The future of the Dutch offshore oil and gas infrastructure

Relevance and role in a carbon emission neutral energy system

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1 Introduction

Renewable forms of energy production are gaining market share at a high pace in the world, and even more so in Western Europe. In the North Sea area mainly offshore wind energy is heavily focused on and invested in. Although the Netherlands is still small in offshore wind with an installed capacity of around 0.4MW, another 0.6MW is coming online in 2017 and the target for 2020 is a capacity of over 2GW (NWEA, 2016). Neighboring countries like the UK (4.5GW installed, 11.5GW 2020 target) and Germany (1GW installed, 7GW 2020 target) are even more ambitious (TKI WOZ, 2015).

A worldwide movement towards a clean energy supply is gaining traction that will continue to support the development of more renewable energy generation, opposed to the continued use of fossil fuels. A major stimulus in this view was the COP21 Paris Agreement that was recently signed by 177 nations worldwide, thereby committing their policies towards a clean energy supply. The 1997 Kyoto Protocol never had this amount of participation and the 2009 conference in Copenhagen unfortunately never came to an agreement. In addition to governmental policies, public opinion on the use of fossil fuels for the worlds energy supply is becoming more negative as well.

The largest part of the countries in the world currently have an energy supply system relying mainly on the use of fossil fuels, being either coal, oil or gas. This includes fuels for electricity generation, for industrial usage, for transportation purposes and fuels for domestic usage. Moving towards a clean energy supply in all of these sectors will require wide support for this change. Especially for the fossil fuel industries as they stand, this will eventually mean that there is no long term business case left. It will also provide opportunities for transformation of existing companies, as well as for new companies to flourish. Innovation in these sectors could determine who will survive the energy transition and who will not. The pace in which governments will implement and enforce clean energy policies will probably determine how fast this transition will unfold. Germany is clearly setting an example in this respect. However, companies could also act as frontrunners in this area which could potentially give them a lead in the changing energy landscape.

The Netherlands has a fifty year history in the production of oil and gas. For around forty years production has also come from offshore fields and facilities. Four decades of investments in offshore wells, production facilities, pipelines and onshore support have created a well performing industry. This recent history also created the Netherlands as being the most intensified gas user in the world (Energiewereld, 2016). Local energy production has contributed for a large part to the wealth, development and energy security in the country. Clearly, the changing energy landscape with reduced use of fossil fuels could cause a major change for the Netherlands in all these aspects.

It is probably possible to just let the gas industry die out over time while the renewable energy industry takes over the energy supply for the Netherlands. However, to make this energy transition possible without destroying decades of invested capital in people, companies, networks and facilities that support the Dutch gas industry is the challenge that should be taken. A transition in which the use of gas infrastructure is adapted to changing requirements, the gas industry transforms to an energy supply industry and people acquire the skills to make this change happen is a much more appealing outlook, and probably much more profitable as well.

This essay will focus on one aspect of the Dutch oil and gas industry, the offshore oil and gas infrastructure. As offshore wind energy is currently developing rapidly as the scalable renewable energy producer of choice for the Netherlands, it seems evident that synergies with the extensive existing oil and gas infrastructure could potentially save costs for the Dutch society. Unfortunately, the existing and planned future wind energy projects seem to be developing as freestanding projects. In conjunction, the offshore oil and gas assets are aging as fields slowly deplete and the long deferred decommission liabilities appear to become reality. It should be possible to create an offshore industry in which the new renewable energy production is connected with the existing facilities and infrastructure to create a stabilized, flexible, cost effective, and carbon neutral energy supply for the Netherlands.

2 Aims

In order to provide an overview of the potential relevance and role of the Dutch offshore oil and gas infrastructure in a future carbon emission neutral energy system, the following aims for this essay are defined:

- Describe the history and current state of the Dutch offshore oil and gas infrastructure;
- Discuss the outlook of the use of the existing infrastructure in its current role;
- Investigate the possibilities for future use of the existing infrastructure in the future energy supply;
- Discuss the roles of Dutch oil and gas operators and regulatory bodies in the transition towards a carbon neutral energy system.

2.1 History and current state of the Dutch offshore oil and gas infrastructure

To understand the situation that the Dutch offshore oil and gas infrastructure is in, its history should be understood that created the current state of it. This includes an explanation of the invested capital over the years and the role in the current energy supply. The way in which energy use in the Netherlands developed in conjunction with its hydrocarbon production will make clear why the country is currently such an intensive user of mainly natural gas.

2.2 Outlook of the use of the existing infrastructure in its current role

Existing offshore oil and gas installations and pipelines are ageing, together with the ageing fields that continue to deplete. When fields deplete and no renewed production can be found for existing facilities, maintenance will be diminished or halted and eventually the installations will have to be decommissioned if no further use can be justified. This is a process that is rapidly coming to a late life stage in large parts of the North Sea oil and gas industry in the coming decades, as this also is happening on the Dutch continental shelf.

2.3 Possibilities for future use of the existing infrastructure in the future energy supply

The worldwide developments in energy use and the public and governmental views on energy supply will inevitably lead to a diminished role of oil and gas in the future energy supply mix. The outlook for the use of the existing offshore oil and gas infrastructure in its conventional role may thereby rapidly develop towards the decommissioning scenario. It is therefore necessary to investigate what the possibilities are to create a role and relevance for these offshore assets in a changed energy supply landscape. Although mainly gas may still play a role for a long time, especially in a transition phase, possibilities should be found to combine the developed offshore renewable energy production forms with the existing infrastructure. The inherently unstable supply of the current renewable energy forms will need a means of stabilizing to provide reliability for the country's energy supply. Secondly, the existing infrastructure could provide a way to transport energy, from production far away from its usage offshore towards the mainly land based usage. As currently renewable energy production consists largely of electricity, this form of energy does not have to be the preferred form for parts of the user base.

2.4 Roles of Dutch oil and gas operators and regulatory bodies in the transition towards a carbon neutral energy system

Oil and gas operators, the exploration and production companies, base their existence on finding and producing hydrocarbons. It will most likely not be a part of the strategy for these incumbents to stop their profitable business and transform towards an energy supplier of a very different type. It is therefore necessary to clearly define the future benefits for the operators to start innovating to cooperate in the transformation of the offshore energy industry. A major support to get this done should be through the regulatory frameworks that are set up by the EU and/or the Dutch government.

3 Conceptual framework

To realize the aims as described in the previous chapter, the major questions and issues will be set out in this chapter. A conceptual framework will in this way be created for the following chapters in which the support for the conclusions will be created.

3.1 History and current state of the Dutch offshore oil and gas infrastructure

How did the Dutch oil and gas industry develop over the last fifty years? This is the general question to which the answer will make clear what the extent of the industry is in the Netherlands. Parallel to that should be asked how the Netherlands developed its intense dependency of gas over this period. These two questions will provide an understanding of the current state of the industry and its current relation to gas usage in the Netherlands.

3.2 Outlook of the use of the existing infrastructure in its current role

A difficult issue to address is what the outlook of the continuance of 'business as usual' for the oil and gas industry in the Netherlands will look like. It is essentially an educated guess at future production, future demand and future policy changes. As a consequence, these three factors will also determine the rate at which operators will start to decommission their end of life assets.

3.3 Possibilities for future use of the existing infrastructure in the future energy supply

The invested capital, Dutch dependency on gas and the 'business as usual' case should then be clear. This will then provide the basis to start on the question what the possibilities are to keep the offshore infrastructure alive and delay the decommissioning phase. Opportunities will mainly lie in integrated solution with the upcoming renewable energy production and the need to provide a stable and reliable energy supply. In the Dutch offshore renewable energy as it looks at the moment will mainly be wind.

3.4 Roles of Dutch oil and gas operators and regulatory bodies in the transition towards a carbon neutral energy system

The opportunities for integration with renewables will be out of the comfort zone of the oil and gas companies. The main question is if the operators have a need to transform themselves for a carbon neutral energy system. To answer this question the influence that the regulating bodies have to steer this in several ways should be investigated.

4 History and current state of the Dutch offshore oil and gas infrastructure

The Dutch gas industry really took off from the moment the Groningen gas field was discovered in 1959, which is still the 9th largest gas field ever found in the world (Wikipedia1, 2016). Production was started in 1963 and provided the country with an abundant amount of natural gas. Oil production started a little bit earlier, but after the Groningen production started oil production has always been insignificant compared to gas.

From the moment the Groningen field started production, the gas network has extended up to a 98% connection of Dutch houses to the network. Most of the Dutch households cook and heat their houses with Groningen gas. Groningen gas stands for the gas quality from the Groningen field that determines the standard for domestic gas usage in the Netherlands. Natural gas from other fields will also be distributed across the country through the network, but will first be treated to be similar in caloric value to the Groningen gas. Other high caloric value gas that is produced will be distributed through a separate network to industrial customers.

All the gas that has been produced in the Netherlands since the 1960's has created a lot of wealth for the country. The national budget could always be balanced with a part of the gas production royalties and has certainly saved the Dutch from tax increase. Although the sustainability of this way of royalty usage is questionable, it has definitely treated the people well in those years. Still, the government earns money from the gas production and will therefore also have an incentive to keep gas production alive.

Although a field the size of the Groningen gas field has never been found again in the Netherlands, exploration activities continued. The smaller hydrocarbon discoveries that were done were difficult to develop in an economically feasible way due to scale, high cost and lack of security of sales. But the oil crisis of 1973 changed this, as the Netherlands, among others, was boycotted by the Arabic oil producers. This made that the Dutch government wanted to stimulate the development of its own resources. Therefore the Dutch policy for the development of small fields was initiated.

In 1975 the first offshore production was started from the L10-A gas field. From that moment onwards the offshore infrastructure has developed strongly until the first decade of the 21st century. The last ten years additions of pipelines and platforms has clearly slowed down (EZ, 2015) and while abandonments will continue, it is expected that the offshore gas infrastructure is now at its maximum extent and will only decline from now on (Peters, 2016).

The offshore infrastructure can roughly be divided into a number of networks. These networks are independent and are based on a few trunk lines to which other fields have been later connected. The three major networks are connected via large 36" pipelines. The first one that started with the L10-A 36" pipeline to Uithuizen in the Groningen province is the NGT network. Secondly, also from 1975, is the 36" pipeline from K13-A to Callantsoog in Noord-Holland that has developed into the WGT network. Then there is the F3-FB to L2-FA (24") to Callantsoog (36") pipeline from 1991, called the NOGAT network. A smaller network is the Q1 to Ijmuiden (Noord-Holland) network that was initiated in 1982 with a 20" pipeline, which is an oil network. The last one to be mentioned here is the P15 pipeline (26") to the Rotterdam Maasvlakte in Zuid-Holland. These pipelines, in total approximately 3500 kilometers in length, connect 158 platforms and 25 subsea completions on the Dutch offshore continental shelf (EZ, 2015).

5 Outlook of the use of the existing infrastructure in its current role

Offshore oil and gas development in the Netherlands is a very mature industry. A large amount of capacity has been installed over the last forty years. However, a clear decline in growth can be seen over the last ten years. As end of life has arrived for many fields, decommissioning has also started and will outpace the new developments. This means that the peak of the offshore oil and gas infrastructure is near.

A study by Atlantic Marine and Offshore (AMO) in 2016 estimated the end of life for the North Sea fields. They showed that almost all of the Dutch offshore fields reach end of life in between 2010 and 2030 (Vollaard, 2016). Half will reach end of life before 2020. As the law in the Netherlands obliges the operators to decommission the facilities within two years of ceased activity, a wave of decommissioning of platforms could be coming.

How fast this decommissioning wave will arrive and the magnitude of it depends on several factors. The price of oil and gas is the first important factor. Revenues of the sales gas should outweigh the operating cost of the facilities to keep it alive. With low prices, as are currently seen, more and more field will perform uneconomically. Operators could hope for better days, even stopping production for a while to save costs, but a prolonged period of lower gas prices will force earlier decommissioning of fields in this way.

Another important factor in the life extension of facilities and pipelines is the potential for more production. This could be achieved either by increased production from the existing wells by enhanced recovery methods or by near field exploration that could add production to the existing facilities. Although with the maturity of the basin, the options to achieve this become less. And the already decreasing production will also not help to fund the drilling of new exploration wells. So a low gas price enhances downward spiral of decreased revenue, decreased exploration, and earlier end of life.

The third import factor of influence is demand for gas. Increasing supply of renewable energy will start to take market share from fossil fuels. However, there are some counter movements as well. As the Groningen field is currently cut back on production due to the earthquakes, there will be more demand from other sources of natural gas. Due to the much lower carbon emission from burning gas opposed to oil and coal, gas will slowly replace these sources. Coal fired power plants will be shut down, as is enforced by the Dutch government in the Energieakkoord (SER, 2013). Altogether, it looks like the demand for natural gas will be growing on the short term. In the long term, when enough renewable capacity is created to replace gas, demand will start to fall.

And then there is competition. The Dutch gas grid is well connected to surrounding countries like the United Kingdom and Germany, but also Russia can supply gas to the Netherlands. With the enormous amounts of gas production that Russia can generate, they could be able to compete on price with the gas produced in the Netherlands. Also liquefied natural gas (LNG) is a growing market. With an LNG terminal in Rotterdam, the Netherlands is also a market for LNG from further away like the Middle East. So although demand for natural gas could be present, competition from foreign suppliers will be strong.

In its current role, there will be steady demand for offshore produced natural gas on the short term. This will motivate gas producers to continue their business as usual. However, with a low gas price and expensive production from small fields, the cheaper gas coming from abroad could be a threat to the Dutch gas industry. This will also shorten the economic life of fields, which will accelerate decommissioning and abandonment of the Dutch offshore assets. As such, a downturn like it is experienced at the moment with low gas prices will only add to this acceleration.

6 Possibilities for future use of the existing infrastructure in the future energy supply

For the existing offshore oil and gas infrastructure to have a purpose in the future energy supply system, a potential remaining role for natural gas can be an option. However, for the longer term, ways to use the pipelines, platforms and fields for other forms of energy carriers will be more sustainable towards carbon emission free energy production. An extensive amount of possibilities will be discussed.

6.1 Natural gas for industrial usage

As it is expected that nearly all residential use of natural gas can be replaced be electrical power or other forms of energy that can be produced in a sustainable way, some consumers of natural gas may not be able to use a substitute for natural gas. This requirement will primary come from industrial users. When natural gas, or any of its elements, is used as a primary ingredient in a production process there may not be a technically feasible option for a replacement.

Large users of natural gas are steel producers where it is used for heating. Natural gas is also used as a feedstock for the production of methanol, which in its turn has a wide variety of industrial applications. Dehumidification by natural gas desiccant systems is another use that is applied in a lot of industries (NaturalGas.org, 2016).

Replacing all industrial use of natural gas by substitutes will not be a rapid process. As long as gas is available and factories will not have to redesign their process and invest in new production equipment it is not likely that anything will change. Only when supply is clearly decreasing, gas prices rise and another technically feasible option is available companies may be willing to review their production process.

6.2 Clean power for gas production

This form of integration is a very minimal type of integration and will help to reduce the CO_2 emissions while producing natural gas. It could also help to reduce the operating expense of the platform. An offshore hydrocarbon production facility needs electrical power to be able to operate. This power is used for all electrically powered equipment on board a production platform like lighting, sensors, communication equipment and pumps. Conventionally this electrical power is provided by diesel or gas generators. Diesel will have to be brought to the platform by supply boat, gas can be taken from the production stream itself.

Supplying electrical power to production platforms from land by a cable is expensive and is only rarely done, for platforms near the coast. The longer the cable needs to be, the more expensive it will be to bring electrical power from land to the platform. However, when electrical power is generated offshore by renewable sources like wind, a nearby solution could be found. When a wind park is near a production platform it could provide power directly.

The length of the power cable could be significantly reduced by positioning the wind park's transformer station close to a production platform. Cost of electrical power could then be lower compared to diesel or gas usage. Secondly, but perhaps more important in view of the carbon emission reduction goals, the carbon emissions for the gas production will reduce significantly.

6.3 Back up for grid stability

Electrical power produced by renewable energy sources is an inherently intermittent supply of energy, not at all driven by demand at the time of production. Solar energy can only be produced when the sun is shining at the location where the solar power modules are positioned. Depending on the location, the weather can be very unpredictable and clouds will influence the power generated on a particular day. Unfortunately the weather is also of major influence in wind generated power. An electricity supply based on only wind and solar would therefore be much too irregular and unstable for the current electricity grid without major storage capacity.

One of the options to stabilize the electricity supply in a largely renewable energy based system is to use natural gas fired power plants. Centralized electricity production by a gas fired power plant, that is relatively flexible in capacity usage, can act as the electricity buffer to provide a stable and demand driven energy supply.

Gas supply for the power plants will then also need to be suited to the varying demand. For several reasons offshore production facilities may not be able to be as flexible as needed to suit the varying demand. Solutions for this are already in place by several gas storage facilities onshore in the Netherlands in salt caverns or gas reservoirs. In this way the offshore production facilities and infrastructure can be used in a potentially carbon emission neutral energy supply, although this does not seem to be a sustainable application for the longer term.

6.4 Wind farm transformer stations

Wind turbines in an offshore wind park are all connected to transformer stations that are positioned on jackets, very similar to production platforms. This, at first sight, simple option is to remove the hydrocarbon process facilities from the platform after end of field life, and replace it with the electrical equipment to create a transformer station for a wind park. The wind park should of course be built near the existing platform. All the wind turbines will be tied in to the platform that will form the transformer station. This approach could save the investment to install the jacket with living quarters and helideck. Removing the hydrocarbon process equipment, which is part of the existing decommissioning liability, and placing the electrical equipment will then be the remaining investment for the station.

Another opportunity connected to this option is related to when the platform that is turned into a transformer station is also connected to shore via a pipeline. From the station the electricity has to be transported to shore, for which the most obvious choice would be to lay a power cable from the platform to shore. Laying this cable is an expensive exercise as the cable trajectory needs to be trenched, cable laid and buried. Then a dune crossing may have to be created. All this could be avoided if the cable could be pumped through the existing pipeline connection from platform to shore or the opposite. Compared to laying a new cable this will be a much less complex and very cost efficient operation. Pump capacity, pipeline pressure rating, pipeline diameter, pulling forces on cable and future accessibility to the cable could be issues for this scenario.

6.5 Power to hydrogen

Because the offshore hydrocarbon infrastructure mainly consists of pipelines through which fluids can be transported, a solution for integration can be sought in conversion of the offshore generated electricity into a fluid. The fluid should be an energy carrier that can transport the energy generated offshore to the onshore market where it is mainly used. Another advantage to fluids over electricity is that energy can be stored efficiently and in a scalable way. A widely discussed energy carrier in this respect is hydrogen (H_2).

Electricity can be converted into H_2 through the electrolysis process. Electrolysis is a chemical reaction in which water can be split into hydrogen and oxygen by applying an electrical current over it. An electrical current can only be applied to water if it is made into an electrolyte, which means that free ions need be present in the water. Free ions can be created in the water for example by dissolving a salt. A developing and very efficient method of electrolysis is polymer electrolyte membrane (PEM) electrolysis (Jepma, 2015), which makes use of a solid polymer electrolyte (SPE) through which positively charged hydrogen atoms can be transported (Wikipedia2,2016).

For now, assuming that the above process is a feasible option, the question that remains is what to do with the hydrogen? There are several answers possible to this question. In general, it could be sold directly, it could be the ingredient to produce another fluid, or it could be stored and converted back into electricity.

The generated hydrogen could be stored offshore to be later used to generate electricity again through a hydrogen fuel cell. This will help to stabilize the power supply as excess generated electricity can be stored in the form of hydrogen, and extra electricity can be generated from the hydrogen in times of supply shortage. Storage of hydrogen could be done in underground salt caverns, depleted hydrocarbon reservoirs or tanks at surface. When the weather depending renewable energy sources cannot meet demand, the stored hydrogen could be used to generate the additional electricity demand.

For direct sales the simplest option is infeed into the produced natural gas. A relatively small addition of hydrogen into the gas stream will not change requirement for usage as is currently done. The limitation for the amount of hydrogen that can be added to the gas grid is related to grid degradation and effects to the usage in households, and is nationally regulated (Jepma, 2015). Currently the total share of hydrogen that is allowed in the natural gas mix is 0.02 vol%, with an increasing tolerance to 0.5 vol% in 2021 (Verhagen, 2012).

Another market for hydrogen is the chemical industry. The two main applications for hydrogen are processing of fossil fuels and the production of ammonia. Traditionally hydrogen is produced by steam reforming of natural gas. Although hydrogen generation by electrolysis demands more energy, it is carbon emission free production opposed to the conventional production. The offshore produced hydrogen should be transported to shore by boat or (most preferably) through the existing pipelines. Connection of the offshore pipeline to existing underground hydrogen pipeline networks would potentially create additional advantage to this scenario.

The third market for hydrogen is the market for mobility. This could include both road transport on land as well as shipping. At this moment there is no widespread adoption to using hydrogen as fuel for road transport. Although this subject is developing, this requires an offering of hydrogen driven cars as well as refueling stations. Smaller scale projects with public transport busses are running, and the first cars with a hydrogen fuel cell are being made. Hydrogen could potentially also become a clean fuel for shipping. The ships could then be filled up with fuel offshore, where the hydrogen is also produced.

Hydrogen could also be used to generate other fluids, which would perhaps have advantages over hydrogen itself in terms of storage, transport and market. The first possibility is to produce methane from hydrogen and carbon dioxide in the so called methanation process. The great advantage of producing methane is that the total infrastructure is already suited to handling methane, end of life hydrocarbon reservoirs can be used as storage, as well as that a fully functioning market is present. One of the difficulties is that sufficient quantities of CO_2 need to be supplied to this process for which a solution needs to be found. Methane gas will in this way be a carbon emission neutral gas opposed to its normal use from natural gas.

The second fluid that has the potential to become the energy carrier of choice is ammonia (NH_3). Ammonia can be produced from hydrogen and nitrogen through the Haber-Bosch process. It becomes liquid at relatively low pressures at room temperature which makes storage not too difficult. Existing pipelines may be used to transport the ammonia to shore. Burning ammonia with oxygen will only result in water and nitrogen emissions, which are no greenhouse gasses. Ammonia is a widely used product in the world, mainly as an agricultural fertilizer. Therefor a lot of knowledge on the production, handling and use of ammonia is already present, including a market for it. Additional markets for ammonia can also be developed when it will be used for electricity production of automotive mobility. In the Netherlands, a test project is ongoing to change a natural gas fired power plant to an ammonia fired power plant (TW, 2016). The first ammonia powered cars have also been developed.

It is now clear that several options in the power to hydrogen scenario are available, but the implementation of these options could meet some challenges. Although the technology to produce H_2 from offshore wind power is available, a fit for purpose offshore platform setup at the appropriate scale is still to be developed. As the H_2 production facilities will already take its place on the space limited offshore platform, any other addition of equipment could run into platform boundaries. The H_2 to electricity, methanation or ammonia production options may run into this problem. Use of existing equipment and pipelines for H_2 or NH_3 handling and transportation may not be feasible without technological upgrades due to the differences in properties compared to natural gas, for example with regards to corrosion. Cost of equipment, upgrades and installation will give the final call for economic feasibility.

6.6 Carbon dioxide storage

As long as fossil fuels will be used, carbon dioxide will be produced. To come closer to a carbon emission free energy supply when fossil fuels are still part of the mix, the CO_2 will have to be captured and stored. Storage could be permanently, or as a buffer for CO_2 usage in the greenhouses in the Netherlands. The current offshore infrastructure and fields could serve for this purpose. Carbon capture and storage (CCS) is investigated worldwide and the first projects are ongoing.

6.7 Compressed air energy storage

The principle of compressed air energy storage (CAES) is that the oversupply of electricity can be used to compress air and store it. Storage can be done in underground salt caverns. When there is a shortage in electricity supply, the compressed air can be heated and expanded in an expansion turbine driving a generator for power production. The difficulty in this process is that air heats up when it is compressed, which is loss of energy. While at the expansion phase, the air has to be heated which requires energy again. This lowers the efficiency of this process and is an important issue to solve. Two CAES plants exist in Germany and the USA.

7 Roles of Dutch oil and gas operators and regulatory bodies in the transition towards a carbon neutral energy system

Oil and gas operators traditionally focus on the exploration and production of hydrocarbons. Although the financial risk involved can be high, return rates have always been much higher, resulting in a highly profitable business to invest in. As the usage of oil and gas intensified over the last fifty years, the market has become highly certain for sales. Combined with Dutch regulation supporting the development of oil and gas resources in the country, it is no surprise that, despite volatility in oil and gas prices, the hydrocarbon industry has done so well.

However, the two main movements of the maturing fields and the trend towards renewable energy supply cannot be neglected. As the major part of existing fields is expected to reach end of life in the coming fifteen years, the decommissioning liability is a burden coming close to realization. Operators will be motivated to delay decommissioning expenses. Reducing carbon emissions is inarguably the goal that the world has now set in the COP21 agreement. Fossil fuel use will have to be reduced to reach that goal, and renewable energy supply will have to fill the gap.

Oil and gas operators will have to change their position in the North Sea area. Companies that have worldwide activity could leave the area after fulfilling their decommissioning liabilities or selling their end of life assets when profitability decreases. Local players will certainly have to change their business model if they want to remain active in the area. New companies specializing in end of field and energy integration operations may arise. Signs of these are already seen as for example Chevron has moved out of the Netherlands recently and Shell has joined a joint venture to bid for the development of an offshore wind park.

The Dutch government can play an important role in ensuring that the offshore oil and gas infrastructure is not neglected for the energy supply of the future. With the published “Energieakkoord voor duurzame groei” in 2013 and the commitment to the COP21 climate goals, the Netherlands has clearly shown its ambition and commitment to a carbon neutral energy supply. However, as the current energy supply is still mainly fossil fuel based and the energy incumbents are not being forced to work towards a cleaner energy supply, there is no incentive for the industry to join the government in a combined effort to reach the clean energy goals. Shaping the right environment with a long term strategy may be needed to support an integrated development focused on providing a ‘green’ and reliable energy supply for the country. The Energieakkoord only sets goals for renewable energy up to 2023, which is short term for a capital intensive and slow moving industry.

Good developments are the combined industry efforts that are currently emerging. A national platform for energy and surroundings (NPEO) has been set up by the energy sector including representatives of renewable energy production, electricity production, oil and gas operators and network companies (NOGEPA, 2016). This platform will be focused on involving citizens and other companies in the energy transition. And the main project focused on integrated offshore energy supply is the project on ‘system integration offshore energy’ driven by TNO, the Dutch national research institute. EBN, the Dutch national energy company and Shell were also closely involved in this project. Their goal was to do a study on the potential for integration and delivering a programme towards subsequent projects to support and accelerate the energy transition.

8 Conclusions

The offshore oil and gas infrastructure has strongly developed over the last forty years after the Dutch government started to stimulate the development of smaller gas fields to reduce the reliance on the Groningen gas field. More than 150 platforms and 3500km of pipeline together currently make up the Dutch offshore oil and gas infrastructure. Large investments have been done to develop this infrastructure and large costs will be incurred when these platforms and pipelines will have to be decommissioned if no further use can be justified.

The oil and gas sector in the Netherlands is a maturing industry. It is expected that the major part of all the offshore fields reach end of live before 2030. The approaching wave of field decommissioning can be postponed by creating more and longer production and by a continuing demand for gas in the country. In the short term it looks like offshore gas demand will grow due to reduced Groningen output and closing down of coal fired power plants. Competition from foreign gas supply may decrease the demand for Dutch offshore gas.

Future use of the offshore assets in a changed energy system has several options. The most conventional role will come from the industrial demand for natural gas. When offshore generated renewable power is connected to gas producing platforms, gas production becomes much cleaner. Gas production can also serve a role of back up for electricity reliability in a combination with less reliable solar and wind energy.

Different use for the offshore platforms could be as transformer stations for wind farms. Offshore wind power could also be used to produce hydrogen. Hydrogen can serve several purposes. There is a current, and perhaps a future, market for hydrogen. Methane could be produced from hydrogen and carbon dioxide. Ammonia could be produced form hydrogen and nitrogen. These fluids could be stored offshore or transported to a market onshore through existing pipelines. Although technological challenges for these different scenarios will still have to be overcome and economic feasibility will have to be evaluated.

As long as gas demand remains high and production profitable there will not be much incentive for the oil and gas operators to change their business model. However, it becomes all the more clear that the hydrocarbon industry will change significantly in the coming decades. Some industry initiatives are already emerging based on the ambitions of the Dutch government. Although a more long term integrated view on the energy transition would benefit the efficiency and pace of the transition towards a cleaner energy supply.

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