Ministerie van Economische Zaken,
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Economic Impact of the Dutch Gas Hub Strategy on the Netherlands

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Report for the Ministry of Economic Affairs, Agriculture and Innovation by the Brattle Group

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Introduction and Summary

Since the discovery of the Groningen gas field in 1959, the Netherlands has been a key player in the European gas market. The Netherlands has built up a large onshore and offshore Exploration and Production ("E&P") sector, it has a highly developed gas transmission and distribution network, and is a major exporter of gas to other EU Member States. The Netherlands has considerable expertise in all parts of the gas supply chain, and is a world centre for Research and development ("R&D") in natural gas supply and use. More recently construction has begun on terminals to allow the import of Liquid Natural Gas ("LNG") to the Netherlands.
However, Dutch gas reserves are now in decline, and the Netherlands will become a net importer of gas around 2025. The Dutch government wishes to capitalise on the existing industry and skills and sustain the Netherlands' place in the European gas industry beyond the life of the existing gas fields. In November 2009 the Minister of Economic Affairs published a paper describing the strategy of turning the Netherlands into a 'Gas Hub' or 'gas roundabout' for north-west Europe, which we refer to as the 'Government Report' for convenience.[1] The Dutch government intends that the gas hub would capitalise on the existing skills and industry, increase competition and security of supply in the Dutch gas market, create employment and make a significant contribution to the Dutch economy.

The Dutch Ministry of Economic Affairs, Agriculture and Innovation (*Ministerie van Economische Zaken, Landbouw en Innovatie* or "ELI") has commissioned The Brattle Group to perform an analysis of the economic impact of the gas hub concept. The study has several aims including:

- To analyse the current contribution of the Dutch gas sector to the economy;
- To assess the Strengths, Weaknesses, Opportunities and Threats associated with the gas hub strategy;
- To quantify the benefits of the gas hub strategy to the Dutch economy.

Note that the aim of the study is to define in more detail what a successful Dutch gas hub strategy would look like, to assess the strengths and weakness of the Dutch gas sector in achieving a successful gas hub strategy, and to quantify its economic impact. A full assessment of how one would achieve a successful Gas Hub strategy, by for example analysing the policy instruments available, is beyond the scope of this study.
The Dutch gas sector consists of several different gas qualities, usually referred to as Hi-cal and Lo-cal gas. Most of the developments and investments discussed in this report relate to Hi-cal gas, but for the purposes of this report the distinction between the different gas qualities is not important.

The Current Contribution of the Dutch Gas Sector

In this study we define the Dutch gas sector as consisting of:[2]

- Exploration and Production ("E&P");
- Gas transmission, distribution and storage;
- Trading and gas supply;
- LNG terminals and imports;
- Research and development.

[1] Ministerie van Economische Zaken, "The Netherlands as a Northwest European Gas Hub", November 2009.

[2] Not all countries have the same elements of the gas sector. For example, many countries do not have an E&P sector, and may have very limited trading.

These segments implicitly include other sectors involved in the Dutch gas industry such as the engineering and financial sectors.

The Netherlands is currently a major producer of gas. In 2008 its gas production was equivalent to 36% of gas production in the EU.[3] Currently it produces about 74 billion cubic meters ("bcm") annually.[4] The Netherlands is a net exporter of gas. In 2009 exports were 53 bcm compared to 19 bcm of imports. This is equivalent to net exports of 34 bcm.[5] We estimate that the gas sector currently contributes about €14 billion per year in government revenues, or 9% of all Dutch central government revenue.[6] The Dutch gas industry invests around €1.5 billion per year in pipelines, offshore platforms and other gas infrastructure, and has operating expenditures of around €5 billion, a significant amount of which goes on employment particularly in the downstream sectors. The Netherlands has become a major gas trading hub – volumes traded at the Dutch Title and Transfer Facility ("TTF") doubled between 2007 and 2008, and the TTF now has the highest volume of traded gas of the continental European hubs. With initiatives such as 'Energy Valley' in the north of the Netherlands, the country is also developing into a key centre for R&D into both natural gas and green gas or biogas. We estimate that around €80 million is spent in gas E&P-related R&D in the Netherlands each year and understand that €90 million is expected to be invested on average each year in relation to green gas at least for the period 2009-2011.[7]

Using a model of the Dutch economy, we estimate that the Dutch gas sector currently supports about 11,600 Full Time Equivalent ("FTE") jobs directly, 31,500 indirectly and 23,300 induced jobs – that is, in jobs created as the gas sector interacts with the rest of the Dutch economy. The value of goods and services produced around the Dutch gas sector is about €41 billion or about 7% Dutch GDP.[8] The gas sector contributes a total of €16.7 billion in final demand each year, or about 3% of Dutch GDP in 2009. Gas exports from the Netherlands had a value of €14 billion and €10 billion in 2008 and 2009 respectively, which represented around 3-4% of the value of all Dutch exports.

We use an input-output model to estimate impact measures – such as employment, goods and services produced – in three different cases. First, we estimate the contributions the Dutch gas sector makes to the Dutch economy. Second, we estimate the impact of a "business-as-usual" investment scenario from 2010 to 2020. Third, we estimate the impact from a "gas hub" investment scenario during the same time period.
These impacts are based on the flow of sales and purchases between firms in each sector of the economy. Conceptually, the impacts are broken down into three distinct parts: direct, indirect and induced effects. Table 1 below illustrates an example where as a result of an initial €25 spent on construction activities, the total value of the goods and services produced will increase by €56 = €25 + €16 + €15. This is the value of the extra goods and services that exchange hands.[9]

[3] Eurogas reports that the Netherlands produced 2824 PJ of gas in 2008 compared to 7835 PJ across all EU-27 countries. See Eurogas publication "Statistics 2008", January 2010, p. 30.
[4] This is the average production level of 2007-2009 according to NLOG. See NLOG publications: "Natural Resources and Geothermal Energy in the Netherlands – Annual Review 2008", June 2009, and "Gas and Oil Production – 2009", March 2010.
[5] From website of Gas Transport Services.
[6] Eurostat reports that Dutch central government revenue was €156 billion in 2009.
[7] From a presentation entitled "*Innovatieregio Energy Valley*" by *Creatieve Energie, Energieakkoord Noord-Nederland* and Energy Valley, January 2009. Page 10 reports the expected investments in the production and transport of green gas as €240-300 mn over 2009-2011. We arrive at €90 million by taking the mid-point of €240-300 mn and dividing by three years.
[8] Based on the period 2005-08.
[9] The figures used in this example are illustrative only.

Table 1: *Example of Direct, Indirect and Induced Effects of Spending*

Description of impact	Example
Direct: Impact in the industry in wich an investment shock occurs.	€ 25 spent on construction activities.
Indirect: Impacts to businesses which provide goods & services necessary for the construction of the project, i.e. inter-industry purchases.	The € 25 spent on construction activities results in € 16 of purchases from sectors such as metals fabrication, whoesale trade, etc. € 9 leaks out of the Dutch industries in the form of taxes, savings, imports, etc.
Induced: The impact on the Dutch economy from the extra spending wich results from the extra household income (eg., extra wages or extra dividends) generated by the increase in the goods and services produced as a result of the direct and indirect efects.	The € 25 in direct expenditures on construction activities and € 16 on indirect inter-industry purchases results in additional household income, part of which is re-spent on sectors of the economy such as food, housing, transport. This will create an additional € 15 worth of goods and services.

Perhaps unsurprisingly, gas plays a key role in the lives of Dutch citizens. The Netherlands has the highest gas penetration rate in the EU, as well as the highest share of gas in primary energy consumption and the highest consumption of gas per person. No other country has a higher proportion of electricity generated by gas than the Netherlands.

The presence of large indigenous gas resources means that the Netherlands enjoys a high degree of supply security. A high degree of security of supply helps avoid volatile prices and scenarios that would lead to damage to industry and the wider economy. Our analysis suggests that the Netherlands would still have a supply margin of around 30% even if one of its major supply points suffered disruption.

Arguably the abundance of gas in the Netherlands has fostered the successful development of several energy intensive industries. Gas-intensive industries such as chemicals and paper manufacturing form a larger part of Dutch industry than in other major EU economies. Compared to other major EU economies, the Netherlands has a higher ratio of industrial gas consumption to industrial Gross Value Added, which suggests that Dutch industry is more gas intensive than the EU overall. We also find that, of the major EU economies, the Netherlands has the highest percentage of gas consumed by industrial customers for industrial processes. This means that Dutch industry uses gas to make other products, rather than only for energy. The high intensity of gas use by Dutch industry confirms that gas has played a key role in shaping the Dutch industrial sector, by attracting more gas-intensive industries.

The Strengths and Weaknesses of a Dutch Gas Hub

ELI has asked us to analyse the economic impact of the Dutch gas hub strategy by identifying the strengths and weaknesses for the Dutch gas hub concept, as well as identifying possible opportunities that arise from the gas hub policy and threats to the policy – a so-called SWOT analysis. The Government report described a successful Dutch gas hub as consisting of a situation in which:

- There would be substantial domestic and foreign investment in the Dutch gas sector. Demand for gas transit across the Netherlands will, via open season processes, translate into substantial investment in gas pipeline infrastructure;
- The Netherlands imports and then uses or re-exports large volumes of LNG to the rest of Europe. This, combined with investments in pipelines, should increase security of gas supply;

- The Netherlands will be an attractive place to develop gas storage projects, which will also provide for the seasonal demand for flexibility in other countries;
- A liquid gas trading hub will continue to develop, with relatively large volumes and where prices are robust and trustworthy;
- The Netherlands is recognised as a world-class gas-related R&D base, and there is substantial investment in this sector.

The Dutch government has set out its plan of action to develop a gas hub strategy.[10] These actions include:
- Cooperating with industry;
- Promoting optimal operation of market forces and integration of the NWE gas hub;
- Using domestic sources of energy promoting investments;
- Pursuing 'gas diplomacy';
- Promoting international entrepreneurship;
- Enhancing the knowledge infrastructure;
- Monitoring of gas supply security.

All of these actions could have a positive impact on the Dutch economy. However, we omit a number of the Government strategy areas from our analysis because we are unable to quantify the economic impact of such actions.

The vision of a successful Dutch gas hub is consistent with the investments that are currently being undertaken in the Dutch gas market. We imagine a market that imports and re-exports or uses LNG and the Netherlands first LNG facility is currently being built. We also imagine a country that can export gas to meet seasonal peak demand in other countries and currently three new gas storage facilities are being built in the Netherlands.

We have divided our analysis of the gas hub strategy into several elements. For example, for transit flows we recognise that the Dutch gas market's strengths and weaknesses in maintaining and expanding its share of transit flows depend in large part on Netherlands' geographic position. Put simply, for the Netherlands to become a 'gas roundabout' it is important that it is roughly in between the source of gas and the destination of gas. To understand which other routes the Netherlands might be competing with, we must have an understanding of the likely gas flows in north-west Europe in the next 10 or so years. To this end, we have performed gas supply and demand balances for the Netherlands, the UK, France, Belgium and Germany. As a result of this analysis, we have identified some of the key transit routes for the Netherlands and the risks involved. To gain some insights into the perceptions of market players we have undertaken a number of interviews with large multi-national firms who are active in gas trading in the Netherlands, other markets in Europe and indeed around the world. The results of these interviews feed into our analysis. Figure 1 below summarises the results of our SWOT exercise.

Starting with the strengths, we find that market participants like the excellent range of options that the Netherlands provides for both buying and selling gas through its connection to multiple markets and gas sources. The TTF is currently the largest trading hub by volume in continental Europe, which further

[10] See Government Report, Appendix 1.

promotes the attractiveness to importing LNG into and transiting gas across the Netherlands. Growing demand for gas imports, especially in the UK, will provide an opportunity to increase transit volumes across the Netherlands. The high quality of the process of energy regulation in the Netherlands – including open and transparent consultation processes and the ability to appeal the regulator's decisions – contribute to the lack of 'regulatory risk'. This in turn makes the Netherlands being an attractive place for investment in energy infrastructure such as gas storage, LNG terminals and gas pipeline capacity. Market participants we interviewed noted that the Netherlands remained an attractive place for gas trading, and was perceived at present as being one of the most important and investor friendly gas markets in the EU.

Figure 1: *Summary of SWOT Analysis*

Strenths	Weaknesses
• Strong and well-developed E&P sector. • Attractive regulatory process. • Connection to several sources of gas with diverse costs. • Multiple options for selling imported LNG. • Existing high liquidity of the TTF. • High volume of market information on flows etc. • Large number of depleted fields that can be developed into storage. • Current strong position of the TTF. • Diverse physical deliveries to support TTF trading.	• Balancing charges - though this is being addressed. • Lack of stable long-term transit tariffs. • Risk of high 'transit' tariffs. • Lack of transparency in some areas relating to gas transport. • High cost of trying tot export flexibility provided by gas storages. • Entry-exit charges for gas storgaes could act as an investment barrier. • Concerns regarding market power of the incumbent. • 'Red tape' reduces the 'ease of doing business'.
Opportunities	**Threats**
• Increasing demand for imports from GB, France and other countries could increase transit volumes. • Sites available for new LNG terminals, relatively cheap expansion of the Gate terminal possible. • Chance to develop a 'first-mover' advantage in gas R&D and create future export opportunities in e.g. Biogas. • Potential for TTF to establish itself as the European reference hub. • Creation of across-border trading hub based around TTF. • Increased gas demand to provide balance for intermittent wind-power.	• Environmental legislation, energy efficiency, biogas and growth in nuclear reducing gas demand, especially in the UK. • Growth of a Belgian hub takes away Russian transit flows. • Bypass via Germany/ • Competition from LNG terminals outside NL. • If TTF did not develop into the premier trading hub, this could threaten LNG imports and transit flows. • Competition from gas storage especially in the UK, maybe Germany. • Current gas 'bubble' could deter infrastructure investment. • Emergence of another trading point as the market reference hub. • Hub of inefficiencies from R&D subsidies.

Our gas-flow scenarios illustrate the potential for increased Dutch transit flows. On the one hand, they highlight the possibility that other countries can compete for transit flows, that the Netherlands could be bypassed by direct imports of LNG and that energy efficiency measures could significantly reduce gas demand in countries like the UK, France and Belgium, and that transit flows would be affected as a result. On the other hand, environmental policies that promote wind could boost gas demand, if more gas-fired plants are required to balance output from intermittent wind power.[11] Ensuring that the gas transport tariffs remain as transparent and competitive as possible will be important in promoting Dutch gas transit volumes.

[11] Working Group 1 of the Gas Hub Consultative Platform is charged with looking in detail at the role of gas in a de-carbonised energy system in 2050, which will include the interaction of gas-fired pant and wind power.

The TTF currently has a lead over other trading hubs in terms of trading volumes, and a geographic advantage in terms of the gas sources it connects. But it is clear that the German trading hubs are catching up fast in terms of volumes. Ensuring that the TTF platform is as integrated as possible with the new Dutch balancing market will help boost trading volumes, and the availability of further volumes of uncommitted gas delivered as LNG or via new transit pipelines should also help boost trading. While the German market has larger volumes of gas demand than the Netherlands, the potential volumes of gas available to a Dutch trading hub are of a similar order to those available on the German trading platforms. We do not see that domestic Dutch gas demand need place a constraint on TTF liquidity.

Market participants have confirmed that the Netherlands is an attractive destination for landing LNG. But our analysis shows that the Netherlands is competing with all other coastal countries in the EU for the ability to re-gasify LNG. Maintaining and building the liquidity of the TTF and the capacity of connections to other markets will be important in giving the Netherlands the edge as a destination for LNG imports.The existing R&D initiatives in the Netherlands and the geographic nexus of industry expertise and university-based research are a strong advantage. The Netherlands could capitalise on these initiatives and focus on a growth area like biogas, which could be used as a platform for future exports and growth. However, if the Netherlands would decide so, it should take good account of the Danish experience, which also points to the dangers of excessive subsidies in pushing a chosen technology. Once initial R&D work is done, the market should be left to decide which technologies will ultimately be successful.

The ambitions of the Netherlands to increase its exports of flexibility seem to have less foundation than other elements of the gas hub strategy. The decline of the Groningen field – which has provided a highly competitive source of flexibility for decades – means that in the future gas storages will need to play a much bigger role in covering the seasonal fluctuations in gas demand. GTS estimates that demand for flexibility could over take the planned supply as early as 2018.[12] While the Netherlands has a wealth of geological opportunities for gas storage development, it is not clear that these storages can compete effectively against gas storages being developed in the UK and Germany. Dutch gas storages will need to buy entry capacity into these countries, which puts them at a competitive disadvantage relative to domestic gas storages.
As Europe's indigenous gas production declines and market liberalisation increases, gas imports and trading will increase. The Netherlands is in a strong position to claim a share of the growing markets in gas transit, LNG imports and gas trading. However, as our analysis demonstrates, this ambition will not go unopposed. Belgium, Austria and Italy all have plans to develop their own gas hubs.

As mentioned previously, the Government Report lists a broad range of actions to promote the Dutch gas hub. We have also developed a number of detailed proposals to address the weaknesses and threats our analysis identifies, which fit in to the actions set out in the Government Report as described below. Our suggested policies include:

- Enabling Gas Transport Services ("GTS") to sell 'open season' capacity under long-term, multi-year tariffs. This would significantly reduce the risk to shippers buying open season capacity, because they would know exactly the financial commitment that they are making. This fits with the Action 4 of the Government report to review the gas transmission tariff regime.
- Maximising the integration between the TTF intra-day market and the new balancing market, with the

[12] See GTS report "*Rapportage Voorzieningszekerheid Gas* 2010", 28 May 2010, p.23.

ultimate aim of a single intra-day market that will maximise liquidity. This will help promote investment in gas infrastructure in the Netherlands.

- Considering if GTS's entry/exit tariff proposals are consistent with the ambition to increase transit flows. GTS's proposal will increase the costs of shipping gas from the north to the south. While GTS claims that these tariffs are required to finance new investments, it could be investigated if the new tariff structure ensures that the Netherlands is competitive for transit routes which other TSOs can offer. As above, this policy could be part of Action 4 of the Government report to review the gas transmission tariff regime.
- There is no particular reason why policy makers would have to choose one element of the gas hub strategy over another, since the different elements do not compete with one another, but rather are highly complementary. We note however that the upstream sector has the most value-added for the Dutch economy. Promoting upstream gas is part of Action 3, 'Using domestic sources of energy'.
- ELI should continue to facilitate the business environment in the Netherlands. We recognise that this is a complex task and that in any case measures that business regards as a burden may be desirable from a social point of view. Measures such as the National Coordination (Energy Infrastructure Project) regulations continue to be important to the success of the gas hub. This policy would fit with Action 4, promoting investments.

The Economic Effects of a Dutch Gas Hub

To assess the economic impact of a successful gas hub policy, we have developed a scenario with a less successful gas hub strategy, which we call the Base Case scenario, and a scenario for a successful gas hub strategy. We describe the gas hub strategy for each of the elements of the gas sector – upstream, transit, trading and so on, and then assess the impacts on the goods and services produced and on employment. We also produce an estimate of the spending and investment in the Base Case scenario and the gas hub strategy scenario. We have focused on the period around 2020, because this is sufficient time for the Gas Hub strategy to be realised but not so far into the future as to make forecasting highly speculative. The implicit assumption is that the private sector will make the required investments,[13] and that the government's role is to provide an attractive investment environment.

We take the case that activity in the upstream sector will increase in the gas hub scenario. We imagine that special efforts are made to increase and extend production at existing fields, and that fields that are currently recognised as potential production sites are drilled. In addition, we assume that an additional 15 wells are constructed each year. EBN has produced a production forecast on this basis which we rely on in our analysis.[14] EBN estimates that it will cost around €1.5 billion per year to realise the additional gas production, including the cost of constructing new wells.

For transit flows in the gas hub scenario, we model a case where shippers located in countries around the Netherlands prefer to import gas via pipeline through the Netherlands rather than import LNG directly. This results in about 7.8 bcm/year of transit flows through the Netherlands, an increase of 7.8 bcm/year with respect to the Base Case scenario. With respect to transit flows to Belgium and France in the gas hub scenario, we model a case where a greater percentage of Russian gas flows through the Netherlands. This results in transit flows of 25.9 bcm/year, or 7.9 bcm/year more than in the base case. In total, the gas hub

[13] We include Gasunie and its subsidiaries in this definition of the private sector, even though it is state owned.

[14] EBN report "Focus on Dutch Gas 2010", June 2010.

strategy involves an about 13 bcm/year of additional transit flows relative to the Base Case.[15] We understand that these numbers are similar to numbers developed by Gasunie in their planning exercises.[16]
Flexibility and storage seemed to be one of the weaker elements of the gas hub strategy. Therefore we do not believe that it would be appropriate to add more than one additional gas storage facility in the gas hub scenario. While we agree that the Netherlands has great potential for gas storage, we do not see an economic role for storage to export flexibility to countries such as Germany and the UK. In the recent past and over the next few years there is a window of opportunity to export flexibility to the GB gas market, as it makes the transition from being a net exporter to importing large volumes of gas. But it is clear that the GB market is aiming to become much more self -sufficient in flexibility in the near future. Similarly Germany is constructing a large number of storages.

With regards LNG supply, we model the addition of an 11 bcm/year LNG terminal at Eemshaven[17] in the gas hub scenario and an expansion of the Gate terminal from 12 to 16 bcm/year. As regards trading at the TTF, we model a case where the volume-growth rate is the same as the Base Case for two years, but then the rate of annual volume increases returns to the current high growth rates of about 30% a year.

With respect to R&D, we model a scenario where the Netherlands attempts to emulate the Danish wind industry by investing in an up and coming 'green' technology, from which it then reaps future rewards. The most promising area with respect to gas is the biogas or green gas sector. We model a case where the Netherlands invests in R&D in the green gas sector, and as a result gains intellectual property in the manufacture of green gas which gives it a share of the sector in the EU. In the Base Case scenario, we assume that spending on R&D reduces from its current/near-future level of about €100 million per year to €50 million per year by 2013, and that patents and licenses give the Netherlands a 0.5% share of the revenue from investing in biogas production. In the gas hub strategy, the Netherlands spends more on R&D and as a result its share of the market for investing in biogas production increases to 60%. This translates to revenues from licenses and patents of about €440 million in 2020, compared to about €150 million in the Base Case scenario.

Relative to the Base Case, the Gas Hub scenario involves an additional €7.7 billion of sector investment and in addition to the usual impact of such spending the additional investment creates a exogenous change in the Dutch economy that generates a €1.8 billion combined additional income from intellectual property royalties and value-added from TTF trading.[18] Our economic model estimates that relative to the Base Case, the Gas Hub scenario could create up to 136,000 FTE job-years, and €21.4 billion of additional goods and

[15] The 7.9 bcm/year we report for transits to Belgium and France also include the transits to the UK that will travel via Belgium and the IUK.

[16] Throughout this study, we have been in contact with staff from Gasunie and its subsidiary Gas Transport Services (GTS), to discuss our ideas and some of the numbers we have used. We are grateful to Gasunie for their assistance. However, we stress that Gasunie bears no responsibility for any of the numbers used in this report, other than those numbers directly attributed to a public Gasunie/GTS report.

[17] We are aware that the LNG terminal project at Eemshaven was recently cancelled. However, we take the view that an investment in an LNG terminal at Eemshaven remains likely over the period considered in this study.

[18] We assume that a successful gas hub will result in substantial new intellectual property royalties and TTF extra revenues which do not change the structure of the inter-industries flows in the Dutch economy. As a result, we include these extra revenues as an exogenous increase in income into our system to capture the impacts that results from these extra income being spent in the economy.

services.[19] This total output represents the value of all goods and services that we estimate would be produced during this period as a result of the hub investments. This is equivalent to the 'Total Output' or 'Gross Output' in the national accounts. It includes the value of intermediary goods and the value of final goods produced during this period.

The additional infrastructure investment would also boost security of gas supply in the Netherlands. A typical way to measure a country's level of security of supply is the supply margin. The supply margin is the supply capacity that a country has in addition to the amount of supply capacity needed to meet peak demand.[20] We estimate that in the event of a major supply disruption in the gas hub scenario, the supply margin would be around 20% or 20 percentage points higher than in the Base Case.[21]

Finally, we find that, by attracting more suppliers into the market, the Gas Hub strategy would have a positive effect on competition and put downward pressure on prices. We estimate that in 2020 the incumbents will have a 73% share of the upstream/supply market in our Base Case scenario, but that this share falls to about 60% in the Gas Hub scenario.[22] We estimate that the reduction in market share of the largest player could result in a reduction in the price-cost margin of up to 17%. Based on assumptions about the marginal cost of gas in the Netherlands, this translates to a reduction in price of around €0.6/MWh, or 3%. If we apply this price reduction to the Dutch gas market in 2020, the result is a reduction in gas purchase costs for Dutch consumers of around €300 million.[23] One of the aims of the Dutch Government is to expand the current gas market to create a true north-west European market for gas. If this is successful, then the market concentration with a successful gas hub will be even lower than described here, and the benefits for consumers would be even greater.

[19] FTE units standardizes the amount of work to what is considered the normal work time. A FTE job-year is the equivalent employment of one person for one year, working under normal conditions and the amount of time considered standard during that year. The 136,000 is the number of FTE job-years that would be created economy wide in the gas hub scenario relative to the Base Case scenario. This is equivalent to hiring 136,000 individual working full time for one year, or, for example, hiring 13,600 individuals working full time for 10 years.

[20] Supply margin is calculated as the ratio of total supply capacity to peak demand minus 1, expressed as a percentage. The total supply capacity is the sum of the capacity at all the locations that can supply gas to the country (i.e. import points, production sites, storage facilities & LNG facilities).

[21] The supply margins have been calculated on an hourly basis.

[22] Note that this market definition is different from the wholesale market.

[23] Our estimate will set an upper limit for the effect of competition, in the sense that, for the purposes of this exercise, see conclusion in Governmental Report, p. 8, "it is within this Northwest European context that the Dutch government wishes to further develop the Gas Hub". If the relevant geographic market in 2020 is larger than the Netherlands, then the new supplies that arrive under the gas hub strategy will have a smaller effect on competition.

Table 2: *Summary of Gas Hub Strategy*

Elements of the Gas Hub Strategy	
Upstream	• Special efforts are made to increase and extend production at existing fields • Potential production sites already indentified are drilled • 15 new wells are explored every year
Transit	• More transit flows to UK, Belgium and/or France • Additional pipelines needed • Estimated additional costs: € 1 billion between 2010-2020
LNG terminals	• Gate terminal exanded by 4 bcm • 11 bcm terminal built at Eemshaven • Associated pipeline expansions • Total additional investment: € 1 billion
Storage	• Storage project currently under construction • One further storage facility, plus necessary pipelines • Extra expenditure: € 550 million
R&D	• Investment in biogas R&D generates return • Investment continues at current rate until 2015 when it halves • International licensing of technology yields additional revenues
Trading	• Increase increase in TTF trades and liquidity • In most years trade volumes grow by ~30% • Trading revenues more than double
Economic & Employment Impacts	
Additional employment created	136,000 job-years
Additional economic output	€ 21.4 billion

Conclusions

We conclude that the Netherlands has many advantages which it can use to implement a Gas Hub strategy, and that this strategy could be successful in stimulating the economy and creating jobs. The Netherlands has an excellent geographic position, regulatory and gas infrastructure which make it an attractive place to invest in transit pipelines and import gas via pipeline and via LNG terminals. We have identified a number of risks, including the volatile nature of gas demand in neighbouring markets and competition from other EU Member States in developing similar gas-based services. However, none of these risks negate the attractiveness of the gas hub strategy.

2 The Current Contribution of the Dutch Gas Sector

In this study we define the Dutch gas sector as consisting of:

- Exploration and Production (E&P);
- Gas transmission, distribution and storage;
- Trading and gas supply;
- LNG terminals and imports;
- Research and development (R&D).

While we have not explicitly mentioned other sectors of the Dutch economy such as engineering and financial sectors, these are implicitly included in the above segments of the Dutch gas sector. For instance, engineering companies are used to construct and/or provide new capacity in the transmission, distribution and storage segment. Engineering companies will also have a strong role in exploration and production at gas fields. The financial sector will be involved in the trading segment.

2.1 An Overview of the Dutch Gas Sector

2.1.1 Exploration and Production

E&P is the business of searching for and producing natural gas, and is also known as the 'upstream' sector of the gas supply chain. As of January 2010, the Netherlands had 235 producing gas fields, of which 135 were offshore.[24] These fields contained developed reserves of 1,371 bcm, of which 1,036 bcm are in the giant Groningen gas field in the north of the Netherlands.[25] Dutch gas production in 2009 was 70 bcm.[26] At this rate of production reserves will last almost 17 years or through 2025.[27] In reality Dutch gas production will tail off more gradually, so we expect the Netherlands to be producing gas for at least the next 40 years, all be it in declining quantities. This is consistent with NLOG which expects that Dutch gas production will continue until at least 2034.[28] As of 2009, the Dutch gas industry had produced over 3,000 bcm of gas.[29] The Netherlands position as a major producer means it is and has been a major exporter of gas to other EU Member States. In 2008, the Netherlands produced around 36% of all gas produced in the EU.[30] Figure 2 shows that the Netherlands is a net exporter, and that during over the last five years exports have always been more than double the size of imports.

[24] NLOG, "Natural Resources and Geothermal Energy in the Netherlands – Annual Review 2009", June 2010, p. 12.

[25] Reserves figures were calculated from 2008 figures in, *ibid.*, p. 15.

[26] EBN report (June 2010), *op. cit.*, p. 4.

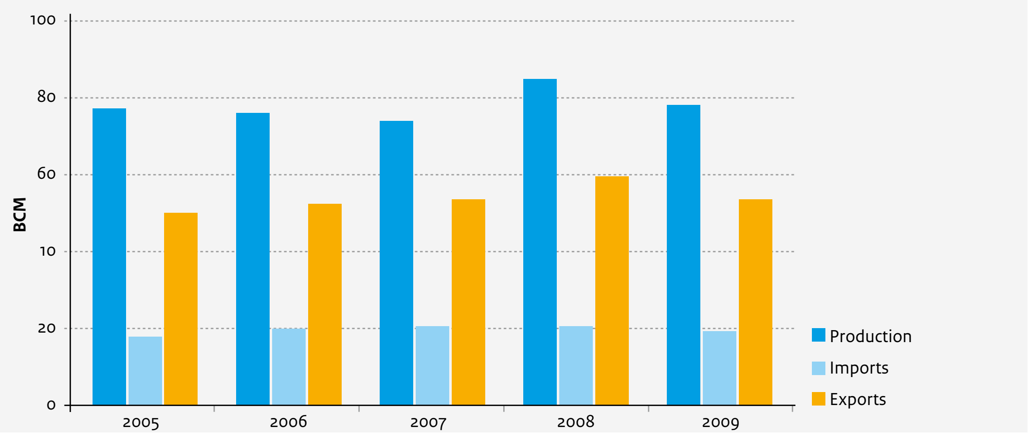
[27] Assuming annual gas production remains constant at the stated rate of 70 bcm/year, Dutch developed reserves of 1,171 bcm would last 1,171/70 ≈ 17 years from the end of 2009, or through the end of 2025. In order to extend the life of the Groningen field, the government has set a limit of 425 bcm Geq total for the period 2006-2015. While extending the life of the field, the reduction in domestic production will likely accelerate the Netherlands' dependence on imports.

[28] *Op. cit*. footnote 24, p. 23.

[29] NLOG (June 2009), *op. cit.*, p. 109.

[30] Eurogas reports that the Netherlands produced 2824 PJ of gas in 2008 compared to 7835 PJ across all EU-27 countries. See Eurogas publication (January 2010), *op. cit.*, p. 30.

Figure 2: *Dutch Gas Production, Imports and Exports*



Nederlandse Aardolie Maatschappij (NAM) which is a joint venture between Shell and Exxon is the largest gas producer in the Netherlands. Annually, NAM produces around 50bcm of gas from both the Groningen gas field and some of the smaller fields. The remainder of the gas is produced by one of the many foreign producers active in the Dutch E&P sector.[31] Table 3 lists the production by the main foreign operators in 2009. Table 3 shows that in 2009 foreign operators produced 25% of gas produced in the Netherlands. Offshore on the Dutch continental shelf, foreign operators produced over 75% of the gas. We include both the Groningen field and the small fields in our analysis.

Table 3: *Percentage of Gas Production in 2009*

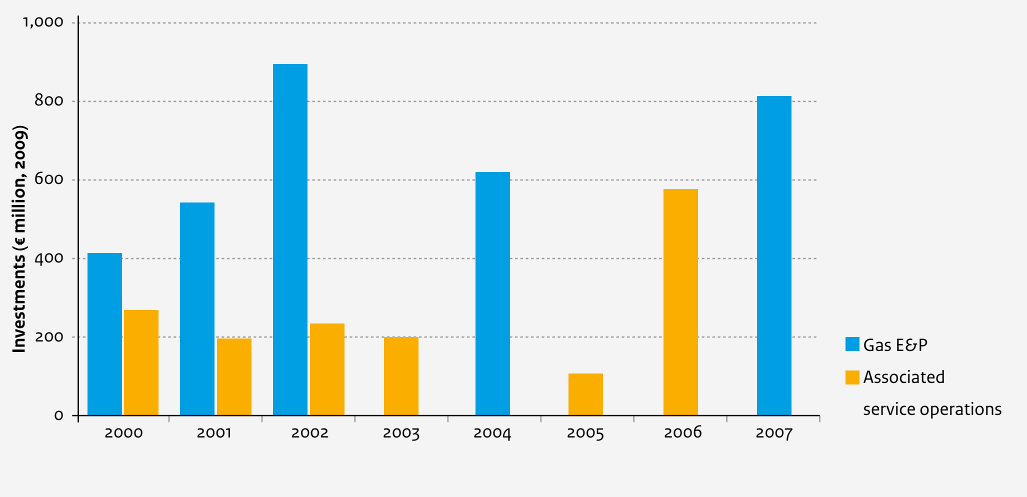
		Onshore [A] mcm (N) See notes	Offshore [B] mcm (N) See notes	Total [C] mcm (N) [A]+[B]
TAQA	[1]	172	487	659
NP	[2]	40	0	40
Vermilion	[3]	324	0	324
Chevron	[4]	0	1,228	1,228
Wintershall	[5]	0	3,581	3,581
GDF	[6]	0	5,851	5,851
PCN	[7]	0	130	130
Total	[8]	0	5,290	5,290
Venture/Centrica	[9]	0	99	99
ATP	[10]	0	21	21
Cirrus	[11]	0	91	91
Foreign operators	[12]	536	16,779	17,314
NAM	[13]	47,183	5,397	52,580
total	[14]	47,719	22,175	69,894
Share of Foreign operators	[15]	1%	76%	25%

[31] We consider a company to be a foreign operator if its parent company is not Dutch. We have not examined the nationality of the share-holders of the companies.

The 100% state-owned company Energie Beheer Nederland B.V. ("EBN") is a significant player in the upstream sector. Through the Mining Act, the Ministry of Economic Affairs, Agriculture and Innovation can designate a company to participate in all production activities. EBN is always the designated company and its interest in the production activity is always 40%. This applies to both onshore and offshore production activities. EBN can also participate in exploration activities but this applies only to offshore exploration and has to be at the request of the exploration company. As well its interests in exploration and production activities, EBN also has interests in 5 offshore gas-gathering pipelines.

We estimate that around €1 billion is invested in the Dutch gas E&P sector annually. Figure 3 shows the investments made in gas E&P and associated service operations between 2000 and 2007 inclusive.[32] On average, for years where data was available, around €730 million was invested annually in gas E&P, and around €300 million was invested in associated service operations. Our estimates of the capital investment in gas E&P can be found in Appendix II. We present our estimates for operating expenditures for the gas E&P sector in Appendix III.

Figure 3: *Investment in the Dutch Gas E&P Sector*



As mentioned earlier, the Netherlands upstream sector plays host to a wide range of foreign companies that have invested in the sector. Table 4 illustrates that in 2009 around 70% of wells were drilled by companies with a foreign (non-Dutch) parent. Most of the wells drilled by foreign companies are off-shore on the Dutch continental shelf. We also estimate that, based on NLOG's 2009 annual review report, foreign-paren-

[32] We have estimated the investments made by the gas E&P sector based on data publicly available from the CBS. CBS only provides these data for the gas E&P sector combined with the oil E&P sector. Accordingly, we estimate the proportion of the combined sector that relates to gas E&P. We estimate the revenues generated from oil production and the revenues generated by gas production, and allocate the E&P investments on a pro rata basis according to these revenues. This approach reveals that 96% of the revenues from oil and gas E&P are from gas E&P. Our calculations can be found in Appendix I.

ted firms operate 70% of offshore pipelines and platforms by value.[33] Given that around €730 million is invested in the gas E&P sector, we estimate that around €510 million is invested by foreign companies annually. Our calculations and the assumptions made can be found in Appendix IV.

Table 4: *Analysis of Wells Completed in the Netherlands in 2009*

		Netherlands Territories & Continental Shelf				
		Exploration [A]	Appraisal [B]	Production [C]	Total [D]	% [E]
Northem Petroleum	[1]	0	0	0	0	0%
Vermillon	[2]	1	0	2	3	10%
GDF Suez	[3]	4	1	4	9	30%
Wintershall	[4]	1	1	1	3	10%
Cirrus	[5]	0	1	1	2	7%
Petro Canada		0	0	1	1	3%
Total		0	0	3	3	10%
Foreign Companies		6	3	12	21	70%
NAM		2	3	4	9	30%
Total		8	6	16	30	

Notes and sources:

[1] through [7], and [9] is from Natural Resources and Geothermal Energy in the Netherlands - Annual Report 2009, pp. 35-37

[8] = sum ([1] - [7])

[10] = [8] + [9]

[D} = sum ([A]-[C])

[Ex] = [Dx]/[D10]

2.1.2 Gas Transmission, Distribution and Storage

The state owned firm Gasunie owns and operates the high-pressure transmission network, illustrated in Figure 4. The transmission network consists of 11,500 km of pipeline, and gas is supplied to the grid from 52 entry points, 35 of which feed in gas from Dutch fields and 17 deliver gas from networks from neighbouring countries. The gas is delivered to Dutch customers via almost 1,100 delivery stations, and to foreign customers through 23 border stations.[34] Gas distribution takes place at lower pressure via 12 Distribution Network Operators ("DNOs").

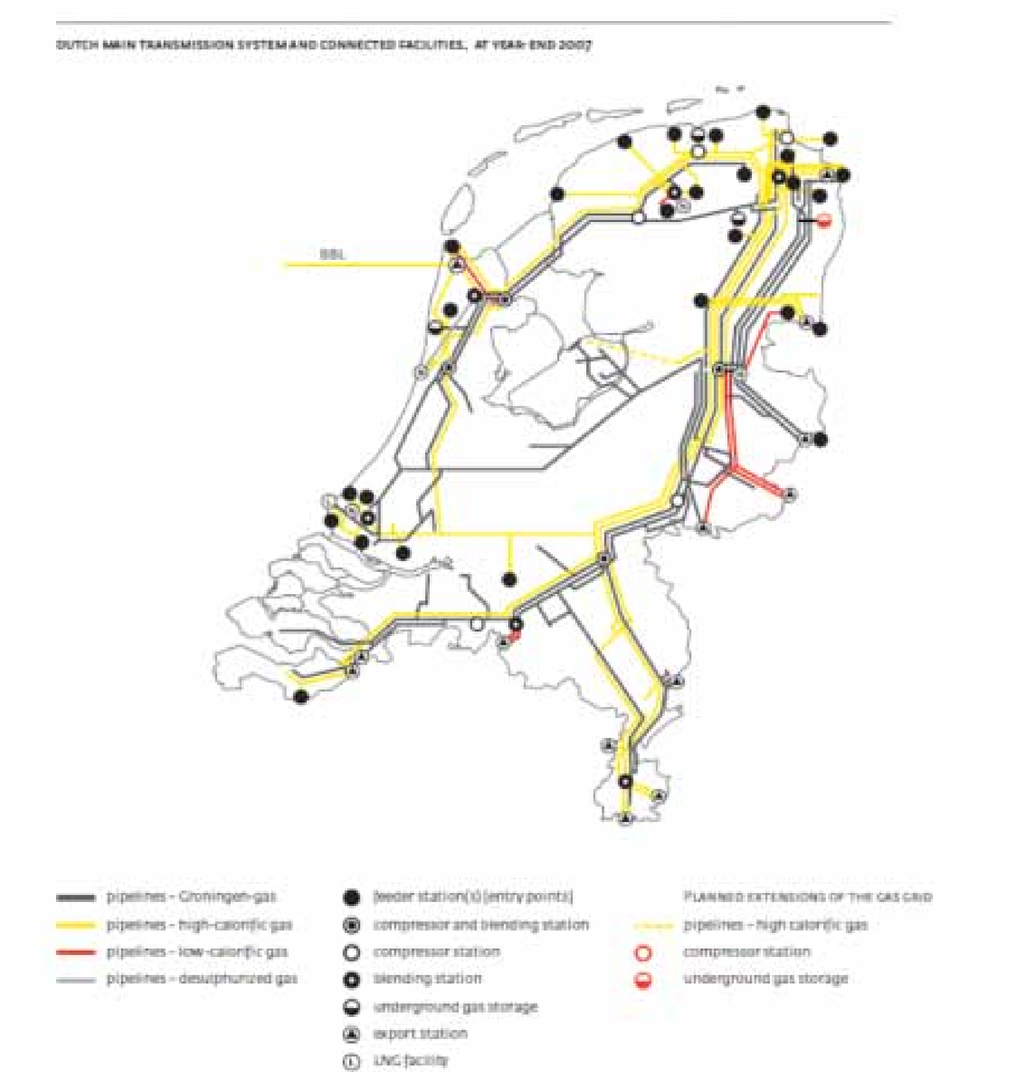
The Dutch gas network has high capacity onshore interconnections with Germany and Belgium. The network is also connected to the UK via the Bacton to Balgzand (BBL) pipeline, which can currently transport up to 16 bcm/year from the Netherlands to the UK.[35] Gas from Norway lands via the Norpipe just over the Dutch-German border in Emden.

[33] We estimate the percentage of platforms operated by foreign-parented firms. We give more weight to platforms with a greater number of legs, because more legs means a larger more expensive platform. Similarly we give more weight to larger and longer pipelines. The source data is from NLOG report (June 2010).

[34] International Energy Agency, "Energy Policies of IEA Countries – The Netherlands, 2008 Review," 2009, p. 64.

[35] BBL capacity is expected to increase to 19.2 bcm/y at the end of 2010. See Reuters, "UPDATE 1-Dutch-UK BBL gas pipe to flow 19.2 bcm/yr by 2011", available online at http://www.reuters.com/article/idUSLJ41175520080819.

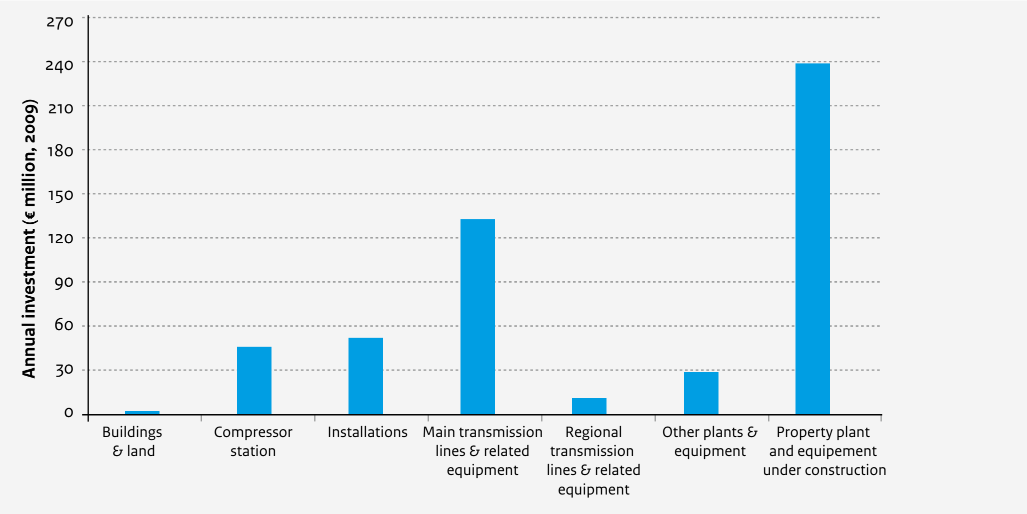
Figure 4: *Map of the Dutch Transmission Network*



Notes and sources: From Gasunie Annual Report 2007

Figure 5 illustrates Gasunie's average annual investment in the Netherlands. Across the five-year period 2005-2009, Gasunie has invested €500 million each year on average. Much of this investment has been in the gas transmission network and the gas storage facility at Zuidwending. We present the operating expenditures of Gasunie for the past five years in Appendix III.

Figure 5: *Annual Investment by Gasunie*



The Netherlands currently has three underground gas storage facilities with a total working volume of about 5 bcm, as well as a peak shaving unit operated by Gasunie at Maasvlakte. The Abu-Dhabi National Energy Company (TAQA) bought the Alkmaar storage facility in 2007 from BP, and NAM operates the other two storage facilities – Norg and Grijpskerk. Nuon also has a gas storage facility in Epe in Germany. The Epe facility uses a former salt cavern and has a working volume of 80 mcm.[36] Essent/RWE also has a storage facility in Germany. The state-owned company EBN currently participates in all three of the underground gas storage facilities in the Netherlands. Through the Maatschap Groningen, EBN's interest in the two NAM-operated storages – Norg and Grijpskerk – is 40%. In addition, EBN will have a 40% interest in the Bergemeer storage facility that is currently being developed.
Three new storage projects are currently under development in the Netherlands: two at Zuidwending, and one at Bergermeer. These projects have a combined working volume of 4.58 bcm.[37] At Zuidwending, Gasunie and Nuon plan to make use of depleted salt caverns to provide a flexible response to peaks in demand. Gasunie plans to use five caverns with a total working volume of 300 mcm and will store Groningen gas at the storage facility. Nuon plans to use four salt caverns to store gas and the caverns will have a total storage capacity oThe Bergermeer Gas Storage Consortium plans to invest €800 million in the Bergemeer storage facility which is

[36] Gas Infrastructure Europe, "GSE Investment Database," March 2010, available online at http://www.gie.eu/maps_data/GSE/database/index.html.

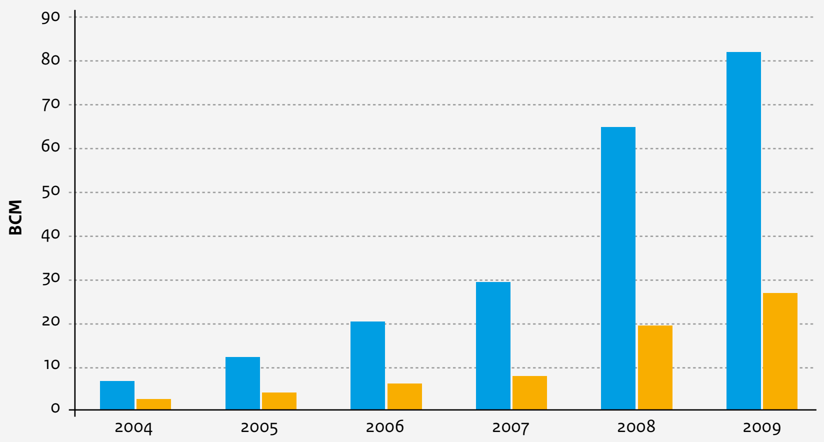
[37] *Ibid.*

expected to be built between 2009 and 2013.[38] The consortium has four partners: TAQA, EBN, Petro Canada and Dyas. Two of the consortium parties are foreign (TAQA and Petro Canada) and these two parties have a share of 48% between them.[39] In effect, the foreign investment in Bergermeer will be around €380 million. This figure excludes the value associated with the large amount of cushion gas which will be provided by Gazprom export. In addition to these new facilities in the Netherlands, Eneco has started construction of gas storage facilities at Epe in Germany that will be connected to the Dutch network. Like the Nuon storage at Epe, the Eneco facilities will make use of former salt caverns. The sites are expected to be completed by 2013 and will have a working volume of around 100 mcm. Eneco has reported that the storage facilities will allow it to better respond to developments in the Dutch market.[40]

2.1.3 Trading & Gas Supply

The Dutch gas transportation system operates using an 'entry/exit' system, whereby shippers acquire entry and exit capacity independently from each other, and do not need to specify a transport route for the gas. This system facilitates the trading of gas which, in the Netherlands, takes place via the TTF. Trading takes place both bilaterally and via the gas exchange, which APX-ENDEX owns and operates. In 2008 market players supplied 20.3 bcm of gas via the TTF, more than double the 2007 volume of 8 bcm and about half of annual domestic consumption. The 65.4 bcm of gas traded on the TTF in 2008 exceeds the Netherlands' annual consumption and had an estimated value of over €15 billion. In 2008 the number of traders active on the TTF rose by 20% to a total of 60. The TTF is currently the most active trading hub in continental Europe, in terms of both the volume traded and the volume physically delivered. By way of comparison, 52 bcm of gas was traded at Zeebrugge in Belgium and 16 bcm was traded on the EGT platform in Germany.[41]

Figure 6: *TTF Traded and Net Volumes*



Notes and sources:

From Gas Transport Service

[38] Gasopslag Bergermeer press release, "Bergermeer Gas Storage Consortium and Gazprom export press ahead with final investment", 09 December 2009, available online at http:// bergermeergasstorage.asp4all.nl .

[39] TAQA, "Bergermeer Gas Storage:right political climate – energy security", 3 November 2009, p. 9.

[40] Eneco presentation "Sustainable energy supply for everyone", 2010.

[41] GTS, "The Security of Gas Supply 2009", July 2009, p. 15.

GasTerra remains the major player in the wholesale market, with a share of between 50-60%, depending on weather conditions.[42] GasTerra is also very active as an exporter on the European gas market, and has import contracts with suppliers from Russia and Norway. GasTerra purchases the vast majority of its supplies from Groningen and the Dutch small fields, but supplements the Dutch gas through these Russian and Norwegian contracts and purchases on the spot market. Russian and Norwegian gas and spot market purchases made up around 14% of GasTerra's purchases in 2009.[43]

GasTerra uses a combination of over-the-counter sales and participation in the APX-ENDEX gas exchanges to sell on its gas supplies. In 2008, GasTerra's sales within the Netherlands equalled 33 bcm, and 63% of this was sold directly to Dutch consumers or suppliers (power stations, industry and retailers). GasTerra offers standard contracts for a range of time periods ranging from daily contracts to annual contracts. GasTerra is also a significant exporter of gas. In 2008 GasTerra exported 51 bcm, mostly under long-term contracts.[44] We provide operating expenditures for GasTerra in Appendix III.
Downstream there are a large number of supply companies (around 30). Four supply companies dominate the market with more than 85% of retail market share: Essent, Eneco, Nuon and Delta. Until recently, all these companies are owned by provinces and municipal governments.[45] The unbundling of energy trading activities and transport allowed Swedish Vattenfall to buy Nuon in July 2009 at a price of €8.5 billion,[46] and German RWE to buy Essent in September 2009 at a price of €7.3 billion.[47] Delta and Eneco remain in public ownership.[48]

2.1.4 LNG Imports

While the Netherlands has no operating LNG terminals at present, the 12 bcm/year Gate Terminal is under construction near Rotterdam. A number of foreign companies – Dong Energy, OMV Gas International, Essent and E.On Ruhrgas – have each taken a 5% share in the terminal. The expected investment cost of Gate is €800 million,[49] which implies a foreign investment of around €160 million. Completion is expected in 2011 and once operating the terminal is expected to employ around 35 staff. The Gate Terminal can technically be expanded to a capacity of 16 bcm/year.

A feasibility study was recently completed with respect to a 12 bcm/year LNG terminal at Eemshaven. The study concluded that there was insufficient basis to arrive at an investment decision, most likely because of the current oversupply of gas in most European markets.[50] A third LNG terminal project near Rotterdam was cancelled last year after there was a lack of interest by industry players. However the project has demonstrated that it would be technically possible to construct another LNG import terminal in the Rotterdam area.

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[42] GasTerra will sell more gas and expand its market share in a colder than average winter, and so its market share varies. The IEA estimates GasTerra's market share as 60% (International Energy Agency (2009), *op. cit.*, p. 63).

[43] GasTerra, "Annual Report 2009", May 2010, p. 24.

[44] *Ibid.*, p. 15.

[45] International Energy Agency (2009), *op. cit.*, p. 63.

[46] See Bloomberg, "Vattenfall Agrees to Pay EU8.5 Billion for Nuon Unit", 23 February 2009, available online at http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aY_K5pNogto4&refer=home.

[47] RWE press release "Essent and RWE complete transaction", 30 September, 2009, available online at http://www.rwe.com.

[48] See RWE, "Annual Report 2009", February 2010, p. 49 and Vattenfall Group, "Annual Report 2009", February 2010, p. 1.

[49] Gate Terminal website, http://www.gate.nl/pagina.php?parent_id=2&pagina_id=8.

[50] Press Release dated September 2nd 2010. See Eemshaven LNG Terminal website, http://www.eemshaven-lng.nl/index.php?id=0&id_taal=2.

2.1.5 R&D

Figure 7 shows our estimate of the level of investment in R&D in the gas E&P industry during the period 2002 to 2006 inclusive. These figures include investment by research and development companies, public research and Universities in the Netherlands.[51] The data is based on information provided by the *Centraal Bureau voor de Statistiek* ("CBS"). CBS did not provide the breakdown between labour costs, other operating costs and investment costs for all years and so for these years we only show the total costs. CBS only provided information on R&D expenditure for a bundled sector called "Mining and Quarrying" which includes gas E&P. We have split the expenditure between gas E&P and non-gas E&P on a pro-rata basis according to revenues. Appendix I provides details of our calculation.

We understand that in the Netherlands, there are different returns to investment between privately funded and publicly funded R&D. This distinction is important as there is an argument to say that R&D funded by the government has no intrinsically immediate value added and will not contribute directly to the overall added value of the gas hub, as it is an input factor. However, according to the PWC report *Monitoring publiek gefinancierd Energieonderzoek* 2007, government funded R&D in oil and gas E&P was only about €6.5 million, so almost all R&D is privately funded and can be counted as contributing toward the value of the gas hub.

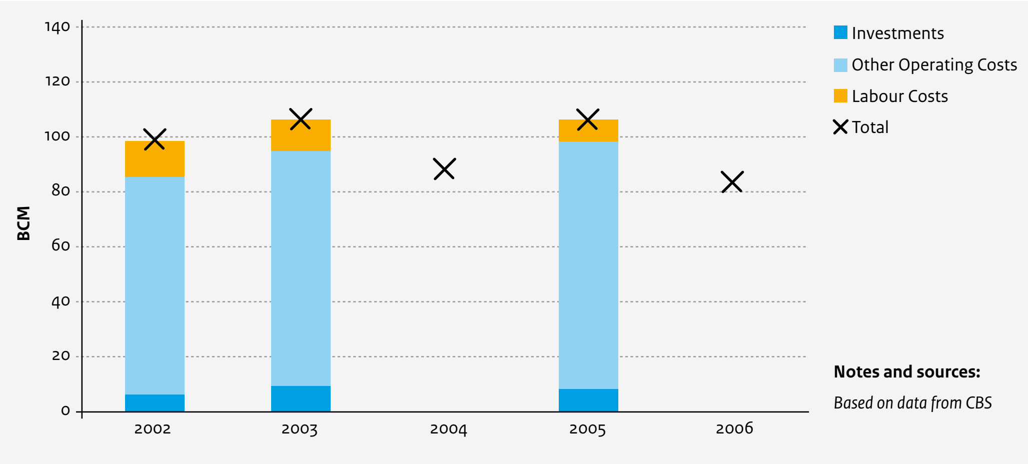


Figure 7: *R&D Capital Expenditure in Gas E&P*

Many institutes in the Netherlands are engaged in gas related R&D, including TNO, ECN, KEMA, and the Energy Delta Institute. Several Dutch universities, such as the Universities of Delft and Groningen, are very actively involved in gas related R&D and have collaborations with the institutions mentioned. The Energy Valley initiative in the north of the Netherlands is the most important of these collaborative R&D efforts, and is also expected to boost investment in gas-industry related R&D. Energy Valley is an initiative of the government, institutions and businesses for the north of the Netherlands to grow into a region with energy-related activities of national and international significance. There are 400 energy-related companies in this region providing 25,000 jobs and 350 development projects, though not all of these jobs relate

[51] The data include companies and research institutions with 10 or more employees.

directly to the gas sector, since they include other forms of energy research.[52] The Energy Valley initiative has a focus on the development of sustainable energy and technologies such as biomass applications, green gas, renewable electricity and sustainable transport. Investment in the production and transport of 'green' gas or biogas is one of the main gas-related focuses of R&D at present. Over the period 2009-2011 investment in green gas R&D is expected to be €240-300 million in total.[53] This number includes funding for demonstration activities, for example biogas production pilots.

2.2 Use of Gas in the Netherlands

The discovery of the Groningen field and subsequent development of a distribution network resulted in gas being the key fuel for the Netherlands. In 2008 the Netherlands had the highest share of gas in primary energy consumption of all the EU27 Member States – gas made up more than 42% of primary Dutch energy consumption, compared to an average of 25% for the EU27.[54] Figure 8 illustrates that the Netherlands has the highest gas penetration rate of EU countries, with almost 100% of households connected to the natural gas network. Figure 9 shows that Dutch gas consumption per head is the highest in the EU by a significant margin.

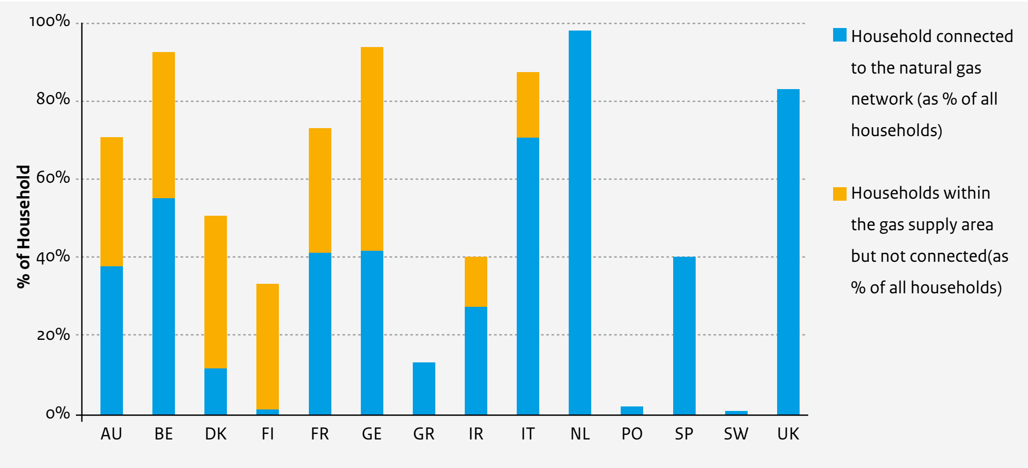
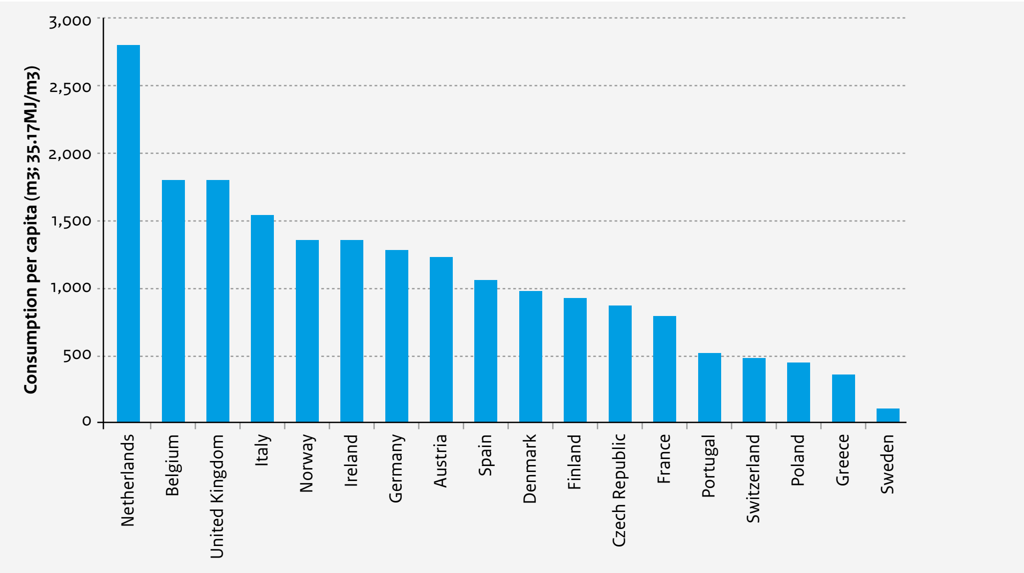


Figure 8: *Households Connected to the Natural Gas Network, and Those Within the Gas Supply Area (Within Economic Reach of a Gas Supply Main) but Not Connected*

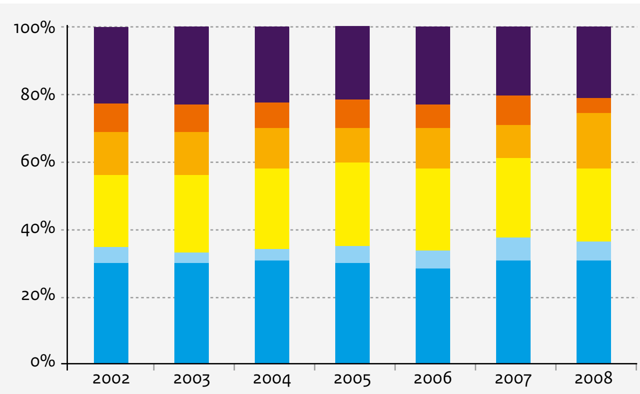
[52] *Creatieve Energie, Energieakkoord Noord-Nederland* and Energy Valley (January 2009), *op. cit.*, p. 2.
[53] *Op cit..*, p. 10.
[54] See Eurogas publication (January 2010).

Figure 9: *Gas Consumption Per Capita in 2008*



Gas demand is currently around 46 bcm per year, although demand from the residential sector especially is highly dependent on temperature.[55] Figure 10 illustrates a break-down of Dutch gas demand by sector. In the Netherlands there are about 18,000 large users and 6.7 million small gas users, of which 6.5 million are households.[56] Just over 30% of natural gas consumption is by power stations while residential customers are responsible for around 20% of the gas consumed in the Netherlands. The remainder of the gas consumption is predominantly by industrial & commercial and agricultural users (see Figure 10).

Figure 10: *Use of Natural Gas in the Netherlands*



Notes and sources:

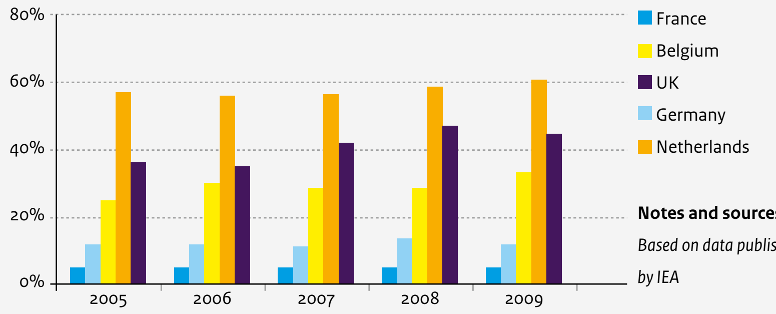
Based on data published by Eurostat

[55] Demand figure from Statline database, *Centraal Bureau voor de Statistiek*.

[56] International Energy Agency (2009), *op. cit.*, p. 62.

Gas is the main fuel used in the Netherlands for power generation. Over the period 2002-2008 more than half of the power generated in the Netherlands was from gas-fired stations (see Figure 11). Coal is the next largest source of fuel for power generation, but has recently generated less than half the amount of electricity as gas-fired generation. Figure 11 shows that during this period, gas-fired generation in the Netherlands made up a greater percentage of power generation than in Germany, Belgium, France and the UK.

Figure 11: *Percentage of Power Generated by Gas*



Notes and sources:
Based on data published by IEA

In future, GTS expects demand in the domestic sector to decrease due to improvements in energy efficiency, while gas demand for power generation and industrial applications will continue to grow.[57] Overall GTS expects gas demand to increase from 47.1 bcm in 2010 to 50 bcm in 2020. Other parties have indicated a decline in the Dutch gas demand between 2010-2020. For example, the Energy Research Centre of the Netherlands (ECN) and the Netherlands Environmental Assessment Agency (PCB) generated their own gas demand forecast as part of a report that examines future energy use in the Netherlands.[58] The report considers a number of scenarios developed in line with the "*Schoon en Zuinig*" (Clean and Efficient) policy programme for energy and climate which was introduced in 2007. The *Schoon en Zuinig* programme sets out a number of targets for the Netherlands for the period 2011-2020. These are a 30% reduction in 1990 greenhouse gas emission levels by 2020, an annual improvement in energy efficiency that is on average 2% during the period 2011-2020, and for the share of renewable energy to be 20% by 2020. One scenario assumed that only established policies were implemented while another scenario assumed that proposed policy measures are also implemented. Under both of these scenarios the total gas demand is expected to decrease.[59] Demand in the household and commercial, agricultural and power generation sectors is expected to decrease while in the industrial sector gas demand is expected to grow.

[57] Gas Transport Services (July 2009), *op. cit.*, p. 6.
[58] The report is entitled "*Referentieraming energie en emissies 2010-2020*".
[59] In the established policies scenario gas demand declined from 40.6 bcm in 2010 to 40.3 bcm in 2020. In the scenario that includes proposed policies, the gas demand decreased from 40.5 bcm in 2010 to 34.7 bcm in 2020. In converting from PJ to bcm we assume 35.17 PJ/bcm.

2.3 The Current Contribution of the Dutch Gas Sector to the Economy

The Dutch gas sector contribution to the Dutch economy can be measured in terms of the goods and services that are produced, in terms of related employment supported and so on. This contribution can conceptually be broken down into three parts:

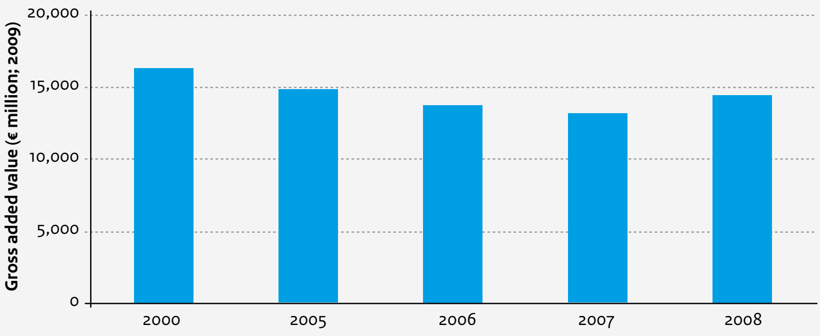
1. Direct contributions given by the total value of output it produces, which is bought by firms in other sectors of the economy, final consumers, the Dutch government and foreign entities.
2. Indirect contributions, given by the impact of the gas industry's spending on other industries' output.
3. Induced contributions, given by the additional effect of household income originating in the gas industry as it impacts the rest of the Dutch economy through additional transactions. When extra spending in the Dutch gas sector occurs, the amount of goods and services produced will increase. At the same time, this extra economic activity will result in some individuals having higher incomes – for example extra wages as a result of longer hours or new hires. Part of this extra individual income will be spent to buy goods and services, which in turn will result in extra goods and services and so on.

To capture these effects we use an input-output model, which captures the flow of transactions within the economy. More details of the model used can be found in Appendix V. We use 2006 Eurostat data to estimate the value of flows between the sectors, and the total output produced by each sector in the Dutch economy. We use 2006 CBS employment by sector data to estimate the employment contribution of the gas sector. More details on these data can be found in Appendix VI.

2.3.1 Direct Contribution to GDP

The Dutch statistical office (CBS) reports estimates of the gross value added from different sectors of the Dutch economy. The CBS does not report an estimate for the gas industry alone nor for different sub-sectors in the gas industry. Instead the CBS reports an aggregate estimate for "Mining and Quarrying" which includes gas and oil E&P, and "Electricity, Gas and Water Supply" which includes the downstream gas sector. We estimated the percentage of the "Mining and Quarrying" sector attributable to gas E&P and used this figure to estimate the gross value added by gas E&P.[60] Figure 12 indicates that the gross value added by the gas E&P sector has been around €14 billion (2009 prices) annually over the period 2005-08.

Figure 12: *Gross Value Added for the Gas E&P Sector (2009 prices)*



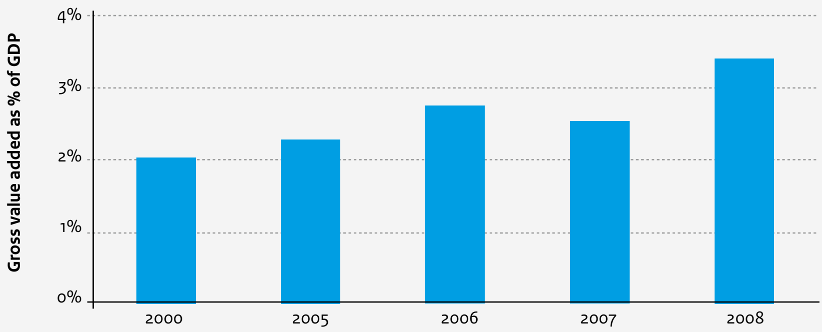
Notes and sources:

Based on data from CBS

[60] We assume that 96% of the Mining and Quarrying sector is gas and oil E&P and allocate 96% of the gross value added to the oil and gas E&P. We then allocate the gross value added between gas E&P and oil E&P on a pro-rata basis according to revenues. Our calculation of oil E&P revenues and gas E&P revenues is shown in Appendix I.

Figure 13 shows the gross value added estimates from Figure 12 expressed as a percentage of Dutch GDP. Although we do not have data for each year, Figure 13 suggests that recently gas E&P accounts for around 2-3% to GDP.

Figure 13: *Gross Value Added for the Gas E&P Sector as % of Dutch GDP*



Notes and sources:

Based on data from CBS

To produce equivalent estimates for the downstream sectors, we used CBS estimates of gross value added for the "Electricity, Gas and Water Supply" industry. While this category includes the downstream gas sector, it also includes the production, distribution and trade of electricity, steam/hot water and water. We estimate the gas component of CBS's "Electricity, Gas and Water Supply" industry is approximately 68%[61] of the reported total or about €7 billion in 2008. This represents around 1% of Dutch GDP. We have also estimated the value-added of TTF trading. We use the trading fee of €0.0075 per MWh of gas traded that APX-ENDEX used until very recently.[62] We multiply this figure by the current volumes traded at the TTF. In 2009, 82 bcm were traded on the TTF. This equates to a revenue of around €6.0 million[63], which we equate to direct value-added. This does not include the economic activity associated with employment generated by the TTF and the value added of, for example, advisory services related to TTF trading. We consider the impact of these activities in section 2.4.

2.3.2 Value of Exports

GasTerra is the main exporter of gas from the Netherlands. A comparison between GasTerra's gas export sales and the amount of gas exported from the Netherlands demonstrates that GasTerra exports the majority of gas from the Netherlands.[64] GasTerra reports that its net turnover from exports was €10 billion in 2009.[65] These exports represent 3% of the value of all Dutch exports in 2009 as Table 5 illustrates. In 2008 the percentage was similar. As highlighted in Figure 14, the value of exports from one year to the next depends strongly on oil prices.[66]

[61] Estimated as the ratio of [2006 Gasunie net turnover from activities in Netherlands + 2006 GasTerra net turnover from gas sales in Netherlands] and 2006 Total Output of Aggregated Sector "Electricity, Gas, and Water Supply". We consider that net turnover is a good proxy for aggregated output. Therefore this method should give a good approximation of the amount the gas sector contributes to gross value added. Note also that we do not use this number in our model – this calculation is simply used to disaggregate the CBS numbers.

[62] We understand that the APX-ENDEX has recently reduced its trading fee to €0.0025 per MWh.

[63] To convert from bcm to TWh we use 9.8 TWh/bcm which is equivalent to 35.17 MJ/m^3. Using this gas quality 82 bcm equals 801 TWh. 801 TWh multiplied by €0.0075 per MWh gives €6.0 million.

[64] In its 2009 Annual Report p. 24, GasTerra reports that it exported 50 bcm of gas in 2009. The Dutch statistical office CBS reports a provisional figure of 1,669 PJ for Dutch gas exports. This is equivalent to 47 bcm for gas with a calorific value of 35.17 MJ/m3.

[65] GasTerra (May 2010), *op. cit.*, p. 53.

[66] The volume of gas exported has remained f€airly constant across the five period 2005-2009 shown in Figure 14.

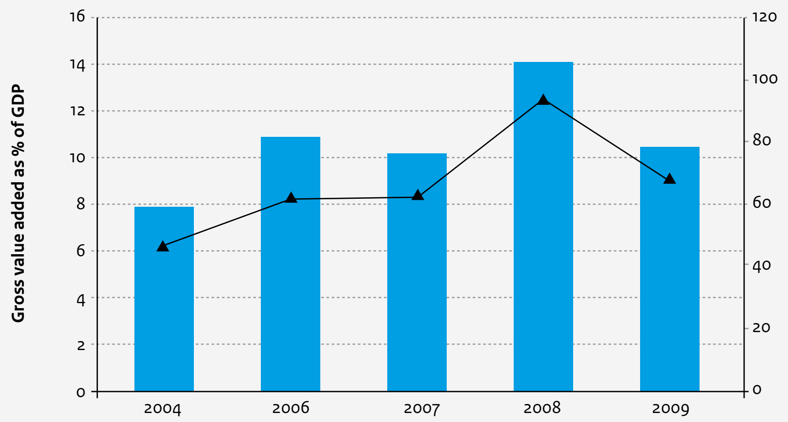
Table 5: *Estimates of Value of Exports*

			2008	2009
GasTerra net turnover from exports (€ mn)	[1]	See note	14,085	10,418
Total value of Dutch exports (€ mn)	[2]	CBS	370,480	309,474
Value of gas exports as % of total exports	[3]	[1]/[2]	4%	3%

Notes and sources:

[1]: GasTerra Annual Report 2009, p. 53.

Figure 14: *Link between Value of Gas Exports and Oil Price*



Notes and sources:

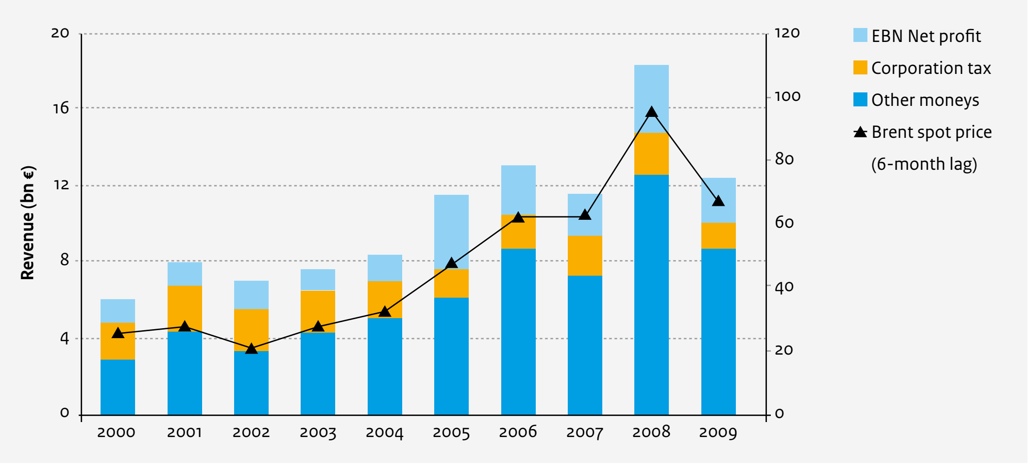
Net turnover figures are from GasTerra's annual reports

2.3.3 Taxes, Royalties & Government Revenue

Like all companies in the Netherlands, companies that participate in natural gas activities will need to pay corporation tax which is currently 25.5%. Production companies also have to pay a royalty equal to 50% of their profit net of corporation tax, although the royalty can be based on a profit that is reduced by 10% of costs. Production license holders also need to pay an annual area fee which was equal to €679 per km^2 in 2009 and onshore license holders incur a severance tax and a pay a fee to the province in which their gas production is located. Through an agreement that has been in place since 1975, the government receives additional income from Groningen production, known as *Meeropbrengsten Groningen*. The amount that the government receives varies with the market price of gas but can range from 80%-90% of net income received by the Groningen producer. The taxes that consumers pay are the regulatory energy tax and VAT. The regulatory energy tax is an environmental tax paid by small consumers with the purpose of reducing CO2 emissions.
The government also receives revenue from gas activities through the state-owned company EBN. EBN has a 40% interest in all production activities and is a partner in five gas-gathering offshore pipelines. Downstream, EBN participates in four gas storage facilities and has 40% interest in GasTerra.

Taxes and other government revenue from exploration and production are the most relevant for this study both because they are likely to be the largest, and because all other taxes would be paid anyway if the same amount of imported gas was consumed. Figure 15 shows the revenues earned by the Dutch government from natural gas exploration and production activities each year during the period 2000 to 2009. We include the taxes and royalties and EBN's profit. Although EBN also participates in downstream activities, we have not separated the profit into upstream and downstream activities and show all of EBN's profit in Figure 15. The revenue increases from €5.7 billion in 2000 to €12.4 billion in 2009. The exact amount of revenue in a particular year is dependent on the gas price which is linked to oil prices. Figure 15 shows how the government revenues from natural gas have followed a similar year-on-year trend to Brent oil prices with a six-month lag.[67]

Figure 15: *Government Revenues from Natural Gas*



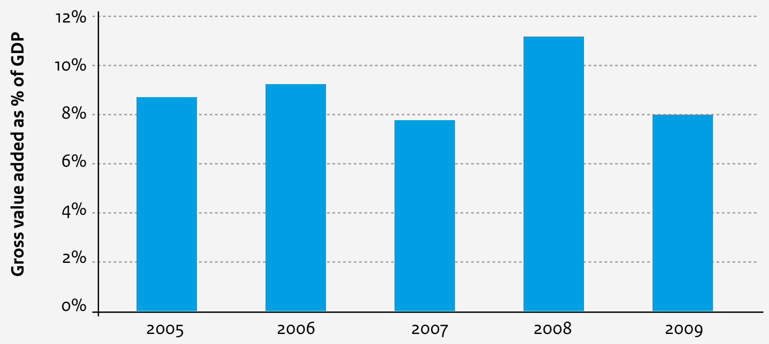
Downstream, government revenues come from both corporate income tax revenues and also EBN's participation in downstream activities. We expect revenues from downstream companies to be notably less than E&P revenues and so have limited our downstream analysis to the main two downstream companies Gasunie and GasTerra. We use these companies to indicate the size of government revenues from downstream companies.

In 2009 Gasunie paid €25 million in corporate income tax. Since Gasunie is 100% state owned, all Gasunie's profits are government revenue. In 2009, Gasunie's profit was €122 million. Together these figures amount to €147 million or 0.1% of central government revenue. In 2009, GasTerra paid €12.9 million in corporation tax and government revenues from its direct participation in GasTerra profit was €3.6 million.[68] Together these are equivalent to 0.01% of cetral government revenue. We would expect the taxes of other gas suppliers and Distribution Network Operators to be even smaller. In total, government annual revenue from gas activities has recently been between around 8-10% of central go

[67] We add a six-month lag because oil-indexed gas contracts are typically linked to the average oil prices over the preceding six months.

[68] GasTerra,(May 2010). The gas price that GasTerra pays NAM, its main upstream supplier, is set so that GasTerra earns the same statutory profit every year. This annual profit is currently pre-set by the shareholders at EUR 36 million. The Dutch government's direct participation in GasTerra is 10%. The state also has a 40% interest in GasTerra through EBN but as this has been included in Figure 15 we do not include it again here.

Figure 16: *Government Revenue from Gas Activities (as % of Central Government Revenues)*

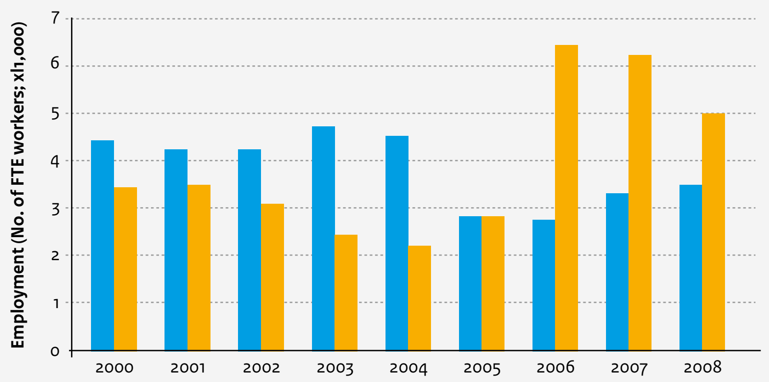


Notes and sources:
From NLOG publication 'Natural Resources and Geothermal Energy in the Netherlands, Annual review 2009', EBN Financial Statements and Eurostat

2.3.4 Employment

Gas Sector Employment
NOGEPA estimates that the Dutch oil and gas E&P sector currently employs over 3,000 people. Similar figures on employee numbers in the Dutch oil and gas E&P are found in the CBS database. From the CBS data we estimate the number of FTE employees directly working in gas E&P in the Netherlands and arrive at a figure 3,500 FTE for 2008 (Figure 17).[69] These numbers are similar to the results from our model of the Dutch economy reported in section 2.4. NOGEPA estimates that about some 10,000 people are employed in engineering companies, suppliers of equipment and construction and installation companies that work in the Dutch oil and gas E&P sector. The vast majority of these employees probably work in the gas E&P sector as the Dutch gas E&P sector is much larger than the Dutch oil E&P sector.[70] In Figure 17 we show our estimate of the number of FTE in services related in to gas E&P which is based on CBS data.

Figure 17: *Number of Workers in Gas E&P and Related Activities*



Notes and sources:
Based on data published by CBS

[69] The CBS only provides data on the number of employees for the oil E&P and gas E&P sectors combined. We allocate the number of employees to oil E&P and gas E&P on a pro rata basis according to revenue.

[70] Our calculations in Appendix I indicate that the revenue generated by the gas E&P sector is much larger than the revenue generated by the oil E&P sector.

Gasunie, which is responsible for the gas transmission network in the Netherlands, had 1,800 employees at the end of 2008.[71] GasTerra, which purchases wholesale gas and sells the gas to consumers or retail suppliers, had 182 employees at the end of 2008.[72] Calculating the number of employees in gas-related positions at the supply/DNO companies is not so straightforward. Many of these companies are active in the electricity industry as well as the gas industry and some are also active in other related areas such as the supply of heat, water and digital services to customers. We have therefore estimated the number of employees at the supply/DNO companies that are employed in gas-related activities. We took the number of employees reported by the companies in their financial statements and allocated these staff to different sectors in which the companies are active. We allocated the staff on a pro rata basis according to either the revenues for the different business sectors or the number of customers/connections, depending on which information was available. We only performed this analysis for the four largest supply/DNOs: Essent, Eneco, Nuon and Delta.[73] We then inflated our estimate for the number of staff in gas-related activities for these supply/DNO companies by 1/0.85 as we understand that these companies are jointly responsible for around 85% of retail sales. We arrived at a figure of around 9,500 for staff working in gas-related positions. Appendix VII shows our calculation.

The Netherlands first LNG facility, Gate, is currently under construction. During construction, it will create around 500 jobs directly and a further 500 jobs indirectly. Once the LNG facility is operational, it will employ 35 staff.[74] Had the Eemshaven LNG terminal proceeded to construction it was expected to employ 60 staff once completed.[75]

There are currently four gas storage facilities in the Netherlands and three more are planned. One of the sites is owned by Gasunie and so staff working at the storage site will be covered by the employment figure we report above for Gasunie. Of the other three storage sites, two are owned by NAM and one by TAQA. TAQA employs 200 people in the Netherlands both directly and indirectly. However, some of these people will work in TAQA's Dutch onshore and off-shore production activities and so will be already included in the figure we quote above for gas E&P. NAM employs around 1,800 staff but like TAQA also has production operations. The number of people employed directly in relation to the storage facilities is a small fraction of the total number of employees that either TAQA or NAM reports. NAM has informed us that ten personnel work at each of its storage facilities although many more contractors will be employed at the sites for maintenance work.

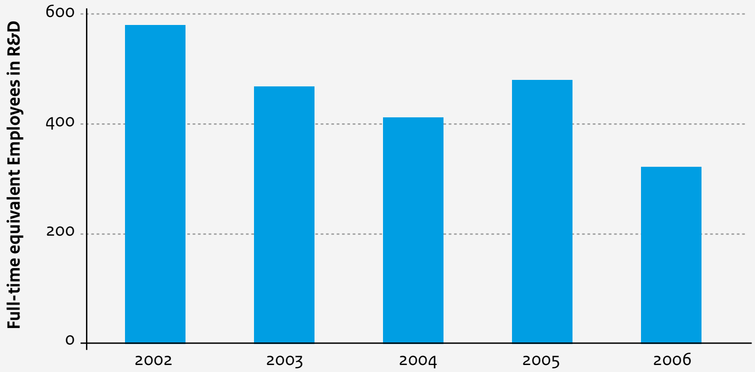
GTS, which is part of Gasunie, operates the gas spot market in the Netherlands, the TTF. APX-ENDEX offers both intra-day and day-ahead trading of gas. APX-ENDEX also offers markets for electricity and markets in the UK and Belgium as well as the Netherlands. We understand from APX-ENDEX that they have a staff of around 80 working in the Netherlands, however, some of the staff will dedicate their time to the electricity exchanges. We estimate that the actual employment figure for APX-ENDEX for gas-related activity in the Netherlands is about half of the total – much less than the staff numbers we report above for other parts of the supply chain.

At the time of writing there were 41 members trading on the APX-ENDEX TTF forward market. Some of these traders will not be very active, and most do not dedicate specific staff to one geographic market – rather, the same traders will be active on several European gas markets and trade between them. However, based on our experience and discussion with traders, it would be reasonable to assume three FTE positions dedicated to gas

[71] 200 of these employees were in Germany. See Gasunie, "2008 Annual Report", March 2009, p. 48.
[72] GasTerra, "Annual Report 2008", April 2009, p. 17.
[73] We used data from 2008 Annual Reports which was before Vattenfall bought Nuon and RWE bought Essent.
[74] Gate Terminal website, http://www.gate.nl/pagina.php?parent_id=2&pagina_id=8.
[75] This information was from the Eemshaven LNG Terminal website. The information has since been removed.

trading in the Netherlands, including back-office and support staff. This implies about 120 FTE staff dedicated to Dutch gas trading. We estimate that the part of the R&D sector that is related to gas E&P employs around 330 staff (Figure 18).[76] These include researchers, assistants and other staff.

Figure 18: *Employment in R&D Related to Gas E&P*



Notes and sources:

Based on CBS data for company/institutes with 10 or more working personnel

2.4 Estimated Total Effect on Employment and the Economy

The previous section described in detail the direct contributions that the Dutch gas sector makes to the economy. To estimate the current direct, indirect, and induced effects of the gas sector, we have developed an 'input-output' model of the Dutch economy. The model is based on Eurostat data on purchases and sales of goods and services in each sector of the economy. For each sector of the economy, we construct 'output multipliers'. Each sector-specific output multiplier shows the change in total output of each sector that results from a one unit change in the final demand of that sector. The direct, indirect, and induced output contribution of the gas sector is then estimated based on the output multipliers and the size of the gas sector. We describe the input-output model in detail in Appendix V and Appendix VI.

We have identified three broad categories of economic activity which match the existing CBS employment accounts categories which would include gas sector-related firms:

1. "Mining and Quarrying of Energy Producing Materials"
2. "Electricity Gas and Water Supply" and
3. "Research & Development".

The direct, indirect, and induced employment effects are based on the relationship between employment in an industry and the output of that industry, on the flow of transactions between industries, on the household income generated by each industry, and on how that household income is spent across different sectors. More details on the calculation can be found in Appendix VIII. Table 6 below summarises the

[76] The CBS only provides data on the number of employees in Research and Development for the whole of the "Mining and Quarrying" sector which includes gas E&P. We allocate the number of employees to different parts of the "Mining and Quarrying" sector on a pro rata basis according to revenue as described in Appendix I.

results of the impact of the Dutch gas sector, by the three aggregated sectors, on the Dutch economy. (Note that this analysis is not directly comparable to the analysis of the Gas Hub scenarios presented later in this report.) Our calculations indicate that the Dutch gas sector supports over 66 thousand FTE jobs, and contributes about €17 billion per year toward Dutch GDP, or about 3% of Dutch GDP.

Table 6: *Current Size and Labour Impact of Natural Gas on Dutch Economy*

Natural Gas Sector	Sector Total Output	Sector Final Demand	Jobs			
			Direct	Indirect	Induced	Economy Wide
	Mil Euros	*Mil Euros*	*FTE*	*FTE*	*FTE*	*FTE*
Exploration and Prodcution	€ 15,519	€ 8,209	2,752	7,504	6,001	16,257
Transmission / Distribution	€ 25,459	€ 8,433	8,298	23,890	16,922	49,110
Research & Development	€ 90	€ 68	502	108	416	1,026
Total	**€ 41,068**	**€ 16,710**	**11,552**	**31,503**	**23,338**	**66,394**

Notes and sources:

[1]: Exploration and Production Total Output is the 2009 Gas Production (see Appendix I).

[2]: Transmission / Distribution Total Output is the 2008 Gasunie Net Turnover plus the GasTerra Net Turnover, from CBS.

[3]: Research & Development Total Output is the annual average Gas R&D over 2009-2011.

From brochure "Innovatieregio Energy Valley" of January 2009.

[4]: Total Output and Final Demand in € millions, job in full time equivalent.

[5]: Final Demand is calculated based on the ratio of Final Demand to Total Output in the 2006 Eurostat data and the estimated Total Output.

[6]: Calculations based on The Brattle Group model, based on 2006 Eurostat and CBS data and represent estimates for 2008/2009.

These numbers are presented by sector in Appendix VIII.

2.5 The Dutch Gas Sector and Security of Supply

The Dutch gas sector is not only noteworthy for what it brings to the Dutch economy, but also for what it takes away – in this case, the risk of supply disruptions. Countries that rely heavily on imports, or have a limited diversity of supply sources are vulnerable to supply disruptions. The gas supply disruptions caused by the dispute between Russia and Ukraine in January 2009 provided a stark illustration of the vulnerability of some countries at the eastern edge of the EU to gas supply disruptions, where countries such as Bulgaria and Macedonia experienced a 100% loss of gas.[77] The presence of indigenous gas in the Netherlands ensures that the country and its neighbours in north-west Europe are not vulnerable to such supply disruptions. Increasing security of gas supply is one of the key objectives for the gas hub strategy according to the Government report.

The Dutch E&P sector, combined with LNG imports and a diverse range of other import sources of gas means that the Netherlands has a very high level of security of supply, and can consequently avoid the problems outlined above.

[77] For more details see Aleksandar Kovacevic's paper, 'The Impact of the Russia–Ukraine Gas Crisis in South Eastern Europe', Oxford Institute for Energy Studies, March 2009.

A typical test of security of supply is the 'N-1' test. A system passes the N-1 test if it can still meet demand after the largest source of gas supply is removed. The N-1 concept has been borrowed from electricity where it is typical to have sufficient operating reserves to cover the failure of the largest plant that is operating at any point in time. Transmission network operators also plan their use of the transmission grid to ensure that the failure of any one line does not trigger a wave of blackouts.

Although Groningen has the largest production, it in fact comprises a number of different production facilities. It is very unlikely that all these facilities will be out of operation at the same time. Therefore the Grijpskerk storage facility would be the largest single outage under a Dutch N-1 analysis. We find that even if there were an outage at this supply point, the Dutch gas system would still be technically able to meet demand and would have a supply margin of at least 30% on an hourly basis (see Table 7). Note that these numbers are based on technical capacity. Unlike in GTS's report "The Security of Gas Supply 2009", we do not consider the contractually available volumes of gas.

Table 7: *N-1 Analysis*

Peak demand in Neherlands (mcm/h)	[1]	See note	22.5
Groningen production capacity (mcm/h)	[2]	See note	14.6
Small fields production	[3]	See note	5.7
capacity (mcm/h)			
Import points (2008 technical capacity; mcm/h)			
Emden EPT	[4]	See note	1.45
Emden NPT	[5]	See note	0.76
Oude Statenzijl (EGT)	[6]	See note	0.93
Oude Statenzijl (GUD-H)[OBEBH)	[7]	See note	0.14
Oude Statenzijl (Wingas-H)	[8]	See note	0.13
Oude Statenzijl Renato (EGT)	[9]	See note	0.59
Zelzate	[10]	See note	0.40
Withdrawal Capacity at Storage Sites (mcm/h)			
Grijpskerk	[11]	See note	2.3
Norg	[12]	See note	2.3
Maasvlakte	[13]	See note	1.3
Alkmaar	[14]	See note	1.5
Total supply capacity (mcm/h)	[15]	Sum [2] to [4]	32
Largest supply point (mcm/h)	[16]	[12]	2.3
Total supply capacity without largest point (mcm/h)	[17]	[15]-[16]	30
N-1 supply margin	[18]	[17]/[1]-1	32%

2.5.1 Security of supply: a case study from the UK

Gas supply disruptions can have significant economic consequences, and so reducing the probability of a supply disruption is highly desirable. Because it is under going a transition from a gas export to a gas importer, the UK has grappled with security of supply issues over recent years. The UK can provide an interesting case study of the effects of a gas supply crisis, and by implication the benefits of having plentiful supplies of gas to avoid such situations.

A 2006 study for the UK's Department of Trade and Industry examined the effect of gas supply disruptions of varying durations to the industrial sector.[78] The study estimated that a three week emergency interruption of gas supply to industry would cost the economy between 0.18% and 0.81% of GDP. This may not sound dramatic, but it is sufficient to significantly reduce economic growth in most years. The study also highlighted that such an interruption could have longer term economic consequences. If customers switched to imported substitutes this could cause a long-term decline in market share for domestic energy intensive industries. Several sectors such as glass and steel manufacture could suffer equipment damage if they were forced to shut down production. The study estimated that in the UK the energy intensive industry employs around 400,000 people and a further 1 million in downstream industries. Some of these jobs would be put at risk by an extended gas-supply disruption.

Security of supply not only relates to a loss of gas supply, but a loss of gas supply at a 'reasonable' price. For example, the UK experienced rising winter gas prices in the winters of 2004/05 and 2005/06 especially. Ofgem, the GB energy regulator, estimated that GB gas costs increased by £3.5 billion, and that industrial customers bore about £1 billion of the increase.

The key concern was not only high gas prices, but high gas prices relative to other European countries. Energy intensive industries are vulnerable to gas-price shocks for two reasons. First, energy intensive industries tend to make commodities which are internationally traded. For example a report examining high gas prices in the UK noted that energy intensive industries such as steel and glass-making were more open to international trade than the average over all sectors.[79] If an industry competes internationally, it will find it difficult to pass on cost increases which its foreign competitors have not experienced. In the UK, glass companies reported cost increases for gas of 40% between 2004 and 2005, and steel manufactures experienced increases of 42%.

Second, energy intensive industries tend to make commodities with relatively low profit margins. Therefore even a small increase in costs can have a large effect on profits. The study cited above estimated that in the UK the gross operating margin of all firms in the economy was 16%, the average gross margin across the energy intensive sector was only 8%.

The UK experienced the impact of significant supply disruption in 2006 when one of its major storage facilities ceased operation for several months following a fire. The outage appeared to have a significant effect on prices, with both high and particularly low prices witnessed on the NBP. During March, the intra-day price swung from a low of 18p/therm (€7.7/MWh) to a high of 255p/therm (€109/MWh) within a week.[80] Day-ahead prices for March varied from 40.25 to 215p/therm and contracts for Winter 2006 were consistently over 80p/therm during mid-March-mid-June after being at 72.5p/therm at the beginning of March.

The 2006 DTI study estimated that 'voluntary' curtailment of gas use by industry due to high prices for 60 days could cause a loss of GDP of between 0.04% and 0.16%. The value of the curtailed gas would be

[78] Ilex Energy Consulting, "Economic Implications of a gas supply interruption to UK Industry – a report to DTI", January 2006.

[79] Europe Economics, "The Impact and Possible Causes of the Rise in Wholesale Gas Prices", 24 November 2004.

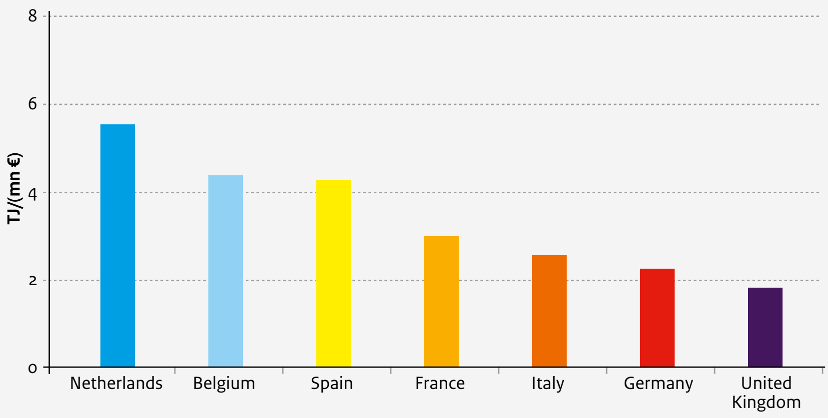
[80] Converted using 1.25 €/£.

between €96/MWh and €417/MWh,[81] far higher than the price of gas has ever reached in Europe to date. The implication is that high gas prices could force industry to make 'savings' that create a net cost for the economy as a whole. By promoting a strong gas hub,, the Netherlands can ensure that it has access to plentiful supplies of gas and that investments are made in a timely fashion. This should help avoid the problems which the UK has experienced.

2.6 Other Benefits of the Dutch Gas Sector

One aspect that is not picked up by the economic modelling in section 2.3 is whether the Dutch gas sector has encouraged more energy intensive industries to locate and/or grow in the Netherlands. For example, gas intensive industries such as steel and glass manufacture could have been historically attracted to locate in the Netherlands because of the supplies of relatively cheap and secure gas.
To check for this effect, we have examined the ratio of gas consumption by industrial customers to industry output for the major economies of the EU. A high volume of gas consumed relative to output could indicate a more gas-intensive energy industry. Figure 19 shows that compared to other major EU economies, the Netherlands has a high ratio of gas consumption by industry to industrial gross value added suggesting that the Netherlands is more gas intensive than the EU overall.

Figure 19: *Ratio of Industrial Gas Consumption to Industry Gross Value Added*



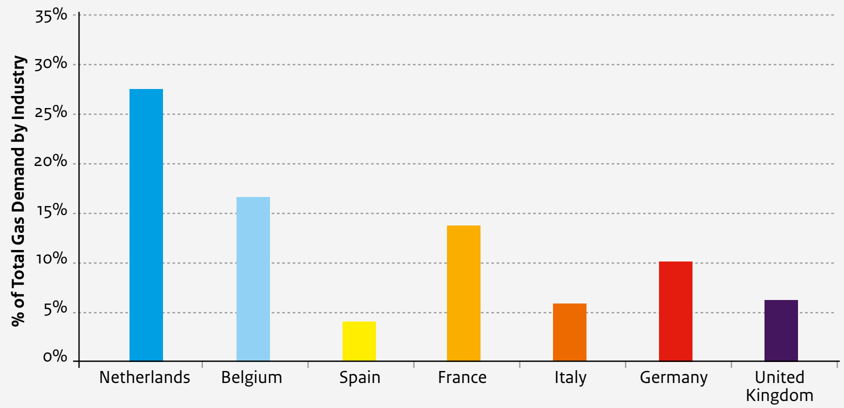
Notes and sources:
Based on Eurostat and Eurogas data

While the ratio of industrial gas consumption to output is useful as a first check, it does not tell the whole story. For instance a country may have a high ratio because it has a high percentage of gas-intensive industries, or it might have a high ratio because the country has relatively low industrial output. It is hard to tell which of these is true by just looking at the ratio. For this reason, we have taken a further look into whether more gas is used in industrial processes in the Netherlands than in other countries. Eurostat provides data on the amount of gas used for "non-energy purposes". Non-energy purposes means the use of gas as a feedstock in chemical processes. Figure 20 shows the gas used for non-energy purpose as a

[81] Converted using 2006 exchange rates.

percentage of the total gas consumed by industry for a number of major EU economies.[82] The data shows that in the Netherlands a higher percentage of gas is used in industrial processes. This further supports the presumption that the Netherlands has a gas-intensive industrial base.

Figure 20: *Industrial Consumption of Gas for Non-Energy Purposes*

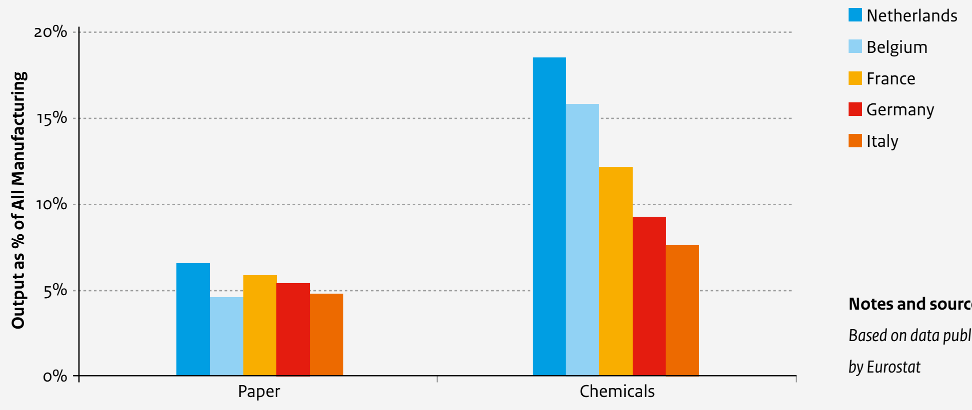


Notes and sources:

Based on data published by Eurostat

Another type of data that Eurostat provides is the output for different types of manufacturing industries. This data covers both the chemicals and paper manufacturing industries. Figure 21 shows that in the Netherlands paper and chemicals industries make up a greater proportion of the output from manufacturing industries than in other countries in north-west Europe. Data in Figure 21 is for 2008 except for data for Germany which is for 2007.

Figure 21: *Output by Gas-Intensive Industries*



Notes and sources:

Based on data published by Eurostat

[82] We have excluded the agriculture sector from the total industrial demand because the Netherlands has a significant greenhouse industry where gas is used for heating.

3 The Strengths and Weaknesses of the Gas Hub Strategy

The previous part of the report highlighted the current contribution of the Dutch gas sector to the economy, and the influence it has had on industry in the Netherlands. In the second part of our study, ELI have asked us to analyse the strengths and weaknesses for the Dutch gas hub concept, as well as identifying possible opportunities that that arise from the gas hub policy and threats to the policy – a so-called SWOT analysis. One important issue to consider is competition with neighbouring hubs, and in particular whether a Dutch gas hub would compete with, or be complementary to, gas hubs in neighbouring countries.

3.1 The Dutch Gas Hub Strategy

In October 2009, the Dutch Government submitted a report outlining its strategy to transform the Netherlands in a north-west European gas hub.[83] The report describes the Netherlands as a 'gas junction' in the international transport of gas and as a distribution centre for gas in north-west Europe. The paper also notes that the gas hub strategy will promote the commercialisation of the expertise and experience present in the Dutch gas sector with respect to gas exploration, production, storage, transport, trading and the integration of green gas. The Government report described a successful Dutch gas hub as consisting of a situation in which:

- There would be substantial domestic and foreign investment in the Dutch gas sector. The Netherlands would be a transit route of first choice, and as a result there will be substantial investment in gas pipeline infrastructure.
- The Netherlands imports and then re-exports (or uses) large volumes of LNG to the rest of Europe. This, combined with investments in pipelines, should increase security of gas supply;
- Export of flexibility to neighbouring markets. The Netherlands will be an attractive place to develop gas storage projects, which will export seasonal peak gas demand to other countries;
- A liquid gas trading hub, with relatively large volumes and where prices are robust and trContinuing R&D initiatives – the Netherlands is recognised as a world-class gas-related R&D base, and there is substantial investment in this sector.

In the report, the Dutch government present eight strategy areas which form part of its Gas Hub action plan. The eight areas are:

1. Co-operating with industry – This component envisages establishment of a Gas Hub Consultative Platform which has responsibility for facilitating development of the Gas Hub.
2. Promoting optimal operation of market forces and integration of the north-west European gas market – This component supports the move towards a north-west European gas market where TSOs coordinate operations and cooperate to deliver security of supply, where legislative and regulatory impediments to a successful market are eliminated, and where cross-border investments are attractive.

[83] Government report p. 5.

3. Using domestic sources of energy – This component will focus on initiatives to encourage development of marginal off-shore gas fields and the use of green gas.
4. Promoting investments – This component relates to investments in the transmission network, storage facilities and LNG facilities as well as international acquisitions and investments.
5. Pursuing "gas diplomacy" – This component intends to focus on strengthening relations with relevant gas producing countries.
6. Promoting international entrepreneurship – This component involves initiatives to promote foreign investment in the Dutch gas market such as economic diplomacy and ensuring a level playing field within the Netherlands.
7. Enhancing the knowledge structure – This component envisages development of a strong knowledge infrastructure in the Netherlands through cooperation between the Dutch gas sector and knowledge institutions.
8. Monitoring – This component involves two actions: monitoring security of supply and monitoring the economic dimension of the Gas Hub.

All of these actions could have a positive impact on the Dutch economy. However, we do not consider the impact of all of the Dutch Government's strategy actions. We focus only on the most tangible and measurable features of the gas hub strategy. For instance, gas diplomacy may be an important part of a gas hub strategy but it would be highly speculative to assign a value to it as part of the economic impact of the gas hub strategy. Instead our analysis focuses on investments that form part of the gas hub strategy such as investment in new transmission capacity, storage capacity and LNG facilities. We also consider the impact of increased trading and development of gas-related research and development.The description of a successful Dutch gas hub is consistent with many of the investments already being undertaken in the Dutch gas market. We imagine a market that imports LNG and then re-exports it or uses it in the domestic market. The Netherlands first LNG facility, Gate is currently being built on Maasvlakte in Rotterdam. Further LNG facilities in the Netherlands have also been considered. Our successful Dutch gas hub vision also imagines that the Netherlands will export gas to meet the demand for flexibility in other countries. Three new gas storage facilities, two at Zuidwending and one at Bergermeer, are currently being built in the Netherlands. Many of the features of a successful Dutch gas hub are complementary and form a virtuous circle. For example a large volume of LNG and transit gas will likely promote liquidity and trading at the TTF, as importers adjust their positions in the market. A liquid TTF will in turn attract more LNG imports and transit gas, because market parties will be confident of the ability of the TTF to absorb any excess gas they have, and multiple transit routes create options for trading and exporting gas. Nevertheless, the strengths and weaknesses of the Dutch transit regime will differ from, for example, the strengths and weaknesses of the gas trading hub. Accordingly, we perform a separate SWOT analysis for each of the elements of the gas hub trategy identified above.
Ultimately, the success of the gas hub strategy will hinge on the perceptions of market participants. It is market participants who will decide – either by equity shares or through long-term contracts – whether or not to buy long-term transit capacity or invest in LNG re-gas capacity. To gain some insights into the perceptions of market players we have undertaken a number of interviews with large multi-national firms who are active in gas trading in the Netherlands, other markets in Europe and indeed around the world. The results of these interviews feed into our analysis.[84]

[84] We discussed the issues regarding the Dutch gas hub, and in particular the attractiveness of the Netherlands as place in which to invest in gas infrastructure, with BG Group, BP, and one other large gas trader and producer which preferred not to be named. We also discussed the storage issues with a storage developer in the Netherlands.

3.2 Transit Gas Flows

The Netherlands has already been successful in attracting transit flows, and recent 'open season' processes by Gas Transport Services (GTS) have demonstrated continuing demand for transit capacity.[85] GTS has also been part of the 'link4hubs' initiative which involves day-ahead trading of capacity between three different TSOs. This should in turn facilitate cross-border trading and transit.
As GTS acknowledges in its quality and capacity report, the future demand for transit capacity depends very much on the future balance of supply and demand in north-west Europe. In particular, declining domestic production in the UK, the Netherlands and to a lesser extent Germany will increase the need for imports and have an effect on Dutch transit flows. Therefore as a first step in considering the Dutch gas market's strengths and weaknesses in maintaining and expanding its share of transit flows, our analysis must recognise the physical limits of the Netherlands geographic position. Put simply, for the Netherlands to become a 'gas roundabout' it is important that it is roughly in between the source of gas and the destination of gas. To understand which other routes the Netherlands might be competing with, we must have an understanding of the likely gas flows in north-west Europe in the next 10 or so years.
To this end we have performed gas supply and demand balances for the Netherlands, Belgium, France, the UK and Germany. As a result of this analysis we have identified some of the key transit routes for the Netherlands and the risks involved. The key transit routes that will determine pipeline investments in the Netherlands are:

- Flows from Norway and Russia via the Netherlands to the UK;
- Flows from Norway and Russia via the Netherlands to Belgium and France.

In the following sections we illustrate that variations in demand from the UK, France and Belgium and the pattern of transit flows to these countries will have a large effect on the need for pipeline investments in the Netherlands.

3.2.1 Transit flows through the Netherlands to the UK

The UK gas market is already importing large volumes of gas, and imports are expected to increase quite quickly in the future. The increase in UK gas imports will have important consequences for the role of the Dutch gas roundabout, since the Netherlands could become an important route for transit flows to the UK. However there are clear rivals to the BBL interconnector for the additional UK imports.
Historically, production at the UK Continental Shelf (UKCS) has supplied much of the demand in the UK. In 2000/01, UKCS production was sufficient gas to meet all of UK demand.[86] However, UKCS production has already started to decline. In 2008/9, UKCS production was only 65% of demand.[87] National Grid has provided a range of forecasts for UKCS production with the assistance of other parties (see Figure 22).[88]

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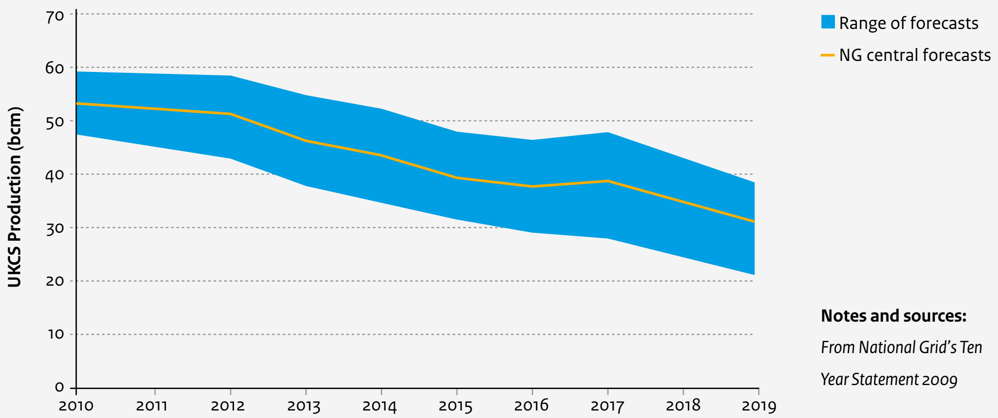
[85] In July 2007 GTS began an open season process for new capacity in 2012. From this open season demand emerged for capacity to serve both foreign and domestic customers, and GTS decided to proceed with the expansions in several phases. GTS approved around 100 km of new gas pipeline investments for phase I in 2008. GTS will decide on phase II later in 2010.

[86] National Grid's "Ten Year Statement 2009", December 2009, Figure 4.8G. We subtracted exports from demand using the numbers in Figure 4.2A.

[87] *Ibid.*

[88] National Grid uses data collection and analysis facilitated by the UK's offshore producer association, Oil & Gas UK as the basis for its forecasts. National Grid, "Ten Year Statement 2009", p 50. National Grid also cites the UK Department of Energy and Climate Change and the UK Office of National Statistics in Figure 4.3 which shows forecasts of gas reserves and production.

Figure 22: *Forecasts for UKCS Production*



Notes and sources:

From National Grid's Ten Year Statement 2009

The forecasts show that UK gas production is expected to decline. However the level of production in 2020 is variable among the forecasts. Under its central forecast, National Grid expects UKCS production to be 30 bcm in 2018/19. Based on the decline in previous years, we estimate that this will drop to 26 bcm in 2020. Our comparable figure for the high-end of the forecast range is 36 bcm or 10 bcm higher.

The fall in production means that the UK will need to import increasing volumes of gas to meet demand. The UK currently relies on imports from a number of sources, including the BBL interconnector as well as the Interconnector UK (IUK) pipeline from Zeebrugge to Bacton. Additional imports through the BBL interconnector would mean more transit flows through the Netherlands if the gas originated from Norway or Russia. Flows through IUK could also transit through the Netherlands.

While there are prospects for the UK's growing gas imports to increase transit flows across the Netherlands, our analysis also shows that there is a high degree of variability in UK imports depending largely on UK gas demand, indigenous UK gas production and LNG imports among other factors. There is a particular uncertainty over the future level of LNG imports into the UK. National Grid's low and high forecasts for LNG imports vary by almost 30 bcm in 2018/19 which is around one-third of demand. Part of the uncertainty is because the UK has no long-term LNG contracts in place.[89] National Grid is also expecting Norwegian imports to increase by 2019, but only by around 5 bcm. However, National Grid also recognises that Norwegian imports may increase by more than this amount. National Grid shows that Norwegian supplies may also be 8 bcm higher than its base case value in 2018/19. The UK is also expecting to become a producer of biogas. However, we do not consider UK biogas production to have a material effect on required imports as the expected production is around only 0.4 bcm in 2018/19.[90]

[89] National Grid's publication (December 2009), *op. cit.*, p. 14.

[90] *Ibid.*, Figure 4.8G. However, in a separate study, National Grid's parent company has noted the potential for UK biogas production could be as high as 5-18% of UK demand by 2020. We cover this possibility with our consideration of a 'green' UK gas demand scenario, where various environmental policies reduce demand for natural gas.

The most optimistic case – from the point of view of Dutch transit – is if UK Continental Shelf (UKCS or offshore) production, LNG imports and Norwegian gas imports were all lower than expected, with IUK and BBL taking a larger share of the UK market. Based on the range of UKCS production forecasts shown in National Grid's Ten Year Statement, we estimate that UKCS production could be nearly 9 bcm lower in 2020 than in National Grid's central forecast. We also estimate that LNG imports could be as low as 9 bcm in 2020, 19 bcm lower than in National Grid's base case scenario, and that Norwegian imports could be 25 bcm lower in 2020 than National Grid's base case forecast. Combined, this results in an additional demand of 53 bcm by 2020 that would need to be served from continental imports via BBL and IUK. Assuming that half the IUK volumes were transited through the Netherlands, this would result in an increase in transit flows through the Netherlands to GB of almost 40 bcm/year by 2020.

At the other extreme, the UK could well end up having a surplus of supply, especially if demand grew at a slower rate than expected. In the National Grid's 'Gone Green' scenario, which assumes that the EU's 2020 targets for renewable energy are met, efficiency measures, low carbon forms of power generation and renewable technologies such as heat-pumps all reduce natural gas demand. Increasing biogas production could also cause a drop in natural gas demand in the gone green scenario. We estimate that gas demand forecast based on the Gone Green scenario will be 12 bcm less than in National Grid's Base Case Scenario in 2020, or 77 bcm.[91] The UK Government has also considered similar scenarios. The UK Government's Low Carbon Transition Plan states that various energy efficiency measures and reduced use of gas-fired electricity generation will reduce UK gas demand by 29% in 2020 to around 66 bcm, 6 bcm[92] less than National Grid's Gone Green scenario.[93]

A combination of low demand, high UKCS production, high LNG imports and high Norwegian imports would see the UK *exporting* over 38 bcm/year of gas. Some of this gas would flow through the IUK Belgium, but significant volumes could flow through the Netherlands to Germany and other markets. While the BBL does not at present have the capacity to flow gas in the direction from the UK to the Netherlands, this could be changed in the future, especially if a surplus of gas emerged in the UK.

Of course, in reality such a scenario seems highly unlikely – if UKCS production was higher than expected, it would likely back-out LNG imports and Norwegian gas flows. It is not clear why gas marketers would ship gas to the UK when gas demand was relatively low, just to re-export it to the continent. Perhaps this could happen if there was a shortage of LNG terminal capacity on mainland Europe, but this seems unlikely given the terminals under development. Norwegian gas has several options to export gas by pipeline to continental Europe. Nevertheless, this scenario is interesting because it indicates the swing that is possible in Dutch transit flows given the variables of the UK supply and demand.

A less extreme scenario involves looking at National Grid's base case scenarios. In some ways this is a worse scenario for Dutch transit flows than either of the two scenarios described above, since in National Grid's base case supply and demand is relatively balanced, with only 0.1 bcm coming from IUK and BBL by 2020.

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[91] This figure represents UK demand and exports to Ireland.

[92] We have reduced our 2020 forecast for the Gone Green scenario of 77bcm by 5bcm to account for exports to Ireland.

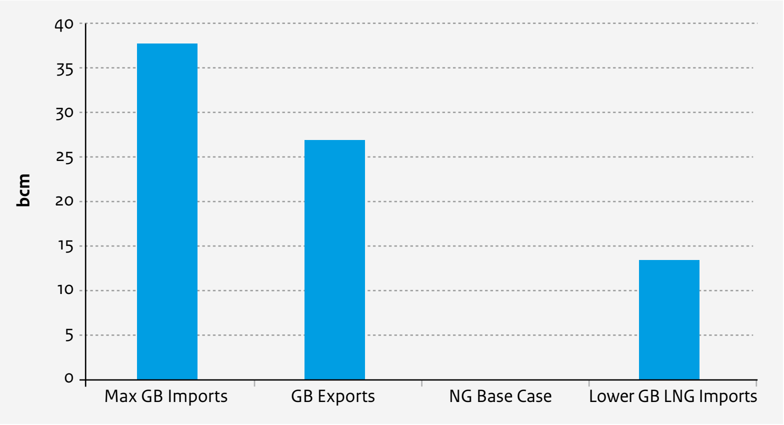
[93] Department for Energy and Climate Change, "The UK low carbon transition plan – national strategy for climate and energy", 15 July 2009, p. 103.

The reason is that National Grid assumes that almost all of UK imports will come from either LNG or Norway, in roughly equal measure. Under National Grid's base case forecast, LNG supplies increase substantially between 2010 and 2019 to reach 25 bcm in 2018/19.[94] Of the 26 bcm increase in supply that is needed for the UK, National Grid assumes that only around 2 bcm will come through the BBL interconnector.[95] Clearly, this would be detrimental the ambitions of the Dutch Gas Hub.

We note that Gasunie's current long-term forecast for Dutch gas supply and demand assumes that no gas will be exported to the UK via the BBL interconnector in 2020. However, we understand that this is because Gasunie's forecasts are based on current contractual arrangements and that as yet no long-term contracts for BBL exports have been signed. The lack of long-term contracts does not mean that Gasunie believes that additional BBL exports and the accompanying transit flows will not happen.

An alternative, but plausible scenario is that the UK's LNG imports could be lower than National Grid's base case forecast. We estimate that this would result in a reduction in LNG flows relative to the base case of over 19 bcm/year in 2020, which would instead be imported via IUK and BBL. While imports via BBL imports are currently quite low,[96] there is scope for additional imports via the BBL interconnector. In 2008/9, 6.4 bcm of gas supplies were imported to the UK via the BBL interconnector.[97] This is around 40% of the BBL capacity which is currently 16 bcm per year and is expected to increase to 19.2 bcm by the end of this year.[98] Assuming that the imports flowed in proportion to the capacity of the BBL and the IUK, and that 50% of volumes flowing to IUK went via the Netherlands, with lower imports of LNG Dutch transit flows to the UK would be 13.8 bcm in 2020. Figure 23 summarises the transit flows in the four different scenarios we have considered: maximum GB imports; GB exports, NG base case and lower GB LNG imports. We provide the assumptions behind each of these scenarios and the related gas volumes and transit flows in Appendix X.

Figure 23: *Alternative Transit Scenarios (Supplies to/from GB)*



[94] National Grid's publication (December 2009), *op. cit.*, Figure 4.8F.

[95] *Ibid.*, Figure 4.8G.

[96] Only 7% of UK's gas supplies in 2008/9 arrived via the BBL pipeline. See National Grid's "Ten Year Statement 2009", Figures 4.8D and 4.8G.

[97] National Grid's publication (December 2009), *op. cit.*, Figure 4.8D.

[98] See Reuters, "UPDATE 1-Dutch-UK BBL gas pipe to flow 19.2 bcm/yr by 2011", 19 August 2008.

We have presented a number of different scenarios which highlight both the opportunities and risks associated with additional transits through the Netherlands to supply the UK. LNG imports, imports from Norway and uncertain demand linked to environmental policies present the greatest variables to Dutch transit flows.

3.2.2 Transit flows from Russia/Norway/Germany to France and Belgium

Another potential source for additional transit flows through the Netherlands is supplies from Norway and Russia to Belgium and France. Belgium and France will require gas from new sources for two reasons. First, demand in the two countries is expected to increase by 2020.[99] While demand forecasts vary, some forecasts expect demand to increase by as much 11.2 bcm.[100] Second, the UK's ability to supply gas via IUK is declining. Currently Russian/Norwegian gas makes up around 39% of gas supplies to Belgium. Russia currently supplies around 6% of Belgian gas, but this is expected to increase to 16% by 2020. Norwegian supplies to Belgium are expected to remain constant over the same time period.[101] The increase in Russian supplies is in part to meet the expected fall in supplies from the UK, as well as rising Belgian demand – which is expected to reach 23 bcm, an increase of 16%, by 2020 – and possibly also increasing exports to France. We have not seen any forecasts of how French supplies are expected to change over the next decade.

Again, there are a number of variables which affect whether increasing supplies from Norway and Russia to Belgium and France will result in a large increase in transit flows across the Netherlands. First, the gas could bypass the Netherlands. Currently around 2.6% of supplies to Belgium are Russian gas that has travelled to Belgium directly from Germany, but Belgian entry capacity could be increased.

Another issue is that, in common with the UK, new gas supplies for France and Belgium could arise from additional LNG supplies to France. Either the existing LNG facilities in France could be expanded or operated at a higher load factor, or new LNG terminals could be added. France could be an attractive choice for new LNG terminals because of its extensive coastline.

France currently has three LNG terminals. The Fos Tonkin terminal and the Montoir de Bretagne terminal have been operating for many years. The Fos Tonkin terminal which is located in the south has a capacity of 5.5 bcm/year (this was 7 bcm/year until the Fos Cavaou terminal was constructed) and the Montoir de Bretagne terminal, located on the west coast, has a capacity of 10 bcm/year. A new terminal, Fos Cavaou, with a regasification capacity of 8.25 bcm/yr has recently been built close to the Fos Tonkin terminal. LNG currently makes up of 25% of French imports.[102] Recently, this was around 14 bcm (prior to commencement of the third LNG terminal which began operations this year).[103] This equates to a load factor of around 75%.[104] Although LNG terminals can operate at higher load factors – for example the new Italian LNG terminal at Rovigo has been operating at load factors of over 90% – 75% is already quite a high load factor

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[99] This is difference between the forecast from 2010 and the forecast for 2020. This is based on a demand forecast for Belgium and France. The demand forecast for Belgium is from the CREG report "*STUDIE (F)090713-CREG-874 de behoefte aan aardgasvoorziening, bevoorradingszekerheid en infrastructuurontwikkeling 2009-2020*", 13 July 2009, p. 128. The demand forecast for France is from a report by the French Ministry of Ecology, Energy, Sustainable Development and Territorial Development "*Plan Indicatif Pluriannuel des Investissements dans le sector du gaz*", March 2007, p.55 (GdF-Suez growth rate forecast).

[100] See Appendix XI for a discussion of alternative demand forecasts for France.

[101] CREG report (July 2009), *op. cit.*, p. 190.

[102] Report by the French Ministry of Ecology, Energy, Sustainable Development and Territorial Development (March 2007), *op. cit.*, p. 25.

[103] *Ibid.* A figure of 143TWh is reported. We have converted this to bcm using 11 kWh/m3.

[104] We have compared the 140 TWh to the total capacity of 17 bcm/year (10 bcm/year for Montoir and 7 bcm for Fos Tonkin).

compared to many LNG terminals in Europe. For example, National Grid expects the UK LNG facilities to operate at a load factor of no more than 40% by 2020. Given the already high load factors, increasing the imports at the original two French terminals seems less likely. However if the new LNG terminal at Fos Cavaou operates at a 75% load factor, this would mean additional imports of around 6 bcm which would be able to a significant part of the 10 bcm increase in demand in France and Belgium. The Fos Tonkin terminal was planned to be operational until 2014. However, the terminal operator, Elengy, has invited market players to sign up to capacity of up to 7 bcm/year at the terminal from October 2014 for a period of up to 20 years.[105] The imports from Fos Cavaou are likely to be in addition to the current level of imports rather than a replacement.

Another option would be expansion of the existing facilities or construction of new LNG terminals. Elengy the operator of the Montoir terminal is currently considering alternative expansion options for expanding capacity at the LNG facility to 12.5 bcm/year by 2014-2016.[106] There have also been a number of other proposed facilities in France.[107]
In the situation where LNG imports in France supply a larger volume of demand for imports in Belgian and France, we estimate that transit gas flows from the Netherlands to Belgium and France would be around 7 bcm/year.

Another key variable is the volume of gas for the French and Belgian markets that will flow via Germany, rather than the Netherlands. At present we estimate that about two-thirds of Russian gas exported to Belgium flows via the Netherlands. Whether this ratio stays the same or not will have a large effect on Dutch transit flows. For example, if we assume that the increases in Russian gas flows to Belgium and France all flow via Germany, then transit flows through the Netherlands are about 15 bcm/year by 2020. If we assume that the additional Russian gas flows transit through the Netherlands then the volume increases by over 4 bcm/year. Whether Norwegian gas flows via the Netherlands or via Germany would have a similar effect.

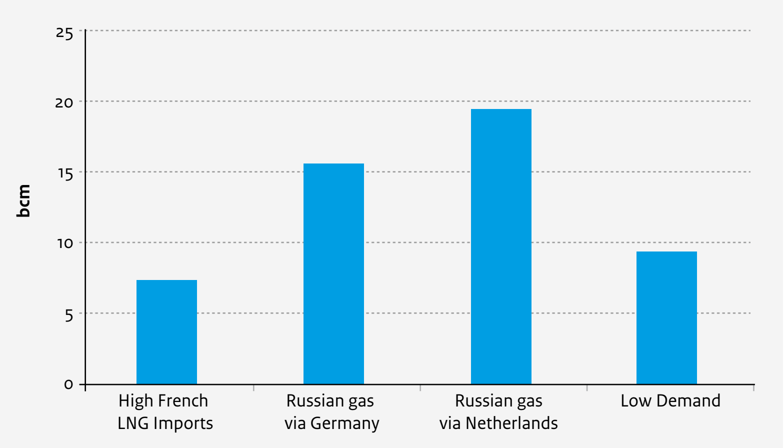
As with the UK scenarios, low demand can also have a large effect on Dutch transit flows. We have modelled a scenario where efficiency measures and other environmental polices have reduced base case gas demand in Belgium by the same proportion as National grid's gone green scenario reduces GB gas demand. For France we use the low demand growth rate reported in the Ministry report we used for the base demand case. We find that in this case Dutch transit flows are around 10 bcm/year – higher than the case with high LNG imports, but significantly lower than scenarios with a base level of demand. Figure 24 summarises the transit flows across the Netherlands for the four scenarios we have discussed. We provide the underlying calculations in Appendix XII.

[105] Deliberation of the French Energy Regulatory Commission (CRE) dated 14 January 2010 approving the open season procedure for the Fos Tonkin LNG terminal continuation project.

[106] http://www.elengy.com/en/projects/montoir-extension.html.

[107] For example an additional four facilities under consideration are reported by the French Ministry of Ecology, Energy, Sustainable Development and Territorial Development in "*Plan Indicatif Pluriannuel des Investissements dans le sector du gaz*", March 2007, p. 26.

Figure 24: *Alternative Transit Scenarios (Supplies to Belgium and France)*



Our calculations illustrate that high LNG imports, reduced demand and additional gas volumes choosing to transit via Germany could all have a significant effect on Dutch transit flows.

3.3 SWOT Analysis of Dutch Transit Flows

The gas flow analysis above highlights both some of the strengths and weaknesses of the Netherlands as a transit route. The demand for gas imports to the UK will increase sharply over the next 10 years as UKCS production declines, and the Netherlands is in an excellent position to transit gas to meet this growing need. Similarly, Norway will remain a major supplier of gas to north-west Europe and gas can transit though the Netherlands to markets such as France, Belgium and onto Italy. If the Netherlands realised its ambition to build a new pipeline directly between Norway and the Netherlands, this would significantly reduce the risk of bypass for Norwegian gas.

But the analysis also highlights several risks. High levels of LNG supply, reduced gas demand due to efficiency measures and the growth of electrical heating, and competition from other countries for transit could each individually have material effects on Dutch transit flows.

The above discussion addresses whether there will be a fundamental demand for transit across the Netherlands. Another important issue is even if demand for gas transit is there, is the Netherlands in a favourable position to serve that demand? In interviews, market participants told us that they welcomed the opportunity to buy long-term capacity via GTS's open season process, which participants felt to be transparent and well-structured. However, one major weakness of the current system is that shippers must sign a binding commitment to 10 year capacity contracts, while only knowing the price of the capacity for the first year. This places significant risks on the shippers and reduces the attractiveness of buying gas transport capacity in the Netherlands. The ability to set multi-year tariffs would boost the attractiveness of Dutch transit capacity. For example in the UK gas market one can buy entry capacity for periods of up to 16 years, where the price is fixed for the entire period. In Belgium the tariff formula is set for four year periods, which is clearly not as good as the UK but at least offers some tariff certainty for a few years. In Germany, shippers have even less tariff certainty. E.ON Gastransport told us that while shippers could purchase firm transport capacity up until 2019, they would pay the published regulated price which could change at time. Longer term transit tariffs could be an area where the Netherlands could differentiate itself from rival transit routes, and gain an important advantage.

Market participants also noted that GTS's proposal to restructure tariffs would make transit more expensive. In essence, GTS is proposing that the entry-exit tariffs should be derived giving greater weight to the average distance travelled, so that, for example, exit tariffs in the south of the Netherlands would increase.[108] Market participants complain that this proposal is at odds with the stated ambitions for the Netherlands to become a gas hub which promotes transit flows.

We asked market participants what were the factors that would make it attractive to transit gas across one country rather than another. Participants listed a number of issues that were key to them. Perhaps most important was the availability of firm gas transport capacity to and from the Netherlands – it is vital to market players to have certainty that capacity will be available.

Market transparency was listed as an important feature of a market. Respondents said that the volume of information published by GTS was very good and probably among the best of all TSOs in the EU. But participants also felt that there was still room to improve transparency with respect to the availability of capacity, especially in terms of the capacity that was reserved as compared to the capacity actually used, and the way in which GTS calculated available firm capacity. One participant questioned the need to keep capacity information confidential where only three shippers or less had bought capacity at a particular entry or exit point. The participant noted that the presence of so few shippers at an entry or exit point was itself indicative of a problem, and that in other markets there had been issues where there were in fact more than three shippers using an entry or exit point but the information had nevertheless been kept from the market (though the participant was not suggesting that this was the case in the Netherlands).

Participants perceived the Dutch balancing regime as a negative feature of the market. Specifically, they felt that the penalties associated with imbalances were too severe, and that the requirement to balance hourly was not required and discouraged trading and transit. It is beyond the scope of this report to assess if hourly balancing is required for technical reason, though clearly GTS thinks that this is the case. At the same time, market participants welcomed GTS's recent efforts to reform the balancing market and the development of a new gas balancing market in co-operation with APX-ENDEX, which is intended to go live in April 2011. The new balancing market should enable balancing charges to reflect actual imbalance costs more accurately than the current system, and reduce the cost of imbalances. While some market participants had concerns regarding some of the proposed details of the new market, the proposed balancing market is recognised as a significant step forward.

[108] For example according to GTS' tariff proposals dated 11 May, 2010, the total cost of importing and exporting gas from Ouden/Emden to Zelzate would increase from about 30 €/m3/hour/year to 44 €/m3/hour/year. Similarly the cost of importing and exporting gas from Ouden/Emden to Bocholtz would increase from about 27 €/m3/hour/year to 41 €/m3/hour/year.

3.4 Dutch LNG Imports

The Netherlands already has one 12 bcm/year LNG terminal under construction – the Gate terminal. This represents a key advantage with respect to future LNG import capacity, because the Gate terminal can be expanded relatively easily to at least 16 bcm/year. Expanding an existing terminal in the Netherlands will be easier and cheaper than building a new terminal from scratch in another country.

The Netherlands has several other advantages in terms of developing LNG terminals. It has at least two other locations where LNG terminals could be developed – the site of the Liongas terminal in Rotterdam and the Eemshaven LNG project in the north of the Netherlands. Both these are technically feasible locations because both locations are already heavily industrialised this helps permitting procedures relative to building on 'virgin' or greenfield land.

However, the nature of the customers in the Gate LNG terminal indicates that the Netherlands faces international competition for LNG terminal development. Dong Energy (Denmark), OMV Gas International (Austria), Essent (the Netherlands) and E.ON Ruhrgas (Germany) have each taken a 5% equity stake in the Gate terminal. While these shippers may market some of their gas in the Netherlands, it seems likely that they will also transit some of the gas through the Netherlands to their traditional 'home' markets'. Similarly EnBW – a German gas company – acquired a 15% in the Liongas LNG terminal in Rotterdam, which has subsequently been cancelled.

The list of shippers above indicates that terminal users import LNG into the Netherlands to serve customers in north-west Europe. This means that the Netherlands is competing with other countries in north-west Europe to develop LNG terminal projects which could serve the same markets. For example, E.ON Ruhrgas holds an authorisation to build an LNG terminal in Wilhelmshaven in Germany. If finalised, this could potentially take customers away from a possible LNG terminal at Eemshaven, or negate the need for a second terminal at Rotterdam. Commentators have been explicit about the ability of German shippers to use terminals in different north-west European countries as substitutes. The German ambassador to Doha said recently that for now, Germany could use existing terminals in Brussels and in Rotterdam in the Netherlands, noting that German utilities were also buying Qatari LNG on the spot market, and that "[i]n the future, Qatar can supply Germany through the Rotterdam facility".[109] But the implication is that German shippers could also switch to using a German terminal if one materialised.

Poland will also begin construction of an LNG terminal this year at Swinoujscie, close to the German border. The terminal should be ready by 2014. While the Polish terminal has contracted for some deliveries from Qatargas, there is still ample spare capacity which German shippers could use to import gas.
Market participants noted that, with respect to the attractiveness of the Netherlands as a landing point for LNG, they were looking for a destination which has multiple options for selling a cargo – either via a gas exchange or for export. The choice of export destinations that the Netherlands offers is therefore a key advantage. Subject to available capacity, LNG landed in the Netherlands can be shipped to the UK via BBL or Belgium and IUK, or onto Germany, Belgium or France. This also illustrates the close relationship between the liquidity of the TTF and the attractiveness of the Netherlands as an LNG landing point.
One shipper felt that there were broadly speaking, two types of markets that were currently attractive for LNG

[109] *Platts* European Gas Daily, 20 April 2010, p. 5.

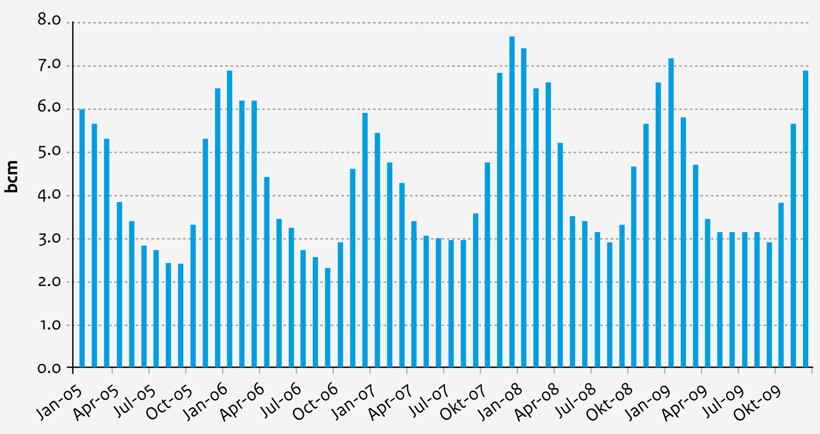
imports. One was a market in which wholesale prices were relatively high, possibly because of a lack of market entry by players other than the incumbent. Italy provides a good example of this kind of market in Europe. Typically it has been difficult to import gas into Italy, and Italian wholesale gas prices have commanded a premium relative to other gas markets in western Europe. While the Italian PSV trading hub is not currently liquid enough for an importer to sell large volumes of imported LNG there, high Italian gas prices more than compensate for this inconvenience.

The second type of market is one with lower, but more volatile prices, and more liquid trading. The market participant thought the market in Great Britain was the best example of this kind of market to date. This kind of market is attractive for committing to long-term re-gas capacity because the market participant will know that it can always find a home for the gas at a reasonable price.
There was a perception that as an LNG import destination the Netherlands risked falling between these two extremes. The Dutch market might not be liquid enough nor prices high enough to attract LNG cargoes. Note that this was highlighted only as a future risk, and was not a perception of the current state of the Dutch market. Nevertheless, this means that concerns regarding the liquidity of the TTF or market power could undermine the attractiveness of the Netherlands as a destination for LNG.

3.5 Storage and Flexibility

The Netherlands has traditionally used the Groningen field to export flexibility in gas supply to its neighbours. Figure 25 illustrates the 'swing' in exports between summer and winter. In a more commercial setting, GasTerra agreed in 2002 to sell 8 bcm/year of gas to GB gas supplier Centrica. The contract specified that GasTerra would deliver 5 bcm of gas in the winter months and 3 bcm in the summer months – thereby exporting flexibility as well as gas.[110]

Figure 25: *Monthly Gas Export Volumes from the Netherlands*



Notes and sources:

Data from Gas Transport Services

[110] Centrica press release "Centrica and Gasunie sign major long term supply agreement", 25 June 2002, available online at http://www.centrica.co.uk. Note at the time the contract was signed GasTerra was part of the integrated supply and transport concern Gasunie.

The decline in production at the Groningen field will mean it will be unable to continue to provide flexibility at current levels. A decline in gas production is also expected in the UK which will further reduce the amount of flexibility that can be provided by production facilities in north-west Europe. GTS notes that over the next decade, peak output in north-west Europe from existing production facilities will halve from approximately 20 million m3/hour in 2005 to approximately 12 million m3/hour in 2015.[111]
In the future gas storage facilities will need to play a much bigger role in covering the seasonal fluctuations in gas demand. Analysis by GTS suggests that the current level of planned development in new storage facilities may not be sufficient to keep pace with demand for flexibility.[112] GTS estimates that demand for flexibility could over take the current levels of planned supply through storage facilities as early as 2018.[113]
GTS also notes that "[n]ational borders are progressively less of a barrier to the use of storage facilities, as shown by the example of the storage caverns near the Dutch-German border" and that [t]he trend of importing and exporting flexibility through the use of storage facilities is expected to grow further over the coming years. In future, facilities in the Netherlands could play an even greater role in the flexibility services on the gas markets of neighbouring countries such as the United Kingdom, Belgium and France."[114]
However, it is not a given that Dutch flexibility exports can compete with gas storages in other markets. The concept of exporting storage to neighbouring countries faces the cost of additional transport capacity. For example, to export peak capacity to France one must book winter transport capacity from the Netherlands to France. In contrast a French storage need only book peak capacity *within* France. Hence gas storages in the same country as their customers have an inherent advantage in terms of gas transport costs.

For example, suppose that storage facilities in the UK costs the same as using storage facilities in the Netherlands. A gas marketer is bringing gas from the Netherlands to serve a customer in the UK. The gas marketer can either choose to import baseload gas into the UK and use UK storage to meet peak demand, or it can use Dutch gas storage to export flexibility to the UK. In the case of using Dutch storage, the shipper would need to book more transportation capacity in the BBL interconnector because it would need to transport the peak gas from the Netherlands to the UK.[115] The shipper would need to book the peak capacity at the Balgzand exit point in the Netherlands, in the BBL interconnector and at the Bacton entry point in the UK. Collectively transportation at the Balgzand exit point and in the BBL interconnector collectively costs €8 per kWh/h of transportation capacity.[116] Suppose the average capacity the customer required was 1 kWh/h, and the customer has a load factor of 70%. Using UK storage the gas marketer would pay €8 for gas transport costs. But if the gas marketer supplied peak gas from the Netherlands, the shipper would need to book peak capacity and pay €11.4 (equal to €8/kWh/h divided by 70%), a difference of €3.4/kWh/h.

[111] GTS, The Security of Gas Supply 2009, July 2009, p.16.
[112] *Ibid*, p.17.
[113] GTS "*Rapportage Voorzieningszekerheid Gas* 2010", p.23.
[114] *Op. cit*. footnote 111, p. 17.
[115] If the shipper used the UK storage it could import only baseload gas to the UK and then supply the peak from the storage facility.
[116] The figure of €8 per kWh/h is the sum of the BBL price for one year of forward flow capacity of 6.9 € per kWh/h and the cost of GTS exit capacity at Julianadorp (€1.4 per kWh/h). For the BBL price we have used the non-indexed capacity fee without adding the variable fee or the service fee. We took the BBL price from BBL's transmission agreement for firm forward flow (see http://www.bblcompany.com/en/commerce/agreements-for-firm-forward-flow). The exit capacity fee for Julianadorp was from GTS's website. We have not included the cost of transportation at Bacton which would of course increase the total transportation cost.

The Alkmaar Gas Storage currently sells capacity at a cost of €9 per kWh/h of withdrawal capacity,[117] In our scenario the gas marketer would pay €3.9 for storage.[118] Therefore the additional transport costs as a result of using Dutch storage, rather than using UK storage, would be nearly as large as the storage costs. This is sufficient to put Dutch storage at a significant disadvantage relative to UK storage. While the economics would not be as extreme for export of flexibility to France, Belgium and Germany, the same theoretical disadvantage applies.

In the past, the low flexibility costs of the Groningen field could offset the additional transport costs. As Groningen's maximum daily output declines, output from gas storage would need to make up more of the peak supply. But the economics of exporting peak gas long distances using gas storages are less obvious than the advantages of the Groningen field. It is not clear that Dutch gas storages are significantly cheaper than storages in other countries.
Gas storage facilities can either be constructed in depleted gas reservoirs or by leaching out salt caverns. One of the largest advantages that the Netherlands has in this area is the number of depleted onshore gas fields that could be used for gas storage developments. As GTS notes in its 2009 quality and capacity report, "[t]he potential for building suitable storage facilities for the north-west European market is localised in a restricted area. This area extends over North Germany, North and West Netherlands and the North Sea."[119] However, this analysis is not completely born out by the statistics on gas storage facilities currently under development. Figure 26 illustrates that one of the most significant trends is that the UK is developing substantial storage volumes. This is perhaps not surprising. The UK is in transition from being a self-sufficient producer and exporter of gas to becoming a net importer, which means taking foreign gas at a relatively high load factor and storing it during the summer. The implication is that, in future, attempts to sell flexibility and swing services to the UK gas market will meet competition from gas storage facilities in the UK. Similarly Germany is developing a substantial volume of new gas storage. While almost all of these new storage projects are based on salt caverns, the ratio of deliverability to working volume is similar to Dutch storages based on depleted gas fields. Therefore it seems as if the German storages would not only offer peak shaving capacity but also seasonal storage.[120] Figure 26 suggests that Belgium will likely remain a customer for Dutch flexibility, and that there is little new storage development in France.

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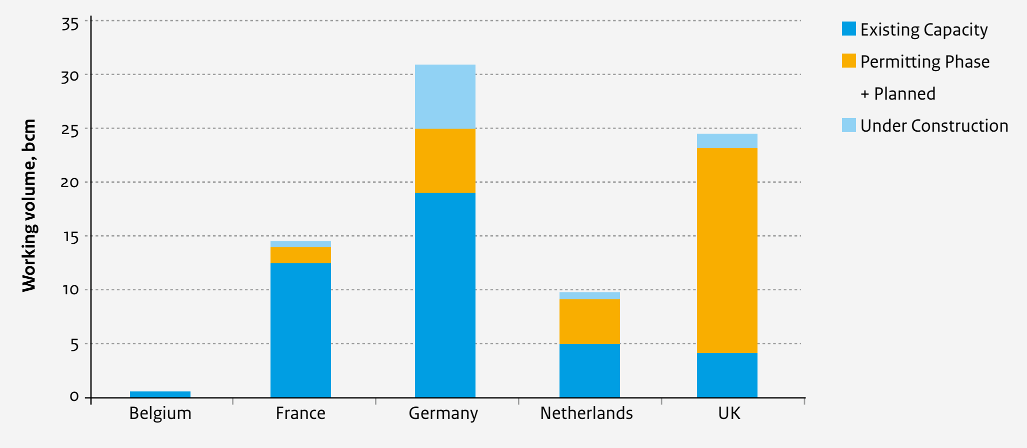
[117] See http://www.alkmaargasstorage.nl/service%20offer.htm. Alkmaar sells it long storage bundle for € 808 thousand which provides 90 MW of withdrawal capacity.

[118] Assuming 1 kWh/h baseload capacity and a load factor of 70%, the gas marketer would require (1/0.7)-1 = 0.4 kWh/h of storage send-out capacity. 0.4 kWh/h x €9 kWh/h equals €3.9.

[119] GTS, "Quality and Capacity Document 2009", p.16.

[120] See Gas Storage Europe Investment data based March 2010 for more details of new gas storage projects. We calculate that the weighted average send-out period for new German storage projects which provided data was 21 days, compared to an average of 34 days for existing Dutch storages built on depleted fields. The planned Zuidwending storage projects have a send out period of only 8 days.

Figure 26: *Existing Gas Storage and Storage Under Development*[121]



The current investment picture for gas storage in the Netherlands is mixed. One developer of Dutch gas storage has recently had to abandon its project because of difficulty in reaching financial close. We understand that the current over-supply of gas in the market is having a detrimental effect on the demand for gas storage, since pipeline imports and LNG will be able to meet peak demand without new storage volumes for several years to come. On the other hand, Gazprom and Gasunie recently discussed "mutually beneficial cooperation in the development of gas transportation and storage capacities amid [a] liberalizing EU gas market" which suggests more investments in Dutch storage will be forthcoming.[122] As mentioned in section 2.1.2, Gazprom has already invested in the Bergermeer storage project.

One complaint that we have heard from market participants that could deter storage developments is the way in which gas storages pay for entry and exit capacity. Shippers must buy exit capacity to leave the GTS system and inject gas into storage. Similarly, they buy entry capacity for withdrawing gas from storage and putting back into the GTS system. The complaint is that GTS sets these entry and exit tariffs based on a 'typical' gas shipper. Storage developers argue that in effect they use 'spare' capacity to inject gas into storage in summer when there is low demand. By then delivering gas close to demand in winter storage actually reduces the need to transport peak gas volume a long distance during the winter. Some storage developers have argued that their role in reducing the load on the transmission system is not fully reflected in the current tariff regime. We have not assessed the merit of these arguments. However, it would seem worth investigating the current entry-exit tariff methodology to see if is sufficiently cost reflective for gas storage. A gas-transport tariff methodology that fully reflects storages' contribution to the gas transmission system could provide a boost to gas storage investment in the Netherlands. We understand that GTS has made proposals to reduce exit tariffs for gas storages in the recent past, but that so far these have not been implemented.

[121] Source: Gas Infrastructure Europe.

[122] *Platts* European Gas Daily, 7 June 2010.

3.6 Gas Trading and the TTF

One of the key strengths of the TTF is its existing popularity. As highlighted in section 2.1.3, the TTF has already grown into a successful trading hub. In a 2008 survey the Netherlands was ranked second after the UK in term of overall market liquidity and efficiency, based on factors such as volume of trading, number of participants, market transparency and price reliability.[123] Table 8 below illustrates that in 2009 the TTF had the highest trading volume of any continental European trading hub. Since traders naturally prefer more liquid trading hubs, a successful hub is likely to grow as more market players want to trade thA trading hub is most useful where it can arbitrage price differences between several different sources of gas. It is interesting to trade at a point where a high-price source of gas meets a low-price source of gas for example. The physical position of the TTF means that it can act as a trading point to arbitrage Norwegian gas landing at Emden, LNG flowing in at the Gate terminal, gas flowing to or from the UK via BBL or IUK, domestically produced Dutch gas and Russian gas flowing via Germany. The potential for arbitraging price differences between these gas sources is a key advantage for the TTF.

Table 8: *European Trading Hub Liquidity in 2009*

Country	Hub	Traded Volume bcm [A]	% Change vs. '08 % [B]	Physical Volume bcm [C]	Churn Factor [D]
UK	NBP	1,089.3	9.7	93.5	11.7
Netherlands	TTF	82.2	28.4	27.0	3.0
Belgium	Z-Hub	67.0	13.6	13.0	5.2
Germany	NCG	51.9	98.9	22.0	2.4
Italy	PSV	24.6	50.0	11.5	2.1
Austria	CEGH	22.8	52.0	7.6	3.0
France	Peg Nord	19.6	117.8	7.2	2.7
Germany	Gaspool	14.2	NA	NA	NA

The diversity of gas to which the TTF has access is also an advantage relative to one of the TTF's potential rivals – the German gas trading hubs of Gaspool and NetConnect Germany (NCG). Market players currently perceive that Germany has great potential as a European trading hub, both because of the volumes consumed and transited across the country. The reduction in the number of German trading zones to two has no doubt boosted liquidity at the German hubs. As Table 8 shows the NCG hub increased its 2009 trading volumes by almost 100% with respect to the previous year. We calculate that as of April 2010 NCG has further closed the volume gap with TTF. Based on Table 8, in 2009 NCG traded 37% less volume than TTF. In the period January to April 2010, inclusive, NCG traded only 12% less volume than TTF.[124] As of April 2010 there were 154 parties trading H-gas at the NCG, compared to just under 70 trading on TTF.

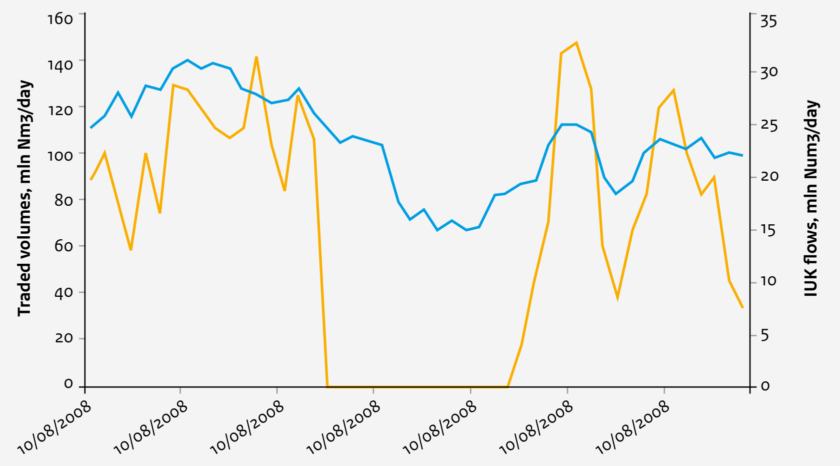
[123] The Moffatt Associates Partnership, "Review and analysis of EU Wholesale energy markets, Evaluation of Factors Impacting on Current and Future Market Liquidity and Efficiency", 2 July 2008, p. 43.

[124] We calculate that in the period January to April 2010, inclusive, 35.3 bcm was traded on TTF compared to 30.7 bcm on the NCG. Both numbers include both H-gas and L-gas trades. At the time of writing, GTS only had TTF volumes available up to the 24th April, 2010. We have extrapolated the remainder of April assuming the average April volumes were traded between 25th to 31st April.

However, we note that much of the German liquidity may be due to the current oversupply of gas, and selling of excess gas volumes bought under long-term contracts. Once demand recovers to pre-crisis levels – which many commentators expect to happen in 3-4 years time – the rate of increase in the liquidity of the German hubs may reduce. Moreover, Germany does not have access to as diverse a range of gas sources as the TTF. Germany has little domestic gas production, and almost all its imports come from Norway, the Netherlands and Russia. The Nord Stream project, which from 2011 will import gas from Russia into Germany, could significantly increase Russia's share of the German gas market, reducing the diversity of supply further. Germany has no LNG import terminal to date, though as we note above a terminal is being considered.

Moreover, market participants did not necessarily think that the success of a German gas market and a Dutch gas market were mutually exclusive. One possibility is that, if Germany becomes a major hub in Europe, this might improve the attractiveness of the Netherlands as a transit route for gas bought in Germany. Other possibilities include the creation of a cross-border hub, perhaps involving a merger of TTF with Gaspool – Gasunie has ownership interests in both. The gas committee chairman of the European Federation of Energy Traders said recently that "[t]he emphasis in Germany is on creating two hubs, but maybe what Europe needs is cross-border hubs".[125]
With respect to the Zeebrugge trading hub, TTF enjoys the advantage of much firmer physical supply from Dutch gas production and storage. Trade at Zeebrugge is highly dependent on the availability of the IUK. If IUK fails, trading volumes at Zeebrugge can fall. For example, Figure 27 illustrates the fall in trading volumes during a planned shutdown of IUK during September 2008. The fall in trading volumes could be more severe if the shutdown was unexpected. In contrast, the gas supply to the Netherlands – including domestic production and gas storage – is sufficiently diverse there is no single supply source to which deliveries to the TTF are vulnerable.

Figure 27: *Gas Trading at Zeebrugge During the September 2008 Shutdown of IUK*



Notes and sources:
Data from Huberator, Interconnector (UK) Ltd.

[125] World Gas Intelligence, "Horizon: Eyes on Germany, Italy as Trading Soars at European Hubs", 9 June, 2010.

While TTF is a successful hub, Table 8 illustrates that the UK's NBP currently dwarfs all the continental trading hubs. One concern is that NBP could dominate all European gas trading, in the way that the Henry Hub in the US acts as the focal point for US gas trading. However, the key advantage that TTF has is that it is located on continental Europe, where it is relatively cheap to expand onshore gas transport capacity to neighbouring markets. In contrast, from a trading perspective, the NBP always has the risk that congestion on the BBL and IUK will cause NBP prices to 'disconnect' from the continent. Since the pipelines that link NBP to the continent are merchant lines that rely on congestion to earn a return, there is no commercial incentive to eliminate all congestion. It seems likely that UK and continental gas prices will continue to have periods of divergence, and for this reason there will be space for both one or two continental trading hubs as well as the NBP.

Market participants see the liquidity of the TTF as one of the most positive features of the Dutch gas landscape. However, market participants did raise concerns with respect to market power and GasTerra's dominance of the Dutch wholesale market. For some market participants the dominance of GasTerra in the domestic market created the impression of a 'managed market' where prices were not as trustworthy as they might be in a market with a more diversified gas wholesalers. This reduced the attractiveness of the Netherlands as a transit route. One participant thought that more could be done to improve liquidity on the TTF, by for example forcing GasTerra to deliver more gas there at terms which allowed easy re-sale of the gas.
We also understand that the new balancing market will be separate from the TTF, although there will some integration between the two markets and information exchange to try and ensure that prices on the balancing market and the TTF are aligned. Nevertheless, we note that the TSO's use of the On the Day Commodity market (OCM) for balancing actions in the UK has been a major contributor to the success of the NBP trading hub. It would be desirable to maximise integration between the TTF intra-day market and the new balancing market, with the ultimate aim of a single intra-day market that will maximise liquidity.
Market participants noted that while the Netherlands is and will likely continue to be an attractive gas hub, it is limited by its 'geographical footprint', located as it is in the north-west corner of Europe. Market participants highlighted that geographic constraints place natural limits on the degree to which they would use the Dutch gas hub for trading.

3.7 Research and Development

The principal strength of gas-related R&D in the Netherlands is that it already has an established base. As described in section 2.1.5, there already exist several initiatives which marry industry expertise and experience with university R&D. The Netherlands has taken advantage of the geographic proximity of the University of Groningen, NAM, Gasunie and GasTerra to create an energy hub in the north of the Netherlands.

The hope or opportunity is that the Netherlands could establish a 'first-mover' advantage in an area such a green gas or biogas that would allow it to export this knowledge and create a self-sustaining industry. The classic example of this kind of investment is the Danish wind industry, which was heavily subsidised in between about 2000 and 2005. As a result, Denmark is a world leader in the manufacture of wind turbines and, according to the Danish Wind industry, the sector employs 28,400 people and contributes an annual €5.7 billion to the economy.

However, the Danish 'success' in the wind sector is disputed. Another study points out that these numbers should be treated with caution, and that the large subsidies poured into the sector have actually distorted the job market, shifting employment from possibly more productive sectors to the wind sector. The study estimates that, after accounting for this effect, net employment created was only about 10% of the headline figure. Moreover, the study estimates that Danish GDP is approximately $270 million lower than it would have been if the wind sector work force was employed more productively elsewhere.[126]

The Danish experience highlights that while the headline rewards from early R&D in an emerging green technology can be large, the risk is that large subsidies can create distortions in the economy which lesson the overall benefits. We understand that in the 1990s the Netherlands spent more public funds on R&D than Denmark, but neglected the overall policy framework conditions needed to gain success. The lesson is that subsidising initial R&D that might be too risky for the private sector to undertake alone may be worth while. But once the technology is more mature the private sector should be left to decide if and how it can be commercialised and at a price that earns a reasonable return. R&D in the gas hub strategy will need a careful 'transition trajectory', which describes an increasing role for green gas in the overall sector, as well as a transition away from subsidised R&D and toward commercial projects at the right time.

3.8 Issues Common to All Elements of the Hub Strategy

Market participants we spoke to agreed that the Netherlands had a strong and credible regulatory regime, where decisions were well argued and documented. The Dutch regulator undertakes transparent consultation exercises where comments are published. Decisions can be appealed within a reasonable time frame and courts have overturned important regulatory decisions in the past. On a more general level, the Netherlands is a transparent and attractive place to do business. In 2009, Transparency International ranked the Dutch public sector the sixth least corrupt out of 180 surveyed – the UK was ranked 17th and Italy 63rd.[127]

In our opinion and the opinion of parties we interviewed, Dutch energy regulation is of a high quality. This means that decisions are transparent, and follow a predictable process, and there are opportunities to appeal regulatory decisions. The high quality of Dutch energy regulation and subsequent lack of 'regulatory risk' contribute to the Netherlands being an attractive place for investment in energy infrastructure such as gas storage, LNG terminals and gas pipeline capacity. Moreover, according to the World Bank's 'ease of doing business' index,[128] the Netherlands ranks 13th out of 183 countries in terms of the ease of trading across borders[129] – one place above Germany and three places above the UK. This should help promote the success of the Dutch gas hub strategy.

However, the Netherlands does less well on several other issues which are relevant to investing in gas infrastructure. The country ranks 30th for ease of doing business overall, which involves a combination of

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126 *Center for Politiske Studier*, "Wind Energy The Case of Denmark", September 2009.

127 Transparency International's Corruption Perceptions Index 2009, available at www.transparency.org/policy_research/surveys_indices/cpi/2009/cpi_2009_table. The CPI score indicates the perceived level of public-sector corruption in a country or territory.

128 See www.doingbusiness.org for details.

129 This includes documents, time and cost to export and import.

measures such as ease of starting a business, employing workers, registering property, getting credit, protecting investors, paying taxes, enforcing contracts and recovery rates in bankruptcy proceedings. In contrast the UK ranks fifth and Germany 25th. The Netherlands does particularly poorly on dealing with construction permits and employing workers, and is in the bottom half of countries for protecting investors.[130] Of course these issues go beyond the gas hub strategy. Nevertheless, it is important to recognise that the Dutch gas hub takes place in the context of the broader regulatory and legal environment in the Netherlands. Measures to improve the general business environment will positively affect the climate for energy investment and subsequently the chances of success for the gas hub strategy.

We asked market participants if the current economic downturn and contraction in gas demand would affect or delay their investments in gas infrastructure. One market participant claimed that this had no effect, and to the contrary they saw the current climate as a good opportunity to take advantage of cheaper assets for sale and reduced construction costs. One interviewee maintained that the key driver for investments, even in the gas industry, remained the oil price. As long as oil prices were over about $60/bbl then firms would continue to invest in the gas industry. We note that this may be true at the upstream end of the gas supply chain. But the recent cancellation of the Eemshaven LNG terminal project shows that the current relatively low spot gas prices can act as a deterrent to projects not sponsored by gas producers.
Firms highlighted that they operate in a global environment, and rank investment opportunities against possibilities in other parts of the world. In this sense it is clear that, in terms of attracting investment, the Netherlands is competing on a global playing field with countries such as Brazil, Australia and the US. However, participants pointed out that the Netherlands remained an attractive place for gas trading, and was perceived at present as being one of the most important and investor friendly gas markets in the EU.

3.9 Competition from Other Gas Hubs

A number of other Member States have expressed ambitions to develop gas hubs or roundabouts. While not all of these projects present competition to every part of the Dutch gas hub strategy, they illustrate that the Netherlands is not alone in its ambitions to attract gas flows and investments.

Back in 2006, the then Russian President Vladimir Putin announced that he wanted to make Germany a gas hub for Europe, following talks with German Chancellor Angela Merkel.[131] Mr Putin also announced that around 50 bcm of gas from the Barents Sea could be redirected to Germany. However, while Germany's trading hubs have attracted large volumes, as far as we are aware the German authorities have not articulated a policy of Germany developing a wider gas hub strategy, involving expanding transit volumes, gas storage and other infrastructure investment. This is probably because to date German policy makers have been concerned with other issues such as reducing the number of market or balancing zones, reforming the charges for third-party access to the gas network and the conditions of access. Now that many of these more 'basic' but essential issues have largely been resolved, we may see German policy makers take a more strategic approach to the next steps for the German gas market.

[130] The protecting investors index is based on an extent of disclosure index, extent of director liability index and ease of shareholder suits index.

[131] BBC news, "Putin details Germany gas hopes", 10 October 2006, see http://news.bbc.co.uk/1/hi/world/europe/6036125.stm.

Gazprom has been active in plans to develop a Belgian hub. During a visit to the Kremlin, Prime Minister Guy Verhofstadt of Belgium and Prime Minister Putin agreed that Belgium should become a hub for the storage and transit of Russian natural gas. A spokesperson for Fluxys stated that it was very important for a small country like Belgium to be a transit country and a hub.[132] Belgian and Russian leaders also agreed to quickly complete a feasibility study for building a large underground gas storage unit in Belgium.[133] However, we note that in 2008 plans to build a Belgian storage facility were cancelled after feasibility studies showed that it was not an economically viable project.[134] It had been hoped that the facility would have a capacity of 300 mcm which would be sufficient gas enough to provide heating for the whole of Belgium for two weeks. As noted above, the relative lack of diverse supply sources will disadvantage the Zeebrugge trading hub relative to the TTF, and plans to develop storage in Belgium are still at a very early stage. However, it is clear that Belgium has ambitions to take as large a share of Russian transit gas flows as it can, and Belgium does represent competition to the Netherlands for this aspect of the Gas Hub Strategy.

Austria also has ambitions to become a major European transit and storage hub. Austrian incumbent OMV, in partnership with Gazprom and the Vienna Stock Exchange, has announced plans to develop the Central European Gas Hub (CEGH) into the most important gas hub in continental Europe.[135] OMV believes that "[t]hrough its connection to important transit pipeline systems and comprehensive storage capacities, CEGH fulfils all requirements for a modern energy marketplace and has enormous potential to become one of the most important gas hubs in Continental Europe".[136] OMV and Gazprom have signed a co-operation agreement to construct the Austrian section of the South Stream pipeline which would connect the CEGH gas hub to the Austrian-Hungarian border.[137] OMV and Gazprom also plan to carry out joint storage projects in Austria and neighbouring countries. In addition, a gas exchange will be developed in co-operation with the Vienna Stock Exchange and further diversification of energy products such as trade in transport capacities is planned.[138] OMV is also the lead partner in the Nabucco pipeline project which would bring Iranian gas via Turkey to central Europe. While our analysis above indicates that an Austrian hub is unlikely to take transit business from the Netherlands, it is possible that Austria could export flexibility to France and Germany in competition with Dutch gas storages.

As early as 2006 the Commission of Productive Activities of the Italian Parliament noted that the ambition was to make Italy into a gas hub for the Mediterranean area, taking gas produced in the Caspian, Middle east and North Africa and delivering this gas to the growing markets in central and northern Europe. The Commission noted the advantages this strategy would have for gas price reductions and security of supply.[139]

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[132] The New York Times, "Gazprom seeks further expansion in Europe via storage depots", 16 April 2007, see http://www.nytimes.com/2007/04/16/business/worldbusiness/16iht-gazprom.5.5310073.html.

[133] We do not include this storage facility in Figure 26 because it is at too early a stage of development.

[134] Reuters, "Fluxys scraps Belgian gas stocks plan with Gazprom", 2 February 2008, see http://www.reuters.com/article/idINL0229548720080202.

[135] Central European Gas Hub report "Gas Trading at the Gateway to the East", December 2009, p. 1.

[136] *Ibid.*, p. 3.

[137] Oil and Gas Journal, 29 April 2010. See http://www.ogj.com/index/article-display/0369470865/articles/oil-gas-journal/transportation-2/pipelines/construction/2010/04/omv_-gazprom_to_cooperate.html.

[138] *Ibid.*, p. 6.

[139] Commissione X Attività Produttive commercio e turismo della Camera dei Deputati, "Indagine conoscitiva sulle prospettive degli assetti proprietari delle imprese energetiche e sui prezzi dell'energia in Italia", Rome, January, 2006.

In 2008 the Italian Ministry of Economic Development (MSE) gave a presentation in which it noted that:

> *"the proposed projects, gas pipelines as well as LNG terminals, make the possibility of Italy becoming a transit country to other continental European countries concrete, and confirms the principal of Italy becoming the gas hub of the Mediterranean basin, expanding also the national system of gas storage with consequent benefits in terms of security of supply and reduction of energy costs for consumers".*[140]

The presentation showed Italian imports supplying Austria, Hungary, France and Germany among other countries. In April 2010 the Italian Minister noted that "the development of storage capacity along with the targeted completion of new import infrastructure, gas pipelines and LNG terminals…is consistent with the Government's energy policy to enable Italy to become a gas hub in Europe."[141]

Our analysis in section 3.2 above indicates that Italy is not a rival for Dutch transit gas. But arguably Italian LNG terminals could compete with Dutch LNG projects for supply to Germany and central European markets. As pointed out in section 2.1.4 participants in the Gate LNG project include German and Austrian shippers, who could in future import gas to their home markets via Italy rather than via the Netherlands. E.ON – a shareholder in the Gate terminal – is also participating in a new terminal venture in Italy. Italy has a further advantage with respect to LNG because it is closer to North Africa and the Middle East which are some of the main sources of LNG supply. This makes it cheaper to deliver LNG to Italy than to the Netherlands. Italy also has significantly more coastline where terminals can be developed, though set against this are Italy's more opaque planning laws and the power of regional and local governments to block projects.

[140] *Ministero dello Sviluppo Economico, "Sicurezza degli Approvvigionamenti Energetici per l'Italia Stato dei Progetti e degli Accordi internazionali al 2008"*, slide 9. Original text in Italian, translation by The Brattle Group.

[141] MSE press release dated 23 April, 2010.

3.10 SWOT Summary

In Figure 28 below we summarise our discussions above into a SWOT analysis. Our SWOT analysis confirms the main strengths and opportunities that are the driving force behind the Dutch gas hub strategy. Market participants like the excellent range of options that the Netherlands provides for both buying and selling gas through its connection to multiple markets and gas sources. The TTF is currently the largest Dutch trading hub by volume, which further promotes the attractiveness to importing LNG into and transiting gas across the Netherlands. Growing demand for gas imports, especially in the UK, will provide an opportunity to increase transit volumes across the Netherlands.

Figure 28: *Summary of SWOT Analysi*

Strenths	Weaknesses
• Strong and well-developed E&P sector. • Attractive regulatory process. • Connection to several sources of gas with diverse costs. • Multiple options for selling imported LNG. • Existing high liquidity of the TTF. • High volume of market information on flows etc. • Large number of depleted fields that can be developed into storage. • Current strong position of the TTF. • Diverse physical deliveries to support TTF trading.	• Balancing charges - though this is being addressed. • Lack of stable long-term transit tariffs. • Risk of high 'transit' tariffs. • Lack of transparency in some areas relating to gas transport. • High cost of trying tot export flexibility provided by gas storages. • Entry-exit charges for gas storgaes could act as an investment barrier. • Concerns regarding market power of the incumbent. • 'Red tape' reduces the 'ease of doing business'.
Opportunities	**Threats**
• Increasing demand for imports from GB, France and other countries could increase transit volumes. • Sites available for new LNG terminals, relatively cheap expansion of the Gate terminal possible. • Chance to develop a 'first-mover' advantage in gas R&D and create future export opportunities in e.g. Biogas. • Potential for TTF to establish itself as the European reference hub. • Creation of across-border trading hub based around TTF. • Increased gas demand to provide balance for intermit-tent wind-power.	• Environmental legislation, energy efficiency, biogas and growth in nuclear reducing gas demand, especially in the UK. • Growth of a Belgian hub takes away Russian transit flows. • Bypass via Germany/ • Competition from LNG terminals outside NL. • If TTF did not develop into the premier trading hub, this could threaten LNG imports and transit flows. • Competition from gas storage especially in the UK, maybe Germany. • Current gas 'bubble' could deter infrastructure investment. • Emergence of another trading point as the market reference hub. • Hub of inefficiencies from R&D subsidies.

Our scenarios illustrate the potential for increased Dutch transit flows. But they also highlight the possibility that other countries can compete for transit flows, that the Netherlands could be bypassed by direct imports of LNG and that energy efficiency measures could significantly reduce gas demand. Ensuring that the gas transport tariffs remain as transparent and competitive as possible will be important in promoting Dutch gas transit volumes.

The TTF currently has a lead over other trading hubs in terms of trading volumes, and a geographic advantage in terms of the gas sources it connects. But it is clear that the German trading hubs are catching up fast in terms of volumes, and something more needs to be done to maintain the TTF's current lead. We discuss possible measures below.

Market participants have confirmed that the Netherlands is an attractive destination for landing LNG. But the Netherlands is competing with all other coastal countries in the EU for the ability to re-gasify LNG. Maintaining and building the liquidity of the TTF and the capacity of connections to other markets will be important in giving the Netherlands the edge as a destination for LNG imports.
The existing R&D initiatives in the Netherlands and the geographic nexus of industry expertise and university-based research are a strong advantage. These initiatives could be used to give the Netherlands expertise in a growth area such as biogas, which could be used as a platform for future exports and growth. However, the Danish experience also points to the dangers of excessive subsidies in pushing a chosen technology. Once initial R&D work is done, the market should be left to decide which technologies will ultimately be successful.

The ambitions of the Netherlands to increase its exports of flexibility seem to have less foundation than other elements of the gas hub strategy. The decline of the Groningen field – which has provided a cheap source of flexibility for decades – means that in future gas storages will need to provide for a much larger share of the demand for flexibility. While the Netherlands has a wealth of geological opportunities for gas storage development, it is not clear that these storages can compete over long distances against the large volume of gas storage being developed in the UK and Germany.
As Europe's indigenous gas production declines and market liberalisation increases, gas imports and trading will increase. The Netherlands is in a strong position to claim a share of the growing markets in gas transit, LNG imports and gas trading. However, as our analysis demonstrates, this Dutch ambition will not go unopposed. In the next section we describe some policies that could address some of the weaknesses and threats identified and increase the Netherlands' chances of executing a successful gas hub strategy.

3.11 Policies to Promote the Gas Hub Strategy

As mentioned previously, the Government report lists a broad range of actions to promote the Dutch gas hub. We have also developed a number of proposals to address the weaknesses and threats our analysis identifies, which fit in to the actions set out in the Government report as described below.
The Netherlands should enable GTS to sell 'open season' capacity under long-term, multi-year tariffs. This would significantly reduce the risk to shippers buying open season capacity, because they would know exactly the financial commitment that they are making. This fits with Action 4 of the Government report to review the gas transmission tariff regime.
ELI could discuss with the Energiekamer whether GTS's entry/exit tariff proposals are consistent with the ambition to increase transit flows. We understand that GTS has developed its tariffs with the broader 'gas roundabout' strategy in mind. Nevertheless, GTS's proposal will increase the costs of shipping gas from the north to the south. While GTS claims that these tariffs are required to finance new investments, it could be investigated if the new tariffs ensure that transit across the Netherlands is still attractive relative to competing transit routes via other TSOs. As above, this policy could be part of action 4 of the Government report to review the gas transmission tariff regime.

To ensure that the TTF maintains its lead over other trading hubs, it would be desirable to maximise integration between the TTF intra-day market and the new balancing market, with the ultimate aim of a single intra-day market that will maximise liquidity. This will help promote investment in gas infrastructure in the Netherlands.

There is no particular reason why policy makers would have to choose one element of the gas hub strategy over another, since the different elements do not compete with one another, but rather are highly complementary. We note however that the upstream sector has the most value-added for the Dutch economy. Promoting upstream gas is part of Action 3, 'Using domestic sources of energy'.
ELI should continue to facilitate the business environment in the Netherlands. We recognise that this is a complex task and that in any case measures that business regards as a burden may be desirable from a social point of view. Measures such as the National Coordination (Energy infrastructure Project) regulations continue to be important to the success of the gas hub. This action fits with Action 4 which relates to promoting investments.

4 The Economic Impact of a Dutch Gas Hub Strategy

The Dutch Government and other market actors are already taking steps to implement a Dutch gas hub strategy. To assess the economic impact of such a policy, we need to describe a world with and without the successful implementation of this policy. In this section we develop a Base Case scenario, where the gas hub strategy is less successful either because policies are not continued or due to external factors that make the policy difficult to implement. We also define a scenario for a successful gas hub strategy (the Gas Hub scenario) in terms of increased investments relative to the Base Case scenario.

Clearly, defining precisely what a successful gas hub strategy would look like in 2020 involves many subjective assumptions. We stress that this is not intended to be a prescriptive view of what a successful gas hub policy will look like. Rather it a plausible scenario that enables us to estimate the likely range of benefits of a gas hub strategy.

We describe the gas hub strategy for each of the elements of the gas sector – upstream, transit, trading and so on, and then assess the impacts on the goods and services produced and on employment. We also produce an estimate of the spending and investment in the Base Case scenario and the Gas Hub scenario.

4.1 Investments With and Without the Gas Hub Strategy

4.1.1. Upstream Sector

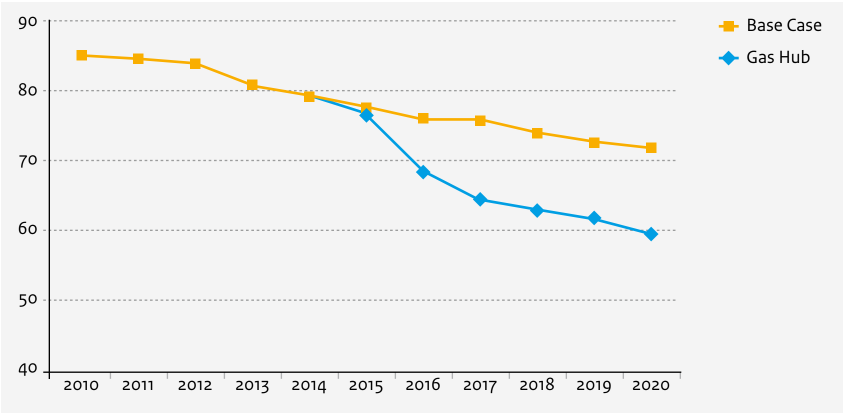
Our Base Case scenario assumes that upstream investment will be proportional to the level of production in the Dutch gas sector, which will decline over time. We recognise that this is somewhat simplistic, since there is a lag between investing in new production capacity and the production itself. However, our approach will give a plausible pattern of the shape of the decline in investment over time.

In the Gas Hub scenario we assume that additional efforts are made to explore and develop new fields. EBN believes it is not unrealistic to imagine a further 15 exploration wells each year, each with a 50 - 60% success rate. This would provide add around 230 bcm over the next 30 years.[142] EBN has developed a production forecast to 2040 that includes production from these new fields. The forecast also assumes that production at existing fields is increased and extended and that fields that are already recognised as potential developments are drilled. In the Gas Hub scenario we have compared the EBN forecast and the NLOG forecast used in the Base Case scenario and use whichever has the highest level of production.[143]

[142] EBN report (June 2010), *op. cit.*, p. 18.

[143] We have not adjusted for any differences in calorific value assumed by the forecasts. The NLOG forecast uses bcm (35.17 MJ/m3) and we do not know of the CV assumption of the EBN forecast.

Figure 29: *Production Forecasts in Base Case and Gas Hub Scenarios*



EBN has set the E&P industry a target of 30 bcm/year for production from conventional small fields and unconventional gas resources in 2030. It expects that additional production could arise from developing technologically challenging fields, further extending production at existing fields, and developing unconventional resources but we have not included production from these potential options in our Gas Hub scenario. EBN reports that to explore 15 or more new fields each year would cost at least €1.5 billion each year. This figure includes both the investment to add to the reserves and for production. In the Gas Hub scenario we estimate the investment needed using the approach used in the Base Case scenario that assumes that investment is proportional to production. We then use either this figure or the €1.5 billion quoted by EBN for the Gas Hub scenario whichever is the largest. Appendix XIII shows the investments and revenues associated with the upstream sector in the two scenarios.

4.1.2 Transit

For flows to the UK in the Base Case scenario we use National Grid's base case scenarios, which results in BBL and IUK supplying 0.1 bcm/year to the UK in 2020. Accordingly, Dutch transit flows are under 0.1 bcm/year. For transit flows to Belgium and France we use the demand forecasts of the CREG and GdF Suez respectively, and we assume that Russian gas follows the same flow pattern as in 2010, with some volumes flowing through Germany. This results in transit flows of 18 bcm/year to Belgium and France via the Netherlands.
For the gas hub scenario, we model a case where UK imports of LNG are lower[144], because shippers prefer to import gas via pipeline through the Netherlands. This results in about 11.0 bcm/year of gas flowing to the UK via BBL and IUK, or 8 bcm/year of transit flows through the Netherlands. With respect to transit flows to Belgium and France in the gas hub scenario, we model a case where a greater percentage of Russian gas flows through the Netherlands rather than flowing through Germany. This results in transit flows of 25.9 bcm/year, or 7.9 bcm/year more than in the base case. In total, the gas hub strategy involves an increase of about 13 bcm/year more than the Base Case.[145] Appendix XIV contains details of the different gas flows and the scenarios.

[144] We assume half the growth assumed in National Grid's base case.

[145] This is less than the sum of 7.8 bcm/year from transit flows to the UK case plus 7.9 bcm/year from transit flows to Belgium because we assume that some of the transit flows to the UK travel via Belgium through IUK and so the 7.9 bcm/year figure includes these flows.

We have made approximate estimates of the additional pipeline investments required to meet the transit volumes in the gas hub scenario. Typically, it would not be required to build new pipeline all the way across the Netherlands, because some parts of the existing pipeline network could be upgraded instead, or may even have spare capacity once other parts of the network are 'de-bottlenecked' or made available due to declining domestic production. For example, Gasunie (GTS) upgrading transit capacity bought in its open seasons by investing in a series of de-bottlenecking projects. However, neither we nor Gasunie knows what the network will look like in 2020, and how much investment will be required to achieve a given level of additional capacity from one border entry point to another border exit point. Accordingly, we have used generic pipeline cost estimates, and assume that new pipeline is required for 70% of the route. Appendix XV gives details of the cost calculations for new transit pipelines.
We estimate that the additional transit volumes would require additional investment of about €700 million. However, based on Gasunie's historic and planned investments this number appears to be rather low for the capacity involved. Given that our transit scenarios are relatively modest and that section 3.2 shows that transit volumes could be much larger, it seems more appropriate to model additional transit investment of €1 billion spread over five years. We model this investment in the gas hub strategy case.

4.1.3 Storage/Flexibility

For the analysis of transit flows, we undertook a supply and demand balance to estimate a realistic number for additional transit flows in the gas hub scenario. We could have tried to undertake a similar approach in assessing the need for new gas storage facilities. However, unlike transit, gas storage is a 'lumpy' investment, in the sense that one either builds an integer number of gas storage facilities of an efficient scale, or none. According, we concluded that it was more realistic simply to add a storage facility of typical minimum economic scale in the Netherlands in the gas hub scenario, in addition to the three gas storage projects already planned. As we described in section 3.5, flexibility and storage seem to be one of the weaker elements of the gas hub strategy. Therefore we do not believe that it would be appropriate to add more than one additional gas storage facility in the gas hub scenario.
The investment in the additional gas storage facility is €500 million, plus €50 million in associated investment in the gas transport network. This number is a rough average of the Bergermeer storage project – which we understand will cost about €800 million[146] – and the two salt-cavern storage projects in Zuidwending. We understand the cost of the first phase at Zuidwending was expected to cost around €350 million and assume the second phase will be a similar cost.[147]

4.1.4 LNG

In our Base Case scenario we assume that only the Gate LNG terminal is constructed. Under the gas hub strategy, the Gate terminal is expanded from 12 to 16 bcm/year. We assume that expanded Gate capacity at two-thirds of the original cost of capacity, because some of the expansion investments have already been made in the first phase of the terminal. This results in a cost of about €190 million for the additional 4 bcm/year of capacity, plus €100 million of pipeline investments to transport the additional gas volumes. We also add an 11 bcm/year LNG terminal at Eemshaven at a cost of €600 million, plus an additional €200 million for associated pipeline investments.[148]

146 Gasopslag Bergermeer news, "Bergermeer gas storage consortium and Gazprom export press ahead with final investment", 21 October 2009, see http://bergermeergasstorage.asp4all.nl/Nieuws/articles/BGC_final_investment.html.

147 A world gas conference report on Zuidwending from 2006 reports that the investment is expected to cost €350 million. See http://igu.dgc.eu/html/wgc2006/pdf/paper/add10531.pdf, Section 3.10.

148 While we are aware that the current Eemshaven LNG terminal project has been cancelled, we consider it likely that an LNG terminal will be constructed at Eemshaven, once the current over-supply in European gas has been addressed by growing demand and curtailment of new supply. Many commentators expect this to happen between 2013 to 2015.

4.1.5 Gas Trading

The gas hub strategy would involve an increase in the traded volumes on the TTF – the expanded volumes would promote new investments while at the same time new gas infrastructure would likely increase traded volumes.

In 2009 TTF trading volumes were 82 bcm and had grown 28% from the previous year. The UK's NBP – a more mature market – grew at about 10% per year. Accordingly, in the Base Case scenario we assume that volume growth in the TTF reduces to 10% a year by 2015, and remains at that level. In the gas hub strategy we assume the same volume-growth rate as the Base Case for two years, but then the rate of annual volume increases returns to the current high growth rates of about 30%. Volume growth rates remain at that level until 2020. The assumption here is that the gas hub strategy promotes volume growth in the TTF, which is why the rate of growth increases in the under the gas hub strategy.

The main value of gas trading is indirect – in the sense that it encourages shippers to enter the market on the supply side and promotes investment in gas infrastructure. Moreover, much of the profit of trading involves transfers from one party to another. However, trading does have a net value added to society, because it matches supply and demand for gas and creates a more efficient allocation of gas resources.
In terms of the net revenues that additional trading in the gas hub scenario creates, we multiply the volumes by the APX-ENDEX trading fee. This broadly assumes that other revenues and profits net out between the different trading parties. Given the 2010 trading fee of €0.0075/MWh, the gas hub strategy results in cumulative trading revenues of about €385 million, slightly more than double for the Base Case scenario (see Appendix XVI).

4.1.6 R&D

Spending on R&D should ultimately generate a return. In the context of the Dutch gas hub policy, we think the most plausible scenario is that the Netherlands attempts to emulate the Danish wind industry by investing in an up and coming 'green' technology, from which it then reaps future rewards. The most promising area with respect to gas is the biogas or green gas sector. We model a case where the Netherlands invests in R&D in the green gas sector, and as result gains intellectual property in the manufacture of green gas which gives it a share of the sector in the EU.
Several EU Member States have already set out targets for biogas production and use. The German government has set a target of feeding 6 billion cubic meters/year of biogas into the country's transmission system by 2020,[149] which would represent over 6% of forecast gas demand.[150] The Netherlands has an ambition to produce 8-12 % of its gas needs from biogas, or about 4 bcm/year by 2020.[151]
We have modelled a scenario where biogas production increases linearly to 4% of EU gas supply by 2020. Cedigaz forecasts that EU gas demand will be 605 bcm/year by 2020, which implies that 24 bcm/year of biogas would be produced in that year.[152]

By biogas, we mean biomethane produced from manure or agricultural/industrial waste, which has been refined to meet the quality standards of the transmission network. Another area of investment would be biogas used for small scale electricity generation or for use in transport. While we acknowledge that these are potential areas for R&D, in our scenario we have focused on biogas for injection into the transmission system.

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[149] *Platts* European Gas Daily, 10 February 2010, p. 4.

[150] Cedigaz forecasts German gas demand of just over 91 bcm/year by 2020. See Armelle Lecarpentier, "European gas demand prospects: Long term supply requirements", Cedigaz, 24 February 2009

[151] Mathieu Dumont, "Biogas in the Netherlands experiences and visions", SenterNovem, 28 April, 2009.

[152] *Op. cit.* footnote 150.

Biogas requires capital investments of about €8,000/kW of production capacity. Based on the gas production numbers above, this implies an average investment in biogas equipment in the EU of about €27 billion per year between 2011 and 2020 inclusive. Appendix XVII gives details of these calculations.
In the Base Case scenario, we assume that spending on biogas R&D in the Netherlands reduces from its current/near-future level of about €100 million per year to €50 million per year by 2013. In the Base Case, we assume that patents and licenses give the Netherlands revenue equal to 0.5% of the amount that the EU has invested in biogas production. A typical royalty rate for the Dutch firms who have developed patents related to biogas technology would be around 25% of the gross profits of the firms who are licensed to use the technology.[153] Assuming a 10% profit margin, this royalty rate translates to 2.5% of revenues. To capture 0.5% of the revenue from investing in biogas production implies that Dutch firms license 20% of the capital invested in biogas in the EU.[154]

In the gas hub strategy, the Netherlands continues to spend €100 million per year on biogas R&D up to and including 2015, whereafter investment in biogas R&D in the Netherlands falls to €50 million per year. As a result of the higher rate of investment in biogas R&D in the Netherlands, a larger share of EU investments in biogas production is linked to Dutch patents. We assume that the share increases 60% in the Gas Hub scenario. As a result Dutch revenues from patents are 1.5% of the EU wide investments in the sector.[155] This translates to revenues from licenses and patents of about €440 million in 2020, compared to about €148 million in the Base Case scenario. We give details of the calculation in Appendix XVII.
Note that we are not claiming that the Netherlands should invest in biogas to the exclusion of all other sectors. This is simply a plausible scenario to illustrate the potential benefits of increased R&D activity in the gas hub scenario.

4.2 Summary of Base Case and Gas Hub Scenarios

Table 9 below summarises the investments for the Base Case and Gas Hub scenarios. It is these numbers that feed into the economic modelling of the effects of the gas hub strategy discussed in the next section. As Table 9 shows, the Gas Hub scenario involves approximately an additional €7.7 billion of investment and that additional investment creates an exogenous change in the Dutch economy that generates additional income from intellectual property royalties and value-added of TTF trading of €1.8 billion revenues relative to the Base Case.[156] Note that all the numbers are in 2009 Euros that is, they are in real terms. Because we are not calculating the present value of the investment, when the money is spent will not make a difference to the results.

[153] For a discussion of royalty rates, see 'Profitability and Royalty Rates Across Industries: Some Preliminary Evidence' by Jonathan E. Kemmerer and Jiaqing Lu.

[154] We arrive at a revenue figure that equals 0.5% of investment costs in the EU using the following approach. Revenues are equal to the royalty rate x gross profit (= 25% of gross profits). Gross profit is assumed to be 10% of investment costs. This means that revenues = 25% x 10% x investment costs. We assume the Netherlands receives royalties on 20% of investments in the EU which produces a revenue that equals 25% x 10% x 20% x EU investment costs or 0.5% x EU investment costs.

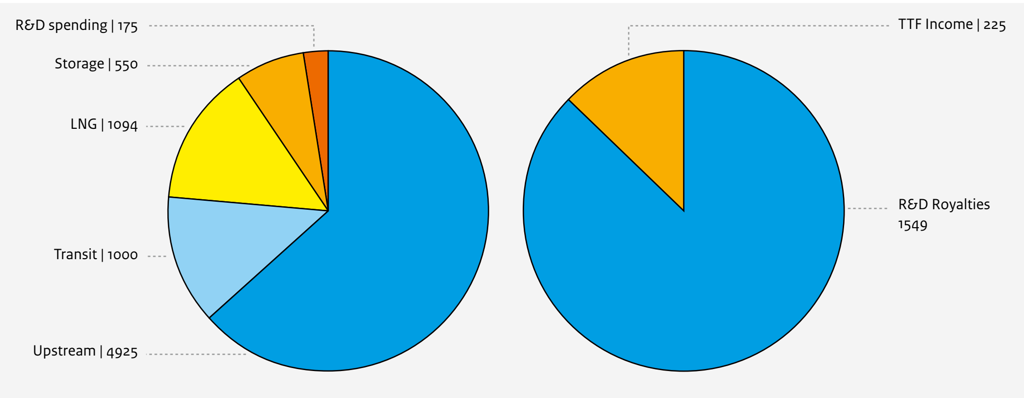
[155] 1.5% is calculated as 25% (royalty rate) multiplied by 10% (gross profits as percentage of investment costs) multiplied by 60% (percentage of EU production market that is linked to Dutch patents).

[156] As noted previously, we assume that a successful gas hub will result in substantial new intellectual property royalties and TTF extra revenues which do not change the structure of the inter-industries flows in the Dutch economy. As a result, we include these extra revenues as an exogenous increase in income into our system to capture the impacts that results from these extra income being spent in the economy.

Table 9: *Summary of Investments and Spending in the Base Case and Gas Hub Scenarios*

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2010-2020
Base Case												
Investments (€ mn)												
Upstream:	1,220	1,212	1,203	1,160	1,134	1,100	980	928	902	885	851	11,575
Transits:	333	333	333	333	333	333	333	333	333	333	333	3,997
LNG:	229	114	0	0	0	0	0	0	0	0	0	343
Storage:	117	117	383	383	267	0	0	0	0	0	0	1,267
R&D:												
Spending:	100	100	75	50	50	50	50	50	50	50	50	675
Royalties	0	121	126	131	135	139	138	140	143	145	148	1,367
Income (€ mn)												
TTF	7	9	10	12	13	14	16	17	19	21	23	160
Gas Hub												
Investments (€ mn)												
Upstream:	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	16,500
Transits:	333	333	333	333	333	333	533	533	533	533	533	4,667
LNG:	229	114	171	274	274	86	147	147	0	0	0	1,436
Storage:	117	117	383	383	267	0	0	167	192	192	0	1,817
R&D:												
Spending:	100	100	100	100	100	100	50	50	50	50	50	850
Royalties	0	146	177	209	244	279	304	337	371	407	443	2,916
Income (€ mn)												
TTF	7	9	12	15	19	25	33	43	56	72	94	385

Figure 30: *Break-down of Additional Spending and Additional Income from Intellectual Property Royalties and Value-Added of TTF Trading Between 2010 and 2020 in the Gas Hub Scenario Relative to the Base Case, € million*



4.3 Economic Impact

To estimate the effect of the Gas Hub strategy on Dutch goods and services produced and employment, we use the same methodology used to estimate the current contribution of the Dutch gas sector, namely the input-output model described in Appendix V and Appendix VI. We estimate the impact on the economy of the investments (a) under the Base Case scenario, (b) with the Gas Hub scenario. The impact of the Gas Hub strategy is the difference of the two. Note that this analysis differs from the earlier estimates of the overall impact of the gas sector on the Dutch economy by focusing the analysis on investment (and structural changes created by that investment in the royalties collected on related intellectual property and increased trading on the TTF) instead of the total impact of the sector on the economy.

The gas sector upstream and downstream investments described above represent revenues for other firms which are part of different sectors of the economy. The gas sector investments over 2010-2010 under Base Case and Gas Hub scenarios are allocated across different sectors using the shares developed in Appendix XIX.[157] We have assumed that the incremental revenues generated by the Gas Hub scenario from returns to leasing intellectual property developed as a result of extra investment in R&D are distributed back into the economy and become extra income to Dutch households. The induced effects in the input-output model captures this effect. To allocate these additional revenues to specific sectors, we use the current share of household income spent in each sector.

The impact of investments under the Base Case is shown on Table 10 below. These values are for the entire investment period of 2010-2020. The details of Table 10 are reported by sector in Appendix XX.

Table 10: *Base Case Investments Impact on Dutch Economy and Labour*

Sector	Final Demand	Total Output	Job-Years			
			Direct	Indirect	Induced	Economy Wide
	2010-2020		2010-2020			
	Mil Euros	*Mil Euros*	*FTE*	*FTE*	*FTE*	*FTE*
Upstream	€ 11,575	€ 26,071	64,045	47,192	49,481	160,718
Transport	€ 3,667	€ 8,458	21,795	15,647	16,614	54,056
LNG	€ 343	€ 791	2,038	1,463	1,554	5,055
Storage	€ 1,267	€ 2,922	7,529	5,405	5,739	18,674
R&D	€ 675	€ 1,442	4,987	1,076	4,127	10,190
TTF	€ 160	€ 319	595	399	627	1,621
Total	**€ 17,686**	**€ 40,003**	**100,990**	**71,182**	**78,141**	**250,314**

Notes and sources:

[1]: Calculations based on The Brattle Group model, based on Eurostat and CBS data.

[2]: FTE = Full Time Equivalent.

[157] Technically, as described in Appendix V, we use the change in final demand as input parameters. We have the assumed investments of upstream, downstream and R&D sectors, and so we need to allocate them as increases in the final demand of several sectors.

Table 11 illustrates the impact of the additional investments over the 2010-2020 period under the Gas Hub scenario relative to the Base Case. We report the results in terms of FTE job-years. A job-year is the equivalent employment of one person for one year. This is a more rigorous way of presenting the employment effects, since most investments will create jobs but for varying lengths of time. The use of job-years gives the most accurate picture of the overall effect on employment. Table 11 shows that in total, the Gas Hub scenario could create up to 136 thousand FTE job-years of employment, which is equivalent to 13.6 thousand FTE jobs per year for ten years. During the period 2010-2020, there is also about €21.4 billion of additional goods and services generated by the investments made.

Table 11: *Additional Impact of the Planned Gas Hub on Dutch Output and Employment*

Sector	Final Demand	Total Output	Job-Years			
			Direct	Indirect	Induced	Economy Wide
	2010-2020		2010-2020			
	Mil Euros	*Mil Euros*	*FTE*	*FTE*	*FTE*	*FTE*
Upstream	€ 4,925	€ 11,0931	27,250	20,080	21,053	68,383
Transport	€ 1,000	€ 2,307	5,944	4,267	4,531	14,743
LNG	€ 1,094	€ 2,523	6,501	4,667	4,955	16,122
Storage	€ 550	€ 1,269	3,269	2,347	2,492	8,108
R&D Expenditures	€ 175	€ 274	1,293	279	1,070	2,642
R&D Expenditures	€ 1,549	€ 3,418	11,253	5,411	7,097	23,761
TTF	€ 225	€ 448	835	560	880	2,275
Total	€ 9,517	€ 21,431	**56,346**	**37,610**	**42,079**	**136,035**

Notes and sources:

[1]: Calculations based on The Brattle Group model, based on Eurostat and CBS data.

[2]: FTE = Full Time Equivalent.

[3]: The incremental revenues generated in the Gas Hub scenario from returns to leasing intellectual property developed as a result of extra investment in R&D are assumed to be distributed and to become extra income of Dutch households.

We note that our estimate of employment associated with these investments differs with recently published estimates by Gasunie, which stated that their open season investment programme would create 15,000 jobs.[158] Gasunie calculates a very sensible and straightforward approximation to the employment impacts by assuming 30% of the investment spending is on imported goods and the remaining 70% of investment spending is divided by average Dutch construction salaries (which they estimate to be about €56,000). This approach finds that one job is created for every €80 thousand invested. In contrast, our analysis based on a more detailed accounting of economic flows finds that on average one job is created for every €70 thousand invested. The details of Table 11 are reported by sector in Appendix XX. The jobs created as a result of the gas hub investments also slightly higher quality than average, as measured by wages. The average annual wage of the extra jobs created in the hub scenario was estimated to be about €32,600.[159] The annual wage of a FTE worker in the Netherlands in 2006 was about €31,500.[160]

[158] Gasunie press release, "Gasunie customers urgently demand capacity expansions in Dutch and German gas transport networks", 09 December 2009, see http://www.gasunie.nl/en/gu/nieuws/gasunie-klanten-dringen-aan-op-uitbreiding-capaciteit-in-nederlandse-en-duitse-gasnet.

[159] In 2006 euros.

[160] In 2006 euros.

4.4 Effect on Competition

The gas hub strategy could increase the intensity of competition in the Dutch gas sector, because it would increase the volumes of gas from alternative sources that could supply Dutch consumers. Transit flows, by definition, are not intended to serve Dutch consumers. But these flows could be diverted to the Dutch market, if prices were to rise sufficiently. The Dutch entry-exit system facilitates such diversions. There are no dedicated transit pipelines that are physically separate from the domestic gas transport system, and it is relatively simply for shippers transiting gas to buy exit capacity at a point in the Netherlands. Therefore transit flows apply a competitive constraint on the Dutch gas market, even though the volumes are not routinely sold in the market. The same logic applies to additional LNG imports, which may usually be re-exported. If a market party attempted to abuse market power and raise gas prices in the Netherlands, LNG importers could respond by diverting their gas to the Netherlands.

Clearly it is highly uncertain what market shares and production volumes will be in 2020. Nevertheless it is useful to investigate whether increased transit flows and imports of LNG could have a material effect on the degree of competition in the Dutch gas market, and gas prices in the wholesale market.
To arrive at an estimate of the effect that the gas hub strategy could have on competition, we have estimated market shares of the upstream/import market under a Base Case scenario and estimated the increase in competition that could result under a gas hub scenario. We are interested in the upstream/import market because the supply of gas – either by production or imports – will determine the wholesale price of gas in the Netherlands, which will feed through to retail gas prices. We have used this market definition in merger and competition cases in the gas industry and it is an accepted way in which to measure 'upstream' market power in the supply of gas to wholesalers. Note that this market definition differs from the definition of the wholesale market, which is typically defined as parties who buy gas from importers/producers to sell to large customers or re-sellers. Note that for the purposes of this exercise we assume Hi-cal and Lo-cal gas occupy the same market.

We also note that one of the aims of the Dutch Government is to expand the current gas market to create a true north-west European market for gas. If this endeavour is successful, then the market concentration with a successful gas hub will be even lower than described in this exercise, and the benefits for consumers would be even greater.

We have constructed a Base Case competition scenario based on the forecast volumes of Groningen gas, production from small fields and imports. We have estimated NAM/GasTerra's share of the upstream/import market in 2020 and the share of other non-NAM producers and shippers.[161] We then calculate the Herfindahl-Hirschman Index or HHI for the Dutch upstream/import market. The HHI is a concentration index which varies from 0 for a perfectly competitive market to 10,000 for a perfect monopoly.[162] Economists generally regard a market with an HHI of less than 2,000 as workably competitive, although the exact boundary will vary by industry.

[161] We do not assume that NAM and GasTerra would compete with one another, because they are both part of the '*Gasgebouw*' and have similar shareholders, and they are in effect vertically integrated. For example NAM would not attempt to sell its gas in competition with GasTerra.

[162] Mathematically, the HHI is calculated as the sum of the squares of market shares. For example, in a market with four players of equal size, each player would have a 25% market share. The HHI would then be 25^2 (= 625) multiplied by 4, which gives an HHI of 2,500.

Our 2020 Base Case scenario assumes that, apart from NAM/GasTerra, there are 10 gas producers of equal size in the Netherlands. GasTerra is responsible for 50% of the gas imported into the Netherlands, with the remainder imported by 10 shippers of equal size. Note that in this context we mean gross imports – some of the gas could be re-exported, but as we explain above it is gross imports which count because volumes could always be diverted into the domestic market. We estimate that in 2020 the largest player – NAM/GasTerra – has a share of the upstream/import market of about 73% in our Base Case scenario, which results in an HHI of about 4,900. This represents a concentrated upstream/import market.

In the Gas hub scenario, we add an additional 13 bcm/year of transit flows and an additional 6 bcm of LNG imports. The latter assumes 15 bcm/year of extra re-gas capacity relative to the base case, operating at a 40% load-factor. We model a case where the additional transit flows are again split among 10 players of equal size. We divide the additional LNG volumes between four players of equal size. In this scenario NAM/GasTerra has a market share of about 60%. The HHI is just under 3,500, a drop of about 1,700 points or 30%. While an HHI still represents a concentrated market, it is still a significant improvement in the degree of competition.

We can translate the reduction in market share to a change in price. In an oligopolistic market,[163] the price-cost margin[164] for each firm is given by the negative of the market share of each firm divided by the elasticity of demand.[165] If we assume that the largest firm will act as a 'price setter', then the change in NAM/GasTerra's market share should tell us something about the reduction in the gas price that could result from increased competition. The percentage reduction in market share will equal the percentage reduction in price-cost margin – so in this case the gas hub scenario will result in a reduction in the price-cost margin of 17%.

Assuming an oligopolistic market structure, we can estimate the price change that would result from the reduction in market share.[166] If we assumed a marginal cost of gas in 2020 of €15/MWh, and that the Base Case price is €18/MWh, then in the gas hub scenario the price would fall to €17.4/MWh. This is a reduction of €0.6/MWh, or 3%.[167]

[163] An oligopoly consists of *n* firms that produce a homogeneous product. Therefore the upstream gas industry seems like a good approximation of an oligopolistic market.

[164] The price-cost margin is given by *(p – m)/p*, where *p* is the price and *m* is the marginal cost. It is essentially a measure of the gross profit the firm is making on each sale. It is also known as the Lerner Index.

[165] The elasticity of demand is defined as the percentage change in quantity that results from 1 percent change in price. Because demand (usually) goes down when the price goes up, then elasticity of demand is negative. In a market where demand is unresponsive to price, elasticity of demand is small. Dividing a market share by a small number will result in a high price-cost market. The intuition is that firms can charge higher prices where demand is insensitive to price.

[166] In an oligopolistic market, if there is a so-called Cournot equilibrium then we know that $p \times \left[1 - \frac{s_i}{\varepsilon}\right] = m$, where *p* is the price, s_i is the market share of firm *i*, ε is the elasticity of demand and *m* is the marginal cost.

[167] We estimate a marginal cost and price-cost margin, and then estimate the corresponding elasticity using the NAM/GasTerra market share in the BAU scenario. We then estimate the price in the gas hub scenario, using the reduced NAM/GasTerra market share and the price elasticity calculated in the first step. Standard theory would suggest estimating a price-elasticity and then estimating the price from the marginal cost. However, experience shows this approach can result in unrealistically high prices. In reality, firms are constrained in their pricing by many factors, including the fear of regulatory intervention, and this tends to reduce prices below the limit suggested by price elasticity and simple theory. The estimated *change* in prices as a result of the change in will not be sensitivity to the initial choice of marginal cost and price.

Of course, this analysis is somewhat simplistic – one could also argue that the incumbent price leader would not opt to cut prices at all, and would rather risk losing market share. As pointed out above, the calculations also assume that the Netherlands defines the relevant geographic market. If this is not the case in 2020 then the effect of the gas hub strategy on competition would be smaller. Nevertheless, the calculations give a feel as to the maximum effect that the gas hub strategy could have on competition and prices in the Netherlands. GTS estimates that in 2020 gas demand in the Netherlands will be about 50 bcm. If we apply a price reduction of €0.6/MWh to this size of market, the result is a reduction in gas purchase costs for Dutch consumers of about €300 million. Appendix XXI shows the details of the calculations discussed above.
The above is not intended as a rigorous exercise in competitive analysis. Rather it is a way to determine the order-of-magnitude effect that the gas hub strategy could have on competition in the upstream/import market. Our analysis illustrates that the infrastructure investments associated with the gas hub strategy could have a significant impact on competition in the Netherlands and reduce the incumbent's market share. Even relatively small price changes can result in large absolute transfers of wealth to the benefit of consumers. This is especially true is one considers that this would be a permanent effect, that could result in a drop in prices that would benefit consumers year after year.
Moreover, as we highlighted in section 3.3, some market players we interviewed had concerns regarding the large role that the incumbent supplier played in the gas market. A scenario where a greater degree of imports reduces the market power of the incumbent could result in a virtuous circle, boosting the confidence of new players to enter the Dutch market, and increasing competition further.

4.5 Effect on Security of Supply

As described in section 2.5, Dutch gas production combined with several gas storages and an LNG terminal give the country an excellent degree of supply security. The gas hub strategy would boost security of supply relative to the Base Case scenario by adding LNG and pipeline import capacity.

We note that just because there is more gas that can flow into the Netherlands in the event of a supply disruption, this does not mean that it will automatically do so. For example, the UK has experienced several occasions where gas prices rose due to a shortage of supply, but gas flows to the UK though the interconnector were less than expected. Similarly, gas entering the Netherlands, either via an LNG terminal or a pipeline, may be committed to other markets. Strong price signals will be required to incentivise shippers to divert supplies to the Netherlands in the event of a supply disruption. Accordingly, security of supply entails a mixture of additional gas import infrastructure and a well-functioning gas market, in the sense that prices reflect scarcity and market players respond efficiently to price signals.

In section 2.5 we estimated that in the event of a failure of the largest source of supply, the Dutch gas system would have a supply margin of around 30% on an hourly basis. In the gas hub scenario, we estimate that this margin increases to more than 50% on an hourly basis. The comparable figure for the Base Case scenario is around 30%. Note that these numbers are based on technical capacity. Unlike the GTS security of supply study, we do not consider the contractually available volumes of gas. Our calculations can be found in Appendix IX.

APPENDICES

Appendix I: Estimates of Share of Gas E&P in Bundled Categories

Some of the CBS data we have used for our analysis of the upstream sector covers both gas and oil E&P. For instance, the data that CBS provides on annual investments and employment for exploration and production sector is for gas E&P and oil E&P together rather than separately. We have estimated the percentage of the CBS data that applies to gas by allocating the data on a pro rata basis according to revenues.

We have estimated the revenues for the gas E&P sector and for the oil E&P sector. Table 12 shows our calculation. For the gas E&P sector we rely on production data from NLOG and GasTerra purchase costs. We understand that GasTerra's purchase also include storage costs but we these costs to be much smaller than the gas costs.

For oil E&P, we use oil production data from NLOG and the Brent price. We find that over the last five the revenues earned by the gas E&P sector were 96% of the revenues earned by the gas and oil E&P sector together.

Table 12: *Estimates of Revenues for Dutch Gas and Oil E&P*

	Gas production					Oil production						
	Production (mn Sm3) [1] See note	Volume Purchased by GasTerra (bcm) [2] See note	Purchase Costs of GasTerra (€ mn) [3] See note	Indicative Gas Price (€/m3) [4] [3]/([2]x1000	Revenue (€ mn) [5] [1]x[4]	Production (1,000 Sm3) [6] See note	Price (US$/bbl) [7] See note	m3/bbl [8]	Exchange rate (US$/€) [9] See note	Price (€/m3) [10] [7]/[8]/[9]	Revenue (€ mn) [11] [10]x[6] /1000	Gas revenue as % of total [12] [5]/([5]+[11])
2005	73,116	80.4	13,568	0.17	12,339	1,825	55.0	0.16	1.244	278	507	96%
2006	70,741	78.8	17,390	0.22	15,612	1,561	65.4	0.16	1.256	328	511	97%
2007	68,310	77.8	16,642	0.21	14,612	2,497	72.5	0.16	1.370	333	831	95%
2008	79,959	84.1	22,956	0.27	21,826	2,102	97.0	0.16	1.471	415	872	96%
2009	73,732	82.4	17,343	0.21	15,519	1,560	61.5	0.16	1.394	278	433	97%
												96%

Notes and sources:
[8]: From IEA publication "Energy prices and taxes, Q1 2010".
[2],[7]: From NLOG publication "Natural Resources and Geothermal Energy in the Netherlands; Annual Review 2009"
[3]&[4]: GasTerra Annual Reports
[9]: European Central Bank

We perform a similar calculation to estimate the proportion of the "Mining and Quarrying" sector that is gas and oil E&P. This time we use data provided by CBS data on revenues to allocate the Mining and Quarrying data between oil and gas E&P and other activities that are included in Mining and Quarrying. Table 13 shows our calculation.

Table 13: *Estimate of % of Mining & Quarrying that is Oil and Gas E&P*

			2004	2005	2006	2007	2008	Average
Revenue for Mining & Quarrying Category (€ mn)	[1]	CBS	20,956	25,021	31,299	30,749	41,263	
Revenue for Oil& Gas E&P Category (€ mn)	[2]	CBS	18,277	22,059	27,480	26,760	37,411	
Revenue for Related Services Category (€ mn)	[3]	CBS	1,797	2,088	2,638	2,953	2,662	
Oil & Gas E&P as % of Mining & Quarrying	[4]	([2]+[3])/[1]	96%	97%	96%	97%	97%	96%

Appendix II: Capital Expenditures in Gas E&P

We present below in Table 14 our estimate of annual investment costs in gas E&P in the Netherlands.

Table 14: *Investments in Gas E&P*

			2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Investment in oil and gas E&P (€ mn)	[1]	CBS	435	566	962		649			845			
Investment in services associated with oil & gas E&P (€ mn	[2]	CBS	283	213	250	210		121	606				
% of oil & gas E&P that is gas E&P	[3]	Appendix I	96%	96%	96%	96%	96%	96%	96%	96%			
Investment in Gas E&P (€ mn)	[4]	[3]x[1]	418	545	925		624			813			
Investment in services associated with gas E&P (€ mn)	[5]	[3]x[2]	272	205	241	202		116	583				
PPI for machinery & equipment	[6]	CBS	95	97	98	97	98	100	102	103	105	108	
Investment in gas E&P (€ mn; 2009)	[7]	[4]x[6]$_{2009}$/[6]	474	606	1,019		688			851			728
Investment in services associated with gas E&P (€ mn; 2009	[8]	[5]x[6]2009/[6	308	228	265	223		126	620				295
Total investment (€ mn; 2009)	[9]	[8]+[7]											1,023

Appendix III: Operating Expenditures in the Gas Industry

We have estimated operating costs for the Dutch gas industry in a similar way to the investment costs: by relying on data published by the CBS and on financial statements of industry players. We allocate costs to individual component of a bundled sector using the approach we describe in Appendix II. We also convert costs to 2009 money. We show how we calculated our estimates in the tables below.

Table 15: *Operating Expenditures for Gas E&P*

			2002	2003	2004	2005	2006	2007	2009	Average
Operating expenses for Oil and Gas E&P (€ mn)	[1]	CBS	2,075	2,255	2,793	2,868	3,888	3,668		
Operating expenses for services associated with Oil and Gas E&P (€ mn)	[2]	CBS	669	515	525	621	790	941		
% of Oil and Gas E&P that is Gas E&P	[3]	See note	96%	96%	96%	96%	96%	96%		
Wage inflation index	[4]	See note	78	83	88	87	91	96	101	
Operating expenses for Gas E&P (€ mn, 2009)	[5]	$[3]/[1]x[4]_{2009}/[4]$	2,581	2,639	3,097	3,199	4,174	3,708		3,233
Operating expenses for services associated with Gas E&P (€ mn, 2009)	[6]	$[3]/[2]x[4]_{2009}/[4]$	832	603	582	693	848	951		752

Notes and sources:
[1].[2]: We include staff costs and other operating costs but exclude costs of sales
[3]: Based on a comparison on revenues generated in the gas E&P sector and in the oil E&P sector.
[4]: We use Eurostat's labour cost inflation index for the Mining & quarrying sector to inflate the operating expenses.

Table 16: *Operating Expenditures for Major Downstream Players*

			2005	2006	2007	2008	2009	Average
Gasunie								
Operating costs (€ mn; nominal)	[1]	See note	469	542	555	617	686	
Wage inflation index	[2]	Eurostat	90	94	97	100	105	
Operating costs (€ mn; 2009)	[3]	$[1]x[2]_{2009}/[2]$	548	607	606	650	686	619
Gasterra								
Operating costs (€ mn; nominal)	[4]	See note	44	44	52	51	59	
PPI (for gas produced by E&P)	[5]	CBS	100	126	128	155	118	
Operating costs (€ mn; 2009)	[6]	$[1]x[2]_{2009}/[2]$	52	41	48	39	59	47

Notes and sources:
[1]: From Gasunie Annual Reports. We include salary and other staff costs and other operating costs.
[2]: We use wage inflation index to inflate the operating costs of Gasunie because a signifcant proportion of the operating expenses are subcontracted work plus in-house staff costs.
[4]: From Gasterra Annual Reports we include staff costs and other operating expenses.
[5]: We use PPI for gas produced by E&P to inflate the operating costs of Gasterra because a signifcant proportion of the opertaing expenses is the cost of purchasing gas.

Table 17: *Operating Expenditures for R&D in Gas E&P*

% of Mining & Quarrying that is Oil & Gas E&P			[1]	See note		96%					
% of Oil & Gas E&P that is Gas E&P			[2]	See note		96%					
			2002	2003	2004	2005	2006	2007	2008	2009	Average
Operating expenses											
Mining and Quarrying category (€ mn)	[3]	CBS	77.0	86.0		91.0					
Gas E&P (€ mn, nominal)	[4]	CBS	71.4	79.8		84.4					
Wage inflation index	[5]	Eurostat	78.1	83.0	87.6	87.1	90.5	96.1	100.0	101.0	
Gas E&P (€ mn, 2009)	[6]	$[4]x[5]_{2009}/[5]$	92.4	97.1		97.9					95.8

Notes and sources:
[5]: We have used wage inflation data to inflate the operating expenses because around 90% of operating costs are labour costs.

Appendix IIII: Foreign Investment in Dutch Gas E&P

We estimate the percentage of investment in Dutch gas E&P that is made by foreign companies. We use two different measures: the number of gas platforms operated by foreign companies and the size and length of offshore pipelines operated by foreign companies. For the estimate based of the number of platforms we rely on data published by NLOG in its annual review report. Platforms of different sizes are associated with different levels of investment. We therefore weight by the number of platform legs as platforms with more legs will have higher costs. We find that around 70% of investment was made by foreign companies as shown in Table 18.

Table 18: *Estimate of Foreign Investment in Gas E&P Sector*

		Rigs for Gas			Rigs for Oil and Gas			Unknown Rigs			
		No. of legs [A] See note	% allocated to gas [B]	Legs allocated to gas [C] [A]	No. of legs [D] See note	% allocated to gas [E] See note	Legs allocated to gas [F] [B]x[C]	No. of legs [G] See note	% allocated to gas [H] See note	Legs allocated to gas [I] [E]x[F]	Total number of legs [J] [C] + [F] + [I]
Wintershall	[1]	115		115	0		0	0		0	115
GDF	[2]	140		140	0		0	8	100%	8	148
Total	[3]	126		126	0		0	4	100%	4	130
Unocal	[4]	8		8	0		0	0		0	8
TAQA	[5]	22		22	0		0	0		0	22
ENI	[6]	6		6	0		0	0		0	6
PCN	[7]	0		0	0		0	0		0	0
ATP	[8]	0		0	0		0	0		0	0
CH4	[9]	4		4	0		0	0		0	4
Chevron	[10]	4		4	0		0	0		0	4
Cirrus	[11]	1		1	0		0	0		0	1
Total Foreign Company	[12]	426		426	0	n/a	0	12	100%	12	438
NAM	[13]	169		169	6	50%	3	4	95%	4	176
Total	[14]	595		595			3			16	614
Share of Foreign Company	[15]			72%			0%			75%	71%

Notes and sources:
[A], [D] and [G] are from Natural Resources and Geothermal Energy in the Netherlands - Annual Report 2009, pp. 105-108
[12] = sum([1] - [11]
[13]: Natural Resources and Geothermal Energy in the Netherlands - Annual Report 2009, pp. 105-108
[14] = [12] + [13]
[15] = [12] / [14]
[E]: NAM has two platforms that are used for oil and gas production. We allocate 50% of these platforms to gas.
[H]: As Totals and GdF's other platforms are used for gas E&P we allocate the unknown 100% to gas. For NAM we use look at its other platforms and allocate in the same proportion.

For the estimate based on the size of off-shore pipelines we again rely on information published by NLOG. We exclude pipeline segments where oil is carried, where the length of segment was not provided and where the substance carried by the pipeline was not identified in the legend. Where a segment comprises more than one pipeline, we include all the pipelines within the segment, even if some carry other fluids such as methanol or glycol. We find that around 73% of investment was made by foreign companies as shown in Table 19.

Table 19: *Estimate of Foreign Investment in Gas E&P Based on Pipelines*

Operator			Length x diameter (inch-km)
ATP	[1]	See note	709.92126
CH4 Limited	[2]	See note	210.45
Chevron	[3]	See note	256
Cirrus	[4]	See note	0
Gaz de France	[5]	See note	3010.2726
GDFSuez	[6]	See note	0
Grove	[7]	See note	160.8
Lasmo	[8]	See note	77
Maersk	[9]	See note	989.2
NGT	[10]	See note	14022.6
Petro-Canada	[11]	See note	488.8
TAQA	[12]	See note	2023.5795
Total	[13]	See note	471.9937
TotalFinaElf	[14]	See note	3017.4488
Unocal	[15]	See note	441.4626
Venture	[16]	See note	42
Wintershall	[17]	See note	15345.903
Total Foreign	[18]	Sum of [1]-[17]	41,267
NAM	[19]	See note	15,648
% that is Foreign	[20]	[18]/([18]+[19])	73%

Notes and sources:
From NLOG publication "Natural Resources and Geothermal Energy in the Netherlands - Annual Review" 2009, Annexe 13.
We exclude pipelines segments where oil is transported, the segment length was missing or the substance carried was not identifiable from the legend.

Appendix V: Economic Impact Analysis using Input-Output Models

A simplified representation of an economic system

The transactions that take place between different sectors in an economy can be summarized using an input-output model. An input-output ("I/O") model traces all of the inter-industry transactions that take place in an economy and accounts for all sales and purchases made by firms in each sector of the economy. I/O models can be represented in a number of ways. One common representation of an I/O model is called a transactions table. Table 20 shows the transactions table for a simple economy with three sectors, S_1, S_2 and S_3. Note that the level of detail contained on a transactions table depends on data availability and the scope of the analysis.

Table 20: *Transactions Table*

		S_1	S_2	S_3	**Final demand**	**Total Output**
		[1]	[2]	[3]	[4]	[5]
S_1	[1]	1.5	1.9	1.1	1.5	**6.0**
S_2	[2]	0.5	5.0	0.4	4.1	**10.0**
S_3	[3]	1.3	1.0	2.0	0.7	**5.0**
Value Added	[4]	2.7	2.1	1.5		
Total	[5]	**6.0**	**10.0**	**5.0**	**6.3**	**21.0**

Each row on a transactions table represents the sales or revenues earned by all firms in that sector from firms in every other sector in the economy, as well as intra-industry transactions. On Table 20, sector S_1's total revenue, €6.0, shown in the first row of column [5], can be decomposed into sales to each sector in the economy by reading across row [1]. Total revenue consists of: €1.5 in intra-industry sales – the value of goods and services produced by firms in sector S_1 and sold to other firms in sector S_1, €1.9 in sales to firms in sector S_2, €1.1 in sales to firms in sector S_3, and €1.5 in sales to consumers, which is shown in column [4], headed "Final Demand." The between-industries transactions represent "intermediate goods" that are, in turn, used to produce other goods and services. Each column on a transactions table shows the purchases, or inputs, bought by firms in each sector of the economy. Reading down column [1], €1.5 of the inputs purchased by firms in sector S_1 come from other firms in sector S_1, €0.5 come from firms in sector S_2, and €1.3 come from firms in sector S_3. The expenditures on inputs in each sector do not sum up to total output or sales of the sector. For example, for sector S_1, purchases of inputs from S_1 or other sectors total €3.3, and total sales are €6.0. The difference of €2.7, called "Value Added" on a transactions table, represents payments to labour and capital. I/O models implicitly assume that the economy is in a stable state with no entry or exit of firms from sectors, so that value added can be distinguished from profits and losses. The existence of profits would induce additional entry of firms into a sector, and the existence of losses would induce exitsRows [1] – [3] and columns [1] – [3] represent inter-sector transactions, i.e., expenditures for intermediate goods and services in the economy and sales. Total output in column [5] can be thought of as total revenues of each sector. The final demand in column [4] represents spending by final users, which includes households, governments, and exports.

The economic system depicted on Table 20 can be represented in matrix notation as

$$\mathbf{A}\,\mathbf{X} + \mathbf{Y} = \mathbf{X} \qquad (1)$$

where **A** is an (n x n) matrix of input coefficients $a_{i,j}$. The matrix **A** describes how each sector *j* allocates its revenues in terms of payments to each sector. $a_{i,j}$ represents the sector *i* expenditure share of sector *j:* payments expressed in € made by sector *j* to sector *i* for each €1 sector *j* receives as revenues.
Based on the simple 3 sector economy shown on Table 20, **A** would be

$$\mathbf{A} = \begin{bmatrix} 0.250 & 0.19 & 0.22 \\ 0.083 & 0.50 & 0.08 \\ 0.217 & 0.10 & 0.40 \end{bmatrix}$$

In this case, $a_{1,1}$ is defined as

$$a_{1,1} = 0.25 = \frac{1.5}{6}$$

X is the (n x 1) column vector of outputs. Based on the simple economy shown on Table 20, **X** is

$$\mathrm{X} = \begin{bmatrix} 6 \\ 10 \\ 5 \end{bmatrix}$$

Y is an (n x 1) column vector of final demand. For the simple economy shown on Table 20, **Y** would be

$$\mathbf{Y} = \begin{bmatrix} 1.5 \\ 4.1 \\ 0.7 \end{bmatrix}.$$

Equation (1) can be solved for X and expressed as

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\,\mathbf{Y} \qquad (2)$$

where **I** is the identity matrix. In this case, **I** is simply

$$\mathbf{I} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

The term $(\mathbf{I} - \mathbf{A})^{-1}$ is known as the Leontief Inverse Matrix in the literature, because it depends on the inverse of the **A** matrix. The Leontief Inverse Matrix for Table 20, $(\mathbf{I} - \mathbf{A})^{-1}$ is

$$(\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} 1.617 & 0.753 & 0.693 \\ 0.373 & 2.228 & 0.434 \\ 0.646 & 0.643 & 1.989 \end{bmatrix}. \qquad (3)$$

A change in one sector

The Leontief Inverse Matrix, sometimes called a total requirements table, shows both the direct and indirect impacts of a change in final demand in any sector on total output in the economy. In order to see how the Leontief Inverse Matrix shows both direct and indirect impacts of changes in final demand, first define two useful variables that can be derived from the matrix

$l_{i,j}$ the row *i* column *j* element of the Leontief Inverse Matrix
y_j the row *j* element of the column matrix **Y**.

The $l_{i,j}$ element from a Leontief Inverse Matrix is interpreted as follows: for a €1 change in final demand for sector *j*, denoted as y_j, leads to a corresponding change of €$l_{i,j}$ in sector *i*'s intermediate input purchases. The economy wide effect of a €1 change in final demand in sector *j* would then be equal to the sum of the elements in column *j* of the Leontief Inverse Matrix, $l_{i,j}$, over all rows *i*:

$$\sum_i l_{i,j}$$

The sums of these elements of the Leontief Inverse Matrix can be interpreted as multipliers that capture both the direct and indirect impact on the entire economy of a change in final demand. Using the simple 3 sector economy shown on Table 20, the direct and indirect multiplier for sector S_1, would be equal to 2.637. This is simply the sum of the elements of the first column of the Leontief Inverse Matrix

$2.637 = 1.617 + 0.373 + 0.646$

This multiplier shows the total economy wide impact, in terms of the increase in total output, of a change in final demand for sector S_1. It reflects the effect of a change in final demand in sector S_1 on all other sectors in the economy, and it accounts for all the inter-industry transactions in Table 20. The multiplier for industry S_1, 2.637, implies that a €1 change in sector S_1's final demand results in a €2.637 increase in total output in all sectors in the economy.
The reason the Leontief Inverse Matrix measures the economy wide effect of a €1 change in sector j final demand can be seen more clearly by expressing equation (2) in terms of changes in Y, ΔY

$$\Delta\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1} \Delta\mathbf{Y} \qquad (4)$$

where Δ**Y** captures the change in final demand in one sector, *j*. Based on the 3 sector economy shown on Table 20, for sector 1 equation (4) becomes

$$\Delta \mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\, \Delta \mathbf{Y} = (\mathbf{I} - \mathbf{A})^{-1} \begin{bmatrix} \Delta y_1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} l_{1,1} & l_{1,2} & l_{1,3} \\ l_{2,1} & l_{2,2} & l_{2,3} \\ l_{3,1} & l_{3,2} & l_{3,3} \end{bmatrix} \begin{bmatrix} \Delta y_1 \\ 0 \\ 0 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1}\ \Delta y_1 \\ l_{2,1}\ \Delta y_1 \\ l_{3,1}\ \Delta y_1 \end{bmatrix} = \Delta y_1 \begin{bmatrix} l_{1,1} \\ l_{2,1} \\ l_{3,1} \end{bmatrix}. \qquad (5)$$

The economy wide impact of a change in final demand in sector 1, Δy_1, would then be

$$\Delta y_1 \sum_i l_{i,1} = \Delta y_1 \text{ times } 2.637 \qquad (6)$$

An alternative way to derive the output effects in the final demand of a sector *j* is to calculate the difference between the output in the case of after-change final demand in sector *j* and the output in the case of before-change final demand of sector *j*.
Equation (2) can be used to calculate the output before and after the change in, say, sector 1:
Before the change in the sector S_1's final demand, the economic system can be represented as

$$\mathbf{X_b} = (\mathbf{I} - \mathbf{A})^{-1}\, \mathbf{Y_b} = (\mathbf{I} - \mathbf{A})^{-1} \begin{bmatrix} y_1^b \\ y_2 \\ y_3 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1} & l_{1,2} & l_{1,3} \\ l_{2,1} & l_{2,2} & l_{2,3} \\ l_{3,1} & l_{3,2} & l_{3,3} \end{bmatrix} \begin{bmatrix} y_1^b \\ y_2 \\ y_3 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1} y_1^b + l_{1,2} y_2 + l_{1,3} y_3 \\ l_{2,1} y_1^b + l_{2,2} y_2 + l_{2,3} y_3 \\ l_{3,1} y_1^b + l_{3,2} y_2 + l_{3,3} y_3 \end{bmatrix} \qquad (7)$$

After the change in the sector S_1's final demand, the economic system can be represented as

$$\mathbf{X_a} = (\mathbf{I} - \mathbf{A})^{-1}\, \mathbf{Y_a} = (\mathbf{I} - \mathbf{A})^{-1} \begin{bmatrix} y_1^a \\ y_2 \\ y_3 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1} & l_{1,2} & l_{1,3} \\ l_{2,1} & l_{2,2} & l_{2,3} \\ l_{3,1} & l_{3,2} & l_{3,3} \end{bmatrix} \begin{bmatrix} y_1^a \\ y_2 \\ y_3 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1}y_1^a + l_{1,2}y_2 + l_{1,3}y_3 \\ l_{2,1}y_1^a + l_{2,2}y_2 + l_{2,3}y_3 \\ l_{3,1}y_1^a + l_{3,2}y_2 + l_{3,3}y_3 \end{bmatrix} \qquad (8)$$

Then the effect of a change in the sector S_1's final demand, $\Delta y_1 = y_1^a - y_1^b$, is

$\Delta \mathbf{X} = \mathbf{X_a} - \mathbf{X_b} =$

$$= \begin{bmatrix} l_{1,1}y_1^a + l_{1,2}y_2 + l_{1,3}y_3 \\ l_{2,1}y_1^a + l_{2,2}y_2 + l_{2,3}y_3 \\ l_{3,1}y_1^a + l_{3,2}y_2 + l_{3,3}y_3 \end{bmatrix} - \begin{bmatrix} l_{1,1}y_1^b + l_{1,2}y_2 + l_{1,3}y_3 \\ l_{2,1}y_1^b + l_{2,2}y_2 + l_{2,3}y_3 \\ l_{3,1}y_1^b + l_{3,2}y_2 + l_{3,3}y_3 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1}\,\Delta y_1 \\ l_{2,1}\,\Delta y_1 \\ l_{3,1}\,\Delta y_1 \end{bmatrix} = \Delta y_1 \begin{bmatrix} l_{1,1} \\ l_{2,1} \\ l_{3,1} \end{bmatrix}.$$

which is the same as equation (5).

Simultaneous changes in two (or more) sectors

If the final demand in two or more sectors changes simultaneously, then equation (4) still holds, as it was derived from equation (2).

Suppose we have a simultaneous change in the demand for S_1 and S_2, Δy_1 and Δy_2.

Then

$$\Delta \mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\, \Delta \mathbf{Y} = (\mathbf{I} - \mathbf{A})^{-1} \begin{bmatrix} \Delta y_1 \\ \Delta y_2 \\ 0 \end{bmatrix} = \begin{bmatrix} l_{1,1} & l_{1,2} & l_{1,3} \\ l_{2,1} & l_{2,2} & l_{2,3} \\ l_{3,1} & l_{3,2} & l_{3,3} \end{bmatrix} \begin{bmatrix} \Delta y_1 \\ \Delta y_2 \\ 0 \end{bmatrix} =$$

$$= \begin{bmatrix} l_{1,1}\ \Delta y_1 + l_{1,2}\ \Delta y_2 \\ l_{2,1}\ \Delta y_1 + l_{2,2}\ \Delta y_2 \\ l_{3,1}\ \Delta y_1 + l_{3,2}\ \Delta y_2 \end{bmatrix} = \begin{bmatrix} l_{1,1}\ \Delta y_1 \\ l_{2,1}\ \Delta y_1 \\ l_{3,1}\ \Delta y_1 \end{bmatrix} + \begin{bmatrix} l_{1,2}\ \Delta y_2 \\ l_{2,2}\ \Delta y_2 \\ l_{3,2}\ \Delta y_2 \end{bmatrix} =$$

$$= \Delta y_1 \begin{bmatrix} l_{1,1} \\ l_{2,1} \\ l_{3,1} \end{bmatrix} + \Delta y_2 \begin{bmatrix} l_{1,2} \\ l_{2,2} \\ l_{3,2} \end{bmatrix} \qquad (9)$$

which means that the effect of a simultaneous change in several sectors' final demand is the sum of the effect of a change in each sector's final demand.

Direct, indirect, and induced effects

From equation (5), which shows the impact of a change in final demand for sector S_1, we can define the direct impact of a change in sector 1's final demand as being given by , Δy_1 and the indirect impact, as the total direct and indirect impact minus the direct impact, given by the column vector

$$\begin{bmatrix} l_{1,1}\ \Delta y_1 - \Delta y_1 \\ l_{2,1}\ \Delta y_1 \\ l_{3,1}\ \Delta y_1 \end{bmatrix} \qquad (10)$$

More generally, for any sector *j*, the direct impact of a change in sector S_j is given by Δy_j, and the indirect impact of a change in S_j is given by

$$\begin{bmatrix} l_{1,j}\ \Delta y_j - \Delta y_j \\ l_{2,j}\ \Delta y_j \\ l_{3,j}\ \Delta y_j \end{bmatrix} \qquad (11)$$

The model can be expanded to capture not only the direct and indirect effects of a change, but also the induced effects. Conceptually, induced multipliers consider the multiplicative effects of the extra income generated by the new activity. For example, an increase in the S_1 activity translates in extra spending by

sector S_1. This creates new jobs or longer working hours in sectors S_1, S_2, S_3 (direct and indirect effects), which result in extra household income. This extra household income generates new demand for the goods and services of all sectors, and thus additional jobs/work, and additional income in each sector, and so on. Because an extra € in revenue of sector *j* results in less than one € extra household income, each additional 'round' of income generation has a diminishing effect, and thus the overall effect is bounded and can be measured.
To estimate the induced effects, the matrix A is expanded by an additional row which includes for example the households' salaries, and an additional column, which represents in our example the households' final consumption, and the multipliers given by the Leontief Inverse Matrix are recalculated using the same procedure as described above.

Table 21: Transactions Table which Includes the Household 'Sector'

		S_1	S_2	S_3	Household Consumption	Other Final Demand	Total Output
		[1]	[2]	[3]	[4]	[5]	[6]
S_1	[1]	1.50	1.90	1.10	0.25	1.25	6
S_2	[2]	0.50	5.00	0.40	1.00	3.10	10
S_3	[3]	1.30	1.00	2.00	0.17	0.53	5
Household Salaries	[4]	0.45	0.42	0.55			
Other Value Added	[5]	2.25	1.68	0.95			
Total	[6]	**6.00**	**10.00**	**5.00**	**1.42**	**4.88**	**21**

Matrix **A** will be in this case a (4 x 4) matrix:

$$\mathbf{A} = \begin{bmatrix} 0.250 & 0.190 & 0.22 & 0.176 \\ 0.083 & 0.500 & 0.08 & 0.706 \\ 0.217 & 0.100 & 0.40 & 0.118 \\ 0.075 & 0.042 & 0.11 & 0 \end{bmatrix} \qquad (12)$$

where, for example, $a_{1,4}$ is defined as

$$a_{1,4} = 0.176 = \frac{0.25}{1.42}$$

The Leontief Inverse Matrix $(\mathbf{I} - \mathbf{A})^{-1}$ would then become

$$(\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} 1.859 & 1.009 & 1.029 & 1.161 \\ 0.827 & 2.709 & 1.065 & 2.183 \\ 0.862 & 0.872 & 2.289 & 1.037 \\ 0.269 & 0.285 & 0.373 & 1.292 \end{bmatrix} \qquad (13)$$

A $l_{i,j}$ element of the Leontief Inverse Matrix has the same interpretation, except now it includes direct, indirect and induced effects. In equation (3) it includes only direct and indirect effects.
If we denote $l_{i,j}$ the (i,j) element of the Leontief Inverse Matrix used to estimate the (direct + indirect effects), and $l_{i,j}$ the (i,j) element of the Leontief Inverse Matrix used to estimate the (direct + indirect + induced effects), then the induced effects of a change in sector 1's final demand Δy_1 are given by:

$$\Delta y_1 \begin{bmatrix} l'_{,1,1} \\ l'_{,2,1} \\ l'_{,3,1} \end{bmatrix} - \Delta y_1 \begin{bmatrix} l_{1,1} \\ l_{2,1} \\ l_{3,1} \end{bmatrix} \qquad (14)$$

These methods for estimating direct, indirect and induced economic impacts are used in the report to determine the effect of the Gas Hub Scenario on the Dutch economy. In this context, we calculate the effects of investments which would occur over the period of analysis[168] (the Base Case scenario), and the effects of investments that would occur if in the Gas Hub Scenario. The 'gas hub effect' will be given by the difference between them.
This I/O model is also used to illustrate the method used to estimate the impact of the existing gas sector on the Dutch economy. To estimate this impact, we interpret **ΔY** as the effect of removing the gas sector from the Dutch economy, and perform the same steps as described above. This provides a rough estimate of the "impact" of the existing gas sector on the Dutch economy, although this method holds the input requirements and output of all other sectors in the Dutch economy constant. Clearly, this assumption can only be interpreted as a hypothetical exercise, as the actual removal of the gas sector from the Dutch economy, the counterfactual in this exercise, would have large, and difficult to predict, impacts on the other sectors of the Dutch economy. Thus the estimates of the impact of the existing gas sector on the Dutch economy must be interpreted with care.

Employment impact

The model can be expanded to estimate impacts other than the output impact of a change in a sector. For example, to capture the employment impact of a change in sector S_1, the ratio of the number of jobs / total output by each sector is also used. This ratio represents the average employment in S_1, measured per unit of output produced. Suppose the employment across the three sectors is

Table 22: Employment

	Total Output	Total FTE Employees	Jobs/ Total Output
	[1]	[2]	[3]
S1	**6**	10	1.67
S2	**10**	15	1.50
S3	**5**	25	5.00
Total	**21**	**50**	**2.38**

Notes and sources:

FTE stands for Full Time Equivalent.

[3] = [2] / [1].

[168] From 2010 to 2020

Assume also that there is a 1.0 change in the sector S_1's final demand. Then using = 1 and Δy_1 equations (5), (3), (13) and Table 22, the impact of this change would be:

Table 23: Impact Analysis

	Final Demand Change	OUTPUT IMPACT				Jobs / Total Output	EMPLOYMENT IMPACT			
		Direct Impact	Indirect Impact	Induced Impact	Total Impact		Direct Impact	Indirect Impact	Induced Impact	Total Impact
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
S1	1.000	1.000	0.617	0.241	**1.859**	1.67	1.67	1.03	0.40	**3.10**
S2			0.373	0.454	**0.827**	1.50	0.00	0.56	0.68	**1.24**
S3			0.646	0.216	**0.862**	5.00	0.00	3.23	1.08	**4.31**
Total		**1.000**	**1.637**	**0.911**	**3.548**		**1.667**	**4.819**	**2.162**	**8.648**

Notes and sources:

[7] = [6] x [2].

[8] = [6] x [3].

[9] = [6] x [4].

Appendix VI : Sector Aggregation

The input-output table used in this analysis is generated using a combination of two tables. One, total employment (full-time equivalent) by sector as reported by the Dutch *Centraal Bureau voor de Statistiek (CBS)* for 2006.[169] Two, the 2006 input-output table for the Dutch economy as reported by *Eurostat*.[170]
The Eurostat input-output table disaggregates the Dutch economy into 95 different sectors. The CBS employment data, however, varies in the number of sectors that is aggregated when providing total employment figures. Using CBS sector mapping the 95 sectors from the input-output data was collapsed into 21 sectors[171]. The total revenues and payments were also collapsed across the 21 sectors and became the input-output table used to generate the multipliers and estimate the impact. This mapping, as shown below, maintained the employment aggregation provided in the CBS data.

[169] http://statline.cbs.nl/StatWeb/default.aspx.

[170] http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/data/workbooks.

[171] See Table 25.

Table 24: *Netherlands, Total Employment, Full-Time Equivalents (2006)*

CBS Sector Name	FTE *Hundreds*	*Sector Mapping for Eurostat I-O Table*	*New Sector*	***New Sector Name***
Agriculture, hunting, forestry and fishing	2,113	01-05	1	Agriculture, Hunting, Fishing
Mining and quarrying of energy producing materials	54	10-12	2	Mining (Coal, Uranium), Extraction (Crude, Gas)
Mining and quarrying except energy producing materials	19	13-14	3	Mining , Quarry (Not Energy Producing Materials)
Food products, beverages and tobacco	1,187	15-16	4	Food Products (Beverages, Tobacco)
Textiles, textile products, leather and footwear	188	17-19	5	Textiles, Leather, Footwear
Wood and products of wood and cork	169	20	6	Wood & Wood Products
Pulp, paper, paper products, printing and publishing	989	21-22	7	Paper, Printing, Publishing
Chemical, rubber, plastics and fuel products	1,014	23-25	8	Manufacturing (Chemical, Rubber, Pharma)
Other non-metallic mineral products	279	26	9	Manufacturing (Non-Metallic Mineral Products)
Basic metals and fabricated metal products	1,122	27-28	10	Manufacturing (Metals, Fabricated)
Machinery and equipment	1,631	29-33	11	Manufacturing (Machinery & Equipment)
Transport equipment	462	34-35	12	Manufacturing (Transport Equipment)
Manufacturing nec; recycling	1,364	36-37	13	Manufacturing (Furniture, Recylcing)
Electricity gas and water supply	284	40-41	14	Electricity, Gas, Water Supply
Construction	4,562	45	15	Construction
Wholesale and retail trade; restaurants and hotels	12,463	50-55	16	Wholesale & Retail Trade
Transport and storage	3,123	60-63	17	Transport & Storage
Post and telecommunications	893	64	18	Post & Telecommunications
Financial intermediation	2,536	65-67	19	Financial Intermediation, Insurance
Research and development	289	73	20	R&D
Real estate, business service, community, social, personal services	31,088	70-72, 74-95	21	Real Estate, Business Service, Community, Social Service
TOTAL	65,828			

Notes and sources:
From (Centraal Bureau voor de Statistiek, CBS)
http://statline.cbs.nl/StatWeb/start.asp?LA=en&DM=SLEN&lp=Search/Search

Table 25: *Input - Output Table for Netherlands (2006, Million Euros)*

Sector	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	Household Consumption	Final Demand	Total Output
S1	3,451	6	7	7,619	2	2	11	46	3	18	45	8	7	149	89	179	50	13	27	1	677	1,530	11,692	**24,102**
S2	0	215	0	222	0	0	140	1,694	127	134	7	0	0	4,974	0	0	0	0	0	0	14	0	8,453	**15,980**
S3	11	0	68	20	0	0	0	90	135	1	0	2	7	0	198	10	1	0	0	0	21	3	433	**997**
S4	2,584	0	0	6,207	15	0	31	547	0	1	7	2	43	13	13	1,629	19	10	6	4	1,486	10,851	36,551	**49,168**
S5	13	0	0	5	349	0	8	38	9	11	15	27	40	0	13	94	22	5	2	0	66	637	3,101	**3,818**
S6	29	0	5	34	1	114	21	36	15	26	16	6	15	5	1,068	36	11	5	4	0	421	112	879	**2,747**
S7	15	3	2	944	23	8	2,702	334	65	107	239	34	69	41	68	1,714	184	137	620	3	3,704	3,332	7,787	**18,803**
S8	435	95	50	523	125	56	288	11,573	235	229	477	387	431	425	1,047	885	1,489	87	91	73	1,662	2,373	57,740	**78,403**
S9	28	0	0	171	0	0	6	35	391	33	66	37	19	6	3,372	72	13	1	6	7	422	104	1,475	**6,160**
S10	44	18	16	288	4	54	108	219	88	3,364	2,363	1,075	158	128	3,021	1,110	17	9	11	0	566	103	11,438	**24,099**
S11	517	75	35	190	21	37	189	324	88	298	3,607	506	110	257	769	1,092	220	301	29	4	1,141	753	29,602	**39,412**
S12	14	2	0	8	5	0	0	11	2	31	53	958	16	0	19	267	507	8	1	0	190	1,974	12,515	**14,607**
S13	109	6	0	83	10	17	44	142	52	291	103	43	357	10	220	158	60	14	27	12	496	1,274	6,806	**9,060**
S14	1,378	1,245	63	627	50	45	253	1,088	163	482	262	79	101	7,497	110	2,078	372	68	213	60	3,058	7,639	9,556	**28,848**
S15	139	38	13	72	10	33	37	107	25	125	190	55	92	261	15,998	417	578	480	308	1	11,453	561	38,909	**69,341**
S16	907	42	73	2,740	304	248	877	3,072	451	1,381	2,884	1,351	431	313	3,272	5,870	2,348	485	845	59	8,284	51,029	91,158	**127,395**
S17	311	232	19	881	41	63	187	590	257	279	363	160	122	114	1,091	1,732	4,466	124	241	10	1,786	9,361	35,602	**48,671**
S18	170	30	4	118	22	13	269	134	34	67	179	39	44	86	290	1,948	466	2,511	1,723	44	3,769	9,331	13,008	**24,968**
S19	594	148	17	606	67	30	281	740	89	280	517	171	93	343	1,007	3,472	836	560	10,099	53	14,515	22,271	33,744	**68,262**
S20	5	5	0	50	5	2	8	83	5	9	284	11	9	5	15	1	5	14	0	150	292	0	2,957	**3,915**
S21	1,632	291	86	3,478	289	277	1,931	4,049	645	2,006	3,892	917	655	2,191	4,701	17,773	5,373	3,370	5,441	195	57,305	59,727	221,499	**337,996**
Value Added	11,716	13,529	539	24,282	2,475	1,748	11,412	53,451	3,281	14,926	23,843	8,739	6,241	12,030	32,960	86,858	31,634	16,766	48,568	3,239	226,668			
Total	**24,102**	**15,980**	**997**	**49,168**	**3,818**	**2,747**	**18,803**	**78,403**	**6,160**	**24,099**	**39,412**	**14,607**	**9,060**	**28,848**	**69,341**	**127,395**	**48,671**	**24,968**	**68,262**	**3,915**	**337,996**	203,363		

Notes and sources:

Input-Output data from Eurostat available at: http://epp.eurostat.ec.europa.eu/portal/page/portal/esa95_supply_use_input_tables/ data/workbooks.

Table 26: *Sector Coding*

Agriculture, Hunting, Fishing	S1
Mining (Coal, Uranium), Extraction (Crude, Gas)	S2
Mining , Quarry (Not Energy Producing Materials)	S3
Food Products (Beverages, Tobacco)	S4
Textiles, Leather, Footwear	S5
Wood & Wood Products	S6
Paper, Printing, Publishing	S7
Manufacturing (Chemical, Rubber, Pharma)	S8
Manufacturing (Non-Metallic Mineral Products)	S9
Manufacturing (Metals, Fabricated)	S10
Manufacturing (Machinery & Equipment)	S11
Manufacturing (Transport Equipment)	S12
Manufacturing (Furniture, Recycling)	S13
Electricity, Gas, Water Supply	S14
Construction	S15
Wholesale & Retail Trade	S16
Transport & Storage	S17
Post & Telecommunications	S18
Financial Intermediation, Insurance	S19
R&D	S20
Real Estate, Business Service, Community, Social Service	S21

Appendix VII : Number of Employees at Distribution Companies

We have estimated the number of employees in distribution companies from data provided in companies' annual report.[172] There are around 30 companies in the Netherlands that participate in distribution activities. We have researched employee number for the four largest – Nuon, Eneco, Essent and Delta. We understand that these four are responsible for supplying around 85% of the market. We estimate the number of employees for all distribution companies by inflating the number for these four companies by 1/0.85. Distribution companies typically deal in other products as well as natural gas, such as electricity, wind, district heating and only provide employees numbers for these activities combined. We have typically allocated the total number of employees report in annual reports to gas-related activities on a pro-rata basis according to revenues generated by gas-related activities. We have also taken into account where appropriate the particular activities for individual business segments. For instance we would not include the employees for a particular business segment if that segment did not include gas-related activities. Our calculations can be found in Table 27 to Table 30.

Table 27: *Estimate of FTE in Gas-Related Activities for Nuon in 2008*

FTE in each business segment			
Downstream	[1]	See note	3,923
Network Company	[2]	See note	4,488
Midstream	[3]	See note	1,525
Other	[4]	See note	761
Estimated % of gas FTE that are in Netherlands			
Gas sales in The Netherlands	[5]	See note	4,733
Gas sales to Belgium	[6]	See note	357
Gas sales to Germany	[7]	See note	101
Downstream	[8]	[5]/Sum of ([5]:[7])	91%
Network Company	[9]	Assumed	100%
Midstream	[10]	Assumed	100%
Assumed % of FTE that work in gas-related activities			
Revenue from gas activities	[11]	See note	2,248
Revenue from electricity activities	[12]	See note	2,905
Revenue from heating & other products	[13]	See note	994
Downstream	[14]	[11]/Sum of ([11]:[13])	37%
Network Company	[15]	[11]/Sum of ([11]:[13])	37%
Midstream	[16]		37%
Other	[17]		n/a
FTE for gas related activities			
Downstream	[18]	[1]x[8]x[14]	1,308
Network Company	[19]	[2]x[9]x[15]	1,641
Midstream	[20]		558
Total	[21]	[18]+[19]+[20]	**3,507**

Notes and sources:
[1]-[4]: Nuon Annual Report 2008, "Nuon at a Glance" section.
[5]-[7]: Nuon Annual Report 2008, p. 30.
[12]-[14]: Nuon Annual Report 2008, p. 29.

[172] By distribution company we mean companies that supply gas from to end users connected to distribution networks and/or transport gas along distribution networks.

Table 28: *Estimate of FTE in Gas-Related Activities for ENECO in 2008*

FTE in Business Segments			
Energy company Eneco	[1]	See note	2,666
Joulz	[2]	See note	2,234
Stedin	[3]	See note	636
Total	[4]	[1]+[2]+[3]	5,536
Revenues (€ mn)			
Electricity	[5]	See note	2,529
Gas	[6]	See note	1,882
District heat	[7]	See note	224
% of gas-related activities	[8]	[6]/Sum([5] to [7])	41%
FTE for gas-related activities	[9]	[4]x[8]	**2,248**

Notes and sources:
[1]-[3]: Eneco Annual Report 2008, p. 92.
[5]-[7]: Eneco Annual Report 2008, p. 91.

Table 29: *Estimate of FTE in Gas-Related Activities for Essent in 2008*

***Energy Value Chain* Segment**			
FTE	[1]	See note	4,274
% of staff in the Netherlands	[2]	See note	70%
% of sub-segments that are relevant	[3]	See note	57%
Number of customers (x 1,000):			
electricity	[4]	See note	2,249
gas	[5]	See note	1,793
Estimate of FTE for gas-related activities	[6]	[1]x[2]x[3]x[5]/([4]+[5])	753
***Energy Distribution* Segment**			
FTE	[7]	See note	3,524
% of staff in Netherlands	[8]	See note	100%
no. electricity connections (x 1,000)	[9]	See note	2,577
no. gas connections (x 1,000)	[10]	See note	1,855
FTE for gas-related activities	[11]	[7]x[8]x[10]/([9]+[10])	1,475
Total FTE for gas-related	[12]	[6]+[11]	**2,228**

Notes and sources:
[1],[4],[5],[7],[9],[10]: Essent's Annual Report 2008, p. 64.
[2]: 70 % of Essent revenue was from its operations in the Netherlands. Essent Annual Report 2008, p18.
[3]: Essent's Energy Value Chain segment has seven subsegments that cover the Netherlands (see Essent's Annual Report 2008, p.32& 33. While all or most of these may have some connection to gas (e.g. gas-fired power stations), we have identified four that are particularly relevant.
The four subsegments are Business Development, Service and Sales, Trading and Value Added Services
We exclude the Projects subsegment because in 2008 Projects appears to have focussed on power stations
[8]: Essent's Annual Report 2008, p.45.

Table 30: *Estimate of FTE in Gas-Related Activities for Delta in 2008*

FTE in Relevant Business Segments			
Energy business unit	[1]	See note	205
Comfort business unit	[2]	See note	184
DNWB	[3]	See note	65
Infrastructure	[4]	See note	463
Total	[5]	[1]+[2]+[3]+[4]	917
Sales of gas (as % of all sales)	[6]	See note	17%
FTE for gas-related activities	[7]	[6]x[5]	**156**

Notes and sources:
[1]-[4]: Delta Annual Report 2008, p71.
[6]: Delta Annual Report 2008, p13.

Appendix VIII : Labour Impact of the Current Gas Sector Across the Dutch Economy

Table 31: *Labour Impact of Natural Gas Sector Across Sectors of the Dutch Economy*

Notes and sources:

Calculations based on The Brattle Group model, based on 2006 Eurostat and CBS data.

	Exploration & Production			
	Direct	*Indirect*	*Induced*	*Total*
Agriculture, Hunting, Fishing	0	102	130	232
Mining (Coal, Uranium), Extraction (Crude, Gas)	2,752	91	3	2,846
Mining , Quarry (Not Energy Producing Materials)	0	1	0	1
Food Products (Beverages, Tobacco)	0	13	107	120
Textiles, Leather, Footwear	0	2	12	14
Wood & Wood Products	0	11	8	18
Paper, Printing, Publishing	0	65	113	177
Manufacturing (Chemical, Rubber, Pharma)	0	112	22	133
Manufacturing (Non-Metallic Mineral Products)	0	18	10	28
Manufacturing (Metals, Fabricated)	0	117	28	145
Manufacturing (Machinery & Equipment)	0	240	34	274
Manufacturing (Transport Equipment)	0	10	24	34
Manufacturing (Furniture, Recycling)	0	83	80	163
Electricity, Gas, Water Supply	0	891	43	934
Construction	0	375	126	501
Wholesale & Retail Trade	0	657	1,796	2,453
Transport & Storage	0	940	251	1,191
Post & Telecommunications	0	117	153	269
Financial Intermediation, Insurance	0	491	391	881
R&D	0	28	3	32
Real Estate, Business Service, Community, Social Service	0	3,142	2,668	5,810
Total	**2,752**	**7,504**	**6,001**	**16,257**

JOB IMPACT (FTE)											
Transmission & Distribution				**Research & Development**				**Total**			
Direct	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*
0	707	368	1,075	0	1	9	10	0	809	507	1,317
0	685	8	693	0	0	0	0	2,752	776	11	3,539
0	3	1	4	0	0	0	0	0	4	1	5
0	67	300	368	0	0	7	8	0	81	414	495
0	5	34	39	0	0	1	1	0	7	47	54
0	48	21	69	0	0	1	1	0	59	30	88
0	250	318	568	0	1	8	9	0	316	438	754
0	312	61	373	0	2	2	4	0	426	84	510
0	73	27	100	0	1	1	1	0	92	37	129
0	422	78	500	0	0	2	2	0	539	108	647
0	586	96	682	0	1	2	3	0	826	132	959
0	10	67	78	0	0	2	2	0	21	93	114
0	165	225	391	0	4	6	9	0	252	311	563
8,298	3,165	123	11,586	0	2	3	5	8,298	4,058	169	12,525
0	1,374	355	1,729	0	2	9	11	0	1,752	490	2,241
0	2,234	5,065	7,298	0	15	124	139	0	2,905	6,985	9,890
0	688	707	1,396	0	2	17	19	0	1,631	976	2,607
0	271	431	702	0	4	11	14	0	391	595	986
0	1,020	1,102	2,122	0	6	27	33	0	1,516	1,520	3,036
0	40	10	50	502	20	0	523	502	89	13	605
0	11,765	7,523	19,288	0	48	185	233	0	14,955	10,376	25,331
8,298	**23,890**	**16,922**	**49,110**	**502**	**108**	**416**	**1,026**	**11,552**	**31,503**	**23,338**	**66,394**

Appendix IX : N-1 Analysis

Our N-1 analysis measures the supply margin that remains when the supply point with the largest capacity fails. By supply margin we mean the supply capacity that is in excess of peak demand. We perform the calculation for the system in 2008, and for our two future scenarios: Base Case and Gas Hub. In each case we calculate the production capacity, the import capacity and the injection capacity available at storage facilities. For production capacity at Groningen we assume that the operational capacity is 350 mcm/day.[173] We understand that a cap has been placed on the annual Groningen production but we assume that Groningen can still produce up to 350 mcm on an individual day if needed. For the small fields we take the capacity reported in the GTS report “Overzicht Ramingen Gas Uit Kleine Velden”. The report has figures for both 2008 and 2020.

For import points we rely on technical capacities reported in GTS’s website. In the two 2020 cases we estimates the amount of new pipeline capacity that would be needed. New pipeline capacity is needed to accommodate additional imports required to offset declining production and increasing demand and for additional transit flows as indicated from our scenario analysis. For supply from storage we include the new storage facilities that are currently being built and the additional storage facility that we imagine is built in our Gas Hub scenario. Table 32 shows our calculations.

[173] From NAM Brochure “Groningen Gas Field”

Table 32: *N-1 Analysis*

			Situation in 2008	Base Case Scenario, 2020	Gas Hub Scenario, 2020
Peak demand in Netherlands (mcm/h)	[1]	See note	22.5	25.5	25.5
Groningen production capacity (mcm/h)	[2]	See note	14.6	14.6	14.6
Small fields production capacity (mcm/h)	[3]	See note	5.7	1.7	1.7
Import points (2008 technical capacity; mcm/h)					
Emden EPT	[4]	See note	1.45		
Emden NPT	[5]	See note	0.76		
Oude Statenzijl (EGT)	[6]	See note	0.93		
Oude Statenzijl (GUD-H) [OBEBH]	[7]	See note	0.14		
Oude Statenzijl (Wingas-H)	[8]	See note	0.13		
Oude Statenzijl Renato (EGT)	[9]	See note	0.59		
Zelzate	[10]	See note	0.40		
Total import capacity	[11]	Sum of [4] to [10]	4.41		
<u>Projected imports in 2020</u>					
Additional imports (bcm)	[12]	See note		31	31
Of which LNG (bcm)	[13]	See note		9	9
Additional imports by pipeline (bcm)	[14]	[12]-[13]		22	22
Additional pipeline transit flows (bcm)	[15]	Appendix XIII		4	17
% of pipeline currently used	[16]	See note		52%	52%
Existing spare capacity (bcm/year)	[17]	[11]x8760/10^3x(80%-[16])		11	11
New pipeline capacity needed (bcm/year)	[18]	[15]+[14]-[17]		15	28
Load factor for pipeline imports	[19]	Assumed		80%	80%
New pipeline capacity needed (mcm/h)	[20]	([18]/[19])x1000/8760		2.2	4.0
Import points (2020 technical capacity; m3/h)					
Emden EPT	[21]	[4]+[4]/[11]x[20]		2.2	2.8
Emden NPT	[22]	[5]+[5]/[11]x[20]		1.1	1.4
Oude Statenzijl (EGT)	[23]	[6]+[6]/[11]x[20]		1.4	1.8
Oude Statenzijl (GUD-H) [OBEBH]	[24]	[7]+[7]/[11]x[20]		0.2	0.3
Oude Statenzijl (WIngas-H)	[25]	[8]+[8]/[11]x[20]		0.2	0.3
Oude Statenzijl Renato (EGT)	[26]	[9]+[9]/[11]x[20]		0.9	1.1
Zelzate	[27]	[10]+[10]/[11]x[20]		0.6	0.8
LNG facility	[28]	(11+4)x1000/8760		0.0	1.7
<u>Withdrawal Capacity at Storage Sites (mcm/h)</u>					
Grijpskerk	[29]	See note	2.3	2.3	2.3
Norg	[30]	See note	2.3	2.3	2.3
Maasvlakte	[31]	See note	1.3	1.3	1.3
Alkmaar	[32]	See note	1.5	1.5	1.5
Bergermeer	[33]	See note		2.4	2.4
Zuidwending I	[34]	See note		1.6	1.6
Zuidwending II	[35]	See note		1.0	1.0
New storage I	[36]	Estimate			2.5
Total supply capacity (mcm/h)	[37]	See note	32	35	41
Largest supply point (mcm/h)	[38]	Max of ([4]:[10],[29]:[36])	2.3	2.4	2.8
Total supply capacity without largest point (mcm/h)	[39]	[37]-[38]	30	33	38
N-1 supply margin	[40]	[39]/[1]-1	32%	29%	51%

Notes and sources:

[1]: For 2008, the figure is from Gas Transport Servcies (GTS) report "2009 Transport Insight", p.9.

[1]: For 2020, the figure is the mid point of peak demand from GTS's *Rapportage Voorzieningszekerheid* 2010, Table 1a.

[2]: For 2008, NAM Brochure "Groningen Gas Field" reports that the maximum production capacity is 350 mcm per day. We have divided by 24 to estimate the capacity in mcm/h.

[2]: For 2020, the NLOG publication "Natural resources and geothermal energy in the Netherlands", Annual Review, 2009, p. 23 shows that Groningen production is expected to dcrease by around 7% between 2009 and 2020. We scale the capacity accordingly.

[3]: For 2008: GTS publication "Overzicht Ramingen Gas Uit Klieine Velden" (September 2008, p7) reports the capacity of the small fields as 5.68 mcm/h in 2008.

[4]-[10]: From the website of Gastransport Services. For Oude Statenzijl Renato (EGT) we use the figure for 2011.

[12]: From GTS report "Security of Gas Supply 2010", p.10.

[13]: From GTS report "The Secutiy of Gas Supply 2009" p. 14.

[16]: Equal to ratio of flows through GTS import points in 2008 as reported on GTS's website and [11] converted into bcm/year.

[21]-[27]: We spread the additional capacity in [20] across the import points on a pro-rata basis according to their original capacity.

[28]: We assume that 15 bcm/year of additional capacity is added in the Gas Hub Scenario. We assume the load factor is 1,000 hours.

[29]-[35]: From a combination of sources includding IEA publication, "Energy Policies of IEA Countries, The Netherlands 2008 Review", p 69 amd Gas Infrastructure Europe database.

Appendix X : Transit Flow Scenarios – Netherlands to UK

Table 33: *Transit Flow Scenarios from Netherlands to UK*

		Scenarios			
		Max Imports from Neths to GB	**GB Exports to Netherlands**	**NG Base Case**	**Lower GB LNG Imports**
Demand:		NG Base Case	NG Gone Green	NG Base Case	NG Base Case
UKCS Production:		Based on NG Low Case	Based on NG High Case	Based on NG Base Case	Based on NG Base Case
Norwegian Imports:		Based on NG Low Case	Based on NG High Case	Based on NG Base Case	Based on NG Base Case
LNG Imports:		Based on NG Low Case	Based on NG High Case	Based on NG Base Case	Based on NG Low Case
Demand:	[1]	89.1	77.4	89.1	89.1
UKCS Production:	[2]	17.7	35.5	26.3	26.3
Biogas:	[3]	0.7	0.7	0.7	0.7
Norwegian Imports:	[4]	8.5	41.2	33.7	33.7
LNG Imports:	[5]	9.0	38.4	28.3	9.0
Total Supply (excl BBL)	[6]	35.9	115.8	89.0	69.7
BBL & IUK flows:	[7]	**53.2**	**-38.4**	**0.1**	**19.4**
BBL Capacity	[8]	19.2	19.2	19.2	19.2
IUK Capacity	[9]	25.5	25.5	25.5	25.5
Flows through BBL	[10]	22.8	-16.5	0.0	8.3
Flows through IUK	[11]	30.3	-21.9	0.0	11.0
Transits through Netherlands	[12]	38.0	-27.4	0.1	13.8

Notes and sources:
[10],[11]: Flows in [7] allocated according to capacities in [8] & [9].
[12]: [10] + 0.5 x[11]

Appendix XI : Demand Forecasts for France

A recent report by the French Ministry of Ecology, Energy, Sustainable Development and Territorial Development shows a number of different demand forecasts for France made by different parties. The demand forecasts apply to the period 2010-2020 and have growth rates that vary from 0.3% annually to 1.5% annually.[174] Two of the forecasts were made the transport operators GdF-Suez (1.5%) and Groupe Total (0.5%). Two other growth forecasts (0.3% and 0.5%) were derived to be consistent with the objectives of the Grenelle Environment programme which supports renewable energy sources and sets a number of targets including reducing greenhouse gas emissions in the transport sector to 1990 levels by 2020.The final demand forecast published by the Ministry assumes that greenhouse emissions will be cut by 20% in 2020 and has a growth of 1.5%. The range of demand forecasts presented by the Ministry are within the range of forecast published elsewhere.

The IEA has recently published a forecast of the gas that will be supplied to France during the period 2010- 2030.[175] The IEA assumes that gas supply will grow from 42 bcm in 2010 to as much as 65.3 bcm in 2020.[176] This is equivalent to an annual growth rate of 4%. Underlying the IEA forecast is an expectation that gas demand by the power sector will increase significantly due to building of new gas-fired plants. Industry consumption of gas is also expected to increase. The IEA admits that demand growth by the residential sector is uncertain, and that it may decline it major efficiency improvements occur. However the IEA assumes that the residential sector when combined with the commercial sector, public services, agriculture/ forestry/fishing will show a positive gas demand growth.

We understand that the recent PRIMES baseline forecast for France shows a much lower growth in demand. The forecast assumes that demand will increase from 46 bcm in 2010 to 48 bcm in 2020, which is equivalent to an annual increase of 0.3%.[177] This growth rate is the same as the lowest of the range of demand forecasts presented by the Ministry.

We are unable to say which of the various demand forecasts is most likely to occur and therefore our analysis uses two demand growth rates that are representative of the alternative demand forecasts we have discussed. For our first case we use a growth rate of 1.5% because this is around the mid-range of the different forecast. We use 0.3% for our lower demand scenario because this is the lowest growth rate of all the alternative growth rates. In the Ministry report, 0.3% relates to one of the forecasts designed to be consistent with the Grenelle programme. A growth rate of 0.3% was also the PRIMES baseline growth rate. However, we have not examined the assumptions underlying the PRIMES growth rate.

[174] "Plan Indicatif Pluriannuel des Investissements dans le sector du gaz", March 2007, p.55.

[175] IEA publication "Energy Policies of IEA Countries: France, 2009 Review", 2010, p. 153.

[176] We have used a conversion factor of 1 Mtoe = 1.1 bcm.

[177] Assuming 1 Mtoe = 1.1 bcm.

Appendix XII : Transit Flow Scenarios – From Netherlands to Belgium/France

Table 34: *Transit Flow Scenarios for Route From Netherlands to Belgium/France*

		Scenarios			
		High FR LNG Imports	Russian gas via Germany	Russian gas via Neths	Low Demand
Belgian Demand:		CREG Forecast	CREG Forecast	CREG Forecast	Low Demand
French Demand:		GdF/Suez Forcast	GdF/Suez Forcast	GdF/Suez Forcast	Low Demand
Additional Russian Gas via Germany and/or Neths:		In 2010 proportions	All increase via Germany	All increase via Netherlands	In 2010 proportions
LNG Imports:		5 terminals at 75%	4 terminals at 75%	4 terminals at 75%	4 terminals at 75%
Belgian Demand	[1]	22.7	22.7	22.7	19.8
French Demand	[2]	49.1	49.1	49.1	43.6
Russian Imports from Netherlan	[3]	4.8	1.6	5.9	4.8
Russian Imports through Germa	[4]	2.7	5.3	1.0	2.7
LNG Imports	[5]	35.3	24.6	24.6	24.6
Other Pipeline Net Imports (exc	[6]	26.6	26.6	26.6	26.6
Shortfall	[7]	2.4	13.8	13.8	4.6
Exports from the Netherlands	[8]	7.3	15.4	19.7	9.5

Notes and sources:
[7]: [1]+[2]-[3]-[4]-[5]-[6]
[8]: [3]+[7]

Appendix XIII : Upstream Investments in Base Case and Gas Hub Scenarios

In our Base Case scenario we assume that production at Groningen and the small fields follows the forecast published by NLOG[178] and that investment is proportional to production. We calculate the average investment to production ratio for five recent years[179] and use this ratio to estimate the future investment (Table 35).

For the Gas Hub Scenario we compare the NLOG forecast used in our Base Case scenario to the EBN forecast[180] and use whichever has the largest production level. For investments, we take either the value that is generated by the method used in the Base Case scenario where investment is proportional to production or the €1.5 million quoted by EBN for the investment needed to explore and extract any viable gas production,. We use whichever of these two figures is highest. Our calculations can be found Table 35: Upstream Investments in Base Case and Gas Hub Scenarios

Table 35: Upstream Investments in Base Case and Gas Hub Scenarios

			2000	2001	2002	2003	2004	2005	2006	2007	2009	Average
Annual investment by Oil & Gas E&P Sector (€ mn)	[1]	CBS	435	566	962		649			845		
Annual investment by related services (€ mn)	[2]	CBS		213	250	210		121	606			
% of Oil & Gas E&P that is Gas E&P	[3]	See note	96%	96%	96%	96%	96%	96%	96%	96%		
Production (bcm)	[4]	See note	68	72	71	69	78	73	71	68		
PPI for machinery & equipment	[5]		95	97	98	97	98	100	102	103	108	
Investment to production ratio (Gas E&P; €/1,000m3; 2009 money)	[6]	[1]x[3]/[4]	7.0	8.4	14.3		8.9			12.5		10.2
Investment to production ratio (related services; €/1,000m3; 2009 money)	[7]	[2]x[3]/[4]		3.2	3.7	3.2		1.7	8.8			4.1

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Base Case Scenario													
Groningen production (bcm Geq)	[8]	See note	47.3	47.3	47.3	47.3	47.3	47.3	44.6	44.6	44.6	44.6	44.6
Small fields production (bcm Geq)	[9]	See note	37.9	37.3	36.7	33.7	31.9	29.5	23.9	20.3	18.5	17.3	14.9
Total production (bcm Geq)	[10]	See note	85.2	84.6	84.0	81.0	79.2	76.8	68.4	64.8	63.0	61.8	59.4
Investment by Gas E&P (€ mn)	[11]	[10]x[6]$_{average}$	869	863	857	826	808	783	698	661	643	630	606
Investment by related services (€ mn)	[12]	[10]x[7]average	351	349	346	334	326	317	282	267	260	255	245
Total investment (€ mn)	[13]	[11]+[12]	1,220	1,212	1,203	1,160	1,134	1,100	980	928	902	885	851
Gas Hub Scenario													
Groningen production (bcm Geq)	[14]	[1]	47.3	47.3	47.3	47.3	47.3	47.3	44.6	44.6	44.6	44.6	44.6
EBN small fields production (bcm)	[15]	See note	34.3	33.9	32.7	32.7	31.8	30.6	31.4	31.2	29.4	28.2	27.6
NLOG small fields production (bcm Geq)	[16]	[2]	37.9	37.3	36.7	33.7	31.9	29.5	23.9	20.3	18.5	17.3	14.9
Total production (bcm)	[17]	[14]+Max([15],[16])	85.2	84.6	84.0	81.0	79.2	77.9	76.0	75.8	73.9	72.7	72.1
Investment by Gas E&P (€ mn)	[18]	[17]x[6]$_{average}$	869	863	857	826	808	795	775	773	754	742	735
Investment by related services (€ mn)	[19]	[17]x[7]average	351	349	346	334	326	321	313	312	305	300	297
Total investment (€ mn)	[20]	See note	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500

Notes and sources:
[3]: Calculated from estimates of revenue from oil E&P and gas E&P
[4],[7]-[9]: From NLOG Annual Review 2009
[15]: From EBN report "Focus on Dutch gas 2010", p. 18.
[20]: [18]+[19] or 1,500, whichever is greatest.

[178] NLOG (June 2010), op. cit.
[179] We use the five most recent years for which there is data
[180] EBM report (June 2010), op. cit., p. 18.

Appendix XIV : Assumptions and Gas Flows for Base Case and Gas Hub Scenarios

Table 36: *Assumptions and Gas Flows for Transit Flows to UK*

		Base Case Scenario	Gas Hub Scenario
Demand:		NG Base Case	NG Base Case
UKCS Production:		Based on NG Base Case	Based on NG Base Case
Norwegian Imports:		Based on NG Base Case	Based on NG Base Case
LNG Imports:		Based on NG Base Case	Half NG Base Case Growth
Demand:	[1]	89.1	89.1
UKCS Production:	[2]	26.3	26.3
Biogas:	[3]	0.7	0.7
Norwegian Imports:	[4]	33.7	33.7
LNG Imports:	[5]	28.3	17.4
Total Supply (excl BBL)	[6]	89.0	78.1
BBL & IUK flows:	[7]	**0.08**	**11.0**
BBL Capacity	[8]	19.2	19.2
IUK Capacity	[9]	25.5	25.5
Flows through BBL	[10]	0.03	4.7
Flows through IUK	[11]	0.05	6.3
Transits through Netherlands	[12]	0.06	7.8

Notes and sources:
[10],[11]: Flows in [7] allocated according to capacities in [8] & [9].
[12]: [10] + 0.5 x[11]

Table 37: *Assumptions and Gas Flows for Transit Flows to BE/FR*

		Scenarios	
		Base Case	Gas Hub
Belgian Demand:		CREG Forecast	CREG Forecast
French Demand:		GdF/Suez Forcast	GdF/Suez Forcast
Additional Russian Gas via Germany and/or Neths:		In 2010 proportions	All increase via Netherlands
LNG Imports:		4 terminals at 75%	4 terminals at 75%
UK Exports		Base Case Scenario	Gas Hub Scenario
Belgian Demand	[1]	22.7	22.7
French Demand	[2]	49.1	49.1
Russian Imports from Netherlan	[3]	4.8	5.9
Russian Imports through Germa	[4]	2.7	1.0
LNG Imports	[5]	24.6	24.6
UK Exports	[6]	-0.05	-6.3
Other Pipeline Net Imports (exc	[7]	26.7	26.7
Shortfall	[8]	13.1	20.0
Exports from the Netherlands	[9]	18.0	25.9

Notes and sources:
[7]: [1]+[2]-[3]-[4]-[5]-[6]
[8]: [3]+[7]

Appendix XV : Cost Calculations for New Transit Pipelines

Table 38: *Pipeline Costs for New Transit Flows in Gas Hub Scenario*

Transits exiting at west			
Additional 2020 transit flows (bcm)	[1]	See note	4.8
Design load factor	[2]	Assumed	80%
Pipeline capacity (bcm)	[3]	[1]/[2]	5.9
Assumed diameter (mm)	[4]	See note	1,008
Assumed length (km)	[5]	Assumed	140
New pipeline cost (€/inch/km)	[6]	See note	35,000
Ancillary compression (€mn/km)	[7]	Assumed	0.24
Cost of expansion (€ mn)	[8]	([6]x[4]x[5]/25.2/1000000+[7]x[5])	230
Materials cost as % of total costs	[9]	Assumed	85%
Total expansion cost (€ mn)	[10]	[8]/[9]	270
Transits exiting at south			
Additional 2020 transit flows (bcm)	[1]	See note	11.9
Design load factor	[2]	Assumed	80%
Pipeline capacity (bcm)	[3]	[1]/[2]	14.9
Assumed diameter (mm)	[4]	See note	1,008
Assumed length (km)	[5]	Assumed	210
New pipeline cost (€/inch/km)	[6]	See note	35,000
Ancillary compression (€mn/km)	[7]	Assumed	0.24
Cost of expansion (€ mn)	[8]	([6]x[4]x[5]/25.2/1000000+[7]x[5])	344
Materials cost as % of total costs	[9]	Assumed	85%
Total expansion cost (€ mn)	[10]	[8]/[9]	405.2
Total expansion cost	[11]	$[10]_{west}+[10]_{south}$	675

Notes and sources:

[1]: For west, transit flows identified by our analysis in Appendix XIII that would flow through the BBL pipeline in the Gash Hub scenario. We use the figure relative to 2010.

[1]: For west, transit flows identified by our analysis in Appendix XIII that would flow through the IUKL pipeline in the Gash Hub scenario. We use the figure relative to 2010.

[4]: We assume a 40 inch pipeline is built in both cases.

[5]: For transits exiting west, 70% of approx distance between eastern entry point and Balgzand exit point

[5]: For transits exiting south, 70% of approx distance between northen entry point and exit to Belgium

[6]: Based on a pipeline investment cost of $25,000 /inch/km

Appendix XVI : TTF Net Revenues

Table 39: *TTF Net Revenues in Base Case and Gas Hub Scenario*

	Base Case				Gas Hub Scenario			
	Traded volumes (mcm) [1] GTS	Trading fee (€/MWh) [2] APX-ENDEX	MWh/ mcm [3]	Estimated revenue (€ mn) [4] [1]x[2]x[3] /1,000,000	Traded volumes (mcm) [5] GTS	Trading fee (€/MWh) [6] APX-ENDEX	MWh/ mcm [7]	Estimated revenue (€ mn) [8] [5]x[6]x[7] /1,000,000
2009	82,235	0.0075	9,769	6.0	82,235	0.0075	9,769	6.0
2010	101,080	0.0075	9,769	7.4	101,080	0.0075	9,769	7.4
2011	120,979	0.0075	9,769	8.9	120,979	0.0075	9,769	8.9
2012	140,889	0.0075	9,769	10.3	157,273	0.0075	9,769	11.5
2013	159,527	0.0075	9,769	11.7	204,454	0.0075	9,769	15.0
2014	175,480	0.0075	9,769	12.9	265,791	0.0075	9,769	19.5
2015	193,028	0.0075	9,769	14.1	345,528	0.0075	9,769	25.3
2016	212,331	0.0075	9,769	15.6	449,186	0.0075	9,769	32.9
2017	233,564	0.0075	9,769	17.1	583,942	0.0075	9,769	42.8
2018	256,920	0.0075	9,769	18.8	759,125	0.0075	9,769	55.6
2019	282,612	0.0075	9,769	20.7	986,862	0.0075	9,769	72.3
2020	310,873	0.0075	9,769	22.8	1,282,921	0.0075	9,769	94.0
Total, 2010 - 2020				160.3				385.2

Notes and sources:
For the trading fee we use the APX trading fee of €0.0075 per MWh that was used until very recently.

Appendix XVII : R&D Spending Base Case and Gas Hub Scenarios

Table 40: *R&D Spending in Base Case and Gas Hub Scenarios*

Cost of biogas production (£/kW)	[1]	Ofgem	6,600										
FX rate, €/£	[2]		1.2										
Cost of biogas production (€/kW)	[3]	[2]x[1]	7,920										
Conversion factor (kWh/m3)	[4]	Assumed	10										
Load factor	[5]	Assumed	80%										
Cost of biogas production (€/m3)	[6]	[3]x[4]/(8760x[5])	11										
Cost of producing 1 bcm/year (€ mn)	[7]		11,301										
			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EU gas demand (bcm)	[8]	Cedigaz	527	537	548	558	568	578	583	589	594	600	605
% biogas	[9]	See note	0.0%	0.4%	0.8%	1.2%	1.6%	2.0%	2.4%	2.8%	3.2%	3.6%	4.0%
EU biogas production (bcm)	[10]	[9]x[8]	0.0	2.1	4.4	6.7	9.1	11.6	14.0	16.5	19.0	21.6	24.2
Annual incremental production (bcm)	[11]	$[10]_t-[10]_{t-1}$	0.0	2.1	2.2	2.3	2.4	2.5	2.4	2.5	2.5	2.6	2.6
Annual biogas investment, EU (€ mn)	[12]	[11]x[7]		24,281	25,219	26,157	27,095	27,892	27,593	28,082	28,570	29,058	29,546
Base Case													
Share of investment returned as revenue	[13]	See note		0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Revenue (€ mn)	[14]	[13]x[12]		121	126	131	135	139	138	140	143	145	148
Gas Hub Scenario													
Share of investment returned as revenue	[15]	See note		0.6%	0.7%	0.8%	0.9%	1.0%	1.1%	1.2%	1.3%	1.4%	1.5%
Revenue (€ mn)	[16]	[15]x[12]		146	177	209	244	279	304	337	371	407	443
Incremental revenue (€ mn)	[17]	[16]-[14]		24	50	78	108	139	166	197	229	262	295

Notes and sources:

[9]: We assume that biogas production is 4% of demand each year

[13]: Equal to 25% x 10% x 20% where 25% is the royalty rate of the licensed firms' profits, 10% if the profit margin, 20% is the percentage of the invested capital that becomes licences.

[15]: Same calculation as [13] except that the percentage of the invested capital that becomes licences steadily increases to 60% in 2020.

Appendix XVIII: Investments Under Base Case and Gas Hub

Table 41: *Investments Under Base Case and Gas Hub Scenarios*

		Scenario Total Gas Hub 2010-2020 Mil Euros	Scenario Total Base Case 2010-2020 Mil Euros	Shock Gas Hub 2010-2020 Mil Euros	Final Demand Sectors
Investment					
	Upstream	€ 16,500	€ 11,575	€ 4,925	See Appendix XVII for cost allocation
	Transits	€ 4,667	€ 3,667	€ 1,000	
	LNG	€ 1,436	€ 343	€ 1,094	See Appendix XVII for cost allocation
	Storage	€ 1,817	€ 1,267	€ 550	
R&D Spending		€ 850	€ 675	€ 175	R&D
R&D Extra Royalties		€ 1,549		€ 1,549	All sectors, shares based on 2006 households' final demand consumption by sectors
TTF		€ 385	€ 160	€ 225	Financial Intermediation, Insurance
	Total	**€ 27,204**	**€ 17,686**	**€ 9,517**	

Notes and sources:

[1]: Upstream: assume to be in line with production.

[2]: LNG: Assumes one LNG facility is built between now and 2020.

[3]: Transits for Base Case assume to be €333 million a year. Similar to Gasunie historical capex and also confidential figures provided by Gasunie for 2010-2015.

[4]: The R&D extra royalties in the hub scenario are assumed to be distributed and to become extra income of Dutch households.

Appendix XIX : Allocation of Investments to Final Demand Sectors

Table 42: *Allocation of Investments to Final Demand Sectors*

Sectors	Investments Type			
	Transits, LNG, Storage	Upstream	R&D	TTF
Construction	30%	25%		
Manufacturing (Metals, Fabricated)	25%	20%		
Real Estate, Business Service, Community, Social Service	15%	15%		
Manufacturing (Machinery & Equipment)	10%	15%		
Transport & Storage	10%	10%		
Financial Intermediation, Insurance	10%	5%		100%
Manufacturing (Chemical, Rubber, Pharma)		10%		
R&D			100%	
Total	**100%**	**100%**	**100%**	**100%**

Appendix XX : Labour Impact of Base Case and Gas Hub

Table 43: *Labour Impact of Scenarios*

	JOB IMPACT (FTE)											
	Gas Hub and Base Case				**Base Case**				**Impact of Gas Hub**			
	Direct	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*	*Direct*	*Indirect*	*Induced*	*Total*
Agriculture, Hunting, Fishing	114	919	2,613	3,646	0	463	1,698	2,161	114	456	915	1,485
Mining (Coal, Uranium), Extraction (Crude, Gas)	0	76	57	134	0	47	37	85	0	29	20	49
Mining , Quarry (Not Energy Producing Materials)	0	82	8	90	0	56	5	61	0	26	3	29
Food Products (Beverages, Tobacco)	222	321	2,134	2,677	0	171	1,387	1,558	222	150	747	1,119
Textiles, Leather, Footwear	26	81	243	351	0	51	158	209	26	30	85	142
Wood & Wood Products	6	1,053	153	1,212	0	715	99	814	6	338	53	398
Paper, Printing, Publishing	148	1,625	2,256	4,029	0	1,001	1,466	2,467	148	624	790	1,562
Manufacturing (Chemical, Rubber, Pharma)	2,161	1,115	435	3,710	1,497	752	282	2,532	663	363	152	1,178
Manufacturing (Non-Metallic Mineral Products)	4	2,285	192	2,481	0	1,559	125	1,684	4	726	67	798
Manufacturing (Metals, Fabricated)	24,583	7,773	557	32,914	16,917	5,307	362	22,586	7,666	2,467	195	10,328
Manufacturing (Machinery & Equipment)	13,548	2,724	682	16,954	9,370	1,836	443	11,649	4,178	888	239	5,305
Manufacturing (Transport Equipment)	53	211	478	742	0	136	311	447	53	75	167	295
Manufacturing (Furniture, Recycling)	162	2,500	1,602	4,264	0	1,686	1,041	2,727	162	814	561	1,537
Electricity, Gas, Water Supply	64	601	870	1,535	0	377	566	942	64	224	305	592
Construction	42,804	16,576	2,522	61,902	29,454	11,193	1,639	42,286	13,350	5,383	883	19,616
Wholesale & Retail Trade	4,226	18,254	35,982	58,462	0	12,069	23,388	35,456	4,226	6,185	12,594	23,005
Transport & Storage	16,175	4,574	5,026	25,774	10,811	3,023	3,267	17,101	5,364	1,550	1,759	8,673
Post & Telecommunications	283	1,444	3,063	4,790	0	889	1,991	2,880	283	555	1,072	1,910
Financial Intermediation, Insurance	8,137	5,044	7,831	21,012	4,705	3,145	5,090	12,939	3,432	1,900	2,741	8,073
R&D	6,280	596	69	6,945	4,987	431	45	5,463	1,293	165	24	1,482
Real Estate, Business Service, Community, Social Service	38,342	40,935	53,449	132,725	23,249	26,275	34,741	84,266	15,092	14,659	18,708	48,460
Total	**157,336**	**108,792**	**120,220**	**386,348**	**100,990**	**71,182**	**78,141**	**250,314**	**56,346**	**37,610**	**42,079**	**136,035**

Notes and sources:

[1]: Calculations based on The Brattle Group model, based on Eurostat and CBS data.

[2]: Figures represent FTE job-years. A job-year is the equivalent employment of one person for one year.

Appendix XXI : Impact on Competition and Prices

Table 44: *Analysis of the Impact of Gas Hub on Competition and Prices*

			Base Case 2020	Gas Hub 2020	Impact on Prices
Production					
Total Dutch gas production	[1]	See note	59.3	59.3	
Of which:					
Groningen	[2]	See note	38.7	38.7	
Small fields	[3]	[1]-[2]	20.6	20.6	
Onshore	[4]	See note	6.4	6.4	
Offshore	[5]	[3]-[4]	14.2	14.2	
%of non-Groningen offshore produced by non-NAM	[6]	See note	75%	75%	
Percentage of non-Groningen onshore gas produced by non-NAM	[7]	See note	5%	5%	
Volume produced by non-NAM players	[8]	[6]x[5]+[7]x[4]	10.9	10.9	
Volume produced by NAM	[9]	[2]+[3]-[8]	48.4	48.4	
Imports					
Total amount of imports	[10]	See note	36.8	36.8	
Additional Gas Hub transit flows	[11]	See note		13	
Additional Gas Hub LNG imports	[12]	See note		6	
Gas Imported by GasTerra	[13]	[10]x0.5	18.4	18.4	
Gas Import by others	[14]	[10]-[13]	18.4	18.4	
Total imports and production	[15]	[10]+[1]	96.1	115.1	
Market Shares & HHI Index					
Share of NAM/GasTerra	[16]	([13]+[9])/[15]	69.5%	58.0%	
Share of each non-NAM producer	[17]	([8]/10)/[15]	1.1%	0.9%	
Share of each non-GasTerra importer	[18]	([14]/10)/[15]	1.9%	1.6%	
Share of each additional LNG importer	[19]	([12]/4)/[15]		1.3%	
Share of each additional transit shipper	[20]	([11]/10)/[15]		1.1%	
HHI	[21]	See note	4,877	3,419	
Fall in HHI (absolute)	[22]	$[21]_{BC}-[21]_{GH}$		1,458	
Fall in HHI (%)	[23]	$[22]_{GH}/[21]_{BC}$		29.9%	
Impact on Prices					
Marginal cost (€/MWh)	[24]	Assumed			15.0
Price in BAU scenario (€/MWh)	[25]	Assumed			18.0
Implied elasticity	[26]	[16]/(1-[24]/[25])			4.17
Price in Gas Hub scenario (€/MWh)	[27]	[24]/(1-([16]/[26]))			17.4
Change in price (€/MWh)	[28]	[25]-[27]			0.58
Change in price (%)	[29]	[28]/[25]			3.2%
Change in price-cost margin (%)	[30]	(([25]-[24])-([27]-[24]))/([25]-[24])			19%
Size of market (TWh)	[31]	See note			500
Annual value, € mln	[32]	[28]x[31]			288

Notes and sources:
[1],[2]: NLOG publication "Natural Resources and Geothermal Energy in the Netherlands; Annual Review 2009", p.23, Figure 2.
[4]: We assume that the proportion of small fields that are onshore and offshore remain the same as in 2009 as reported in the NLOG publication "Natural Resources and Geothermal Energy in the Netherlands; Annual Review 2009", p.9.
[6],[7]: Consistent with our analysis in Table 1 .
[10]: Total amount of imports currently envisaged by Gasunie in 2020. Gasunie security of supply report 2010.
[11]: Difference between Gas Hub and Base Case Scenarios as suggested by our transit flow analysis.
[12]: In our Gas Hub scenario we assume an extra 15 bcm in LNG capacity. We assume that the LNG facility operates at a 40% load factor.
[17]: Assumes that there are ten producers in addition to NAM.
[18],[20]: Assumes that there are ten suppliers in addition to Gasterra.
[19]: Assumes that there are four importers of LNG.
[21]: $([16]^2+10x[17]^2+10x[18]^2)x10,000$
[31]: Gas Transport Services report "Security of Gas Supply 2009". We convert from bcm to TWh using 10 kWh/m3.

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