WP6 Markets and regulation: Overview over Danish and EU tariffs

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Overview over Danish and EU tariffs

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Preface

This overview report on gas structures and tariffs is the first deliverable from work package 6 on Markets and Regulation of the FutureGas-Project (Deliverable 6.1.1). The report is thought as a first introduction to the Danish gas system with special emphasis on gas tariffs and by no means intends to cover all aspects within this area. In the coming years the FutureGas-project will make in depth analyses of gas regulation and gas market issues, especially in relation to other sectors of the energy system – power, heat and transport.

The report is put together by the DTU-staff on WP6 with help from the Danish TSO on gas and power, Energinet.dk, and the Danish gas company, HMN. Especially, we acknowledge the help from Julie Frost Szpilman and Christian Rutherford, Energinet.dk and from Alexander Kousgaard Sejbjerg, HMN.

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1. Introduction

According to the Danish energy concept 2030, introduced by Energinet.dk, the stability and efficiency of the Danish energy system is strongly dependent on the interaction between different sectors and geographical regions. Natural and renewable gases can along with other technologies, offer the future Danish energy system the backbone to develop power markets with high volatility levels resulting from the increasing volumes of wind and solar power.

Grid tariffs is an important factor in order to enable the integration of new technologies into the Danish energy system. Together with the regulative framework – hereunder taxes and subsidies, will tariffs affect the opportunities for emerging gas utilization technologies and renewable gas resources to enter the European gas market.

In Table 1: Overview of reports on tariff structures in the future gas projectTable 1**Error! Reference source not found.** we present the reports that will be written within Work package 6 (WP6) of the Future Gas project in relation to tariff structures. The current report is the first, with the purpose to create an overview of the Danish and European gas network regulation and the following tariff principles. In the following reports, we will identify important barriers for economic effectiveness and afterwards introduce cases for improved tariff structures. In order to focus our analysis we investigate the net regulation and tariffs concerning a number of cases, which we present in the end of this report.

6.1.1	Overview over Danish and EU Tariffs	Short report	M10
6.1.2	Identification of barriers for economic effectiveness	Short report	M14
6.1.3	Cases for improved tariff structures	Report	M17

Table 1: Overview of reports on tariff structures in the future gas project

In the first part, we introduce the Danish gas system and the connection to the European gas market. We then introduce the net regulation for the Danish TSO and DSO's which are regulated as natural monopolies. We also present the European coordination work on gas grid regulation at TSO level, and present the DSO regulation for relevant neighbouring countries.

Further, we gather an overview of the Danish Tariff structures at TSO and DSO level, and then consider the principles of the Tariff structures at European level.

After this, we introduce the case studies that we will relate to throughout future reports, and we initiate a preliminary discussion on how these cases will be affected by the tariff system. The case studies used in relation to tariff structures will mostly be the same cases that we use in our analysis on market and regulation, however some cases might not be evaluated and some cases might be added in future reports This depend on their relevance.

1. The gas system[1]

1.1 Infrastructure

The Danish parliament "Folketinget" voted to establish the Danish natural gas project in 1979. The Danish gas infrastructure was established in the 1980s in order to exploit the North Sea reserves of natural gas and to cushion the Danish people and the Danish economy from the international energy crisis of the 1980s. The main infrastructure is now more or less the same as when it was built, though it has been expanded on the transmission level with a compressor in Egtved and on the distribution level with the addition of decentral biogas plants.

Today, the gas system transports a considerable amount of energy around in Denmark and Sweden. Not counting transit to Sweden and Germany, about 2.5 billion Nm3 of natural gas is transported to consumers in the Danish market. This is the equivalent of about 30 TWh of energy.

Figure 1: The Danish gas system on a transmission level, source: Energinet.dk "Gas security of supply 2015"

The Danish gas system is an integral part of the European gas infrastructure. It is designed to receive gas from both the North Sea and Germany. It also operates as a transit country for natural gas to the Swedish market and the wider European market via Germany. With regard to transit from the North Sea to the European market, the Danish system is in competition with the Dutch gas infrastructure, which is also linked to the fields in the Danish section of the North Sea. The gas is transported using the route with the lowest transport costs and risks. It is therefore crucial that the cost of using the Danish infrastructure is kept competitive.

Looking further ahead, the Danish system could be used to transport gas from the Norwegian gas fields to Denmark and Poland. The project to create a new transmission link from the Norwegian gas fields via

[1] Strongly inspired from Energinet.dk

Denmark to Poland is called the Baltic Pipe Project, and identified by the EU as a project of common interest (PCI). An Open Season is running from the end of 2016 and in 2017 in order to see whether there is an economic support among customers to establish the Baltic Pipe Project.

1.2 Players and roles in Denmark

The companies in the Danish gas market have different roles. This means that different companies own and operate the physical installations, transport the gas and trade the energy until it is available to individual consumers. The owners of the physical infrastructure occupy three roles:

- Gas transmission system, with a Transmission System Operator (TSO)
- Distribution system, with one or more Distribution System Operators (DSO's). The distribution areas are shown in Figure 2.
- Gas storage facilities, with one gas System Storage Operator (SSO)

The commercial users occupy three roles:

- Shippers
- Gas suppliers
- Storage customers

There are two types of consumers:

- DM consumers are business users with remotely read meters
- Non-DM consumers

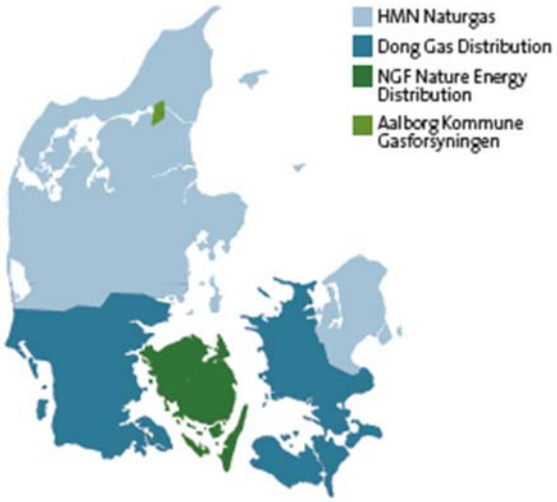

Figure 2: Distribution companies in Denmark, source: Energinet.dk "Gas security of supply 2015"

1.2.1 Gas transmission system

The backbone of the gas infrastructure is the transmission system, which links the North Sea to the distribution grids connecting to consumers. The transmission grid in Denmark is owned and operated by Energinet.dk, who is responsible for volume balancing in the Danish natural gas system and for managing security of supply in Denmark. In total, the pipelines in the transmission grid are about 900 km in length.

The transmission grid is connected to the distribution grids via 43 metering and regulator stations, which reduce the pressure for the pipeline systems of the distribution companies. The transmission system also provides access to the two Danish gas storage facilities now united under Energinet.dk.

1.2.2 Gas storages

The gas storage facilities Stenlille Gaslager A/S and Lille Torup Gaslager A/S are used to compensate for seasonal fluctuations in consumption and for commercial reasons to reduce gas price differences. They are also used as a tool to maintain security of supply.

The storage facilities are operated on commercial terms in competition with other European facilities. The products on offer allow storage customers to store; inject and withdraw gas.

1.2.3 Gas distribution system

The closest part of the infrastructure to the consumers is the distribution system, which consists of distribution lines and service lines. The gas is carried from the distribution lines to the individual customer in service lines.

The distribution grid is primarily owned and operated by the Danish distribution companies HMN Naturgas, NGF Nature Energy and Dansk Gas Distribution (Energinet.dk), see Figure 2. Further there is Naturgas Net in Aalborg which is a small network supplying consumers with modern town gas – a mixture of natural gas and air, there is also a town gas net in Copenhagen and Frederiksberg, which is operated by HMN.

The distribution grid has a total line length of about 17,000 km and is connected to more than 400,000 customers with a total yearly gas consumption of 98 PJ (2014). It was originally designed to receive natural gas from the transmission grid, but now, biogas upgraded to natural gas quality is supplied to the distribution grid from biogas plants.

1.2.4 Market players and consumers

The commercial users (market players) of the physical infrastructure occupy three roles:

Shippers are Danish and international commercial players that arrange the wholesale transport of gas in the transmission system. The shippers purchase transport rights in Energinet.dk's transmission system in order to supply the gas to gas suppliers in the distribution systems. The shippers arrange the delivery of natural gas into the transmission system from Danish or foreign producers or shippers in adjacent systems. At present, there are 39 registered shippers, of which approx. 20 are active.

Gas suppliers provide the consumers with natural gas and bill them for the offtake. There are currently 15 gas suppliers registered in Denmark.

Storage customers purchase the right to use the storage facilities to inject, store and withdraw gas. A storage customer is able to sell the gas in the storage facility to a shipper or to another storage customer.

Consumers are everyone who purchases and uses natural gas for their own use. There are two types of consumers:

- DM consumers are business users with remotely read meters, typically using more than 300,000 m3 per year per consumption site. There are just below 1,500 DM consumers.
- Non-DM consumers make up the majority of the 400,000 or so consumers. The typical annual consumption of a detached house is 1,500 – 2,500 Nm3/year for heating and hot water.

1.2.5 The European gas market

As EU gas production declines, the EU has become more dependent on gas imports from other regions. The European gas system is linked to Russia and Norway, which are major suppliers. Liquefied natural gas (LNG) is imported from overseas by ship. In 2013, the EU imported approximately 40% of the consumed gas from Russia. The EU is Russia's biggest gas customer, creating a relationship of mutual dependence.

To date there have been no failures in supply from the Russian gas fields to the EU, however, there have been shortages in situations where transit countries (Belarus and Ukraine) have prevented the free transit of gas as part of a conflict with Russia. [2] The building of North Stream with creating a direct link from Russia to Germany have reduced the effects of these challenges, already now is an expansion of North Stream considered, it has however not been approved yet.

On the long term, the gas supply of the European Union will be covered to a large extend by the import of Russian gas together with LNG from other countries.

2. Net-regulation

Gas is primarily transported through gas-pipes, which to a very high extent are natural monopolies. Therefore gas transport is generally monopoly regulated. In Denmark is both the transmission system operator owned by the state as well as the gas storage facilities, and the distribution companies are owned publicly. In other countries are there both privately owned transmissions systems and distribution systems - with competing transmission companies.

2.1 Gas system, Denmark

2.1.1 Legislative framework

Both Danish and European regulation affects the gas grid operators and the gas market. Below are listed the most important regulation.

- Bekendtgørelse af lov om naturgasforsyning (LBK nr 1157 af 06/09/2016)
- *Bekendtgørelse af lov om naturgasforsyning (LBK nr 1331 af 25/11/2013 Historic)*
- Lov om ændring af lov om naturgasforsyning, related to the upgrading of biogas (LOV nr 77 af 27/01/2016),
- *REGULATION (EC) No 715/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009*, https://publications.europa.eu/da/publication-detail/-/publication/f1610b76-5447-4182-97d3-375a42748ab8/language-da
- EUROPA-PARLAMENTETS OG RÅDETS DIREKTIV 2009/73/EF,
- EUROPA-PARLAMENTETS OG RÅDETS DIREKTIV 2009/28/EF,
- Bekendtgørelse af lov om Energinet.dk (LBK nr 1097 af 08/11/2011)
- Bekendtgørelse om økonomisk regulering af Energinet.dk (BEK nr 816 af 27/06/2016)

[2] http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_production_and_imports

2.1.2 Transmission (primary sources: Energinet.dk and DERA)

The gas transmission system was originally built by Dong Energy, and drawn out of Dong as a separate company called Gastra in 2003. In 2005 Gastra and the the two Danish electricity transmission companies Elkraft and Eltra were merged into the current Danish transmission company Energinet.dk[3].

Energinet.dk gas and power transmission are regulated following the cost-of-service-regulation, also known as rest-in-it-self. The basic principle of this regulation form is that the owner (the state in this case) is not allowed to gain any profit from the ownership. On the other hand, the ownership should not impose any costs to the owner. Therefore Energinet.dk can obtain an income from the tariffs which corresponds to the costs related to the transmission service, if income from the tariffs is insufficient in one year, Energinet.dk can obtain the loss the following year through higher tariffs and vice versa.

Energinet.dk is not as such governed by any efficiency regulation, as this is something the owner (the minister of climate- and energy) is supposed to assure. However, in order to secure, that Energinet.dk does not overinvest or in other ways increase costs extensively, the Danish Energy Regulatory Authority (DERA) assesses tariffs and other regulation. Furthermore are economic reports and investment plans reported to DERA, where Energinet.dk accounts for any differences between "necessary costs" and realized incomes.[4]

2.1.3 Gas Storage (primary sources: Energinet.dk and DERA)

There are currently two natural gas storages in Denmark. The first gas storage was inaugurated in 1987 in Li. Torup in Northern Jutland and consists of 7 gas caverns flushed out of a large subterranean salt dome. First owned by Dong and later bought by Energinet.dk in 2006. The other gas storage in Stenlille on Zealand was also bought by Energinet.dk from Dong, this time in 2014. Stenlille Gas Storage Facility is an aquifer storage facility and was inaugurated in 1994.[5]

Unlike gas transmission and distribution are the gas storage facilities not entirely natural monopolies, as Danish gas shippers can also use foreign gas storages as Danish gas storages and vice versa. The gas storage part of Energinet.dk is therefore operated on market conditions concerning pricing however; DERA does supervise the customer access in order to assure equal access for all customers. So for example, Energinet.dk itself is not granted any special terms.[6]

2.1.4 Distribution[7]

Gas distribution is a natural monopoly and has been regulated by an income cap since 2005, see BKG No. 1117 of 14/0472014 on income limits, opening balances for natural gas distribution companies.

The income limit consists of five elements:

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[3] http://www.energinet.dk/DA/GAS/Det-danske-gasmarked/Om-naturgas/Sider/Naturgassenshistorie.aspx
[4] Source: http://energitilsynet.dk/gas/regulering/transmission/
[5] Source: http://gaslager.energinet.dk/EN/Pages/default.aspx
[6] source: http://energitilsynet.dk/gas/regulering/lager/)
[7] Source: Ienergy project

1. Cost Frame: operating expenses (referred to as often as §7 costs) + depreciation + efficiency requirements
2. Annuity for settlement of net debt: Risk free interest rate + risk premium for foreign capital for the company
3. Interest on new investments and net turnover fortune: All investments after 2005 can become profitable by a WACC set by the Energy Regulatory Authority based on 5-year government bond yield + company-specific credit risk
4. Regulatory Costs: costs related to the authorities, imposed costs, transmission losses, etc. (Often referred to §13 costs)
5. Energy-Saving Activities: actual costs

Pt. 1 constitutes the ceiling on how much income a company may have.

Para. 2-5 is a preliminary budget for the company's income.

After a regulatory year: DERA decides how much the income limit must be corrected in relation to actual costs and atypical costs. This is called the Annual correction of the income cap.

The income limit is announced ex ante for a 4-year regulatory period, the current covers 2014-2017 including a general demand for efficiency gains. At the same time, the companies are benchmarked by DERA with respect to efficiency. Low performing distribution companies will then receive additional annual efficiency requirements in order to keep distribution costs down. The income limit also includes an allowed rate of return, which can be distributed to other owners. This however, poses a challenge for HMN and NGF, which are Municipal owned by respectively 57 and 8 Municipalities.

2.2 Gas systems, EU

The latest round of EU energy market legislation, known as the third package, has been enacted to improve the functioning of the internal energy market and resolve structural problems. It covers five main areas:

1. unbundling energy suppliers from network operators
2. strengthening the independence of regulators
3. establishment of the Agency for the Cooperation of Energy Regulators (ACER)
4. cross-border cooperation between transmission system operators and the creation of European Networks for Transmission System Operators (ENTSO-G and ENTSO-E)
5. increased transparency in retail markets to benefit consumers

In the following we address unbundling, ACER and ENTSO-G

2.2.1 Unbundling[8]

Unbundling is the separation of energy supply and generation from the operation of transmission networks. If a single company operates a transmission network and generates or sells energy at the same time, it may have an incentive to obstruct competitors' access to infrastructure. This prevents fair competition in the market and can lead to higher prices for consumers.

Under the third package, unbundling must take place in one of three ways, depending on the preferences of individual EU countries:

Ownership Unbundling: where all integrated energy companies sell off their gas and electricity networks. In this case, no supply or production company is allowed to hold a majority share or interfere in the work of a transmission system operator

Independent System Operator: where energy supply companies may still formally own gas or electricity transmission networks but must leave the entire operation, maintenance, and investment in the grid to an independent company

Independent Transmission System Operator: where energy supply companies may still own and operate gas or electricity networks but must do so through a subsidiary. All important decisions must be taken independent of the parent company.

2.2.2 ACER (primary source: ACERS homepage)

The Agency for the Cooperation of Energy Regulators (ACER), a European Union Agency, was created by the Third Energy Package to further progress the completion of the internal energy market for both electricity and natural gas. ACER was officially launched in March 2011, and has its seat in Ljubljana, Slovenia.

As an independent European structure, which fosters cooperation among European energy regulators, ACER ensures that market integration and the harmonization of regulatory frameworks are achieved within the framework of the EU's energy policy objectives. The latter aim to create:

- A more competitive, integrated market which offers consumers more choice;
- An efficient energy infrastructure guaranteeing the free movement of energy across borders and the transportation of new energy sources, thus enhancing security of supply for EU businesses and consumers;
- A monitored and transparent energy market guaranteeing consumers fair, cost-reflective prices and the deterrence of abusive practices.

Building upon the sustained efforts of National Regulatory Authorities (NRAs) and the continuous support of all stakeholders, ACER's Gas Department is working towards meeting all the challenges associated with creating a well-functioning, competitive, integrated, secure and sustainable European

[8] https://ec.europa.eu/energy/en/topics/markets-and-consumers/market-legislation

gas market, delivering tangible benefits to European consumers. Work still to be done includes aligning national market and network operation rules for gas as well as making cross-border investment in energy infrastructure easier.

ACER's Gas Department is divided into three key areas of work, all aiming to support the achievement of the goals mentioned above:

1. Framework Guidelines & Network Codes, including the Gas Regional Initiative
2. TSO Cooperation and Infrastructure & Network Development
3. Market Monitoring[9]

2.2.3 ENTSO-G[10]

The European Network of Transmission System Operators for Gas (ENTSOG) is a compulsory European TSO cooperation organization with headquartered in Brussels. ENTSOG has been operating since December 2009 and is a part of the third liberalization package, and its tasks are defined within European Gas regulation (EC) 715/2009.[11]

The role of ENTSOG is to facilitate and enhance cooperation between national gas transmission system operators (TSOs) across Europe in order to ensure the development of a pan-European transmission system in line with European Union energy goals.

ENTSO-G has the task of providing 10-year investment plans for the European gas infrastructure and network regulations for gas transport in Europe in close cooperation with especially regulators, but also stakeholders and market players.

Network regulations are being formulated based on a range of overall guidelines issued by ERGEG (European Regulators' Group for Electricity and Gas) in the areas of capacity products, congestion management, balancing, transparency and data communication.[12]

Tasks[13]

The tasks on ENTSOG include:

Network codes: The network codes developed by ENTSOG will set out the rules for gas market integration and system operation and development, covering subjects such as capacity allocation, network connection and operational security. The process begins with a request from the European Commission (EC) to ACER (Agency for the Cooperation of Energy Regulators) to submit a Framework Guideline. ENTSOG then develops the related network code in line with the ACER Framework Guideline, conducting extensive public consultations throughout the development process. On the EC's approval, the network code becomes legally binding, being adopted in accordance.

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9 Source: http://www.acer.europa.eu/da/Sider/default.aspx

10 Sources: Entsog.eu-homepage and Energinet.dk

11 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0036:0054:EN:PDF

12 source: http://www.energinet.dk/DA/OM-OS/Samarbejde/Samarbejdsfora/Sider/ENTSO-G.aspx

13 source: http://www.entsog.eu/mission

Network development plan: The TYNDP provides a picture of European gas infrastructure and future developments and includes modelling of the integrated gas network based on a range of development scenarios. It includes a European capacity.

Supply Outlooks: Annual Summer and Winter Supply Outlooks review projections for gas supply, demand and capacity. Supply Reviews analyse the actual situation over the period in question.

Operational tools: Going forward, Regulation (EC) 715/2009 envisages the use of common network operation tools to ensure the transparency and coordination of network operations under normal and emergency conditions. These include ENTSOG research plans and an incident classification scale.[14]

One of the larger parts for the ENTSO-G work is to agree a common tariff-network code, this work was initiated in 2009 and has finally been concluded in 2016. One reason why this took so long is that the tariffs bear the fundamental income for the European TSO's, which are all regulated differently.

2.2.4 Regulation of the Distribution system [15]

The distribution activity is currently going through major changes, which may affect the structure of optimal regulatory schemes. First, an investment cycle is being spurred by the need to increase the distribution network's capacity to host an expanding fleet of renewable generators. Future investments appear to depart from traditional distribution upgrades in several respects:

1) They involve innovative technologies whose cost and performances are more uncertain and on which information asymmetries between regulators and firms might be greater;
2) Multiple options to achieve the same results are available, such as deployment of storage capacity or increasing demand response, deploying smart technologies as an alternative to upgrading lines and substations, distributing or centralising network intelligence, developing new telecommunication infrastructures or exploiting existing ones;
3) Distribution investment decisions interact with the outcome of decisions in areas beyond the distributors' control, such as renewable production targets or national deployment strategies of IT infrastructures.

Second, the content of the distribution business is enriching, as distributors take on responsibilities related to dispatch of embedded generation and flexible loads, facilitation of retail competition, energy efficiency. Such changes are affecting the terms of the trade-off between efficiency and protection objectives in distribution tariff regulation.

Table 2 gives an overview on how distribution systems are regulated in Denmark(DK), Germany(DE), Netherlands(NL), Greater Britain(GB) and Sweden(SE). In several countries, cost benchmarking is used to assess allowed distribution revenues; although capital costs are typically subject to a cost reimbursement regime, except in GB, NL and DE where total cost benchmarking is applied. In Germany

[14] Read more: http://www.entsog.eu
[15] Source: Mercados report "Study on tariff design for distribution systems", 2015

for example, DSOs are supposed to adjust their revenues from grid tariffs to the most efficient DSO. The following cost reductions are transferred to the end-consumer.

Table 2: Regulation of the Distribution systems in selected European countries

	Ex-ante vs. Ex-post allowed cost		Volume risk on DSO's	Actual cost vs. Standard cost		Regulatory lag	Financial incentives for quality of service	Ex post assesment of investments
	Fixed price /revenues	Cost of service		Actual cost	Standard cost	*Years*		
DK	Allowed revenues set at the beginning of the regulatory period		No	Book value	Benchmarking of operationg costs (unit cost model)	4	No	No
DE	Total allowed cost set at the beginning of the regulatory period, with firm specific X factor	Costs are treated as pass-through, when highly volatile or only marginally influenced by the DSO	No	Historic costs (60%), revaluated costs (40%)	Benchmarking to assess cost differences among distributors; use of standard costs related to service expansions	5	No	Through the TOTEX benchmarking
NL	Price cap with firm specific x factors based on benchmarking of total costs		Revenue comes mainly from capacity tariff components	actual revenues (or costs) to set start-of-period	Estimated industry-average costs at end of period (yardstick) based on benchmark, with X factors closing gap during period	3, re-openings allowed	No	Via benchmarking of total costs at the start of the regulatory period
GB	Revenues are set as part of a price control process. Which are automatically updated with penalties or rewards from incentive schemes (on a 2 year lag).		No, over- or under recovery of revenues is corrected in the following allowed revenue formula	In determining the revenue requirement the toolkit approach used also makes use of historical and network company forecast data	Standard costs are calculated using a combination of aggregated and disaggregated econometric and engineering based approaches, TOTEX and disaggregated data	8, re-openings allowed	Yes	No
SE	Price-cap on controllable OPEX	Cost-plus on CAPEX and non-controllable OPEX	Yes	Actual costs for CAPEX and non-controllable OPEX. RAB includes planned investments in the fortcomming regulatory period	Standardised costs when an efficiency factor is used to estimate controllable OPEX at the end of the period	4	No	No

3. Tariffs in the gas system

An overall purpose of the network codes initiated by the third liberalization package has been to increase competition on the energy markets. A part of this is to increase transparency between markets by coordinating transport products, and some of the first network codes were concentrated on an alignment of the product types instead of the pricing.

3.1 Transport products

In the following, we present the form of some products, which affects the tariffs, and that have been treated in the network code.

3.1.1 Entry-Exit point based tariffing

Going back in time, several tariff schemes have been used in gas transmission. One tariff scheme is distance pricing, where transport costs depend on how far the gas is transported. Another model is the entry-exit point based tariffing, which is commonly used in Europe, and implemented in connection with the work in the third liberalisation package in 2009. This model is payment point based, so shippers pay for entering the system at a given entry point, and then again pay for exiting the system, at an exit point. In Denmark there are four entry points (entering Denmark from the North Sea (Nybro), Germany (Ellund), Sweden (Dragør) and Denmark (upgraded biogas, BNG)) and four exit points Denmark (Exit zone), Ellund, Dragør and Nybro.

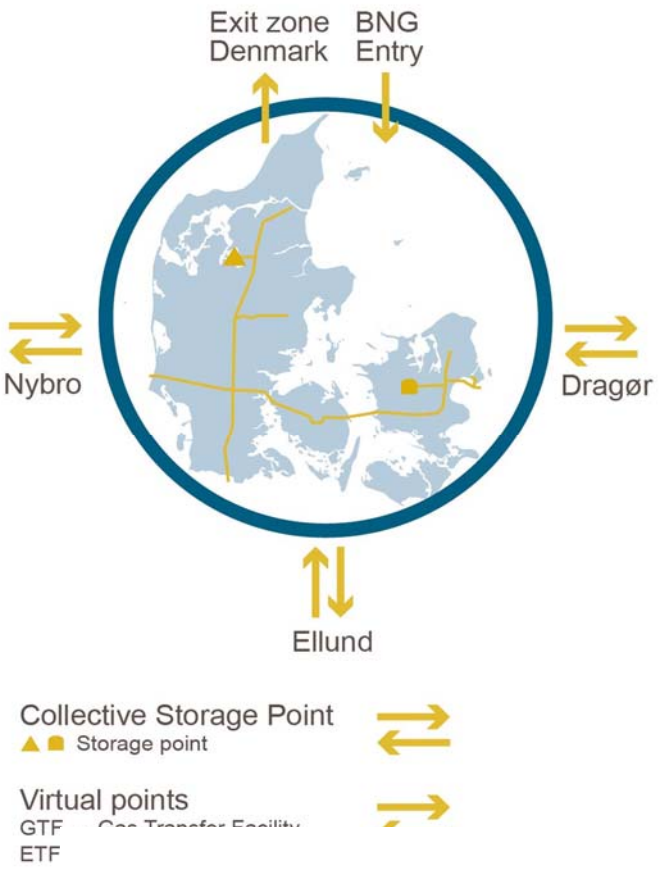

Figure 3: Entry and Exit points in the Danish gas system, source: Energinet.dk

3.1.2 The virtual and the physical system

Within the gas market, there is a distinction between the virtual and the physical system, trading happens on virtual points such as for example the Danish GTF and ETF, where gas shippers can trade gas on the market (ETF) or bilaterally at the GTF.

Physically the gas does not enter the trading point, but stays in the system or at storages. A virtual point in Denmark, which is only physical in one case[16], is the BNG entry point. Currently the biogas producers entering the distribution net both paying distribution tariff AND transmission tariffs even though the biomethane does not enter the transmission system physically – only virtually. Another example is the Ellund entry point from Germany, where it has been possible to enter the Danish system virtually, but not physically before 2013.

3.1.3 Capacity products

Tariffs have historically been capacity based in the European gas transmission system, in many cases with a 100% capacity tariff. This means that shippers pay for an access to transport a given amount of gas each hour, each day for a given amount of years – while they do not pay for the actual energy

[16] There is one biogas producer directly connected to the transmission system (in Bevtoft in the south of Jutland)

volumes that are transported. The argument for this type of tariffing is to give an incentive for shippers to use the capacity at a constant low level instead of using much capacity occasionally, which reduces the overall need for capacity investments. This kind of reasoning is reasonable when gas is transported over long distances from for example Russia to Germany, where the countries in between only function as transit countries. The reasoning is less clear, when gas is transported over shorter distances and closer to final usage – for example in the distribution system.

It has been common in Europe that new gas transmission investments were decided based on revealed demand in connection with an open season, where shippers bid in their demand, and often commit themselves to buy long-term contracts lasting for 30-45 years. There the capacity tariff is determined either directly or following a very predictable rule. This investment form reduces the investment risk for the TSO.

These many long term capacity contracts have however reduced the competition in the gas system, as the long term contracts have hampered the access for new shippers. The long term contracts have also meant that some transmission systems at times had excess capacity compared to the energy volumes transported in the system, but at the same time scarcity on the capacity market. This could occur, when new shippers wanted to transport gas, in systems, where almost all capacity was sold on long-term contracts, and the owners of the contracts (incumbents) didn't sell the capacity to the new shippers.

Several measures have been made in order to reduce the effect above, e.g. have interruptible capacity been introduced together with a "use-it-or-loose-it"-rule stating that capacity owners should use their capacity, otherwise others can use it. Interruptible capacity is the opportunity for shippers to buy capacity, which is already sold but not used. In cases with physical overcapacity are the interruptible products as good as non-interruptible capacity products.

Along with the new network codes have some countries, in particular Germany, changed regulation to reduce the dominance of long term products in order to increase competition and liquidity in the market. In recent years there has been a huge transition towards short-term gas trading in all of EU, so long-term bookings have been reduced remarkably.

3.1.4 Auctions at border points (and contract length)

With the new network code on capacity products which is only related to border points, it was decided, that all European TSO's should implement capacity auctions (on border points), on Yearly, quarterly, monthly, daily and intraday products. The auctions are coordinated such, that shippers should be able to buy e.g. both exit capacity out of Germany at the Ellund point and Entry capacity into Denmark at the Ellund point at the same time, so they get the same amount of capacity at the relevant points. A maximum contract length of 15 years was also decided in this network code. Concerning tariffs it was not decided what should be the starting price of the capacity products, and thereby the expected capacity price in cases of excess supply in the system. In Denmark, Energinet.dk has used the "regulated tariff" as the starting point for the auctions, meaning the tariffs calculated based on their own method, and subject to NRA approval. Tariff NC will be published in spring 2017, and will give guidance to which method should be applied in the coming tariffing.

The capacity network codes (CAM NC) does not regulate internal points and points from production fields, which still are sold as first come first serve (FCFS).

It is also possible to trade capacity at Dragør and Ellund through the PRISMA platform. Through PRISMA, shippers have the possibility to trade both firm and interruptible capacity. Capacity will be bundled with adjacent TSOs – Gasunie Deutschland and Open Grid Europe – whenever possible. If capacity is not bundled with adjacent TSOs, the capacity will be sold unbundled.[17]

3.2 Gas transmission tariffs, Denmark

Transmission tariffs are not an overwhelming part of the gas prices – in particular not for the households. Distribution tariffs on the other hand are significant – however still not the largest part of the tariffs. With the distribution systems being depreciated for large parts of the distribution grids gas distribution tariffs could be expected to go down –HMN will be depreciated by 2020[18], NGF Nature Energy will be depreciated in 2025 and even though Dansk Gas Distribution have just recently been bought by Energinet.dk – it will be depreciated by 2023[19].

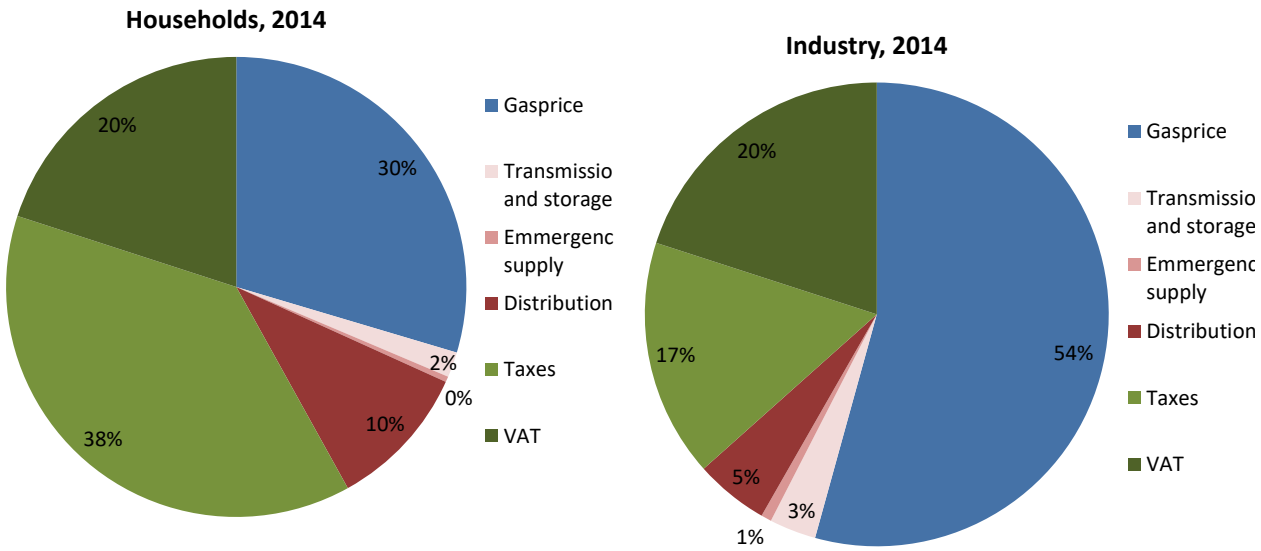

Figure 4: This cost distribution is an estimation which is based on the distribution costs from HMN. The exact costs depend on the consumption pattern, and at which price the gas has been bought, also the distribution cost share depends on which distribution company is used, as tariffs vary across distribution companies.

The Danish gas TSO has traditionally both applied a capacity and a volume tariff. There can be several arguments for this. One could be, that the Danish system has been built with the purpose of end use, though a large part of the gas produced in the North sea and send through the Danish system have been

[17] http://www.energinet.dk/EN/GAS/Produkter-og-handel/handelmedgas/Sider/PRISMA.aspx
[18] Source: DERA: "Indtægtsrammer for naturgasdistributionsselska-berne 2014-2017" p. 25
[19] Source: DERA: " ÆNDRET AFVIKLING AF NETTOGÆLD FOR DONG GAS DISTRIBUTION A/S", http://energitilsynet.dk/fileadmin/Filer/0_-_Nyt_site/EL/Tilsynsafgoerelser/2015/14-13428_-_DONG_Gas_-_Tilsynsafgoerelse.pdf

exported to Germany and Sweden, have the largest share been used in Denmark (source: E.g. Gas in Denmark 2010).

As the Danish TSO historically have been regulated following the cost-of-service-regulation with a 1 year regulation lag are tariffs overall estimated using the cost base divided with the expected consumption. This principle means, that the TSO is not allowed to generate a surplus and set aside money for later use. Therefore, any surplus will be subtracted from the expected cost base the following year, and thereby returned to the consumers if e.g. income have exceeded the expected income or costs have been lower than expected the year before. The TSO thereby have generated a surplus, in the same way any deficit will be added to the cost base the following year. This regulation form yields a high level of security, which has also been an argument for only having relatively short capacity products, with a one year product as the longest capacity product.

The division between capacity and volume tariffs have for a long time followed a 75/25-rule such that 75% of the entire cost base was distributed on capacity tariffs and the remaining 25% of the cost base was distributed on the volume tariffs. *Another principle in the Danish gas transmission system was uniform tariffs*, where all entry and exit points shared the same tariff, also called *stamp tariffs* implying, that the unit cost would be the same no matter where the gas is transported within the system – just as with stamps. An argument for this kind of tariffing is, that it is simple and transparent and independent on the actual flow pattern.

The tariff methodology is dynamic over time. In the later years have the tariff method been changed a number of times, and with the acceptance of the new European network code for tariffs (TAR NC) is it expected, that the tariff method will be changed once again.

3.2.1 Open season in 2009 and new gas flow patterns

Until 2013, all gas consumed in Denmark and Sweden was produced in the North Sea as, there was no physical access to the Danish gas system from Germany. Around 2008 the DUC partners could no longer guarantee a sufficient gas production from the North Sea, to supply the Danish and Swedish demand by 2014, therefore there was an open season held in 2009 in order to expand the Danish gas system with at least an opening of physical flow from Germany or Norway.

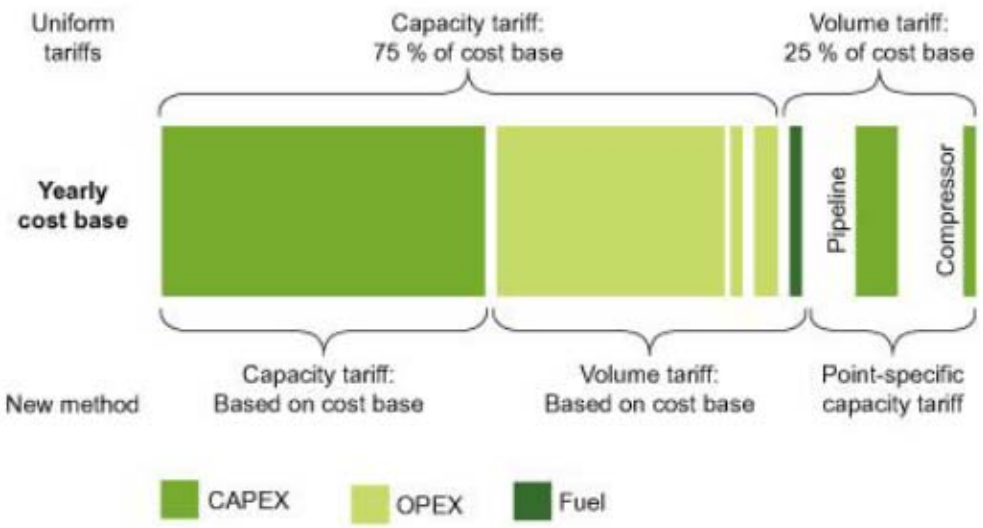

Figure 5: Changed capacity/volume ratio combined with point-specific capacity tariff, source: Gas in Denmark 2013

The result was an additional pipeline in southern Jutland and a compressor in Egtved. The new investments finished in 2013 and at the same time, Energinet.dk changed the basic principles of the pricing.

The division between volume and capacity tariffs was also changed, so that capacity tariffs are now calculated on the basis of capital costs, while volume tariffs are based on operational costs. Further Energinet.dk was allowed to try out the consequences of deviating from the uniform tariffs and instead to add a point specific capacity tariff at those points that was expanded through the open season. With the open season in 2009, this principle only resulted in additional costs on the Ellund Entry point (where the Ellund Entry point should pay for capacity costs to the compressor station) - and most exit points (exit zone, Dragør Exit and Nybro exit) should pay for the capital costs related to the additional pipe from Ellund to Egtved. Opex related to the compressor should be covered by the volume tariff. The overall principle was however general and was supposed to be used in case of other investments on other points.

The new tariff principle compared to the old principle is presented in the figure above. This tariff principle is the basic principle on how to calculate the fundamental tariff from which yearly, quarterly, monthly, daily and intra-daily are calculated. *Another basic principle for the tariffs is, that the daily cost of a yearly product should be cheaper than a daily product*, giving the shippers an incentive to buy yearly products, if they expect to use the capacity much, but still allow for a chance to buy additional capacity should this be needed.

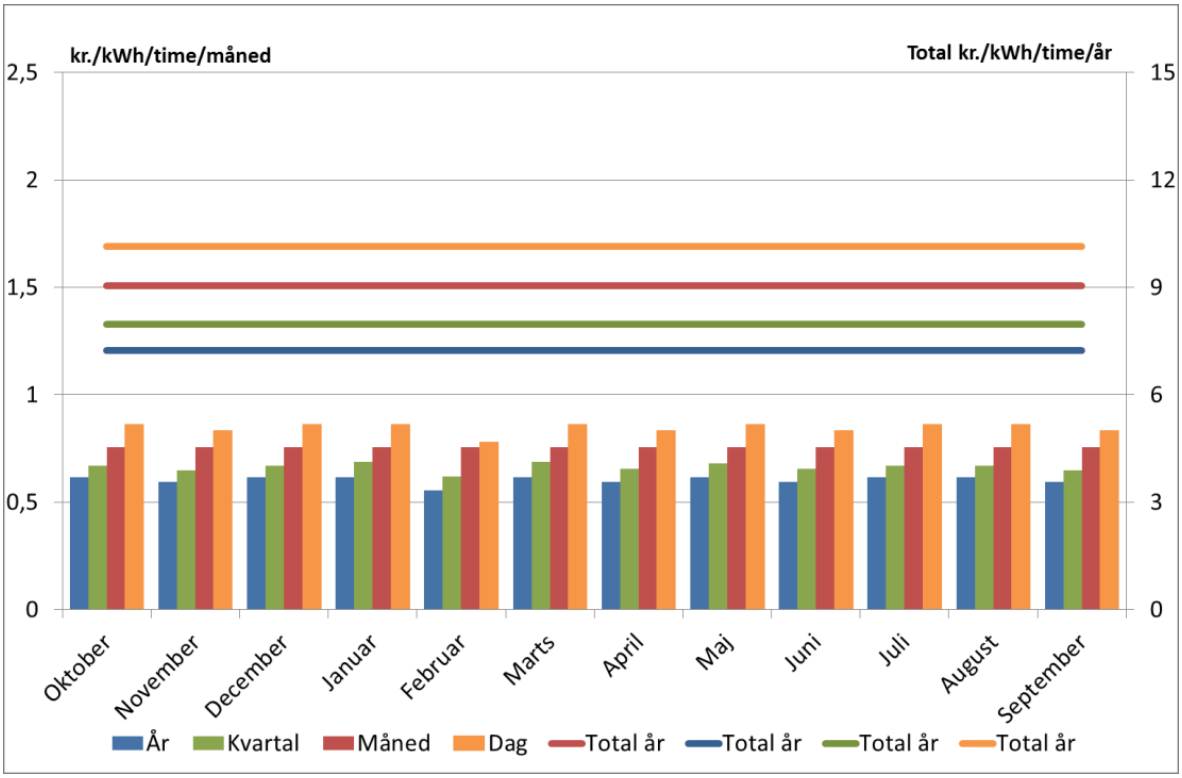

Figure 6: Example of how capacity costs changes with the length of the product, source: Dera (Energinet.dk) Dok. 15/12978-14

The intra yearly products have traditionally included a seasonal element, as gas demand increases during wintertime. With the implementation of auctions, where the gas tariff became a starting price of the auction, this seasonal element becomes less relevant as additional demand due to the wintertime could be expected to be included in the auction results. In 2016, the seasonal principle was abandoned, but the structure with a higher unit cost – the shorter the product, was kept. Alternative distributions can be seen in appendix C.

Along with the change away from the seasonal principle, was the multiplier between yearly, quarterly, monthly and daily products also reduced, the results can already be seen in the form of a movement away from yearly products. In Figure 7 you can see a move away from long term products (the blue columns) towards shorter term products (grey, read and green).

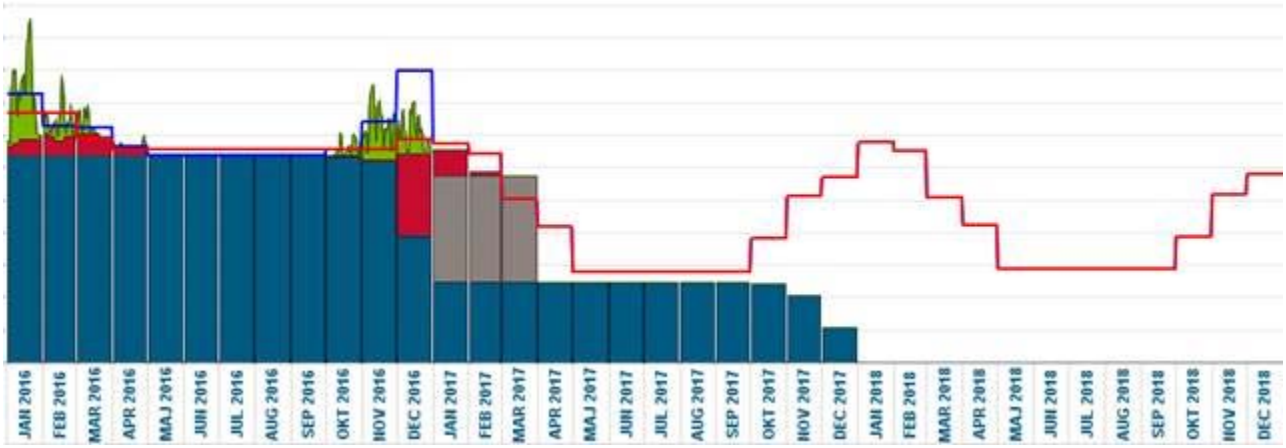

Figure 7: The development of products sold to the Exitzone. The blue column shows the yearly product, grey monthly, read daily and green within day. The red line is Energinet.dk's expectations to how the development will be

3.2.2 Current results from point specific tariffs

When the point specific tariffs were approved in DERA, it was a temporary 2-year permission, with the demand that Energinet.dk should present an analysis on the results for this new method in order to find a permanent method. This analysis was presented in summer 2016.

From the analysis it was concluded, that the method would be more unpredictable, due to future flow expectations and that there would be a risk, that the Ellund tariffs could become 50% more expensive, than capacity tariffs at the other points, which could pose a real problem for the competition on the gas market. With regard to the analysis on the new investments it could be concluded, that security of supply costs was lowered due to the new investments, which could be an argument for posing some of the investments costs on the security of supply tariff (see section 3.2.3~~4.2.3~~ with regards to an explanation of security of supply).

The new method, approved in June 2016 includes

- A higher share of the additional investment costs allocated to the exit zone, Dragør- and Nybro exit
- Some of the costs allocated to the security of supply tariff
- A variable element, depending on the gas flows

3.2.3 Other tariffs and fees

Other tariffs and fees have an influence on the costs of using the system, but also on how the system is used. Below are some of those tariffs and fees presented

Overdelivery charge: Shippers should buy the capacity they need each day and each hour, it is possible to exceed the bought capacity with 2% but every usage above this is charged with a fee, corresponding to the cost of a daily product.

The security of supply tariff: The security of supply have traditionally been high in the Danish gas system, one reason for this is, that the gas TSO follows the principle, that gas consumers should be able to receive gas even in cases where parts of the supply chain breaks down. Historically, the starting point

have been, that all consumer types should be secured for at least three days – even in a cold winter, furthermore gas should be secured for 60 days based on the n-1 assumption (covering the lack of gas from the largest supply source in 60 days). Therefore the TSO has secured additional gas supply from the storages and other supply lines in case of any break down in the supply chain. These security costs are added as a volume tariff. With the EU regulation on security of gas supply no. 994/2010 which came into force in 2012 the security level was changed so that not all consumers were protected in the same way, this led to two security of supply tariffs instead of just one[20]. The costs for security of supply have been dramatically reduced, from around 300m DKK when it was highest in 2008, to around 50m DKK in 2016. This is mainly due to the Ellund/Egtved investment and to the lower gas consumption in Denmark.

BNG entry point: The BNG entry point is the entry point for BioNaturalGas also called biomethane or upgraded biogas, the biomethane is typically produced close to the distribution system and injected at some point in the distribution system, it can however also be injected directly into the transmission grid. The biogas upgrader is obliged to inject the biomethane at a proper gas quality (within the gas spec, (see Figure 12)) and at the pressure for this part of the distribution company. If the amount of biomethane exceeds the demand downwards in the distribution system, it is the responsibility of the distribution system, to install a compressor to increase the pressure of the biomethane in order to move the biomethane up in the system. When biomethane is injected into the gas system, the gas shipper (who is transporting the biomethane) will both pay distribution tariffs AND transmission tariffs, even if the biomethane never enters the transmission system physically. This is because; the biomethane *will have to* enter the transmission system – however only virtually, in order to be able to trade the biomethane on the trading platforms and to receive a biogas certificate.

Gas storage points and trading platforms: The gas transmission tariff for exiting to the gas trading platforms and gas storage points is zero, unlike the tariffs for all other entry and exit points in the system. An argument for this could be that shippers should be able to balance their gas flow without additional costs except for the storage and trading costs.

3.2.4 Balancing

Each shipper should balance the transported gas, in the system, this means that gas inflow should correspond to gas outflow each gas day. The balancing regime in Denmark changed significantly in October 2014, as Energinet.dk implemented the rules of the European balancing network code. The main change is that the balancing should be more market based, and that shippers no longer were allowed to have free balance margins. Instead, within-day data on consumption was introduced, to back up the shipper's ability to balance their portfolio. The within-day market is Key for the balancing regime, where both shippers and the TSO are active. The shippers use the within-day market to balance their own portfolio, whereas Energinet.dk is active if the aggregated market is expected to be out of the boundaries (in the yellow zone) end of day. After each day the balancing level is established and over- or undersupply is settled either at a cost corresponding to the neutral gas price – plus/minus a small incentive fee, or Energinet.dk's marginal price for yellow zone trades.

[20] http://www.energinet.dk/EN/GAS/Aktuelle-temaer-ny/Gasforsyningssikkerhed-i-europaeisk-perspektiv/Sider/Gasforsyningssikkerhedsforordningen-og-de-danske-forbrugere.aspx

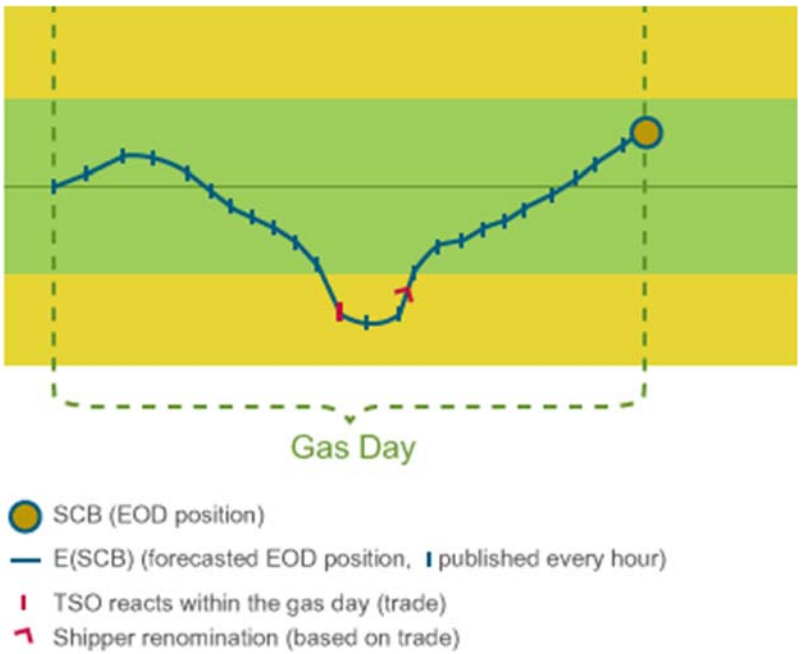

Figure 8: : Illustration of the balancing rules (Energinet.dk, 2015, 2016)

One advantage of the gas system is the potential flexibility in the system with regard to line pack and excess capacity. Line pack is a phenomenon, which implies, that the system operator can allow more gas to enter a pipeline, than what is being withdrawn - simply by adjusting the pressure in the system.[21] The gas system itself can thereby offer a certain degree of flexibility and storage ability. This flexibility may, however, not be used as much as it potentially could, if there is a high cost balancing system and high overdelivery charges. Lately Energinet.dk has changed the regulation in order to secure the flexibility of the system and reduce the risk of high balancing costs.

3.2.5 Capacity tariffs versus volume tariffs in the exit zone

In a cost-of-service-regulated system, with a high degree of excess supply are preferences towards capacity tariffs relative to volume tariffs to a high degree depended on consumption patterns.

Earlier we have described the benefits of capacity tariffs in relation to new investments and transit, where capacity tariffs give an incentive for transit customers to demand as few investments as possible and instead have a steady and constant transport through the system. In exit points to the distribution system, and thereby final use, is the story different, as consumption differs between consumers.

Private households and heat producers (such as CHP's) tend to use more gas during winter time, and less during the summer time, while many industrial consumers tend to have a more constant consumption pattern. Power producers will typically have a more volatile consumption pattern throughout the year – following the power and other commodity prices.

It has often been argued, that since there is an excess capacity in the Danish transmission system, it is irrelevant to use capacity tariffs in order to discipline consumers into a steady consumption pattern, instead a 100% volume tariff should be implemented in the exit zone.

With the current method a flexible consumer can choose two strategies;

[21] http://www.gasstrategies.com/industry-glossary#L

1) To buy a longer capacity product, and only use the capacity, when it seems relevant. This could result in relatively high average costs, however low marginal costs for entering the power market (MC_c) (at least on the gas part)
2) An alternative could be that the CHP buy daily capacity products whenever he wants to enter the electricity market. This would result in low average costs, however higher marginal costs (MC_d), postponing the point, where it's profitable to enter the market

If the exit zone had a 100% volume tariff it could be expected, that this volume tariff would be quite a bit higher, than otherwise, giving a lower average cost to the CHP, however a larger marginal cost (MC_v) compared to the first example (source: DERA (Energinet.dk) Dok. 15/12978-14). Overall it could be expected that $MC_d > MC_v > MC_c$, while the average costs would depend on how much the plant was used. While average costs most likely would be higher for an industrial user in the case of a 100% volume tariff in the exit zone.

As already mentioned a main driver for level of the tariff is the amount of used capacity and flow, when the gas transmission system is cost-of-service-regulated; meaning that if sold capacity and flow is high, will the average cost per product be low and thereby the tariff. Otherwise if product sales are low, will the tariff be high. So when the tariff is designed – hereunder the ratio between capacity- and volume tariffs is it maybe even more important for the cost-of-service-regulated TSO to consider, how to assure a large gas flow (or sold capacity) also in the future. With the changed multipliers – described in section 3.2.1 the marginal cost of using daily products have been reduced for the CHPs which thereby could increase the incentive for using gas a bit. How this will affect the overall consumption of the grid and thereby the tariff and the average costs for industrial consumer has not been revealed yet.

In case of a realisation of the Baltic Pipe Project, it is expected, that the flow (and sold capacity products) will increase significantly, which can decrease tariffs in the Danish system – or at least secure that tariffs will not increase as gas consumption decreases in Denmark and the gas production from the North Sea stops.

3.2.6 Baltic pipe 2017

The open season in 2017 regarding the Baltic Pipe Project can result in new investments in the gas transmission system, and this can affect tariffs in several ways.

- New complications to the current tariff method
- Flow and or the general consumption level
- The economic lifetime of the gas transmission system

With the given regulation form – cost-of-service-regulation, two factors are the primary determinant for the tariff cost level.

1) Total costs of the system – CAPEX and
2) How much the system is used - OPEX

If total costs are low and or the system usage is high, then tariffs can be low. Total costs can be reduced in several ways, one very efficient way of lowering total costs is to extend the depreciation time for

capital costs – this is particularly effective in a capital intensive system as the gas system. In contrast to the power system, it is not given, that the gas system will still be used in 50-100 years. With an investment in Baltic Pipe Project, there is a possibility, that the economic lifetime of the Danish transmission system can be extended. Currently the expected economic lifetime is following the development in Danish and Swedish consumption combined with the supply from the Danish part of the North Sea. With a realisation of the Baltic Pipe Project, this can be extended to the lifetime of the Norwegian gas supply and Polish gas demand, which is considered to be a lot longer.

Another way to reduce tariffs is a high consumption, this could be in the form a high degree of sold long time capacity products or high flows. A Baltic Pipe Project investment could give both.

A Baltic Pipe Project investment could however also increase the complexity of the current tariff method, as it could be expected, that the Egtved compressor would be used for optimizing the flow from Nybro to the Baltic exit point, and how should costs of the compressor then be distributed? Several options are possible within the current regulation – including the new network codes. The method could become more complicated, simplified a bit or even return to the original uniform tariff system, where all costs were distributed uniformly at all entry and exit points – following the argument, that it's too complicated to form a proper method for point specific tariffs.

3.3 Gas Transport Tariffs, EU

Following REGULATION (EC) No 715/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009 European TSO's (ENTSO-G) should decide on a group of common network codes on capacity products, balancing, tariffs and so on following an overall framework within a given timeframe. The European net regulators (ACER) should then approve this network code, and if ENTSO-G could not present a proper suggestion for the network code, ACER would decide one.

The idea is not, that all TSO's should follow exactly the same system, however keep themselves within a given framework. The network code for tariffs (TAR-NC) is one of the more difficult network codes to agree on, as this directly determines the income path for the TSO's which are all regulated differently within their countries, and works under different market conditions.

The European Network code for Tariffs is still under way but a proposal from ENTSO-G has been re-submitted to ACER and is currently being evaluated. Information on the re-submitted network code can be found following this link: http://www.entsog.eu/publications/tariffs#TAR-NC-RE-SUBMITTED-TO-ACER

An example of the suggestions in the new Tar-NC is a multiplicator level for the intra yearly products – basically on how much more expensive a daily product can be compared to a yearly product. An example of how Energinet.dk uses this can be found in Table 3.

	Nuværende	Pr. 1. oktober 2016	ENTSOG's Network Code for Re-Submission to ACER
År	1	**1**	1
Kvartal	1,47	**1,1**	1-1,5
Måned	1,47	**1,25**	1-1,5
Dag	1,8	**1,4**	1-3*

* Efter 4 år under 1,5

Table 3: Multiplicators between yearly, quarterly, montly and daily products, in Denmark before October 2016, suggested multiplicators for Denmark after 2016 and the suggested multiplicator span from ENTSOG in from the latest Re-submission, source: Dera (Energinet.dk) Dok. 15/12978-14

3.3.1 Distribution[22]

In many countries, tariffs are differentiated by Distribution Company or by tariff zones larger than the areas covered by individual distributors. In Netherlands (NL) only metering tariffs for small users are nationwide uniform.

Connection charges are defined "deep" when they are intended to cover both consumer specific costs and part of the cost of infrastructures shared among multiple network users. Deep connection charges are implemented in DE, GB and SE. All other Member States in table 2 implement "Shallow" connection charges; i.e. charges that cover only (and sometimes not entirely) the cost of infrastructures that are not shared among multiple network users. Total distribution costs are split differently among types of consumers in different countries.

In particular, the share of distribution cost paid by residential consumers ranges from 33% to 69% for electricity, while small gas consumers pay a share of distribution cost between 32% and 86%. Generally, distribution tariffs do not appear to be related to the consumer's (or consumer's type) withdrawal at times in which total load is highest.

[22] (Mercados, 2015)

	Cost reflectiveness	Tariff splitting for different DSO activities	Tariff structure	Time of use tariffs	Geographical uniformity	Connection charges	Share of distribution costs on consumer classes *Large/small*
DK	N/a	No	Energy charge	No	No! 3 DSO's charges different tariffs	Mostly shallow for consumers and embedded generators	N/a
DE	Energy (30%) and Capacity (70%)	Network usage metering, metering point operation and billing	Standard load profile: -Fixed monthly fee - Energy charge load Metered: - Capacity charge -Energy charge	No	No! 728 gas DSOs each one charges different tariffs	Deep	46%/18%/36%
NL	Based on energy and connection capacity	Distribution and connection metering	Administrative cost Transportrelated capacity Connection cost Metering	No	- Uniform metering tariffs for smal consumers - Same calculation method for other tariffs -but the actual tariff may not be	Shallow	13%/87% based on connection capacity differentiation
GB	Energy and Capacity (no typical customer category capacity definitions)	Distribution system use, metering	System charges Customer charges	No	No	Deep	Not published
SE	Based in capacity component and other variables *	No	Fixed charge - capacity charge - Energy charge	No	Yes	n/a	69%/7%/24%
	*actual usage of cost center by the sale group - e.g. number of customers, gas volumes sold, gas						

Table 44: Rules for Distribution tariffs in selected European countries

3.4 Gas distribution, Denmark[23]

Gas distribution tariffs and fees follow similar principles as gas transmission tariffs in Denmark, so even though the income regulation differs is the tariffing quite similar.

3.4.1 Legal foundations text

The purpose of the Natural Gas Act - see. §1: "*Natural gas supply is aimed to provide security, economy, environment and consumer protection, and to give consumers access to cheap natural gas*"

Tariffs are determined in accordance with specific principles, section 37:

- *To be determined in consideration of their costs for the purchase of energy, wages, services, administration, maintenance, other operating costs and depreciation and return on capital.*
- *Prices must be reasonable, objective and non-discriminatory*

Comment to Law no. 449 of 31 May 2000:

- *Costs must be distributed independently of the transport distance (stamp principle)*

[23] Source: Ienergy project 2016

- *The tariffs are cost oriented towards individual users of the network, so the consumer at least bears his direct relatable costs (gas metering, billing, supervision etc.)*

3.4.2 Tariffs and fees

At the market opening in 2004, the three gas distribution companies agreed to introduce a 100% volume based tariff in order to ensure a transparent pricing system that was easy to manage and calculate for market participants. DERA decided, that this was in line with the Natural Gas Supply Act § 1 and 37. The volume tariffs fits well with a variable consumption pattern as is characteristic for the consumption at combined heat and power production plants (CHP's) and private households. And as transit is not an issue in the distribution system, would the educative argument for capacity tariffs in the transmission system not be reasonable.

In the HMN system, follows the variable payment based a block tariff, where the tariff drops incrementally with higher consumption. Everyone starts at the high tariff.

The Gas distribution companies pointed out in 2004 the possibility of later introducing a more flexible and market-oriented system, for example to introduce a capacity component based on pooled capacity reservation (only appropriate to introduce at capacity in the system). This could become more relevant in the future, as some distribution systems are truckling with connected users (typically CHP's), to whom the system should be available, but who rarely uses the system. With a 100% volume tariff these users pay nothing or almost nothing to the distribution system, but they still pose costs on the system for the availability – which is actually not in line with the comments to law no. 449 from 2000, that consumers should at least bear the direct relatable costs.

HMN has introduced a fixed charge (administration fee) of 300 kr. p.a. excl. VAT for all customers regardless of size in order to meet the challenges of too little consumption from some customers. Furthermore can expected small consumers be imposed the direct connection cost, if they want to connect to the system this could for example be customers that only use gas for cooking. With regards to low consuming CHP's are other measures taken into consideration.

4. Case studies

Gas is an important element for intersectional energy storage for power, transport and heating. For the purpose of this report, the focus lies within the tariffs of the gas distribution network. Furthermore, taking the increasing connectivity between the gas, power, transport and heating sector into account, the influence these tariffs have on the connected markets are being analysed using case studies. These case studies will demonstrate the bricks connecting the different distribution grids in the Danish energy system, see Figure 9.

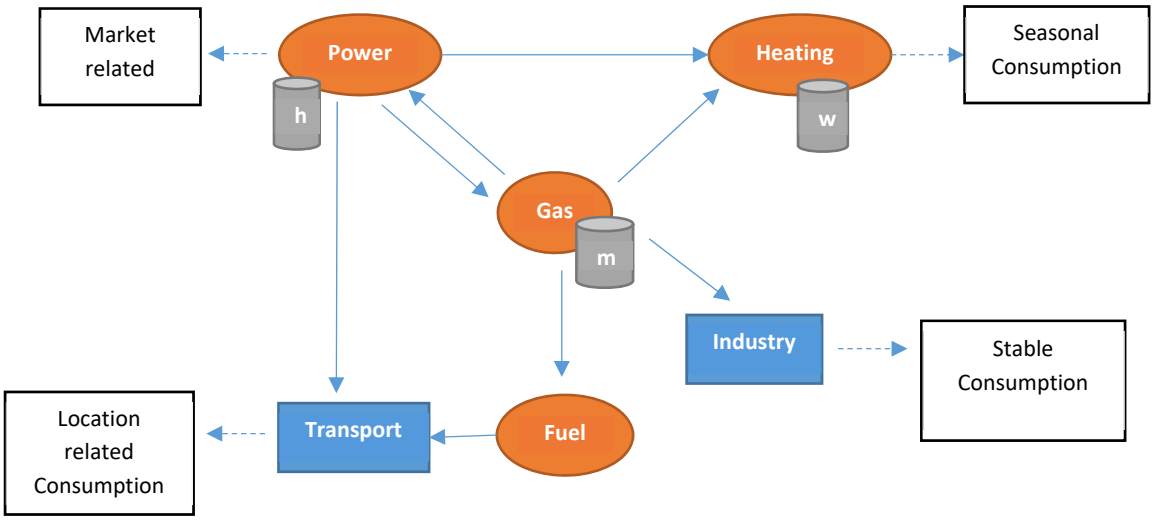

Figure 9: Gas as the connecting element between different sectors

The case studies are divided into technological case studies and system related case studies. The technological case studies introduce some of the present and upcoming technological challenges within the Danish gas system. The approach is presented in Figure 10~~Figure 9~~, where the actual technologies are presented together with the output and the cases we have chosen with regard to these technologies. The system related case studies introduce occurrences within the Danish gas market that cause the need for further analysis.

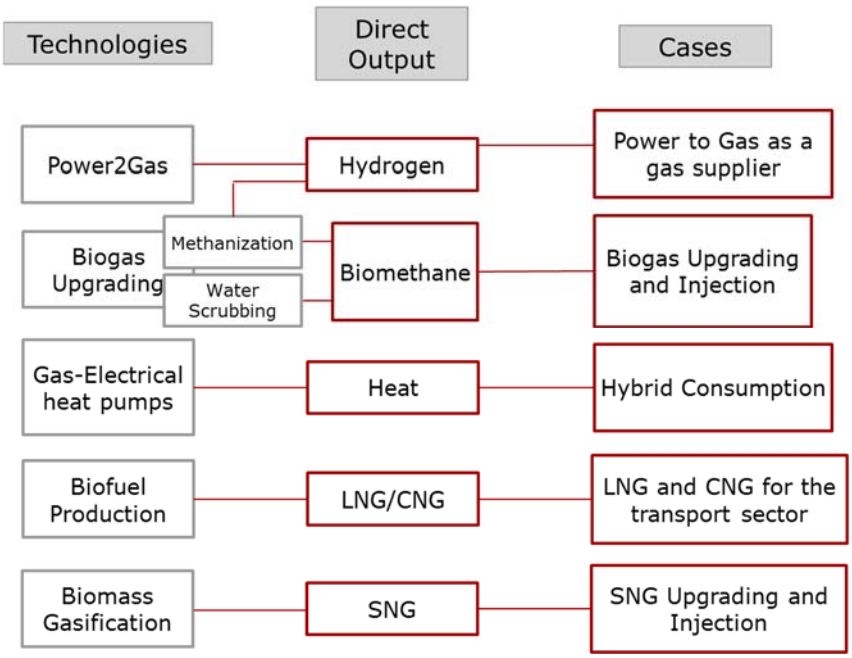

Figure 10: Overview of the emerging technologies and resulting case studies

In Figure 10 we describe the approach used in this report, in order to highlight cases, which cause challenges to the Danish gas grid in its current constellation. The system related case studies focus on issues within the gas grid and market design of the Danish energy system.

The case study approach used in this report will be continued and adjusted in the following reports of the FutureGas project. Focus of this report is on tariffs, therefore the cases are considered here related to the gas grid operation and its connection to the power grid and the transport sector. Overall we investigate how the feasibility of the selected technologies can be affected by the gas grid tariffs.

4.1 Case study 1, Technology focus: Power to Gas-Hydrogen injection

Technology

"Power to Gas" describes the technology, where excess electricity from the power grid is stored by the use of electrolysis, typically when the power prices are significantly low or negative (peak supply situations).

The Hydrogen resulting from the electrolysis process can be added to the existing gas infrastructure either as Hydrogen, underlying the relevant volume constraints of the national gas grid, or to a 100% volume as methane, after going through a methanization process (Sterner & Stadler, 2014). The hydrogen resulting from the power to gas technology can have following applications:

1- Fed into the gas grid
2- Stored locally and used for transport
3- Stored locally and converted back to power using a converting electrolysis process
4- Stored locally and used for chemical production
5- Used as input for an upgrading process of biogas (methanization)

Description-Power to Gas in the Danish gas grid

Hydrogen can be added to the national gas grids in variable but low volumes. These constraints are present in all the utilization technologies of Hydrogen. As shown in Figure 11**Error! Reference source not found.**, the transport sector, taking into account that only vehicles using natural gas are considered, shows the least tolerance for hydrogen (Henel, Köppel, Mlaker, Dr. Sterner, & Dr. Höcher, 2013).

The revenue from Power to Gas can be calculated as the gas price subtracted the cost of producing syngas at given power costs and net costs for entering the gas grid/- market. A techno-economic study conducted by Para and Patel (2016), has shown that a mixed utilization of the Hydrogen produced in Power to Gas plants may offer more benefits than single use systems (Parra & Patel, 2016).

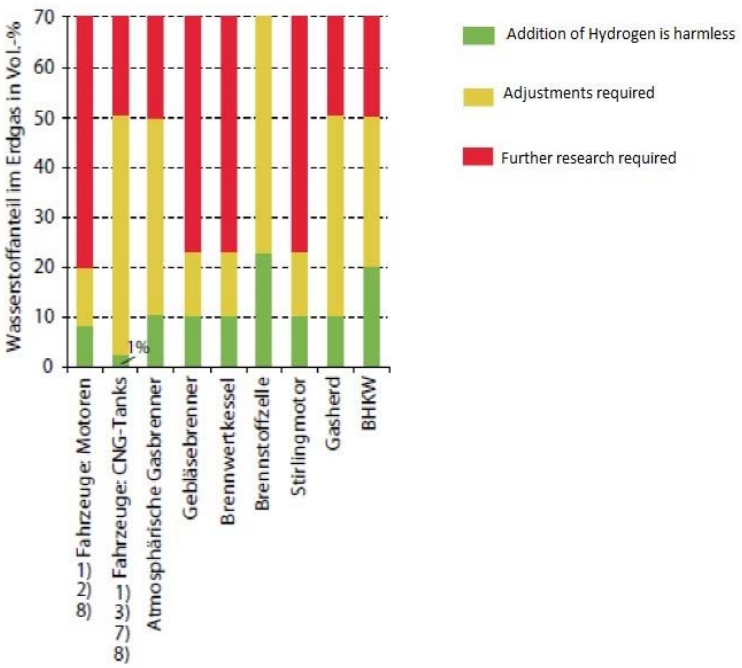

Figure 11: Hydrogen Tolerance of different technologies (Henel et al., 2013)

The majority of the Power to gas projects facilitated in Europe have hydrogen as their end-product. In Denmark, Power to Gas projects seem to focus more on delivering biomethane to the gas grid (Vartiainen, 2016). The reason for this can be the existing gas infrastructure in Denmark and the subsidies payed to Biogas upgrading plants. A quantitative analysis conducted by Græsted et al. (2017), shows that using hydrogen for biogas upgrading and methanization tends to be a feasible option, even with a 50% reduction in natural gas prices. This result is also stable regarding changing electricity prices. This is only given though, if upgrading plants are being subsidized and biogas plants are not paying electricity taxes (Græsted et al. 2017).

Discussion

The Danish gas tariff system is designed for natural gas transmission and distribution. Therefore the direct injection of hydrogen, besides the technical challenges, requires adjustments to the tariff and tax structure and the price of the hydrogen injected into the system to be able to compete with the adjusted gas price.

Regarding the distribution tariffs, irregular patterns of gas injection which might result from power to gas plants, will also offer a challenge to the gas system. Physically, the irregular injection will lead to unpredictable supply situations within the distribution grids. The cost of the adjustment of the grid to

these irregularities will be reflected in the operational cost factor of distribution tariffs. Financially, shippers have the responsibility of keeping their responsibility areas in balance and Energinet.dk is responsible for balancing the whole Danish gas zone. Increasing volatility in the gas system will lead to increasing balancing costs for the shippers and Energinet.dk. It is uncertain whether these costs will stay with these parties, or if they will be transferred to the producers and customers within the Danish gas system.

On the other hand, capacity tariffs need to be bought by the plant operator, in order to inject gas (hydrogen or natural gas) into the grid. The operation of power to gas plants is supposed to offer flexibility to the power sector. In this regard, there might be a challenge when predicting the times where the plant is going to operate. The capacity in the transmission grid capacity needs to be purchased according to the gas which the plant is going to inject into the grid. The amount of gas injected to the grid cannot exceed the purchased capacity more than 2% of the gas volume. Energinet.dk is in the process of developing short term capacity, demand and storage products in order to enable a flexible operation of power to gas plants.

4.2 Case study 2, Technology focus: Biogas upgrading

Technology

Biogas is the gas generated by the anaerobic digestion of organic material in the absence of air. It consists mainly of methane, carbon dioxide, water and other trace elements such as ammonia, hydrogen sulfide, hydrocarbons, etc. (Ryckebosch, Drouillon, & Vervaeren, 2011).

According to the Danish gas grid codes, each biogas producer aiming to feed in gas into the Danish distribution grids is required to assure that the gas meets the requirements according to the section C-12 of the Danish gas regulation. These requirements define the burning characteristics (Wobbe-index, density, etc.), pollutant limitations and odourization of the produced biogas. For this purpose, the Biogas requires to be cleaned and upgraded. The upgraded biogas will have a quality comparable to the natural gas quality and is referred to as biomethane or bio natural gas (Ryckebosch et al., 2011) (Figure 12~~Figure 11~~).

There are different ways to clean and upgrade biogas. Most of the biogas treatment and upgrading processes consist of two stages: 1. Cleaning and removal of trace components, 2. Upgrading of biogas in order to increase the calorific value. The upgrading stage enables biogas to be used as a fuel for vehicles or to be injected into the national gas grid. This report focuses on injection into the gas grid. The most common process for this purpose is water

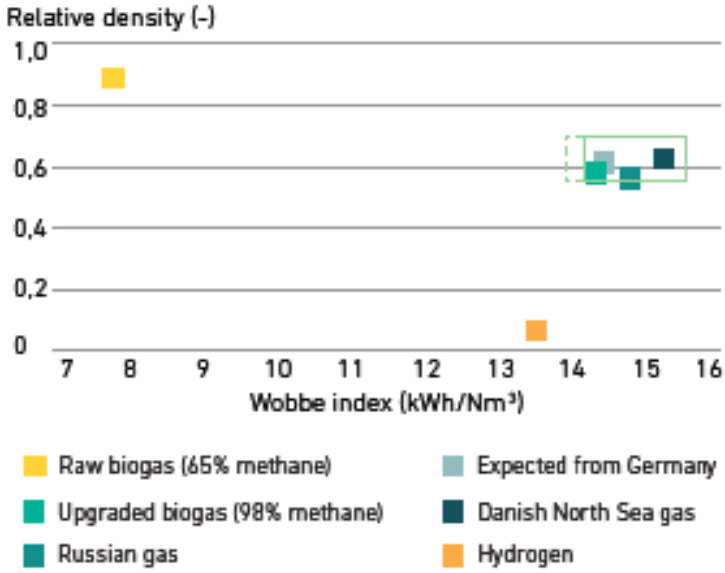

Figure 12: Illustration of gas quality for different types of gas. Biogas must be upgraded to natural gas quality before it can be injected into the natural gas grid. Source: Energinet.dk "Gas

scrubbing. Other processes are methanization, Absorption with polyethylene glycol, Chemical absorption with amines, Molecular sieves, Membrane technology and biological removal.

For the purpose of this report, a special focus is set on CO2 hydrogenation, due to the emergence of power to gas plants and fuel cells. Biogas methanization using hydrogenation offers the possibility to use Hydrogen to upgrade biogas and produce biomethane, which can be injected into the Danish gas grid. Hydrogen can be converted to methane by a process called hydrogenophobic methanogenesis with more than 90% of the hydrogen converted into methane (4H2+CO2=>CH4+2H2O). Possible unconverted hydrogen mixed with methane improves the combustion properties of biogas as a fuel (Luo et al., 2012).

Description- Biogas Upgrading using Hydrogen

With highly fluctuating prices on agricultural products, biogas production is becoming the preferred option for farmers to utilize their resources. Biogas production can offer farmers a relatively stable income source for a long period of time. Especially with the subsidies, which are paid to upgrading biogas plants, this option has gained more in popularity. Figure 13 gives an overview of the upgrading plants currently operating in Denmark. The Danish Energy Agency has anticipated all biogas to be upgraded and sent into the natural gas grid from 2035 and from 2050 to replace all fossil natural gas.

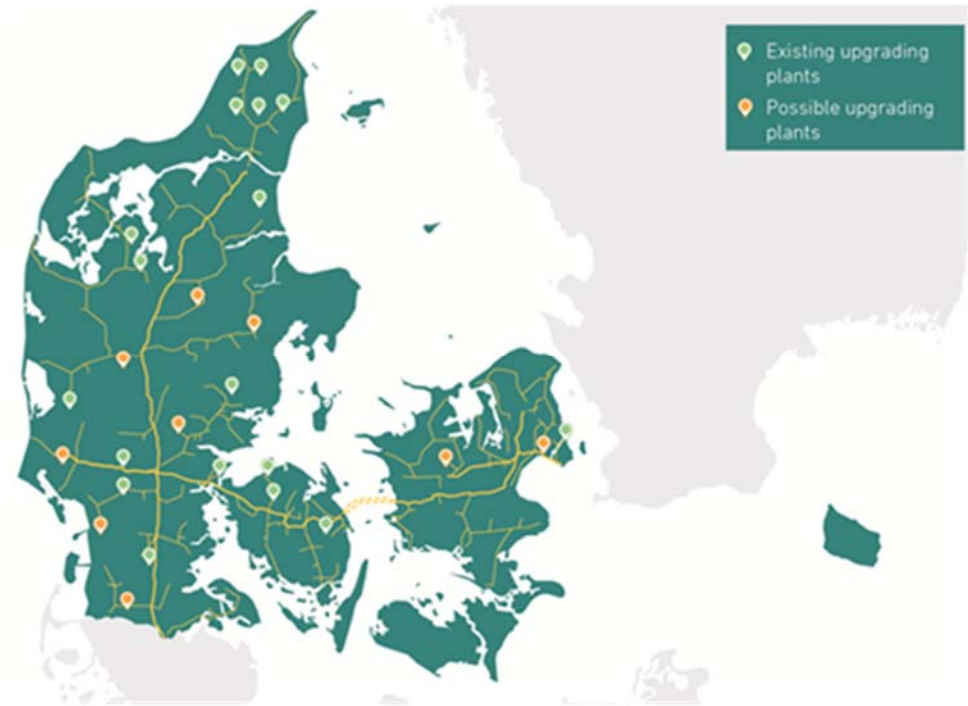

Figure 13: Upgrading plants, source: Energinet.dk, "Gas security of supply report 2016"

Upgraded biogas injected to the Danish gas grid receives a subsidy of 115 DKK/GJ and Distribution grid operators are obliged to connect every upgrading plant to their grid. This has caused a growing investment in Biogas upgrading facilities in Denmark. The increasing biomethane injection into the

Danish gas grid, resulting from the investments in biogas upgrading plants, causes new challenges for the Danish gas distribution and transmission grid. These challenges are being further evaluated in section 4.6~~5.5~~.

Discussion

As mentioned in 3.1.2~~4.1.2~~, biogas producers who inject biomethane into the gas grid are obliged to pay distributions tariffs and capacity tariffs, even when the biomethane does not enter the transmission system. Since biogas is usually produced at a constant rate during the year, biomethane producers would benefit from a tariff system, which has a stronger focus on capacity tariffs.

With current knowledge and technology, it is still a challenge to exactly predict and thereby determine when and how much production changes with different inputs. Due to the high local storage costs of biogas, upgraded biogas is aimed to be fed into the gas grid at a constant rate. The constant grid consumption pattern is suited for a high degree of capacity tariffs, since a certain amount of capacity can be bought and consumed throughout the year.

4.3 Case study 3, Technology focus: Gas Electrical Heat Pump

Technology

Electric Heat pumps are devices that absorb and transfer thermal energy from a low-grade source such as air to a heating element with a higher temperature. In a pilot project from Best Green Energy, electric heat pumps are combined with a conventional gas boiler, in order to offer flexibility in using the sources for heat provision.[24] These plants are called Gas electric heat pumps (GEHP).

Description-Hybrid heat pumps in the power and gas markets

The business concept of the hybrid heat pumps functions by an actor (aggregator) owning and operating the hybrid pump and selling the heat to the consumer. The aggregator has the control over the heat pump and can operate it based on the power price on the spot market or based on the capacity in the local power infrastructure. Currently this technology is being tested in some schools in the city of Horsens in Denmark. Currently these hybrid heat pumps are not being operated according to power and gas markets. The only influential factor on when the heat pump is switched to gas and when it is switched to power is the capacity of the power cord connecting the building to the grid.

Discussion

Gas electric heat pumps set power and gas prices in competition with each other, for providing heat for local utilization. If operated market based, the operation would be based on the constraints shown in Table 5. These price and Tariff relationships are considered, not including taxes. Taxes can have a strong influence on the operation of Gas electric heat pumps, since they make up a large fraction of the power and gas prices. In addition, the efficiency of the boiler and electric heat pump can influence the operational conditions.

[24] http://www.bestgreen.dk/nyheder/best-green-leverer-naervarme-til-horsens-kommune

Table 5: Operational conditions for gas electric heat pumps (without taxes and efficiencies)

	Baseload	Operational Conditions
Option 1	gas	Price(spot)+Tariff(el)>Price(gas)+Tariff(gas)
Option 2	electricity	Price(spot)+Tariff(el)<Price(gas)+Tariff(gas)

With the scale within GEHP's are built, the division of the costs allocated to capacity tariffs and distribution tariffs has a relatively insignificant effect. On a conceptual level, GEHP's would benefit from a larger share of volume based tariffs, since they are meant to operate between power and gas markets based on economic opportunities within these markets. Imposing a large share of capacity tariffs, would increase the overall operation costs of these plants when they are using gas for heat provision.

4.4 Case 4, Technology focus: Biogas for transport

Technology

Biofuels can be divided into four main categories: Bioliquids (Bioethanol, Biomethanol, etc.), Bionatural gases (LNG and CNG), Electricity and Hydrogen. For the purpose of this study, only Bionatural gases are considered.

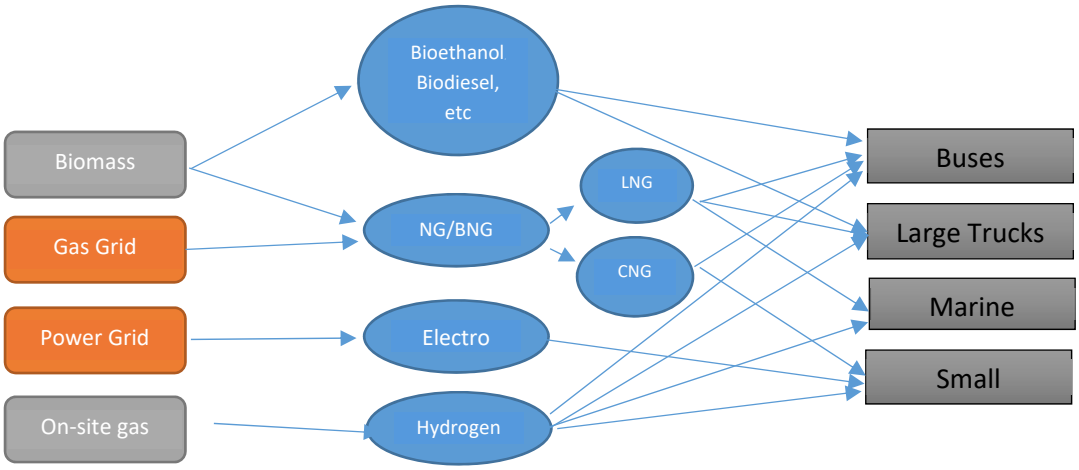

Figure 14: Overview on renewable transport technologies

Table 6: Characteristics that differ between LNG and CNG (Sinor, 1992)

Characteristic	CNG	LNG
Physical state	Gas	Liquid
Temperature in vehicle tank	Ambient	-162 C
Typical pressure in tank	17,3-24,9 MPa	170-446 kPa
Typical density in tank	130-190 mg/ml	410 mg/ml
Typical energy density (Lower Heating Value)	6500-9500 MJ/L	21000 MJ/L

The chemical composition of LNG and CNG is often identical. The differences in the characteristics of CNG and LNG are listed in Table 6~~Table 5~~ (Sinor, 1992). Both CNG and LNG are less dense forms of energy than petroleum-based liquid fuel. Therefore, LNG and CNG base vehicles generally need to have larger fuel tanks to store the same amount of energy (Howell, 2013) .

Description-Biogas for transport

According to the Renewable Energy Directive from 2009, the European Union (EU) is required to fulfil at least 20% of its total final energy consumption from renewable energy until 2020. A special focus is set on the transport sector where EU countries must ensure that at least 10% of their transport fuels is coming from renewable resources until this time (European Parliament, 2009). This directive has been revised in 2016, implementing a EU wide renewable energy target of 27% by 2030 (European Commission, 2016). With a variety of fuels and technologies and taking the clean energy movement into account, there has not been any dominant fuel options besides oil present until today (Connolly, Mathiesen, & Ridjan, 2014).

Denmark is realizing this goal using a quota system, which must ensure, that at least 10% of the Danish fuel mix, consists of renewable fuels. These fuels are also subject to tax incentives and in the case of biogas used for transport, also to a direct premium tariff (Banasiak, 2016).

As shown in Figure 14~~Figure 13~~, CNG is an option mostly utilized by buses and small vehicles. The reason for this is the low energy density of CNG compared to other fuels. The public transport sector has a foreseeable schedule of fuel consumption and can therefore utilize CNG better than irregularly fuelled transport vessels (Howell, 2013).

Europe hosts the second largest LNG market in the world (IGU, 2016). For marine and heavy goods transport, Liquefied Natural Gas (LNG) is perceived as the clean alternative to fossil fuels (Fevre, 2014). Especially in the marine transport industry, LNG has gained more popularity due to recent regulatory restrictions on SOx, NOx and CO2 emissions (Danske Havne, 2015).

Currently two LNG ports are planned in Hirthals and Frederikshavn, operated by different private ferry operators. The upcoming LNG projects consider mostly renewable gas resources, especially biogas. This enables LNG plants to gain revenues from green certificates and quotas (Tobergte & Curtis, 2013) and increases the demand for biomethane production in the respective areas.

Taking the increasing seasonal oversupply within the Danish national gas grid into account, LNG and CNG terminals offer a flexible demand option for the Danish gas market. Hence, it has to be considered that LNG terminals have much higher investment costs than a compressor, it is not economic to invest in LNG terminals, when there is no further financial incentive for that.

Bio LNG production in Denmark also underlies the risk of competition with global LNG markets. Currently the implementation of LNG ports in Denmark is financially more beneficial than buying LNG from global market and transporting it from the nearest LNG terminal which is currently located in Rotterdam, Netherlands. However, if there is an expansion of LNG terminals in northern Europe, with European ports expanding and facilitating for LNG transport, this might not be the case.

When biogas is injected into the grid, it will be taxed as natural gas. Since LNG plants will only be certified for their biogas production, but will still have to pay the natural gas taxes. CNG on the other hand, has lower plant investment costs than LNG and therefore would have a lower Capital Expenditure (Capex) compared to LNG.

Discussion

Depending on the storage capacity of LNG plants, they can offer a buffer to the gas grid and provide a service for the gas system. Therefore, a further evaluation of regulatory incentives for this technology can be of interest for the Danish gas market.

As there is no infinite LNG storage, LNG plants will not use the grid at a constant rate. Therefore, they will pay the capacity tariffs according to their storage and LNG consumption plan. A more volume based tariff system would be in favour of LNG plants,

4.5 Case 5, technology focus: Biomass Gasification

Technology

Biomass gasification is a thermal process where biomass is heated and converted into a gaseous fuel, known as Syngas. There are different concepts for the gasification process which will not be discussed in this report. Syngas, similarly to biogas, can be used for heat provision, power production, or after going through an upgrading process, feed in to the gas grid (Ho, Ngo, & Guo, 2014). When Syngas is upgraded to the extend, that it has the same quality as natural gas and can be injected into the gas infrastructure, it is referred to as Bio-SNG. Figure 15 illustrates the upgrading steps and the by-products of bio-SNG production.

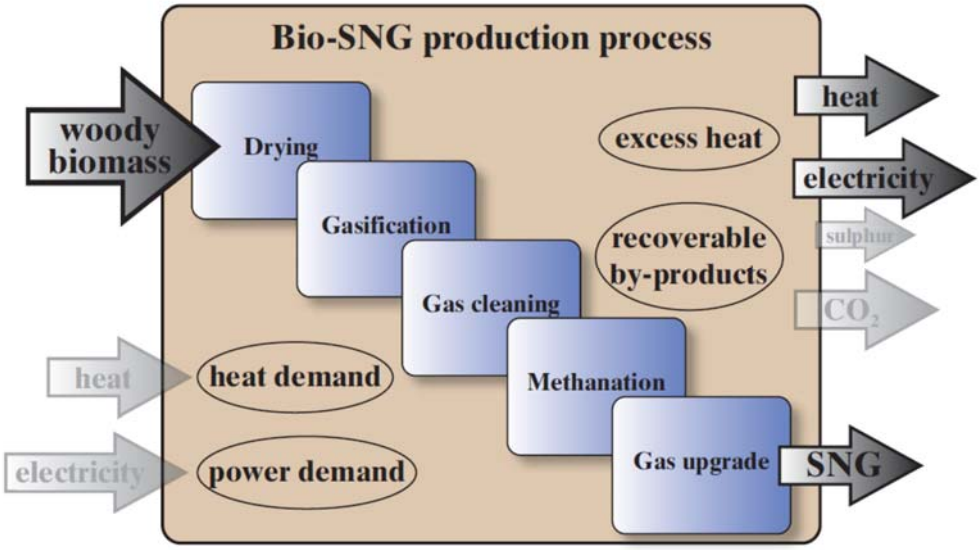

Figure 15: Bio-SNG production process with illustration of additional export (as well as possible import) of by-products and services.

Description-SNG injection into the Danish gas grid

The scarcity of Biomass and the ethical and environmental considerations regarding the utilization of crops for energy production causes the efficiency of bioenergy production to gain more attention. Thermal gasification is more efficient than other bioenergy production processes and can offer a variety of outputs from renewable fuels up to electricity (Ahrenfeldt, Thomsen, Henriksen, & Clausen, 2013).

Currently there are no Syngas upgrading plants operating in Denmark. The reason for this can be that none of the Danish subsidy and support schemes is including bio-SNG as a renewable gas into their spectrum. Since bio-SNG is as renewable as biogas and is currently lacking financial incentives for investment and operation, this is an issue, which needs to be tackled by Danish energy authorities.

Discussion

In the case of bio-Syngas injection into the Danish gas grid, the effects on the Danish gas grid would be similar to biogas upgrading plants. These effects are discussed in 4.2~~5.2~~ and 4.6~~5.6~~.

4.6 Case 6, Energy system focus: Temporary local excess supply of renewable gas

System challenge

The Injection of locally produced (bio)-methane, is a new phenomenon in the Danish gas system. Throughout the history of the gas system in Denmark, gas was produced in the North Sea and send into the Danish transmission system in one direction, with a few exceptions of imports from Germany and interaction with the gas storages in Lille Torup and Stenlille, all happening in the transmission system. Therefore, the gas system has been built from a top-down model, where the system pressure was decreased when gas was injected into the distribution system from the transmission system. As a result, there are no compressor stations at the intersections between the distribution system and the transmission system.

Lately biogas has been injected into the local distribution systems for local consumption. As the biogas production has increased the risk of temporal excess supply in local systems have emerged opening the potential need of moving the gas up in the system. This could for example happen during the summer period, where the heat consumption is low and some industrial plants have closed for the summer holiday. The local demand of biogas is very low during this time and will lead to an oversupply in the gas distribution net.

As shown in Figure 16, in 2015 there has been a situation of oversupply on the 27.07.2015. At that time, the excess of supply was at an amount, that it could be stored in the pipes through the line pack In 2017 the situation of overflow occurred with a higher intensity and duration. According to the projections of HMN Naturgas, this situation will occur to a larger extend in the future.

The demand and supply of biogas during low demand summer days

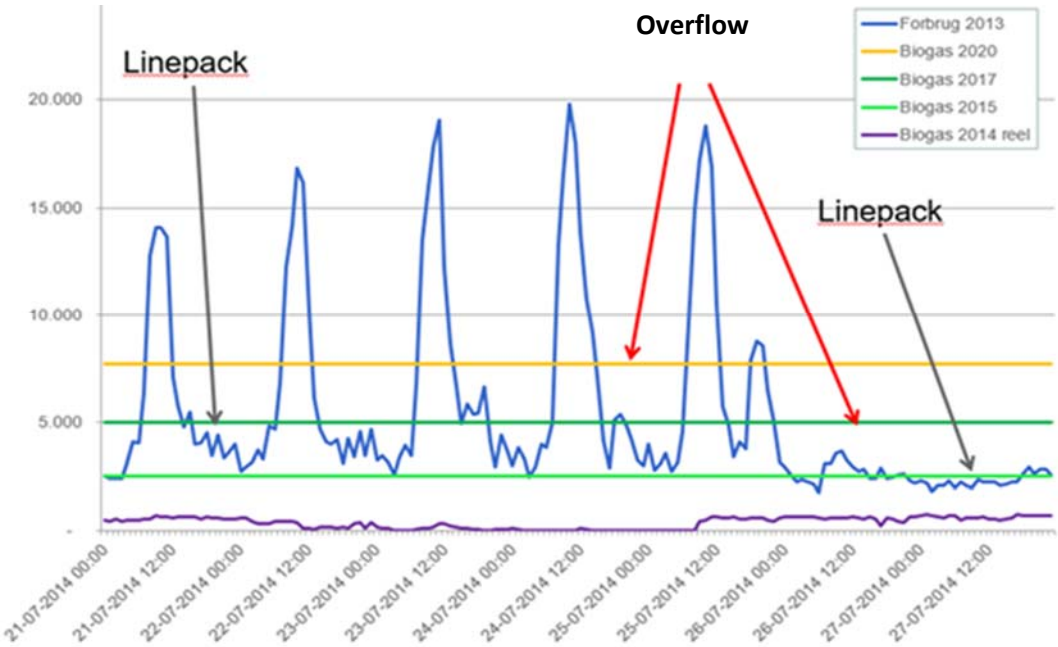

Figure 16: Seasonal oversupply of gas in the Danish gas grid (HMN Naturgas L/S, 2016)

Description- Increasing supply of renewable gases

With more investments into renewable gas production, there will be more biogas flowing through the Danish distribution grids during the upcoming years. Also taking the uncertainty for gas consumption in the transport sector into account, the injection into the gas grid remains the number one option for the utilization of biogas.

As no compressor stations have been built on the border between the transmission system and the distribution system, a debate has started on whether to build a compressor station or to find alternative options. These options are for example temporary reductions in the biogas production, building up more

consumption (e.g. installing LNG-terminals), or to create a market solution and letting the market decide for the best option. Another option would be the flaring of the excess gas, which is not a popular option.

Another option would be increasing the incentives for LNG terminals. By extracting gas from the grid and storing it as LNG, an additional flexibility factor is added to the grid additionally to the existing storage and line pack. There is also the possibility of the development of market instruments such as auctions, in order to regulate the supply and demand during times, where oversupply is given. According to a survey conducted by Energinet.dk, there is more willingness to adjust consumption on the demand side that there is on the supply side. The auctions will be most efficient, if the situation of oversupply occurs not very frequently.

Discussion

The oversupply of gas into the grid due to the increasing biomethane injected into the distribution grids is a challenge, which will increase during the upcoming years. Currently Energinet.dk is planning to reduce the pressure in the transmission grid, if the situation of oversupply occurs in 2017. This enables the excess gas to flow from the distribution grid to the transmission grid.

In case of further investment into a new compressor the question, which remains to be answered, is whether the distribution grid or the transmission grid operator should bear the cost of this compressor, since the capital investment for such a compressor is relatively high. It needs to be also evaluated if and how these kind of additional costs should be reflected in the gas tariff system.

5. Initial conclusions on the cases

As mentioned in 3.2~~4.2~~, gas tariffs does not have a significant economic impact for consumers and producers in most cases. Other factors such as the price of the technology input and taxes have most often a stronger effect on the feasibility and developments of the cases. Depending in the tariff design can tariffs, nevertheless be used as a tool to enable and promote or they can reduce the effectiveness of the inter-grid connections in the Danish energy system. Emerging technologies such as Power to gas plants and GEHP's aim to use the gas and power grid in relation to each other and hereby, offering flexibility to each of the sectors.

An overview of the influencing market factors for the technological cases mentioned in the previous section is given in Table 7. A further analysis of these market factors, especially regulatory tools and incentives will be conducted in future reports of the WP6 of the FutureGas project.

Case	Grid interaction	Influencing market factors	Regulation	Barriers	Tariff preference
Injecting hydrogen to the gas distribution grid	Power-gas	Power price (spot, regulatory), power tariff, taxes	In progress	Gas quality, capacity tariffs, no subsidy for hydrogen	Volume based tariffs
Biogas Upgrading	Gas (on-site)-gas (distribution)	Gas price, Gas tariff	Subsidy for biogas upgrading	none	Capacity based tariffs
LNG and CNG	Gas-transport	Gas price, Gas tariff, LNG price	"green energy in transport"	Competition in international LNG markets, electricity price	Volume based tariffs
Gas-Electrical Hybrid Heat Pumps	Power-Gas-Heat	Gas price, Gas tariff, Power price (spot, regulatory), power tariff, taxes	In progress	Investment cost of heat pumps, electricity price	Volume based tariffs
SNG Upgrading	Gas	Gas price, Gas tariff, Biomass price, Taxes	none	Investment cost, lack of economic incentives	Capacity based tariffs

Table 7: Summing up our initial conclusion

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Appendix A: The significance of the distribution tariff

We have made an updated version of the gas price composition for 2016 based on a simple average on monthly prices for natural gas for households, using "gasprisguiden.dk". Transmission tariffs cannot be seen in this graph, as the gas traders are not required to present these costs, therefore they can be considered to be hidden somewhere
in the gas price.

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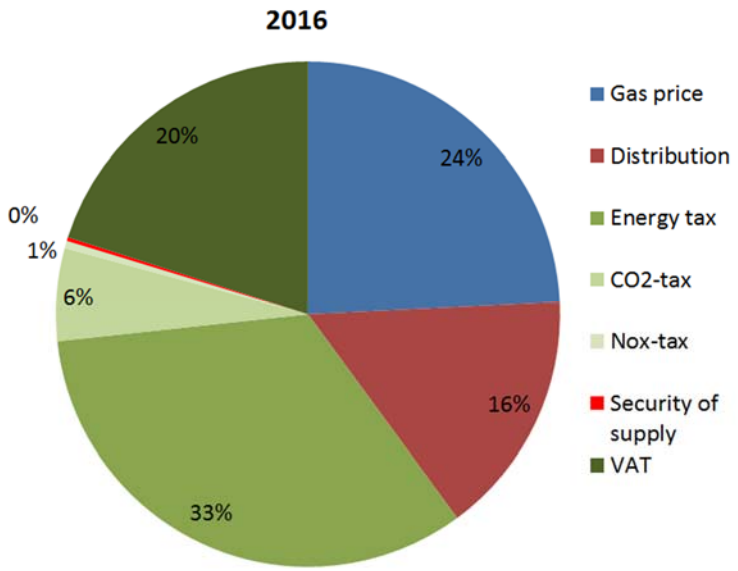


Figure 18~~Figure 17~~ we see, that transmission counts for a very small part of total costs, that distribution still counts for a more significant part, however HMN distribution tariffs are lower compared to the other distribution companies

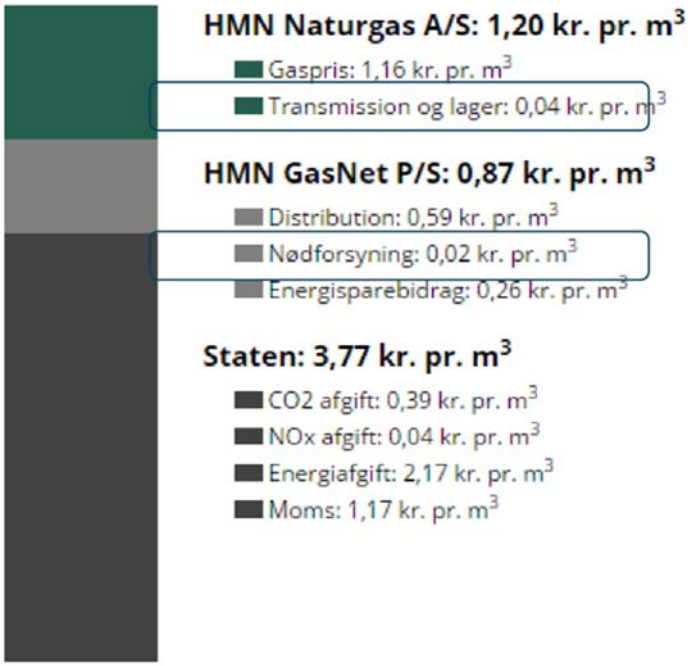


Figure 17: The gas price composition in 2016, households, source: DERA gas price statistics

Figure 18: Gas price composition in april 2016, with a total gas price of 5.83 DKK/m3, Source: Energinet.dk using HMN as the source of a month price.

Appendix B: Gas transmission pricelist, 2016

ENERGINET DK

Betalinger for transport i gastransmissionsnettet

Gældende fra 1. oktober 2016

Transport

Uafbrydelig kapacitetsbetaling/reservationspriser (årsaftaler)

Entrykapacitet	
- Ellund	14,50 DKK/kWh/time/år
- Nybro, BNG, Dragør	9,30 DKK/kWh/time/år
Exitkapacitet	
- Ellund	9,30 DKK/kWh/time/år
- Exit-zonen, Nybro, Dragør	13,04 DKK/kWh/time/år

Uafbrydelig kapacitetsbetaling/reservationspriser (kortere aftaler)

- pris i % af årskapacitetsbetalingen, startpris ved auktion

	Okt	Nov	Dec	Jan	Feb	Mar	Apr	Maj	Jun	Jul	Aug	Sep
Kvt	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%	27,5%
Md	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%	10,4%
Dag	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%	0,38%

Within day pris (rest of day)

- pris i % af dagskapacitetsbetalingen

Timer	24	23	22	21	20	19	18	17	16	15	14	13
Fra	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00
Rest of day	100,0%	95,8%	91,7%	87,5%	83,3%	79,2%	75,0%	70,8%	66,7%	62,5%	58,3%	54,2%

Timer	12	11	10	9	8	7	6	5	4	3	2	1
Fra	18:00	19:00	20:00	21:00	22:00	23:00	00:00	01:00	02:00	03:00	04:00	05:00
Rest of day	50,0%	45,8%	41,7%	37,5%	33,3%	29,2%	25,0%	20,8%	16,7%	12,5%	8,3%	4,2%

Afbrydelig kapacitet

- pris i % af årskapacitetsbetalingen

Ellund:	**Niveau 1**	**Niveau 2**
Entry	-	-
Exit	90%	-

Dragør:	**Niveau 1**	**Niveau 2**
Entry	95%	-
Exit	95%	-

BNG:	**Niveau 1**
Entry	100%

Volumenbetaling

- Variabel betaling 0,00336 DKK/kWh

Volumenbetaling opkræves ved aftag fra systemet i Exitzonen og ved øvrige exit-punkter. Der opkræves ikke volumenbetaling ved indfødning i entry-punkter.

Nødforsyning

Nødforsyningsbetaling

- Nødforsyningsbetaling - beskyttede slutbrugere	0,00126 DKK/kWh
- Nødforsyningsbetaling - ikke beskyttede slutbrugere	0,00064 DKK/kWh

Betaling for nødforsyning opkræves direkte hos slutbrugeren af det relevante distributionsselskab.

Balancering

Køb og salg af balancegas

Definition af Energinet.dks neutrale pris på balancegas:
Den vægtede gennemsnitspris for alle within-day handler på Gaspoint Nordic i gasdøgnet, i DKK/kWh.
Prisen kan dog ikke afvige med mere/mindre end 10 % fra Gaspoint Nordic Spot Index for gasdøgnet.

- Omregnes fra EUR/MWh til DKK/kWh ved brug af Nationalbankens dagligt offentliggjorte middelvalutakurs

Energinet.dk's købspris på balancegas

- Justering trin 1:	Neutral gaspris minus 0,5% af den neutrale gaspris
- Justering trin 2:	Neutral gaspris minus 3,0% af den neutrale gaspris
- Marginal købspris:	Den laveste pris af enten 1) laveste handlede pris af Energinet.dk i gul zone i den relevante gasdag, eller 2) den relevante justerede pris (trin 1 eller trin 2). Prisen vil dog ikke være lavere end 65 procent af den neutrale gaspris.

Energinet.dk's salgspris på balancegas

- Justering trin 1:	Neutral gaspris plus 0,5% af den neutrale gaspris
- Justering trin 2:	Neutral gaspris plus 3,0% af den neutrale gaspris
- Marginal salgspris:	Den højeste pris af enten 1) højeste handlede pris af Energinet.dk i gul zone i den relevante gasdag, eller 2) den relevante justerede pris (trin 1 eller trin 2). Prisen vil dog ikke være højere end 135 procent af den neutrale gaspris.

I situationer med "Early Warning", "Alert" eller "Emergency", kan Energinet.dk øge den justerede procentdel op til 100 %, for både justering af trin 1 og 2, og fjerne minimum og maximum prisniveauer.

GTF, CTF og ETF

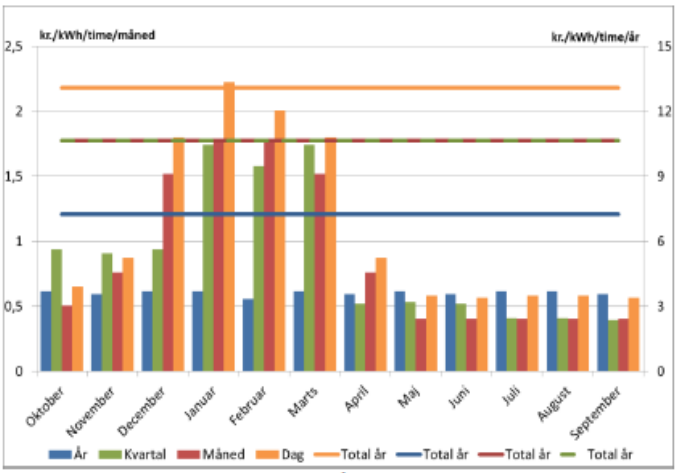
Gas Transfer Facility (GTF)	0,00 DKK/Transaktion
Capacity Transfer Facility (CTF)	0,00 DKK/Transaktion
Exchange Transfer Facility (ETF)	0,00 DKK/Transaktion

Øvrige betalinger	
Nomineringsgebyr	0,002 DKK/kWh
Incitamentsbaseret overleveringsgebyr (BNG entry)	For hver overskredet kWh/time betales for en tilsvarende døgnkapacitetsaftale. Dvs. at der fx betales for tre døgnkapacitetsaftaler ved en overskridelse foretaget i tre timer.
Neutralt overleveringsgebyr (BNG entry)	For hver overskreden kWh/time betales for 1/365 af en tilsvarende årskontrakt. Dvs. at der fx betales 3/365 af en årskapacitetsaftale ved en overskridelse foretaget i tre timer.
Incitamentsbaseret overleverancegebyr (Exit-zonen)	For hver overskredet kWh/time betales for en tilsvarende døgnkapacitetsaftale. Dvs. at der fx betales for tre døgnkapacitetsaftaler ved en overskridelse foretaget i tre timer.
Neutralt overleverancegebyr (Exit-zonen)	For hver overskreden kWh/time betales for 1/365 af en tilsvarende årskontrakt. Dvs. at der fx betales 3/365 af en årskapacitetsaftale ved en overskridelse foretaget i tre timer.
Underleverancegebyr (Exit-zonen)	0,009 DKK/kWh
Betalinger for leverancer i force majeure-situationer (inklusiv nødforsyning)	Den neutrale gaspris (som beskrevet under punktet Balancering) og/eller de direkte dokumenterede omkostninger.
Off-spec	
Off-spec-gebyr	
- ved Exit-zonen eller exit	0,006 DKK/kWh
- ved entry	0,006 DKK/kWh
Leverancer i forbindelse med off-spec - leverance fra transportkunden ved entry trods afvisning ved exit på grund af off-spec	Den neutrale gaspris (som beskrevet under punktet Balancering) eller de direkte dokumenterede omkostninger.

Alle priser og øvrige betalinger er angivet ekskl. moms.

Der henvises i øvrigt til den til enhver tid gældende version af Regler for Gastransport.

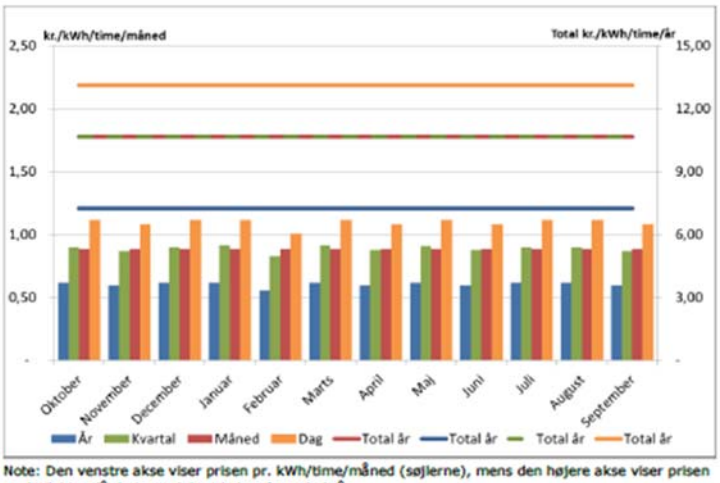
Appendix C: Alternative costdistributions for intra yearly products



Note: Den venstre akse viser prisen pr. kWh/time/måned (søjlerne), mens den højere akse viser prisen pr. kWh/time/år hvis produktet købes for et helt år.

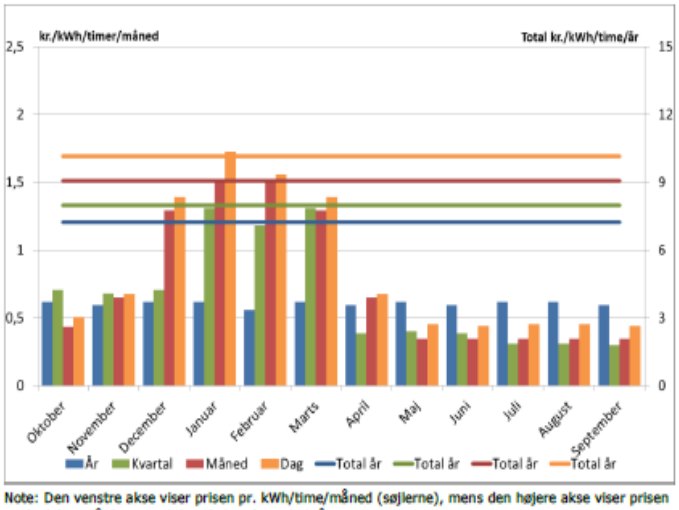
Figure 20: Existing ratio between short- and long term products with a seasonal profile, source: DERA (Energinet.dk) Dok. 15/12978-14

Source: DERA (Energinet.dk) Dok. 15/12978-14



Note: Den venstre akse viser prisen pr. kWh/time/måned (søjlerne), mens den højere akse viser prisen pr. kWh/time/år hvis produktet købes for et helt år.

Figure 19: When existing multiplicators are kept, and the seasonal profile is removed, source: DERA (Energinet.dk) Dok. 15/12978-14



Note: Den venstre akse viser prisen pr. kWh/time/måned (søjlerne), mens den højere akse viser prisen pr. kWh/time/år hvis produktet købes for et helt år.

Figure 21: When multiplicators are lovered, while the seasonal profile is kept, source: DERA (Energinet.dk) Dok. 15/12978-14