ENERGINET.DK

27 November 2015

The role of gas in the green transition

The gas system is valuable to the green transition.

The Danish and European energy system is experiencing a transition towards a greener system. Phasing out fossil fuels like coal, oil and natural gas and implementing a system based on renewable energy.

This means that the gas system changes from supplying households, power stations and the industry with natural gas from the North Sea to receiving gas produced from biogas, wind and biomass from many different sources and then distributing and storing the gas for usage in the industry, transport sector and as backup for wind and solar energy. A transition not unlike the one the Danish electricity system has experienced on the supply side; however, with the difference that the transition at the same time means lower gas consumption.

In the coming years, the gas system must transform to new usage and ensure that the system is coherent in terms of technology and economy in order to contribute to the green transition. As integrator of wind and sun as well as supply of fuel for the industry and transport sector, the value of the gas system is very high. In the shorter term, the gas system can reduce emissions, CO_2 and NO_x from the transport sector, particularly within heavy transport and shipping.

In this analysis, focus is on the future role of gas in the Danish energy system. The analysis is part of Energinet.dk's planning task for the electricity and gas system of the future.

2 The gas system is valuable to the green transition.

3 The gas system adds a socio-economic value of DKK 2-3 bn per year.

4 The role of natural gas is reduced as part of the transition

5 Decreasing gas consumption and gas production in future.

6 Gas production becomes more local and more green.

7 Projections of the gas consumption: electricity, heat and industry

10 Gas for transport reduces emissions

11 Certificate market for gas supports gas in transport

12 The transmission grid must be made attractive for transit

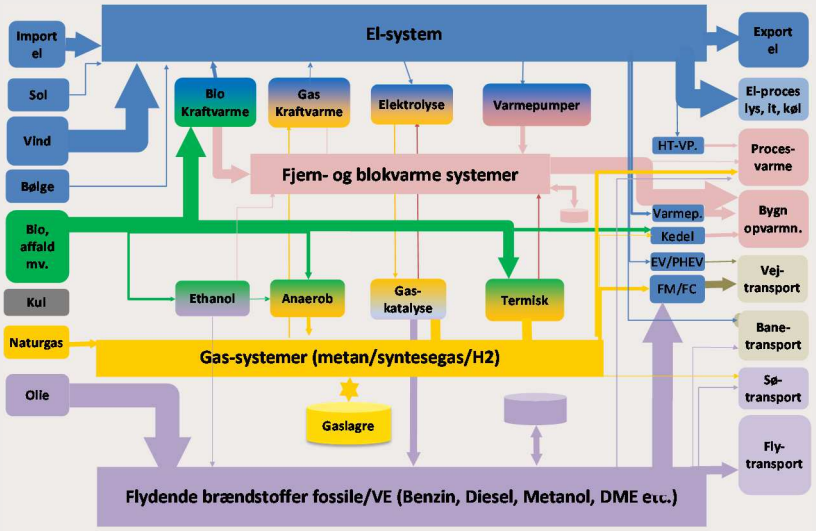
13 Gas market development through dialogue

The gas system adds a socio-economic value of DKK 2-3 bn per year.

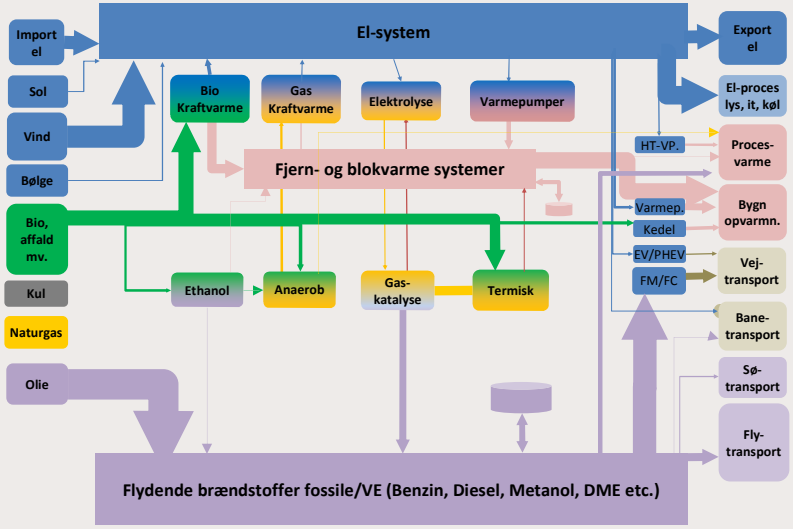
In future, the electricity and gas systems will constitute the backbone of the total Danish energy system. Surplus electricity is converted into gas. Gas is used as fuel in the industry and transport sector and for electricity and heat, when the electricity production from other renewable energy sources is insufficient. Surplus gas is exported to or stored in one of the large gas storage facilities. The alternative to a gas transmission and distribution grid is local use of biogas as well as exchange of gas with biomass and oil. Analyses of the energy system in 2035 show that the possibility for gas transmission and distribution in the existing grids gives a socio-economic net saving of DKK 2-3 bn per year compared to a situation without the gas system.

Without the possibilities of the gas system, biogas and green gas can be used only locally for power and process heat, and there is no or only little chance of storing the green gases. Consequently, a larger part of the green gas will be used directly for combined heat and power than in a situation with a gas grid. Other use of gas must be converted into liquid fuels, such as oil, biofuel or gas supplied as CNG or possibly LNG[1]. The conversion into oil, biofuel or LNG requires investments in infrastructure and entails higher fuel costs.

With the gas grid in 2035



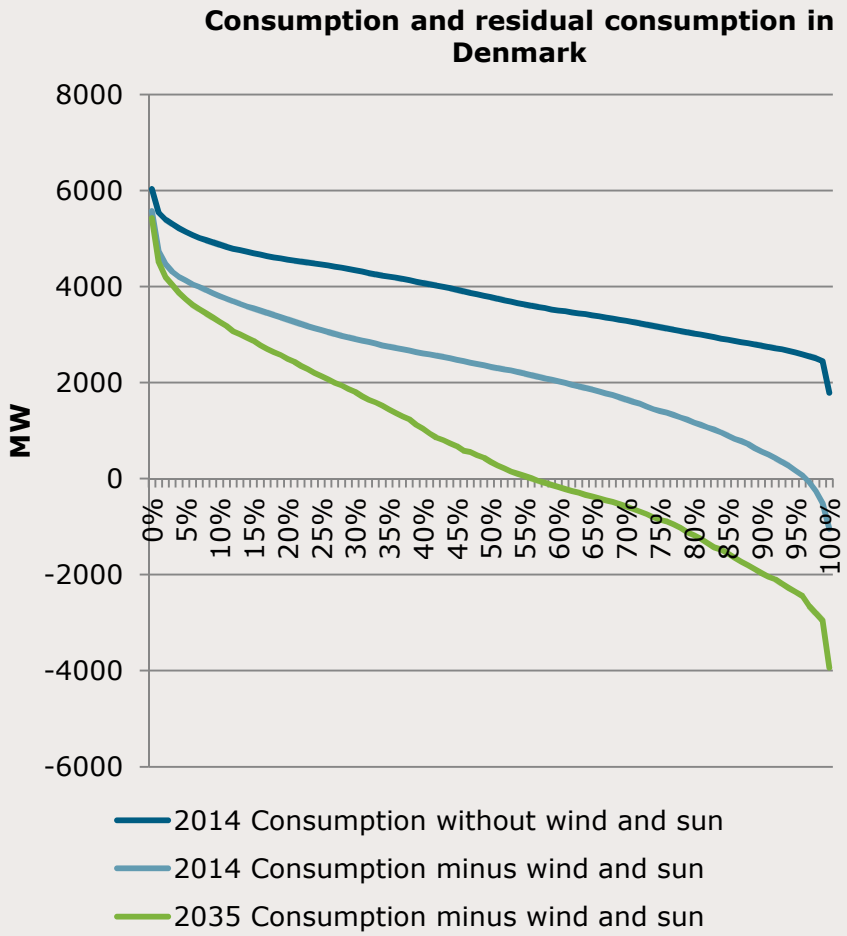
Without the gas grid in 2035



Source: Analysis 'Benefits of the gas system to society in 2035' (Gassystemets gevinst for samfundet i 2035), Energinet.dk 2015.

[1] *CNG compressed natural gas: Bottled natural gas LNG Liquefied natural gas: Natural gas cooled and stored as liquid.*

The role of natural gas is reduced as part of the transition



Source: 2014 Energinet.dk's market data. 2035 data from 'Energy concept 2030'.

The terms for thermal power stations during the green transition can be illustrated with a duration curve of the residual consumption in Denmark. That means electricity consumption without electricity generation from wind and sun. The three curves illustrate the green transition: One year's electricity consumption without wind and sun, one year's residual consumption with wind and sun like now and residual consumption in a future situation with approx. twice the amount of wind power generation compared to today. With increasing amounts of wind and sun, the need for other electricity generation, particularly base load, will be smaller. In addition, renewable energy production holds periods with surplus electricity generation.

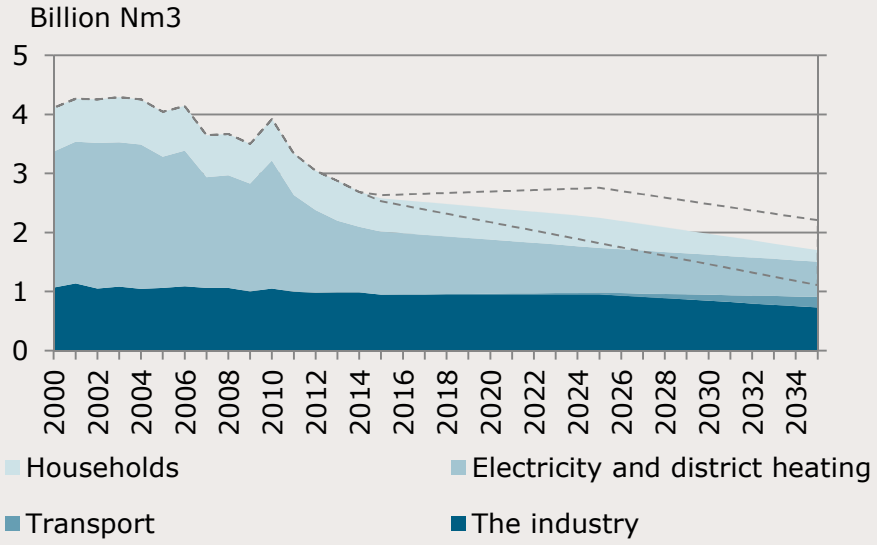
Today, the electricity market ensures that consumption needs are met, and the surplus is divided in the most economic, rational way by domestic and foreign resources. Therefore, consumption needs will initially be met by units with very low variable generation costs and later by units with high variable generation costs. Today's smooth integration of renewable energy is due to the interconnection of electricity systems and the European electricity market.

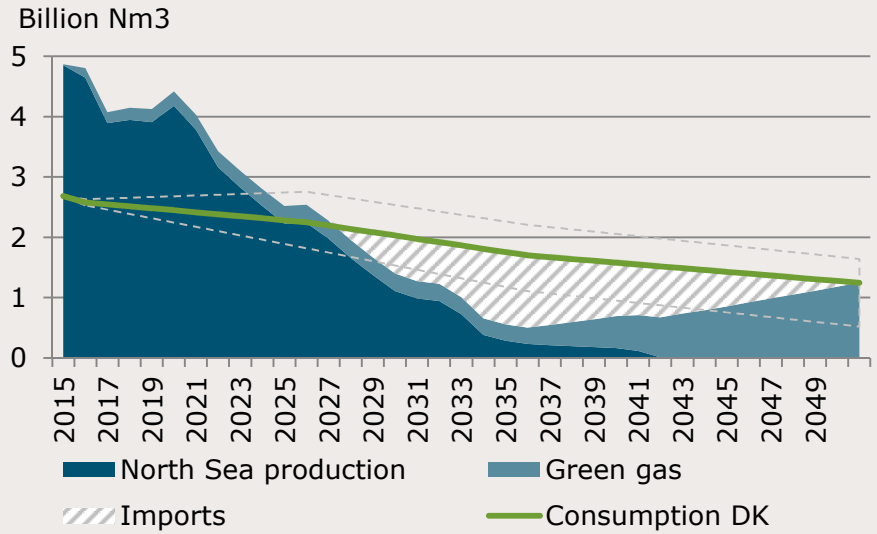
A consequence of the above is that there will be continuously less room for generation with variable generation costs. This applies to gas, coal and biomass, but the most expensive fuels will be affected first. Specifically for gas, this means that even with very low gas prices (eg lower than coal prices), electricity from gas power or gas combined heat and power will play a continuously smaller role in future, when the electricity system in Denmark and Europe is expanded with increased production from wind and sun.

Decreasing gas consumption and gas production in future.

The following is a projection of the development of gas consumption within: Households, electricity and district heating, industry and transport. The overall picture shows a decrease in traditional gas consumption and a small increase in gas for the transport sector and a considerable use of the gas grid for green gases. The outcome of the gas consumption projection is relatively big: Gas for the transport sector may develop slower than anticipated. The decrease in consumption for heating and combined heat and power can be smaller, if eg the gas price is low, or if the framework conditions are changed, and the industry's consumption depends on economic conditions and competition.

The gas supply is expected to be converted into an even greater share of green gas: Biogas and synthetic natural gas made of wind power electricity. In a way, gas is experiencing a development that is parallel to the development of the electricity market in connection with the introduction of local generation and renewable energy. The gas will change from being supplied from a few local points (the North Sea and Germany) to being supplied from many different places in the system and distributed to the consumption sites or exported.



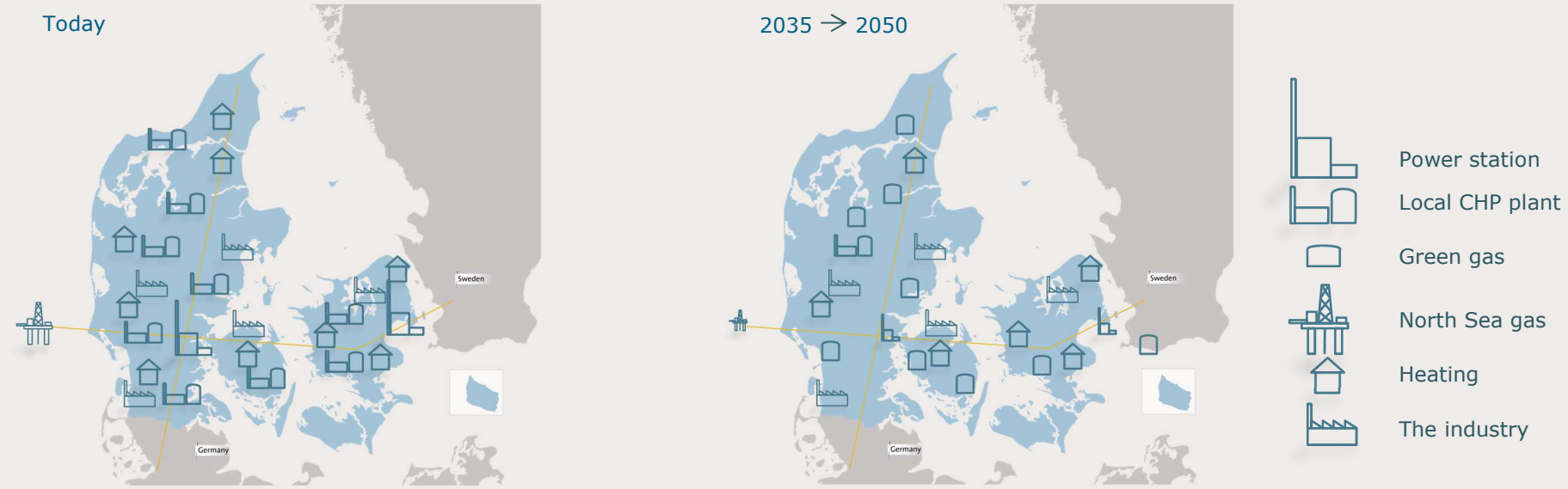


Projection based on current framework and legislation towards 2025. Followed by socio-economic projection.
Source: Energinet.dk's analysis assumptions, October 2015

Gas production becomes more local and more green.

In the future energy system, the production of gas will be based on biogas, gasification of raw biomass as well as electrolysis with methanisation. Compared to the electricity system, the gas system gas can both obtain and deliver very large energy amounts and therefore functions well in an electricity system dominated by wind and sun. Green gas and gas producted from surplus electricity will not be produced concurrently with the consumption of gas. This is handled through the very large storage capacity of underground storage facilities and the possibility of exporting surplus gas and importing gas when there is a deficit.

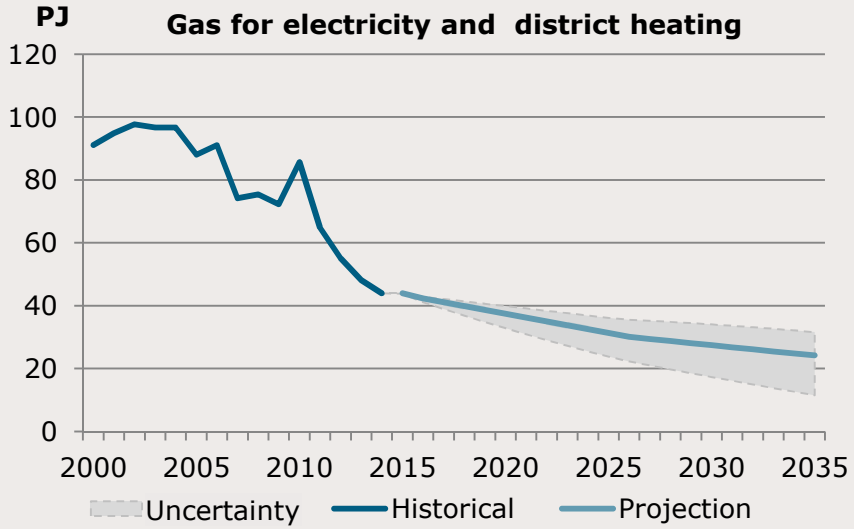
The development of gas supply means decreasing production centrally from the North Sea and increased production of green gas distributed locally across Denmark. The development is not unlike the development experienced by the electricity system in Denmark on the supply side. The difference, and the challenge for gas, is that the developement will take place concurrently with the decreasing gas consumption with less use of gas for electricity and heat.



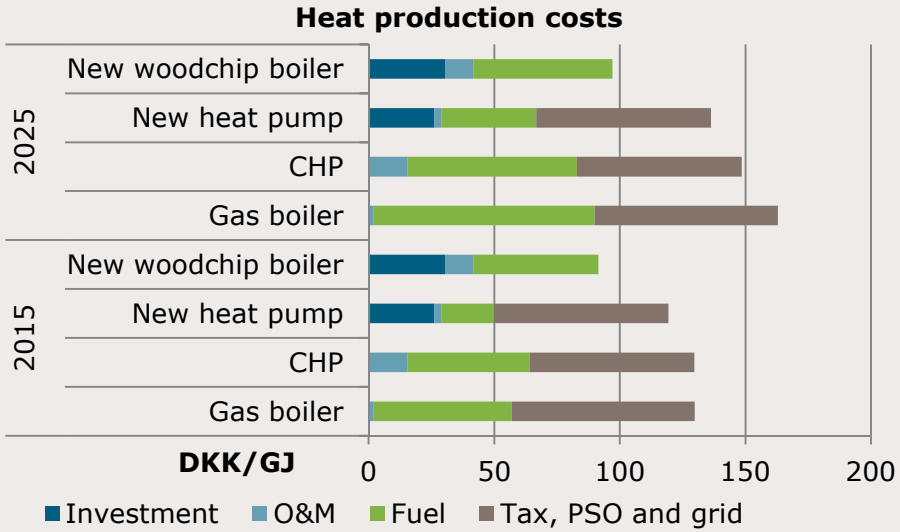
Gas for district heating and electricity generation is decreasing

In recent years, the gas consumption for electricity, district heating and combined heat and power has decreased, and that development is expected to continue in future. The development is fuelled by the prices of gas and electricity as well as the combined heat and power duties. The relation between the price of gas and electricity is not favourable to neither gas power at present nor in future. For a local CHP plant, it is often more worthwhile to use peak load boilers for heat production instead of combined heat and power. If the CHP plant can change to a less expensive fuel or biofuel without tax, it will often result in a lower heat price. For many CHP plants, it means that the CHP part will be scrapped when the plant is replaced or renovated. For the CHP plant, the alternative is a heat pump, solar heating, operation on gas boiler and - if possible - investment in a woodchip boiler.

The uncertainty in the gas consumption indicates that there may be years with high or low electricity prices compared to the costs of electricity generation with gas. Due to competition from wind and sun, gas will not play as important a role as base load power stations, even if the gas prices in Europe will fall to a level that makes it competitive with coal. A development that is not only due to the Danish expansion of wind and sun, but to a great extent also the expansion in our neighbouring countries.



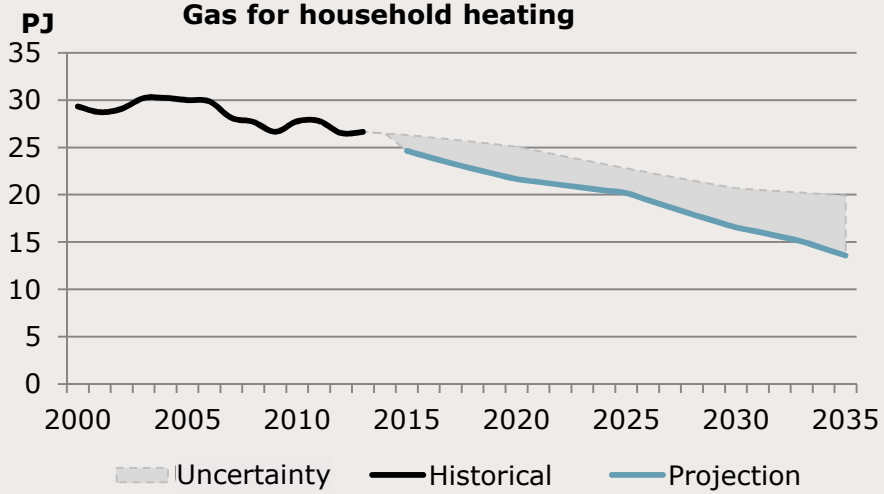
Source: Energinet.dk's analysis assumptions, autumn 2015

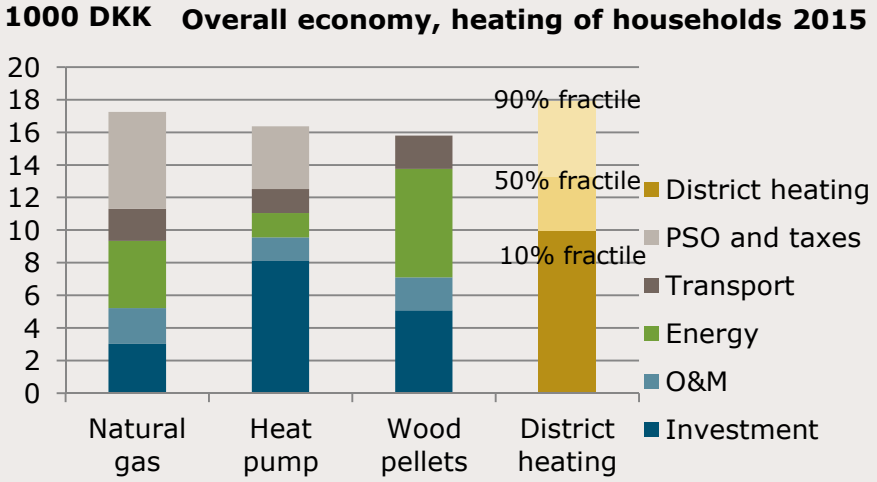


Gas amounts for heating is decreasing

During the last few years, the number of natural gas installations in households has decreased. Among other things because the current legislation prohibits natural gas in newly built houses; however, this does not apply to houses built in existing natural gas areas. Despite a growing number of installations, the total gas consumption for households has decreased due to increased efficiency in new natural gas boilers, low heat consumption in buildings as well as use of secondary heat sources, such as wood stoves. The development with a decreasing consumption per installation is expected to continue in future as a consequence of among other things energy savings.

The projection shows that the number of natural gas installations decreases as a consequence of competition from heat pumps, district heating and wood pellet stoves. This means that when it is time to replace a gas furnace, other heat sources will be considered. Individual conditions decide whether the gas furnace is replaced and with what other heat source. It may be easier and less liquidity-requiring to get a new natural gas boiler instead of converting into electricity or biomass, though it is less expensive in the long run.



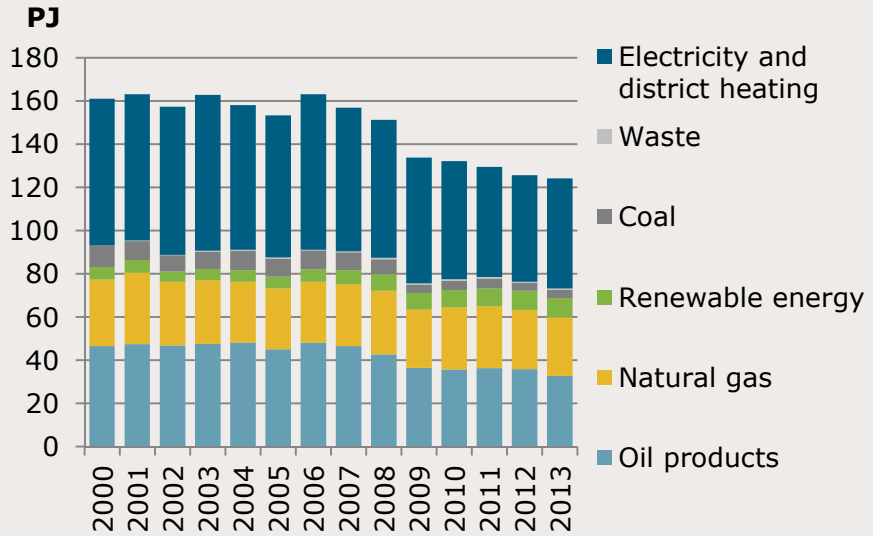


Source: Analysis 'Course of development for transition of individual heating solutions towards 2025' (Udviklingsforløb for omstilling af individuelle opvarmningsløsninger frem mod 2035), Energinet.dk.

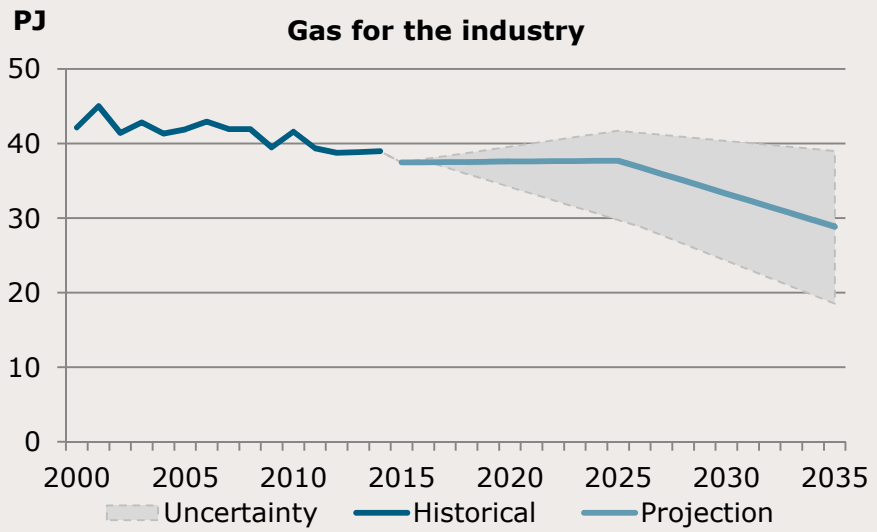
Gas supplies for the industry is decreasing

In recent years, the consumption of gas in the industry has been modestly decreasing. The decrease is attributable to a change in the use of fuels, energy efficiency measures as well as close-down or relocation of companies. During that period, the gas consumption supported by conversion of oil products into natural gas, which often will be lucrative due to the price difference between oil and natural gas. An analysis of the gas consumption in the industry shows that most of the potential for conversion into gas has been exploited, and a further gas consumption of maximum 7 PJ can be expected, if investments in expansion of the distribution grid are made at the same time.

The projection of the gas consumption shows a reasonably constant gas consumption for the industry. This is due to a combination of low expectations of a large and new conversion wave into natural gas or new gas-consuming industries. In the long term, part of the industry's gas consumption is expected to be converted into electricity, heat pumps or biomass. The development may come sooner because of support from the subsidy scheme 'VE til proces' (RE for process), which subsidises conversion from fossil fuel into renewable energy fuel or electricity.

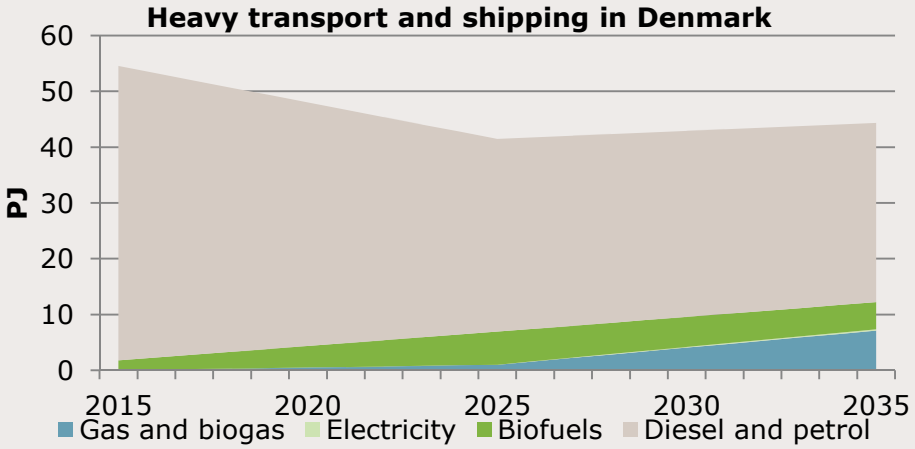


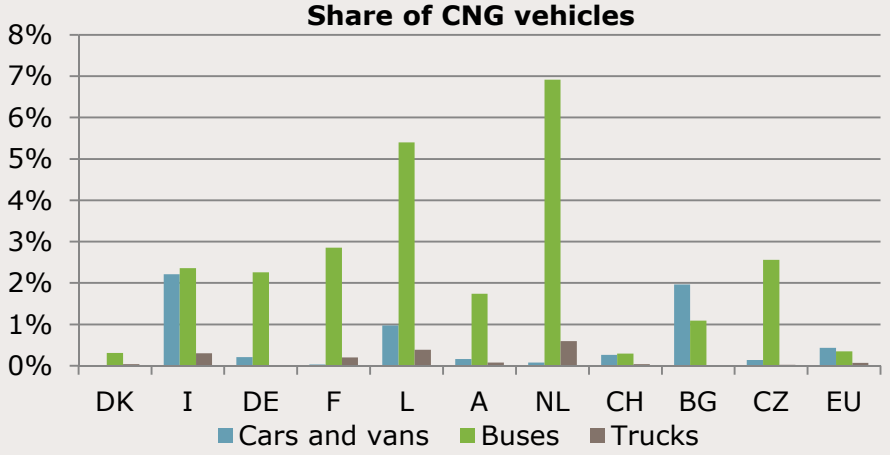
Source: Statistics Denmark



Source: Energinet.dk's analysis assumptions and 'Energy concept 2030' (Energikoncept 2030).

Gas for transport reduces emissions





Source: Natural gas vehicles in Europe, NGVA Europe. Energy consumption for transport; 'Energy Concept 2030'.

Gas is interesting in the transport sector, as it can potentially reduce the dependency on oil and may in the long term become an important fuel in the sectors where it is practically impossible to use electricity, eg for heavy transport and ships. As to shipping, gas has a great advantage in terms of adhering to NO_x emission requirements in the Baltic Sea region. As to vehicles in the cities, CNG means lower emissions in practice of NO_x compared to diesel. If bio natural gas is used, the fuel is CO_2-neutral. At the moment, bio natural gas is the least expensive renewable energy fuel.

Economically, natural gas is less expensive than petrol and diesel, but the infrastructure for refuelling gas has yet to be expanded in Denmark. As yet, the development primarily takes place within heavy transport and ferries. It is appropriate to use of biogas as fuel for heavy transport with regular service (eg buses and lorries) in order to reduce CO2 emissions from the transport sector. As to light transport (cars and vans), the current framework conditions provide no economic incentive to invest in cars running on natural gas or biogas in Denmark. The cars are too expensive and in practise, the cost-saving on fuel is too small. Shipping primarily uses gas in the form of LNG. Imported LNG at first; in long term, locally produced LNG from the natural gas grid.

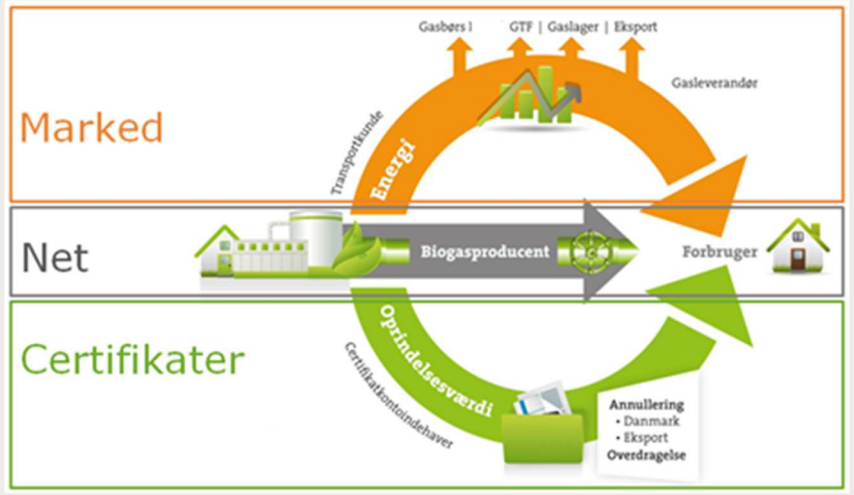
Gas for transport is more developed in most European neighbouring countries than in Denmark, both the number of gas stations and vehicles. Gas for transport is primarily used for bus traffic. A Danish concentrated effort on gas and biogas for transport can push a development where large amounts of gas and biogas are used for transport with great potential.

Certificate market for gas supports gas in transport

Gas is gradually becoming more green in step with phasing in continuously larger amounts of biogas in the grid; in the long term, also bio natural gas from biogas or SNG[1] from wind power electricity and CO2 - with and without use of biomass. In the short term, gas can be completely green through direct refuelling at biogas plants or through purchase of certificate for green gas. At the moment, biogas is the least expensive CO2-neutral fuel compared to biomass fuels, such as bioethanol and biodiesel.

Today, bio natural gas is used as transport fuel in the first fleets of buses, refuse collection trucks, etc. in the Danish cities. A number of first movers have invested in gas vehicles and refuelling facilities and have made good experiences. Local authorities in particular have found that bio natural gas and gas fleets are technological and inexpensive alternatives to other renewable energy fuels in the transport sector. Based on the first experiences, the City of Copenhagen has decided that all refuse collection trucks in downtown Copenhagen must run on bio natural gas from 2017. All four regional traffic companies are testing bio natural gas for transport. At present, about 75 gas bus contracts have been entered into, and there are ongoing tender procedures for a further 60-70 contracts. If this development continues, it may help support an expansion of the Danish tank infrastructure, which at the moment counts only 10 tank installations.

In 2015, an important step for this development has been the recognition of bio natural gas traded via the certificate model under the Danish mixing requirement of 5.75 per cent renewable energy in the transport sector.



Trade with bio natural gas via the gas grid: A biogas producer gets the biogas upgraded to bio natural gas at an upgrade owner. The upgrade owner will be connected and deliver the bio natural gas to the gas grid. The grid companies are responsible for the physical distribution and handling of the gas. The energy content in the bio natural gas is traded on the gas market like all other gas. The original value and CO2 reduction are traded through the certificate model. The certificates are issued to the biogas producer and traded between the certificate account holders. When the end consumer purchases bio natural gas certificates corresponding to the gas consumption, it is guaranteed that the consumer has purchased the added bio natural gas and thus the related CO2 reduction.

[1] *SNG: Synthetic natural gas.*

The gas system must be made attractive for transit

Figure: ENSTOG.

The general gas grid in Denmark is designed to supply Denmark and Sweden from the North Sea or Germany and function as transport road between the North Sea and the gas storage facilities to the European market, of which the Danish gas market is a part. With decreasing domestic production and consumption of natural gas, the role of the transmission system will change to primarily deal with:

- Transmission of green gases.
- Transit of gas to Sweden and in the long term possibly transit of green gases from Sweden.
- Balancing the production of green gases in relation to consumption through import/export or use of storage facility.

The transmission grid is financed through distribution of all costs on a tariff for the transported gas. The tariff will increase due to decreasing consumption and transit from the North Sea. Therefore, the task is to make the transmission grid more attractive in order for it to be used as much as possible in a socio-economically optimum way.

Instrumental measures in terms of leading gas through the Danish system to ensure optimum use of the gas grid internationally:

- Simplifying the tariff structure. Gas from the North Sea to Germany is charged with a tariff on the connection to Denmark, a tariff in Denmark and a tariff to enter the German market.
- Increase the gas transit, eg through connection to Poland (Baltic Pipe) with interconnection of the Danish and Norwegian part of the North Sea.

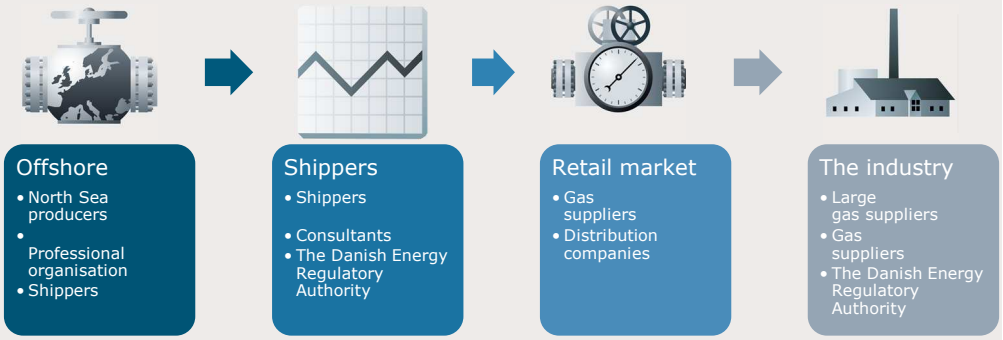
Gas market development through dialogue

Energinet.dk collaborates with gas distribution companies, market players, NGOs, companies and authorities to create a well-functioning gas market in Denmark. This means a market where producers, trading companies and consumers have access to purchase and sell gas at a liquid trading centre on transparent and fair terms:

- A market that encourages investors' willingness to invest through minimisation of risks in the access to the Danish market platform.
- A market that is closely integrated in a coherent European market with possibility of a socio-economically optimum exchange of gas and price correlation.
- A market with possibility of objective consumer information about the suppliers' prices and the gas system's security of supply.
- A market where consumers have the possibility of valuing the production of green gas through trade with certificates.

This requires dialogue and development. Therefore, Energinet.dk has established a number of fora which cover the entire value chain for gas in order to include all ideas and views of the development of the framework conditions for gas. These will be performed 1-4 times a year. Add to this working groups and workshops on specific topics in relation to market development, eg balance model, tariffs, certificate model, etc.

One forum for each part of the value chain.



Green gas
- Bio natural gas producers
- Certificate account holders
- Grid companies
- NGOs
- Gas suppliers
- Authorities

Links to background material

Analysis assumptions (Analyseforudsætninger): http://energinet.dk/DA/El/Udvikling-af-elsystemet/Analyseforudsaetninger/Sider/default.aspx

Analysis 'Benefit of the gas system to society in 2035' (Gassystemets gevinst for samfundet i 2035): http://energinet.dk/SiteCollectionDocuments/Danske%20dokumenter/Klimaogmiljo/Gassystemets%20gevinst%20for%20samfundet%20i%202035.pdf

Analysis 'Energy concept 2030' (Energikoncept 2030): http://energinet.dk/DA/KLIMA-OG-MILJOE/Energianalyser/Analyser/Fremtidens-Energi/Sider/default.aspx

Analysis 'Course of development for transition of individual heating solutions towards 2035' (Udviklingsforløb for omstilling af individuelle opvarmningsløsninger frem mod 2035): http://energinet.dk/SiteCollectionDocuments/Danske%20dokumenter/Forskning/Udviklingsforloeb%20for%20omstilling%20af%20individuelle%20opvarmningsloesninger%20frem%20mod%202035.pdf

Danish Energy Agency regarding alternative fuels: http://www.ens.dk/klima-co2/transport/strategier-analyser/alternative-drivmidler-transportsektoren-21

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Om Energinet.dk's analyser

Energinet.dk har ansvaret for forsyningssikkerheden for el og gas, både i nuet og i fremtiden, hvor meget mere vedvarende energi skal ind i ikke bare el- og gassektoren, men i hele energisystemet. Energisystemet står derfor overfor store forandringer og der er behov for meget mere sammentænkning i energisektoren.

Energinet.dk tager ansvar for en samfundsøkonomisk effektiv omstilling. For at skabe fundamentet for den bedst mulige omstilling, belyse udfaldsrum og sikre værdien af de store investeringer, der skal foretages, analyserer Energinet.dk løbende udviklingen af både energisektoren som helhed og enkelte dele af energisystemet.

Energinet.dk anvender som udgangspunkt på alle analyser altid samme fundament, der opdateres årligt. Fundamentet består blandt andet af forudsætninger om priser, teknologidata samt beregningsmodeller.

www.energinet.dk/energianalyser

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