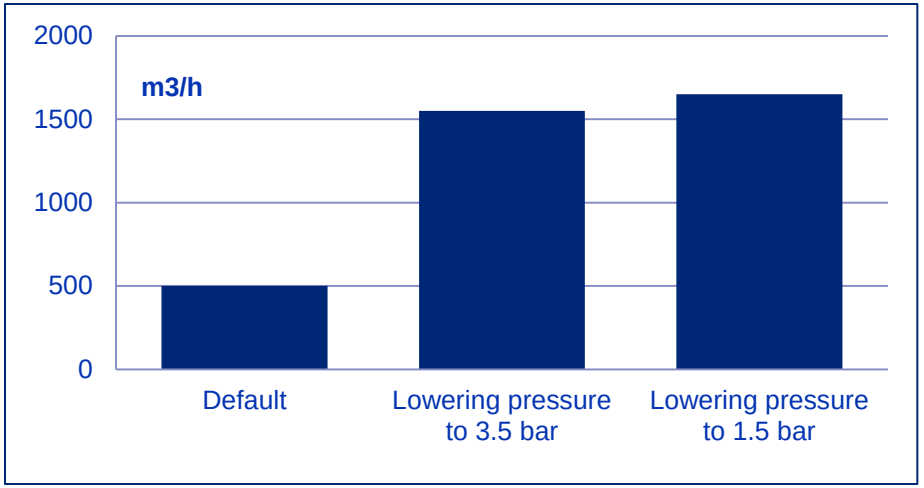
SHORT TERM BUFFERING IN THE DSO GRID

- Excess gas would be injected into the network during the night and consumed during the day if demand allows for it
- Whether or not short term buffering is possible is determined by the DSO
- Costs of buffering are case-specific and depend on the grid configuration
- Additional investment is not required, since buffering effectively means using the capacity of the grid more efficiently

LONG TERM BUFFERING

- Spare capacity due to lower demand in summer could be used to buffer the gas in the grid to be consumed in winter
- Lowering the operating pressure of the DSO grid is required to allow injection of more gas than is actually consumed
- Costs are case-specific and depend on the grid configuration

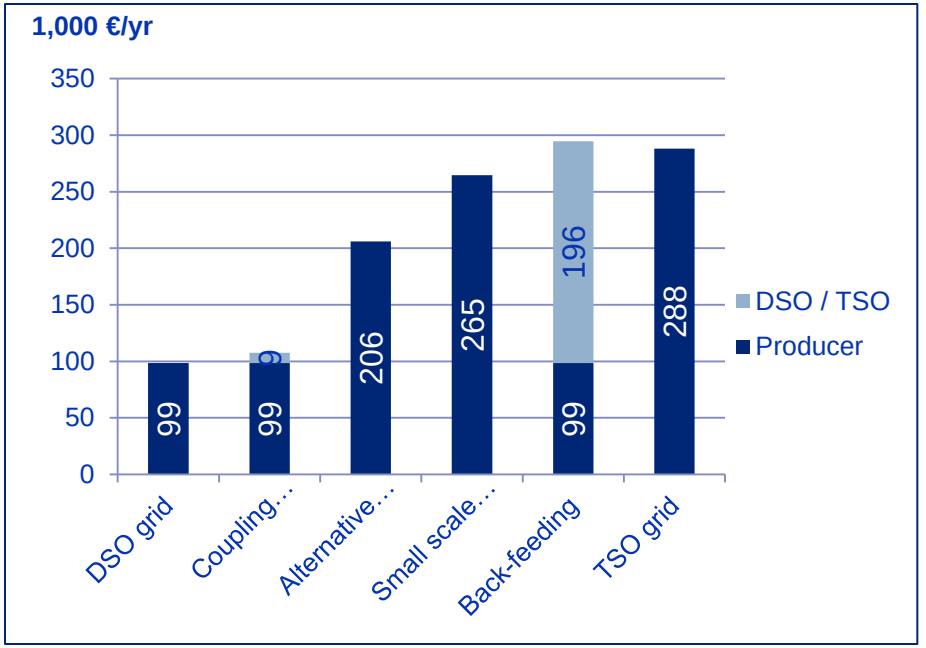
Maximum biomethane injection capacity at different receiving stations' pressures (Pmax = 8 bar)



Biomethane grid injection – Cost allocation

- Costs of injection into the existing grid are borne by the producer
  - Any grid modifications, as well as administrative and operational costs related to the injection of biomethane would fall outside the responsibility of the producer
- Grid operators have the obligation to connect the producers
  - subject to available capacity and technical standards
  - FCFC
- Accommodating the biomethane into the grid does not fall under the grid operators' responsibilities and therefore does not qualify as regulated activity

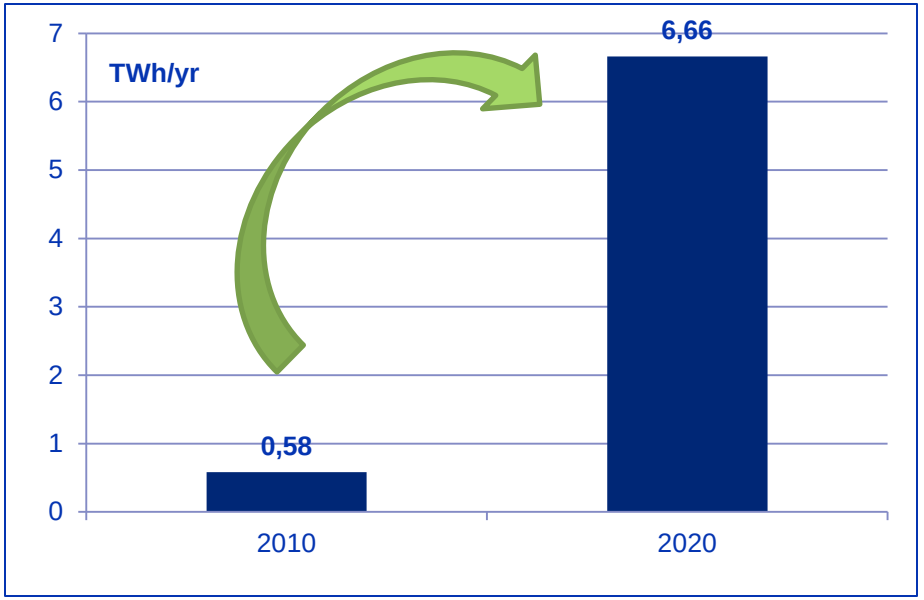
Indicative allocation of costs between grid operators and producers



Conclusion

- Given the Dutch target for biomethane of 6.66 TWh in 2020, it would be a major challange to accommodate this volume in the grid
  - The majority of cost is borne by biomethane producers, while
  - Grid operators are not primarily interested in facilitating biomethane injection when it requires investments or other costs on their side

Biomethane injection target



Thank you for your attention

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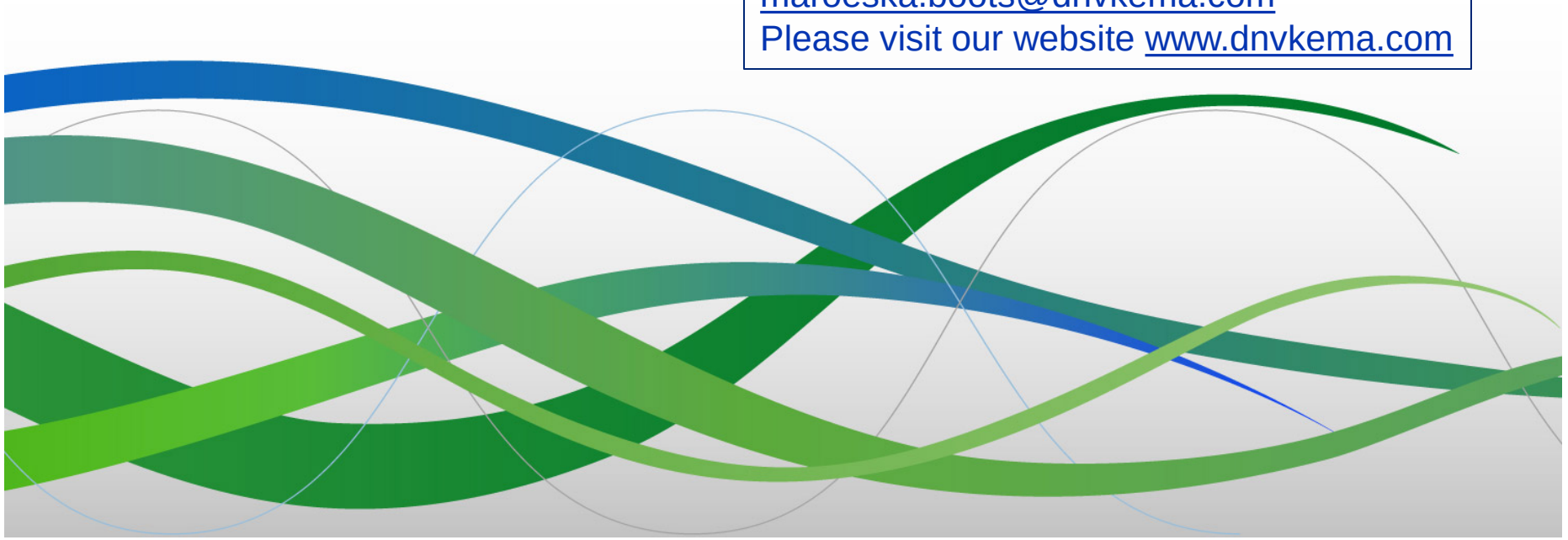
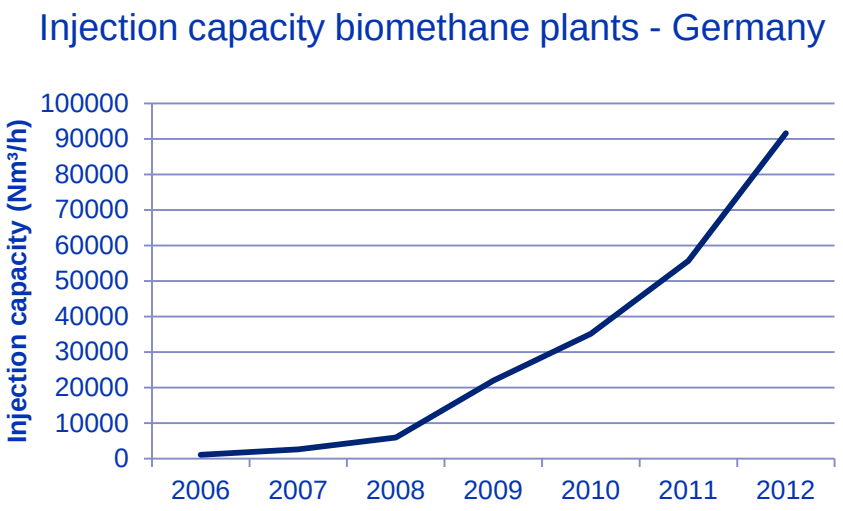


Biomethane grid injection – Germany

GERMANY

- Currently some 84 biomethane injection plant; plant size is growing
- About 270 mln m³ of biomethane were injected to the natural gas grid in 2010
- Biomethane is injected into different pressure levels
- Gas Ordinance guarantees free access to the gas grid and stipulates a 25% / 75% cost split between biomethane producer and grid operator;
- Grid operator is owner of the connection and responsible for biomethane odorization, conditioning and compression
- Investments can be recovered through the tariffs



Biomethane grid injection – France

FRANCE

- Biomethane injection only possible since November 2011 as a package of Decrees was adopted
- At the moment only one upgrading facility; grid injection is in the experimental phase
- Connection costs are producers' responsibility and are to be recovered through feed in tariffs
- Priority access to the grid. DSOs and TSOs are responsible for grid extension, and accommodating the green gas injection qualifies as such
- Additional costs incurred by the respective operators to accommodate green gas can be socialized and recovered through tariffs