Moving mountains

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Abstract

'Moving mountains' sketches the challenges faced by a particular group of incumbent fossil firms; the producers of natural gas in The Netherlands. As partner to all these producers, government body EBN faces these challenges as well. A brief overview of historical events reveal how natural gas and its value chain built the pillars of the energy system, projecting The Netherlands into wealth, welfare and comfort. Then, three major trends for the Dutch natural gas system reveal the changing context in which a different mode of operation is crucial to sustain its success. EBN's strengths could prove useful by creating synergies between fossil and renewable energy production and renewable energy system functions, especially in areas where new business cases have not yet been proven, and the market has not yet taken shape due to risks and uncertainties. These opportunities encompass activities currently out of its mandate. Three of the most spoken of opportunities are described in detail.

Disclaimer

This Essay is intended as a discussion document for educational purposes. This document does not represent an official statement of any of the companies mentioned and therefore should not be interpreted as such.

Contents

Introduction

The future holds many uncertainties, this is a given. This definitely holds for the European energy landscape and the activities of the actors within it. Climate change demands a rigorous greenhouse gas emission reduction from our energy system. This allow for flexible new start-ups to seize exciting business opportunities by developing new products and services. Supported by a policy of subsidies, an increased amount of intermittent energy sources are fed into the system. Large incumbent fossil based firms are forced to diversify their business portfolios to accommodate to the changing context, and will struggle to keep their businesses healthy. Also, governments struggle with the necessary steering, after having let loose of the 'reins' by successfully introducing liberalization in the energy markets of electricity and natural gas. Liberalization effectively strengthened the cornerstones of energy policy, making energy more available, reliable and affordable. The fourth constraint, 'clean' now asks a lot from societal stakeholders. Established innovation systems, business cases which held for many decades, providing jobs and wealth are now demanded by society to act into a different direction.

1. Dutch peaks

How our natural gas system came to be

From the early 1960's The Netherlands has rapidly developed a natural gas dominated energy system. This all started with the discovery of the large Groningen gas fields, initially holding near 3000 BCM of low-calorific natural gas. At this time, there was no market for natural gas, the main energy sources were oil and coal/lignite. This new energy source was so abundantly available all of a sudden, and its main element methane can be used in so many ways, that markets were rapidly created. Market players Shell and ExxonMobil in close cooperation with the Dutch government developed the necessary infrastructure quickly connecting 98% of domestic households to the system. Also interconnections were made to Germany and Belgium. This infrastructure eventually expanded all the way to France and Italy, expanding the market widely leading to similar developments in other parts of Europe.

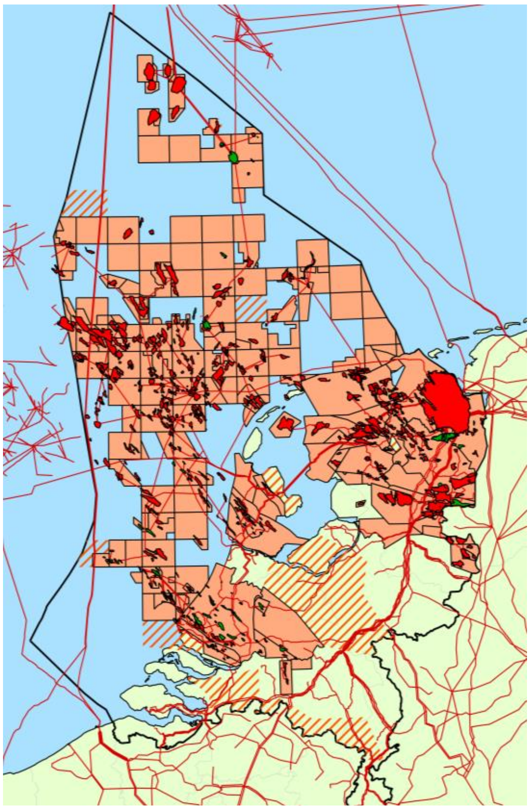

Figure 1. Dutch gas fields and infrastructure (Source: EBN)

For financial benefits, and to keep a close eye on market players and effective and efficient development of subsurface resources, a State participation of 40% was introduced. Firstly this was held by DSM (Dutch State Mines). Later, this became a separate entity, called EBN. The second decade after discovery of Groningen showed highest production rates. Government and market were eager to cash in early before nuclear energy would inevitably diminish the need for natural gas. This never happened, and on top of this the 1974 oil crisis made Dutch government realize that the Groningen gas field should be used as a strategic resource, filling in to stabilize the gas system, and policy focus was set on creating conditions allowing development of the hundreds of small fields on- and offshore. The Small fields policy was born. Production from small fields got priority over Groningen gas which production was capped, and the gas production companies were guaranteed offtake for their developed resources for a fair market price. For the State participation, this entailed an entirely new role. Now, focus was made on optimally exploit all small reservoirs in the Netherlands. The separate entity EBN grew from a passive into a pro-active organization, increasingly challenging market players and inviting them to invest more (effectively).

This facilitated the development of over 250 gas fields on- and offshore in the timespan of 40 years, adding peaks on the production rates. Currently 160 offshore production platforms are currently installed on the Dutch continental shelf interconnected by an intricate network of pipelines. The stake of EBN in the license has usually been 40% and nowadays EBN holds over 200 participations.

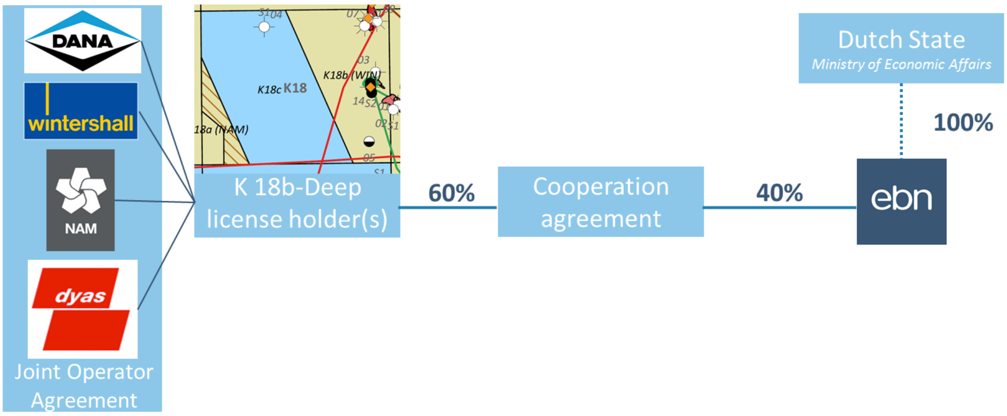

Figure 2. Example of small field Cooperation agreement (Source: EBN)

The new reserves from small fields have mainly been used in industry for high temperature processes and as feedstock. Apart from all the effects in industry and everyday lives of the Dutch citizens, the Dutch upstream industry also bloomed. Currently, there are 15 companies still active exploring and producing natural gas. There are many specialized companies who innovate to provide cheaper, smarter technologies adding value from current and new production. Besides these, universities, companies and knowledge institutes have a long history of working together in advancing state of knowledge and technology regarding to oil and gas exploration and production. This can be regarded as a well-developed innovation system.

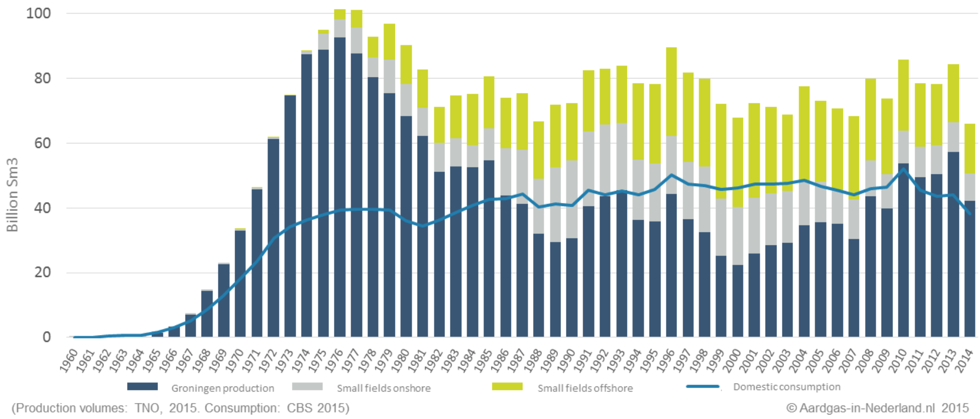

Figure 3. 'Mountain peaks' of historical production and domestic consumption (Source: CBS, TNO)

Domestic production of natural gas and oil has been bringing The Netherlands wealth, comfort, health and well-being. Apart from the undesirable increase of the value of the Dutch guilder currency and accordingly less demand for Dutch products this development has given a continuous boost to Dutch economy lasting well into the 21st century. The average yearly downtime of natural gas supply for consumers amounts to only 3 minutes, making it the most reliable energy source and system. The domestic resource development and broad use of the abundant resource had led to a strong decline in the use of coal. Coal being the most emission intensive way of generating power, from a climate perspective The Netherlands has outperformed many European counterparts.

From an average consumer and citizen's perspective, natural gas was and is a great gift to society, and for a long time the backbone of the energy system stood lonely at the top, but slowly but surely times have changed…

2. Erosion of solid mountain slopes

No longer business as usual

Currently, 4 major trends affect the Dutch natural gas industry. First and foremost, GHG induced climate change is causing harmful effects to biodiversity, water levels and living environment, demanding a change in attitude towards the energy system. Policy makers are now burdened to adapt their available, reliable and affordable energy system to accommodate a new pillar; the system should be clean. During the COP21 195 countries decided to increase the ambitious goal of a maximum of 2 degrees Celsius by 2100 in comparison to pre-industrial times, to an even more ambitious one by setting the goal to a maximum of 1,5 degrees Celsius. Greenhouse gas emissions should be greatly reduced in order to reach this goal. The Dutch national government recognized an Energy agreement made with 42 companies in the energy industry, underlining stability of policy towards 2023 in expanding the share of renewable energies from 4% to 16% in 2023. Great efforts are made in creating a new system for tendering windfarms in offshore The Netherlands, subsidies are granted for both innovation and capacity expansion. Currently, to very little effect. 2015 ended with a renewable energy percentage of 5,8%, risen from 5,5% in late 2014. In the “Energierapport 2015” (Energy report), the Dutch government made a policy change, setting a single target of CO_2 reduction, having flexibility for the best options to develop themselves. This strong focus on sustainability provides new threats and opportunities.

The second major trend is decreased public acceptance of fossil fuels and its production. Three major causes of decreased public acceptance can be distinguished. First and foremost, earthquakes in the Groningen field have led to many homes being damaged, causing extensive damage from 2012 when a major earthquake occurred. This is diminishing public support for natural gas production in other parts of The Netherlands. Second, intensified environmental activism driven by an aim for CO_2 reduction by reduction of fossil fuels is a key driving force of resistance. Last but not least, potential future environmental effects of shale gas development in The Netherlands also have led to widespread uncertainty and unease caused by subsurface activities.

The third major trend is increasing availability of energy. Deployment of renewable energy, abundant supply of cheap coal, and ever increasing cross-border gas interconnectivity, together with low oil prices have driven down the price of natural gas. Lower demand of natural gas in the USA due to their domestic gas production have redirected Asia’s LNG towards other markets, one of which is Europe. The continuing quest to recover new hydrocarbon resources might even unlock methane hydrates, unloading hugely onto the market.

The fourth major trend is maturation of Dutch fields and aging infrastructure. Netherlands is a mature basin. Although yearly new reserves are added, total reserve base decreases. On top of this, lowering gas prices causes acceleration of maturation. Resources are calculated on the basis of economic recovery of gas. With lower prices, the prospect of future production is reduced due to the halt of investments. Offshore fields are depleting, infrastructure is aging, increasing costs and lowering margins. When activities cease, offshore regulations demand removal of platform, losing the opportunity to ever explore and produce new gas fields.

These trends combined create a perfect storm which causes erosion to the business models. Could this mean the beginning of the end or create a fruitful soil for new business models?

3. Flourishing on fertile sediments

Exploring new subsurface energy functions

Even though alternatives will increasingly substitute natural gas in households and industries, natural gas will play a substantial role in our energy system for decades to come. Domestically produced gas will provide the lowest GHG footprint of any predictable energy form which provides (government) revenues, energy independence and energy system stability. The four major trends as written above will however limit the extent of which the full technical potential of the subsurface can be recovered. And at some point in time, recovery would be diminished so that no extra efforts could be made economically. The upstream gas industry would retreat, the portfolio of EBN would then diminish and this government body would be dissolved. All subsurface knowledge, in human and physical form would then be useless. This long term perspective does not sound appealing, and from the challenges that lie ahead, EBN´s strengths could lead to a great synergies with sustainability. A SWOT analysis with added long term perspective in the form of Dreams and Nightmares provide insights into future business strategies.

S • Short lines with policy maker • Short lines with operators • Long experience in subsurface development • NOV business line • Financially robust • Knowledge in G&G and Engineering • Broad asset base • Reduces financial risk for market players	O • Opportunities to contribute to sustainable projects • Political landscape is favorable for sustainable endeavors Synergy advantages: • Link fossil & sustainable • Improving CSR • Increase license to operate	D • Optimized natural gas and oil production • 95% revenues from sustainable energy projects • No subsidies needed by continuous application and innovation of sustainable energy technologies
W • Fixed mandate, parliament needed for adaptation • No operating experience • Business cases strongly dependent on external prices • Low public acceptance of fossil fuel production • Aging infrastructure	T • Failure is costly • Little experience in business development • Moving slow causes infrastructure to be dismantled	N • Failure of business developments • Losing value • Loss of license to operate due to reduced credibility & reputation

Figure 4. EBN SWOTDN analysis

Geothermal energy

Short description

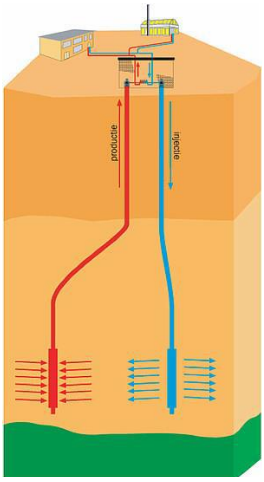

Figure 5. Schematic model of geothermal energy production

Every kilometer down in the earth, the temperature rises about 31 degrees Celcius. Geothermal energy production is a technology which uses the energy from this heat. At all depths in the subsurface water is present to some extent. The concept is that drilling and completing two wells in a permeable reservoir would allow water to flow in from one well, through the reservoir, to be produced by the other. Because of the higher temperature, injected water will heat up. Heat from this reservoir water can be recovered from a cheat exchanger and delivered as heating to households, horticulture or industrial processes.

Conventional geothermal energy production occurs at a depth of less than 3 km (typical 1,5-2 km), and delivers heat of 60-85 degrees Celcius. This is the right temperature for heating in buildings. Ultra Deep Geothermal energy encompasses recovery of heat from 5,5 km to 7,5 km. This delivers heat from a temperature between 100 and 200 degrees Celcius, making it useful for industrial processes and cascaded down to lower heat demands.

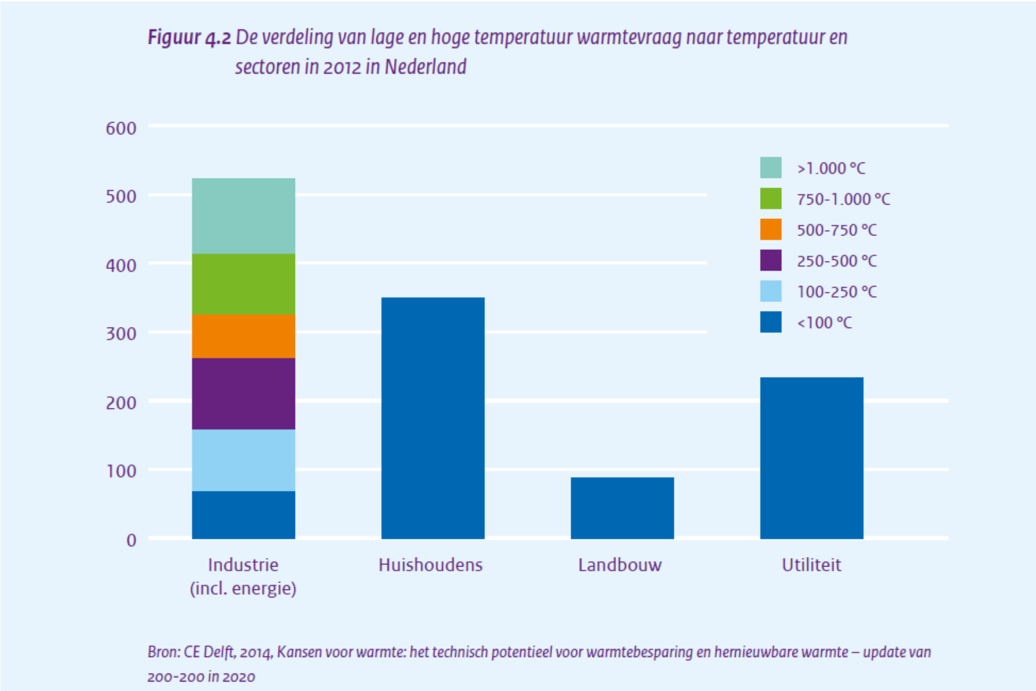

Figure 6. Low and high temperature demand The Netherlands (source: Energierapport 2015)

Market demand potential

Geothermal energy supplies heat, and can therefore (only) play a role in households, buildings, horticulture and deliver a part of industrial heat demand. The limitation lies in the maximum recoverable temperature, which is about 200 degrees (steam). The demand market for heat is therefore already there. Apart from great challenges and costs in the transition of installed equipment and infrastructure there is no reason why geothermal energy could not substitute all demands below 200 degrees Celcius if the supply is available. The market potential is therefore huge, especially considering incumbent firms pledged to give broad support to renewables at the cost of natural gas, which dominates this heat market (GILDE initiative[1]).

Market supply status

In The Netherlands, currently, geothermal energy is recovered from depths <3km. A mere 2462 TJ is supplied by Geothermal energy, making up 0,12% of the energy system[2]. 13 out of 14 projects installed up to 2015 have been supplying heat to horticulture. The first geothermal well was drilled in 2008. The market is demand-driven; most of the projects currently running in the Netherlands are an initiative of a heat-demanding company. Suppliers have no interest as described in previous paragraph.

Business assessment

The technology for (ultra deep) geothermy is commercially available. Wells have been drilled for centuries and complexity of wells do not exceed that of hydrocarbon wells. An important drawback is in the business case. Knowledge and capital is not fully deployed due to the competition of its applications in hydrocarbon wells. In other words, investing in geothermal energy is not appealing enough for upstream oil and gas firms. 70% of the production costs of the energy are made up of capital investments (wells and infrastructure) which are tens of millions of euro's. Apart from production subsidies (SDE+), the Dutch government initiated a Guarantee[3], taking some of the risk associated with geothermal projects in return for a premium. Still, geological uncertainties and consequently higher risks of dry-wells and modest margins essentially make geothermal investments not appealing to many firms.

EBN: Added value

Reviewing the Strengths of the SWOTDN analysis, and connecting them to challenges of geothermal development in The Netherlands, the window of opportunity can be assessed. There is a necessity for a reduction in financial risks in order to spark investments. For small oil and gas operators in The Netherlands, EBN is a stable partner with deep pockets willing to take 40% of investments, and as a consequence take 40% of the burden of financial risks as well. This has made developments of fields interesting. The same would count for geothermal projects. Second, these partnerships has proven useful in the exchange of knowledge and experience, creating synergy advantages. The in-depth knowledge of subsurface structures, (stimulating) technologies would be a valuable contribution to the market. On top of this, the whole innovation system of players would be connected to by this aligned interest. Third, EBN could monitor progress more closely, identifying thresholds and adequately committing resources from a financial or technology perspective, and also advising the policy maker on how to remove these boundaries. Fourth, Current physical assets could be (re)used. Wells could technically be adjusted to reach new reservoirs and accommodate the flow of water.
Unmistakably, taking on geothermal energy is miles away for EBN. There are many fields in which EBN does not yet possess the necessary competences. Heat cannot be stored or transported over large distances.

[1] http://www.energiedialoog.nl/category/lopende-projecten/
[2] http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=83109ned
[3] http://www.rvo.nl/subsidies-regelingen/risicos-dekken-voor-aardwarmte

Therefore offtake should be in the neighborhood, such infrastructure and demand side management lies out of current capabilities of EBN.

EBN: Synergies with current activities

Due to the fossil character of our current mandate, EBN is not seen as a part of government contributing to sustainability. By taking on these new activities, appreciation would increase. Furthermore, combined business cases could unlock sustainable as well as hydrocarbons, potentially enhancing the business case of either of them.

Offshore wind

Short description

Windmills have been around for many centuries, The Netherlands is even famous for it. By converting kinetic energy of air molecules to electrical energy. This power is used for many purposes.

Market demand potential

Because the product is electricity, the market is basically the entire electricity market (see figure for electricity demand). In comparison to heat, electricity can be transported over large distances. Electrical infrastructure offhore is being built by Dutch owned infrastructure company Tennet[4]. Electrification of current natural gas markets by use of heat pumps is a feasible development, in particular in households.

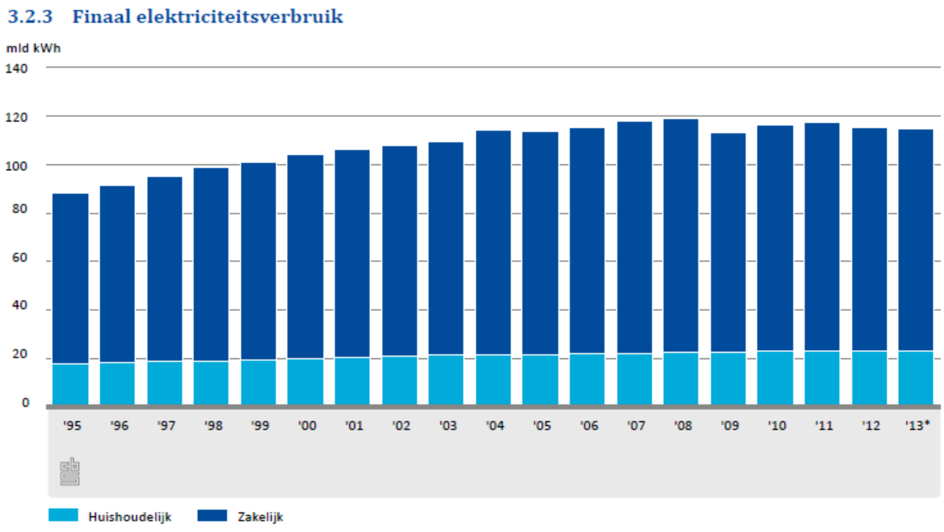

Figure 7. Final energy consumption in The Netherlands (Source: CBS)

Market supply status

In the Energy Agreement of 2012, offshore wind capacity was projected to expand by 6000 MWh offshore. At time of writing, 3 major wind farms are installed with a total capacity of 357 MW. Currently, major wind farm tenders are being written out to power companies. Even Shell as major upstream oil and gas player decided to opt in on a tender. In comparison to the huge challenge ahead, making the transition from fossil to renewables, the 6000 MWh offshore wind by 2023 will look dim. In 2013, 80.000.000 MWh of 100.000.000 MWh is

[4] http://www.tennet.eu/nl/nl/nieuws/article/tennet-plaatst-s-werelds-grootste-en-krachtigste-stopcontact-voor-windmolens-op-zee.html

generated by fossil fuels. In 2013, 1.983 windmills produced 5.049.000 MWh[5]. In 2015, 1,22% of our total energy production is generated by wind[6]. Generating 100% of just our electricity by wind would entail another 37.292 windmills of average 2013 generation capacity to be built. A grand challenge.

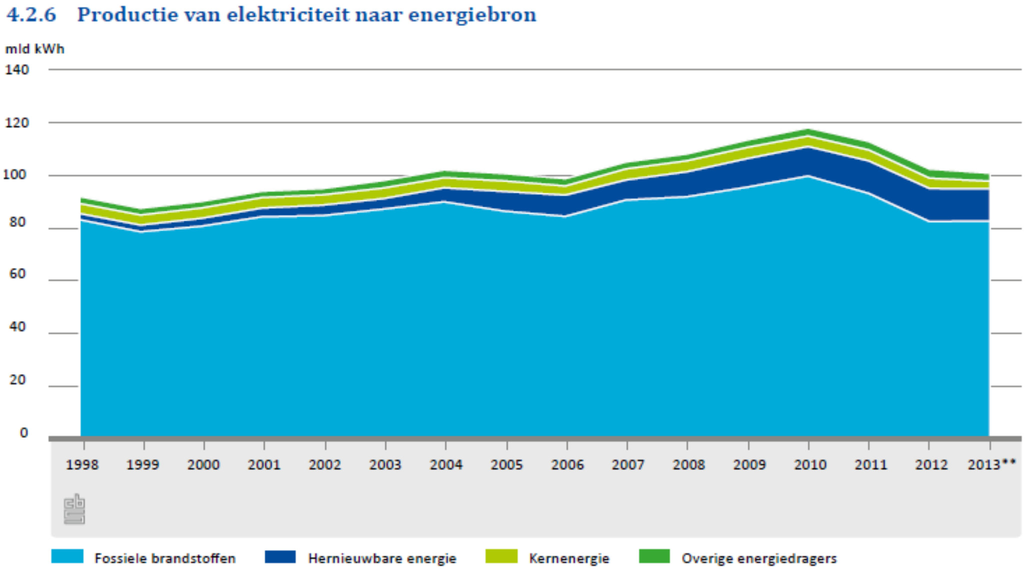

Figure 8. Production of electricity in The Netherlands (Source: CBS)

Business assessment

Wind energy exploitation would not be commercial without subsidies. Therefore generation subsidies (SDE+) are available. Due to the favorable subsidy system, many companies apply for the tender, confirming a positive business case, also for wind offshore. To spread financial risk, companies decide to write in on tenders together.

EBN: Added value

EBN does not possess many of the necessary knowledge or experience with wind energy production. To explore added value of EBN in wind production without interfering with international competition laws, a NOV role similar to the one it plays in oil and gas production could be evaluated. Funding wind parks requires deep pockets. In comparison to subsurface projects such as oil, gas or geothermal energy production, up front financial risk is low. Wind can be predicted more easily. Nevertheless many funds are to be invested to deploy mills and generate zero-emission electricity. With current portfolio, EBN can attract funds with low interest rates. However, rates and other funding conditions are inherently connected to the certainty and extent of profitability of the activities for which funds are granted. Profitability of oil and gas projects is higher regardless of the greater financial risk associated with separate projects, hence the conditions of the lot is attractive. Attracting funds for less profitable activities would therefore accordingly either result in less attractive funding conditions, or, when funds are addressed towards the entire business portfolio negatively affect funding the other part of the portfolio.

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5 http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=70960NED&D1=0,6,9&D2=0&D3=a&HDR=T&STB=G1,G2&VW=T

6 http://statline.cbs.nl/StatWeb/publication/?DM=SLNL&PA=83109ned

There is one great advantage of a potential role in offshore wind, this is the extensive gas infrastructure, leading all the way up to the northern part of the North Sea. EBN holds 40% of all installations and pipeline systems. By converting generated electricity to gas (power to gas technology), the entire area of the North Sea could be unlocked without laying expensive electrical infrastructure. Participation of EBN in wind generation, however, is not necessary for this activity. This could also be achieved by expanding EBN's mandate only a little bit.

EBN: Synergies with current activities

There are potentially great synergy options by combining offshore wind farms with oil & gas activities. Firstly, connecting platforms to wind parks allows electrifying of platforms (mainly production, equipment and compression). This would make offshore gas-turbines obsolete. This has major advantages in the field of economics and emissions. Opex would greatly be reduced; more gas can be sold and maintenance is practically zero.

Carbon capture & storage

Short description

The goal of Carbon capture & storage is to permanently store emitted CO2 into deep gas reservoirs or aquifers. This CO2 is emitted from industry or power sector.

Market demand potential

In 2050, GHG emissions should be reduced by 80-95% in comparison to 1990. According to the EU, this means that GHG emissions from power generation should be reduced to 0, and industry also to near 0 emissions (see figure below). For the power sector, large amounts of intermittent energy sources such as solar and wind power means a great demand for both storage and a flexible reliable back-up capacity that preferably can be ramped up quickly. For industry to reduce emissions so profoundly, increasing efficiency, a transition to biofuels and cradle to cradle manufacturing. For both areas, on top of described developments, CCS will be necessary to achieve these goals. However, Barendrecht 2009 has taught us that also public acceptance of CCS is an important issue. Therefore, in the context of evading climate change, CCS makes sense, but lack of acceptance might prove detrimental to its widespread application, forcing application to limit itself to offshore.

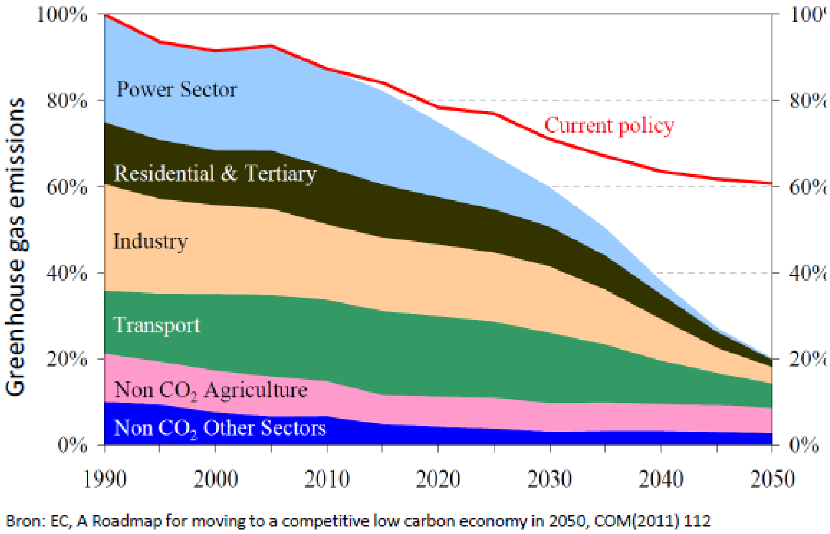

Figure 9. EU roadmap for competitive low carbon economy in 2050

Market supply status

Technically, the concept is proven. Currently, CCS is being performed offshore the Netherlands. Operater Engie scrubs CO2 from their CO2 rich gas production and redirects the CO2 back into the field, evading emissions. Application to the power sector in Europe is confined to a pilot project, called ROAD[7]. A new coal fired powerplant at the Maasvlakte area is manufactured 'capture-ready'. The sink of the CO2 would be in a gas field in the North Sea. Final investment decision is still not made. EBN is 40% owner of activities of the gas field which is still in production. The total theoretical potential for CO2 storage is 2,2 Gton, 1,6 Gton of which is offshore and a staggering potential of 7 Gton in the Groningenfield. Its application potential is therefore huge. However, OSPAR regulation forces owners of infrastructure to fully remove all installation in the North sea after end of activities. The window of opportunity in such a maturing basin as The Dutch offshore is therefore closing rapidly.

Business assessment

By storing CO2 underground permanently, CO2 abatement would save the emitting party to pay for CO2 credits. CCS as abatement option is now too expensive due to the high cost of the capex and opex and low cost of CO2 credits. The pilot project is subsidized by both Dutch government as the EU. The costs of transport and storage are around €10-20/tonne CO2. Most of the costs come forth from capturing technology.

EBN: Added value

EBN owns 40% of all assets, both gas fields as well as production infrastructure. Subsurface knowledge, petroleum engineering know-how and experience with currently producing fields make EBN a logical partner in CCS activities. The role EBN plays in its current mandate, partnering up with oil and gas production companies would be very similar regarding CCS storage. Instead of producing hydrocarbons, EBN and operator could work as the upstream part of a CCS supply chain. Activities in CO_2 capture do not have a direct link to EBN business, apart from current small scale process engineering which takes place when gas is made suitable for the national gas grid.

EBN: Synergies with current activities

By simultaneously injecting CO_2 in gas fields, potentially more gas can be recovered from fields. More importantly, offshore infrastructure would be on-line for a longer period of time, allowing new discoveries of oil and gas fields.

[7] http://www.road2020.nl

Conclusion

Natural gas has a long history of providing benefits to Dutch society. Since the 1960's natural gas production progressively contributed to availability, affordability and reliability of energy. Climate change throws up new system boundaries, urging governments and countries to act towards achieving a zero emission economy. Decreasing acceptance of fossil-based activities is an important factor on top of this. There are opportunities by using the old to facilitate the new. Losing the old too quickly, closes the windows of opportunity to achieve sustainability in an effective and efficient ways. This means that now is the time for EBN to take on new activities. Three activities are evaluated. Geothermal energy provides the most obvious synergies. There are many similarities between current subsurface activities such as drilling wells. EBN's participation would mean that oil and gas production can be enhanced, and an impulse can be given to a development that cannot take off autonomously. Second, participation in the upstream part of CCS could accelerate production rates, and is a logical step due to the position in current assets. EBN will be a party which cannot be ignored in this respect. Offshore wind participation is not necessarily made for EBN due to the little resemblances to current activities. Nevertheless, as an offtaker of electricity and offering gas infrastructure to transmit wind energy in gaseous state EBN would make a valuable contributor to this clean energy developments.

Concluding, it might feel as the outside world is desperately trying to move mountains, and as a consequence, the eroded slopes could provide fertile grounds for new and exciting business opportunities for long established industries...