OGT Oil & Gas Transitions

Denmark without Oil and Gas Production:

Opportunities and Challenges

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About this report

This report was written by Aalborg University as part of the Oil and Gas Transitions (OGT) programme, which is co-led by Climate Strategies (CS) and the Stockholm Environment Institute (SEI). OGT is an evidence-based programme which aims to generate evidence and co-produced pathways for policy action to accelerate oil and gas just transitions in the UK/Scotland, Denmark and Norway. The report identifies the current state, opportunities and barriers for a just transition of the oil and gas sector in Denmark, as well as the key stakeholders and their views on the transition. The findings will serve as inputs for the co-production of just transition pathways and international blueprints for oil and gas transitions in upcoming stages of the programme. The statements herein do not directly represent the views of CS, SEI, the funders of the programme or other members of the OGT consortium.

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Executive Summary

Denmark has gradually reconsidered its status as a major oil and gas producer and, through the 2020 North Sea Agreement, has set 2050 as the end date to produce fossil fuels. The Agreement is framed within a just transition perspective, but how just the transition will be for the oil and gas sector and beyond remains to be seen.

This report attempts to answer the following questions:

a) What is the background, which are the processes and conditions behind the Danish 'oil stop', and is this compatible with a just transition for the oil and gas industry?

b) Which challenges, opportunities and further action points arise from the Danish oil phase out?

c) Which lessons can be learned from the Danish case?

The questions are answered through a mixed approach which analyses relevant policy and legal documents, statistics, and previous research, and is supported by 9 semi-structured interviews with key Danish stakeholders.

The economic significance of the Danish oil and gas sector has been decreasing for a long time. Partly because of this, the North Sea Agreement has received widespread support at political level and from the industry. Carbon capture, utilisation, and storage (CCUS), offshore wind power, as well as power-to-X and green fuels are being explored and supported by the state and the market. New business ventures, especially related to offshore wind, are cushioning some of the negative effects on employment in the sector. Beyond that, the transition is affecting the number of jobs in two ways. On one hand, many offshore workers are close to retirement and are likely to need special attention. On the other smaller suppliers, unable to restructure, may be disproportionally impacted by the phase out.

The overall understanding, however, is that the 2050 deadline is a 'no-brainer' and a lot of efforts are made to ensure that the Danish example inspires other countries to follow. This process could be further strengthened if Denmark could phase out oil and gas production even earlier than 2050, an option that needs to be investigated.

Economic rather than moral arguments have fuelled the phase out decision, but the process has also been mediated through a close dialogue with authorities in the main oil and gas region, around Esbjerg, and the oil and gas industry, which has committed to explore cleaner business avenues. The versatility of both the workforce and businesses, and a strong renewable energy base, are expected to soften the negative impacts of the oil and gas transition.

This report focuses on the conditions of the phase out in Denmark, but to fully understand the extent to which the Danish example could be emulated by other oil-producing countries requires supplementary in-depth analysis.

1. Introduction

Denmark is known for its unique transition from being nearly 100% dependent on imported fossil fuels in the 1970s to becoming a world leader on renewable energy and energy efficiency, in particular wind power, district heating and combined heat and power. There is no doubt that Denmark is a global frontrunner in making and implementing ambitious energy policies in an inclusive manner that benefits the national economy and supports social welfare. In 2011, Denmark was the first country in the world to announce the goal of complete independence from fossil fuels by 2050. This occurred under a right-wing government, demonstrating how widespread and early consensus on these matters was established in the country.

While the relatively long history of Denmark's ongoing energy transition has been described and analysed to a considerable extent, the background, prospects and challenges of the recently announced oil and gas phase out require further analysis and concrete action plans for the years to come, to leave no one behind. This involves securing a just transition as described by Atteridge and Strambo's[1] 7 principles[2].

The already agreed 2050 deadline raises the question as to what the Danish case can bring to the global community in terms of accelerating the transition to zero oil and gas production. First, other countries might benefit from some of the lessons learned from the Danish decision-making process. In addition, how to further strengthen and realise the just transition will become a relevant matter in the Danish process as well as internationally, particularly when it comes to companies and workers that risk losing out. Such restructuring issues will be especially relevant in countries where larger shares of the workforce depend on the oil and gas industry. Second, since the transition towards zero oil and gas production has already begun, it might be argued that the 2050 deadline is too unambitious for a country that aims to reduce greenhouse gas emissions by 70% by 2030.

The objective of this report is to answer the following three questions: a) What is the background, which are the processes and conditions behind the Danish 'oil stop', and is this compatible with a just transition for the oil and gas industry? b) Which challenges, opportunities and further action points arise from the Danish oil phase out? c) Which lessons can be learned from the Danish case?

The main empirical background to the report consists of a mapping of policies, stakeholders, and socio-economic characteristics of the Danish oil and gas sector, which was carried out based on desk research and a literature review. The analysis was supported by 9 semi-structured interviews conducted between May and September 2021. These focused on issues specific to the transition of the oil and gas sector in Denmark, including the 2020 North Sea Agreement and the impacts on the main oil and gas region, in and around Esbjerg. The interviews were recorded and transcribed using Konch (a transcription programme).

The report is structured as follows. Section 2 provides an overview of the oil and gas sector in Denmark, including the main policies and strategies related to its transition. Particular attention is paid to the 2020 North Sea Agreement, which includes the commitment to end oil and gas production by 2050. Section 3 sheds light on the economic significance of the sector nationally and discusses the case of Esbjerg detailing the implications of the North Sea Agreement for the region. Section 4 presents the perspectives of some of the main stakeholders regarding the challenges and opportunities of a just transition for the sector. Section 5 discusses the overall findings looking at the future. Sections 6 concludes with recommendations from an international point of view.

[1] Aaron Atteridge and Claudia Strambo, 'Seven Principles to Realize a Just Transition to a Low-Carbon Economy' (2020).

[2] Actively encourage decarbonisation; avoid the creation of carbon lock-in and more "losers" in these sectors; support affected regions; support workers, their families and the wider community affected by closures or downscaling; clean up environmental damage, and ensure that related costs are not transferred from the private to the public sector; address existing economic and social inequalities; ensure an inclusive and transparent planning process.

2. Overview of the oil and gas sector

This section presents a short overview with the history of the Danish oil and gas sector. It shows how Denmark in few decades has transformed from a country entirely dependent on oil and coal to one in which most of the electricity is supplied by renewable energy without compromising the principles of a just transition. It is argued that this development is due primarily to being a first mover in wind energy and energy efficiency.

2.1 History of oil and gas exploration, production, and consumption

The history of the national oil and gas industry started when the first oil reserves in the Danish North Sea were discovered at the Kraka field in 1966. The discovery was made by the Danish Underground Consortium (DUC), which was established by the logistics company Maersk. In 1972, after the formation of the state-owned company Danish Natural Gas Ltd. (later DONG[3] Ltd.), systematic exploration in the Dan Field began. However, it was only after 1981, when exploration activities started in a second oil field (Skjold), that production reached a significant level.

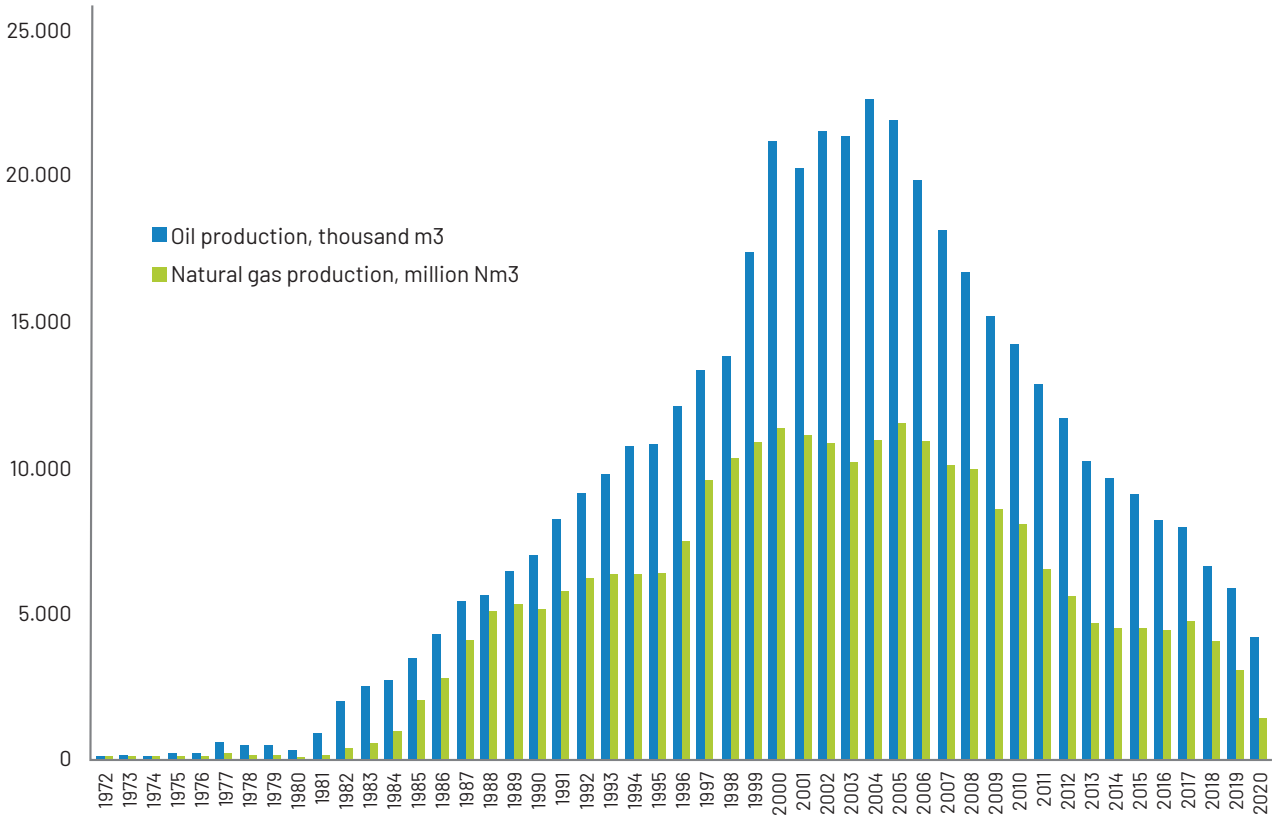
Prior to the oil crises of the 1970s there was little interest in establishing a domestic energy production base given the low oil price. As both crises, in 1973 and 1979, hit the Danish economy and energy sector hard, the state engaged in an exploration and production effort that led to a rapid increase in oil production between 1981 and 2005.

Between 1981 and 1991 exploration started in five additional oil fields and oil production increased from 800 to 8,000 m^3 per year.[4] In 1993, oil production surpassed the domestic demand making Denmark self-sufficient. By comparison, the country was nearly 100% dependent on imported oil around 1973.[5] Oil production peaked in 2004 at roughly 22,700 m^3, corresponding to twice the domestic oil demand. Since 2005 production has been gradually decreasing and in 2019 it returned to 1988 levels.[6] In 2018 Denmark became a net importer of oil[7]. While it is estimated that exploration may become feasible in only a few unexploited fields, the business case for continuing oil production has gradually become less promising and activities are expected to terminate completely sometime between 2040 and 2050[8].

Natural gas production has been following a similar trend (see figure 1). Self-sufficiency peaked in 2005. The latest resource assessment made by the Danish Energy Agency in 2021 projects a production profile (reserves + contingent resources) of 146 million m^3 of oil and 76 billion Nm^3 of natural gas, expecting the country to remain a net exporter of gas until 2035[9]. As a new feature, the Danish Energy Agency also projects fewer oil and gas sales from exploration activities because of the 2020 North Sea Agreement, under which oil and gas production will be phased out by 2050.

[3] Danish Oil and Natural Gas.
[4] (Danish Energy Agency 2021)
[5] (Danish Energy Agency 2018)
[6] (Danish Energy Agency 2021)
[7] (Danish Energy Agency 2021, 2018)
[8] (Danish Energy Agency 2021, 2018)
[9] (Energistyrelsen 2021)

Figure 1: Oil and gas production 1972-2020. The total production has been distributed across 20 oil fields throughout history. As of 2020, 11 fields were in operation out which 2 accounted for more than 50% of the production (Dan, and Halfdan fields)[10].



On the demand side, the transformation also involved the uptake of renewables, as about 55% of electricity was produced from wind in 2019[11] while coal accounted for 11.2%, following a decline in consumption by 79% since 1990. In 2020 only 5% of the total energy consumption was covered by coal, according to preliminary data[12]. In comparison, about 7% of the total electricity production is now based on oil and gas while CO_2 emissions have decreased by 43% since 1990.[13]

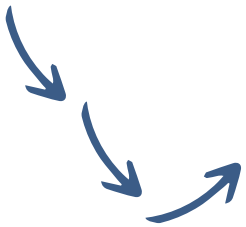
This structural change is mainly due to an increase in natural gas consumption in the power sector, until around 2005, and in households, where gas gradually replaced oil and coal. The main reduction in oil consumption was recorded in power (-72%) and heat (-83%), in manufacturing (-47%), the service sectors (-90%) and households (85%).[14]

In contrast, oil consumption in the transport sector has increased significantly from 1990 to 2019. Diesel consumption increased by 71% and jet fuel by almost 60% over this period, reflecting a growth in road traffic and domestic air travel and being only slightly offset by a 23% decrease in petroleum consumption[15].

As regards oil and gas exploration, the industry has improved energy efficiency by 30% since 2008, according to one of the interviewees.[16] This was stimulated by a series of energy efficiency agreements with the state and has been possible thanks to a combination of declining production, reduced flaring, and increased electrification (e.g., replacement of gas engines with direct drive electric ones for pressurising water).[17] The general development is summarised in table 1.

[10] Danish Energy Agency, 'Yearly Production, Injection, Flare, Fuel and Export in SI Units' (n 4).
[11] Danish Energy Agency, 'Energistatistik 2019. Data, Tabeller, Statistikker Og Kort' (2020).
[12] Danish Energy Agency, 'Energistatistik 2019. Data, Tabeller, Statistikker Og Kort' (n 11); The Danish Energy Agency, 'Key Figures from DEA's Preliminary Energy Statistics 2020' (2021).
[13] Danish Energy Agency, 'Energistatistik 2019. Data, Tabeller, Statistikker Og Kort' (n 11).
[14] Danish Energy Agency, 'Energistatistik 2019. Data, Tabeller, Statistikker Og Kort' (n 11).
[15] Danish Energy Agency, 'Energistatistik 2019. Data, Tabeller, Statistikker Og Kort' (n 11).

Table 1: Key figures about current Danish oil and gas production with arrows indicating and downward trends or no change over the last 5 years.[18]

	Status	Trend (last 5 years)
Current production (2019): Oil Natural gas	4,143,000 m^3 1,396 million Nm^3	
Active fields (2020)	11	
Share of national GDP	DKK 5.9 billion (0.25%)	
GHG emissions from oil and gas production (2019): Fuel consumption Flaring Share of national	1.115.149 ton CO2 157.824 ton CO2 2.6 %	
Share in national energy mix (2019): Oil Natural gas	279 PJ (39%) 106 PJ (15%)	

[16] Martin Næsby, 'Interview with Managing Director of Oil & Gas Denmark, Martin Næsby, 28 May 2021 (MS Teams)'.

[17] Næsby (n 16).

[18] Danish Energy Agency, 'Økonomi for Olie Og Gas' <https://ens.dk/ansvarsomraader/olie-gas/oekonomi-olie-og-gas> accessed 15 June 2021; Danish Energy Agency, 'Yearly Production, Injection, Flare, Fuel and Export in SI Units' (n 4); Danish Energy Agency, 'Energistatistik 2019. Data, Tabeller, Statistikker Og Kort' (n 11).

2.2 Current Status and Trends

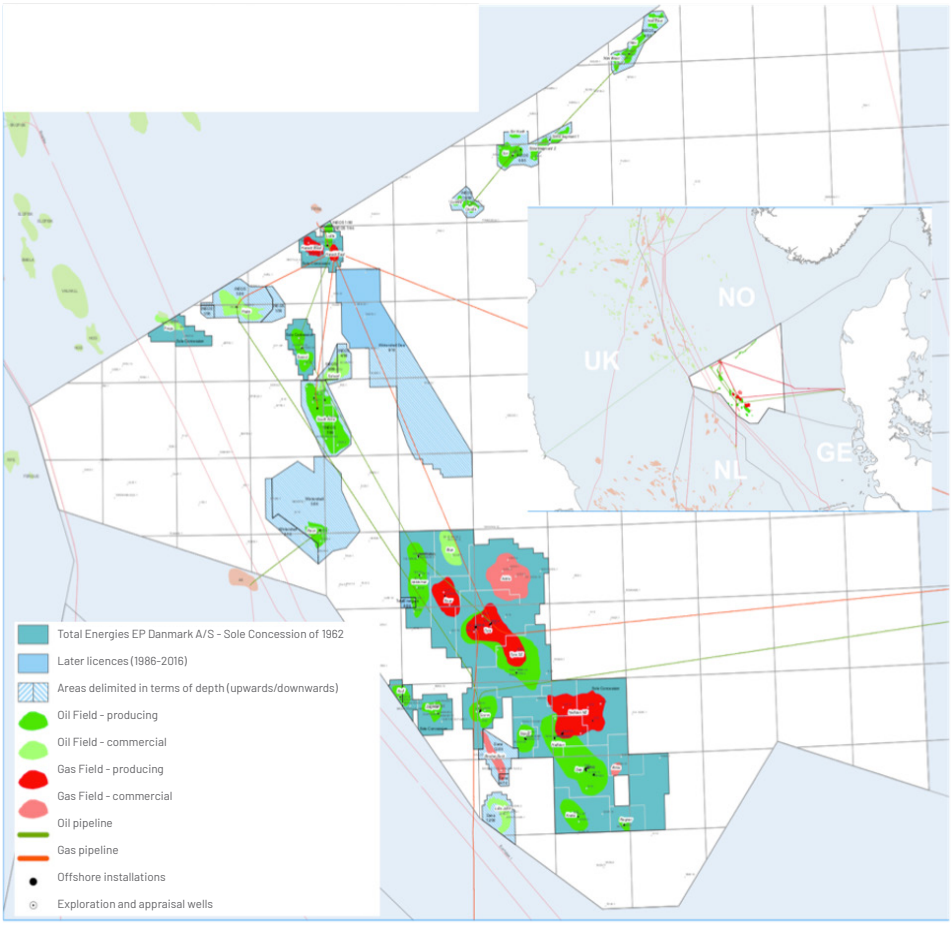
Section 2.2.1 presents an overview of the Danish oil and gas industry value chain which facilitates the understanding of the present and future business model of the sector.

2.2.1 Value Chain

Figure 2 shows the oil and natural gas fields in the Danish North Sea, as well as the pipelines connecting the fields to the shore. Once extracted, natural gas is transported to the treatment plant in Nybro and then delivered to the onshore transmission network, which connects with the national distribution grids and the transmission grids in Sweden and Germany (see Figure 3). About 400,000 consumers, including households, electricity and heating companies and other businesses, are connected to the gas distribution grid in Denmark.[19] In areas where there is no network, gas can be delivered to households and businesses in bottles and tanks.

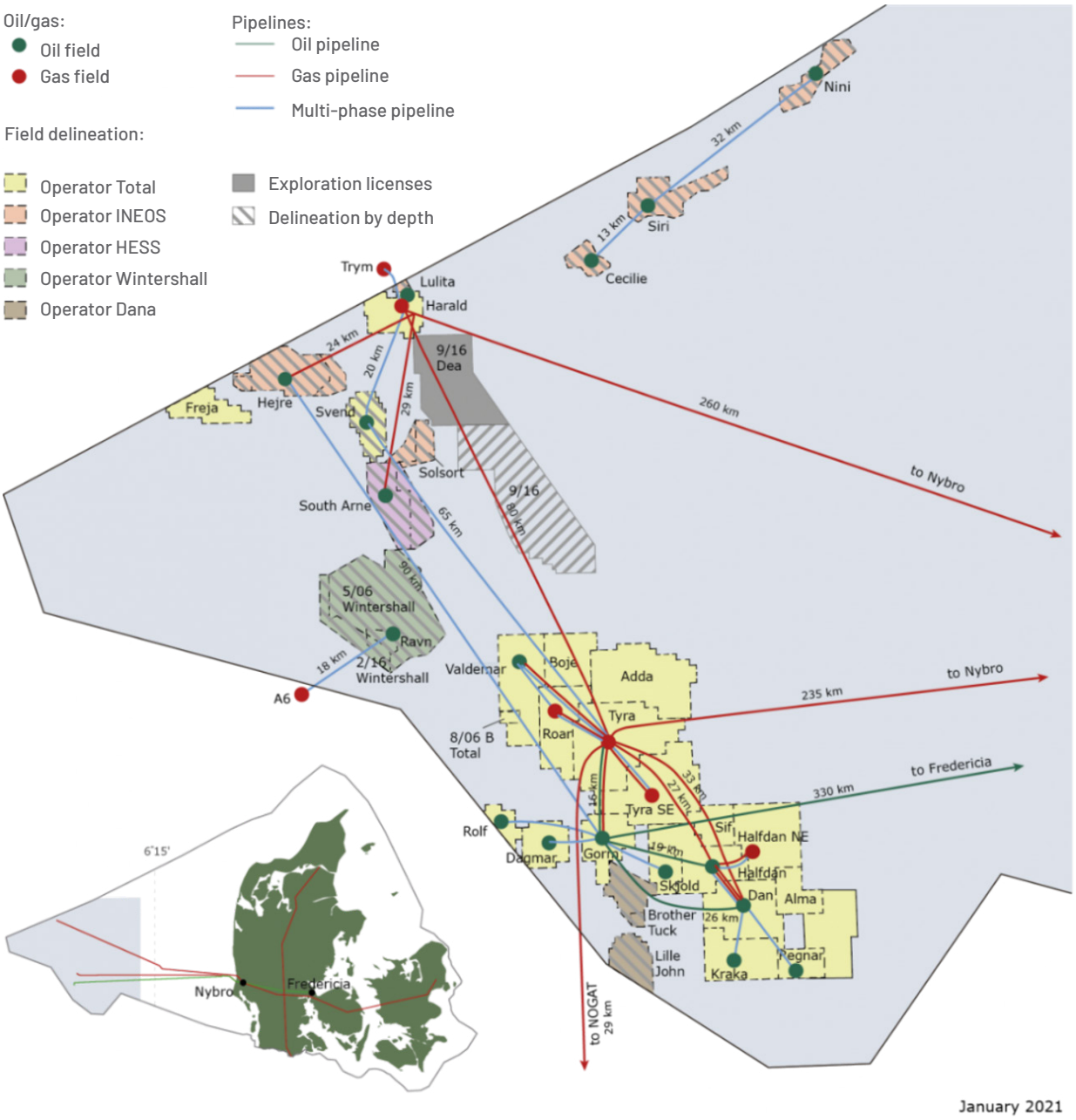
Figure 3 presents the two large gas storage facilities in Lille Torup (435 million Nm3) and Stenlille (513 million Nm3),[20] and the compressor station in Egtved. The 'Baltic Pipe' project is currently under construction. This will connect the Norwegian, Danish, and Polish natural gas transmission systems, as presented in Figure 4. In Denmark, the project involves the expansion of the gas transmission system (both in length and capacity) and the installation of a new compressor station in Zealand.[21]

Figure 1: Danish oil and gas fields in the North Sea. Source: Danish Energy Agency.[22]



[19] Evida, 'Grøn Gas'.
[20] Gas Storage Denmark, 'Our Storage'.
[21] Energinet and GAZ-SYSTEM, 'Baltic Pipe Projects'.
[22] Danish Energy Agency, 'Danish Oil and Gas Fields' (2021).

Figure 2: Danish gas system. Source: Energinet and GAZ-SYSTEM, 2017.[23]



[23] Energinet and GAZ-SYSTEM, 'Baltic Pipe Project. Shipper Information Meeting. Stavanger Meeting. 20 June 2017'.

Figure 3: Danish gas system. Source: Energinet and GAZ-SYSTEM, 2017.[24]

Figure 4: The Baltic Pipe project. Source: Energinet and GAZ-SYSTEM 2017.[25]

[24] Energinet and GAZ-SYSTEM (n 23).

[25] Energinet and GAZ-SYSTEM (n 23).

About 15 million tonnes of crude oil from the Danish oil fields are transported annually via the pipeline to the refinery in Fredericia, where approximately one third is processed. The rest is shipped in tankers to other refineries.[26] The second oil refinery in Denmark, located in Kalundborg, receives about 5.5 million tonnes of crude oil each year, shipped in tankers mostly from Norway, as well as from the US and West Africa.[27] Once processed, most of oil products from the two refineries are shipped in tankers to consumers in Denmark and abroad.[28] The remaining part is transported in trucks. Both refineries have large oil storage facilities, 0.66 million m^3 [29] and 1.2 million m^3 [30] respectively. Other large oil storage facilities are also located close to the old refinery in Stigsnæs (which was operational between 1963 and 1997) and in Ensted,[31] where oil products are delivered in tankers.

Which innovations and changes are afoot?

One of the main reasons for the rather smooth transition in Denmark is that politicians, companies, and workers have witnessed a rapid development of alternatives to oil and gas production, and related alternative job opportunities. Some examples are:

- Biogas production, which has substantially increased in recent years reaching 16.6 PJ in 2019.[32] Evida, a subsidiary of the state-owned transmission system operator (T) Energinet, estimates that 20% of gas in the Danish network comes from renewable sources and says that the share could increase to 40% by 2025.[33] Moreover, the company argues that "there is a technical potential for 100% of gas in the network to be green as early as 2035"[34] (own translation). For an overview of the Danish biogas plants see data from the Danish Energy Agency[35].

- Charging stations for electric cars and hydrogen fuelling facilities, which are being built by major operators[36].

- Projects to supply green hydrogen and other electrofuels to buses, trucks, vessels, and planes, which are under development too and include, for example, "Green Fuels for Denmark" (see 4.3.2) and plans to produce bio-oil at the Fredericia refinery.

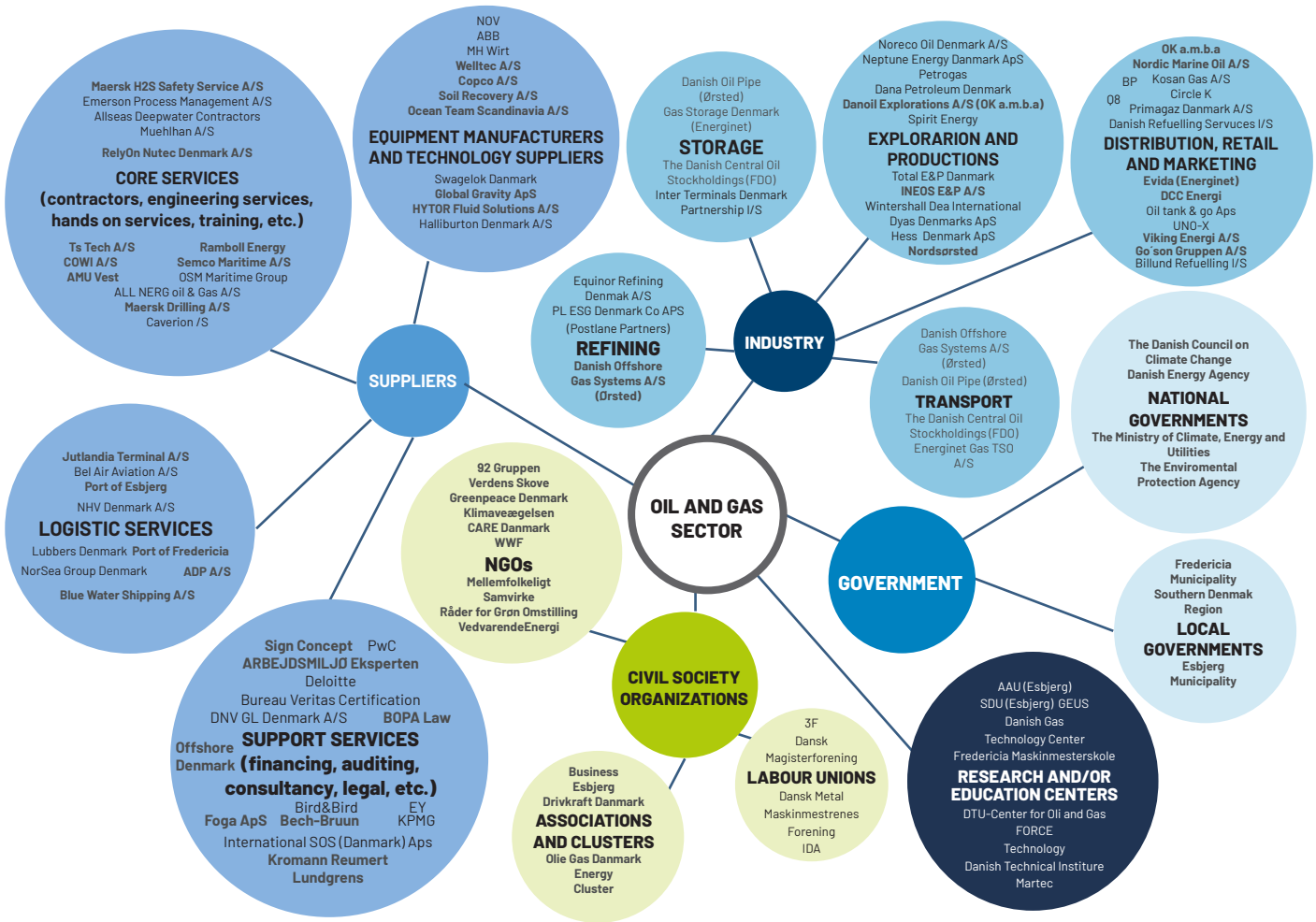
[26] Shell, 'Shell Raffinaderiet i Fredericia'.
[27] Equinor, 'Equinor Denmark'.
[28] Equinor (n 27); Shell, 'Shell Raffinaderiet i Fredericia' (n 26).
[29] Shell, 'Shell Raffinaderiet i Fredericia' (n 26).
[30] Equinor (n 27).
[31] Inter Terminals, 'Danish Terminals'.
[32] The Danish Energy Agency, 'Månedlig Og Årlig Energistatistik' (2021).
[33] Evida (n 19).
[34] Evida (n 19).
[35] The Danish Energy Agency, 'Biogas Plants in Denmark' (2020).
[36] OK a.m.b.a., 'Ansvar for Miljøet'; Q8, 'Bæredygtig Transport'.

2.2.2 Stakeholder Map

This section (figure 5) presents the main stakeholders in the Danish oil and gas sector as a basis to discuss their alignment to the just transition.

Apart from various (groups of) businesses in the value chain, stakeholders include trade unions, national and local government, associations, and NGOs. The significance of the latter in the phase out of oil and gas activities has been considerable and is discussed in later sections.

Figure 5: Overview of main stakeholders in the Danish oil and gas sector. Danish-owned companies are highlighted in bold.



Suppliers in the value chain can be categorised in three groups: (1) specialised oil and gas sector suppliers, (2) general oil and gas sector suppliers, and (3) general suppliers. Stakeholders in the first group are first or second tier suppliers to the industry, e.g., drilling companies, well management companies, producers of drilling equipment, etc. These have competences that are specific to the oil and gas value chain and have specialised their products and services to satisfy the needs of the oil and gas industry.

Stakeholders in the second group are also first or second tier suppliers to the oil and gas industry, but their core competences, products and services can be applied to other supply chains. This group encompasses, for example, general maritime service and offshore logistic suppliers with expertise in navigation, transportation of heavy structures, maintenance of steel structures, etc.

Stakeholders in the third group are second or third tier suppliers whose competences, products and services are useful to a broad variety of supply chains. General suppliers provide safety equipment, paint, steel sections, engines, etc. The main difference between the specialised and the general suppliers is that the first are heavily dependent on how the oil and gas sector will develop and, hence, vulnerable to any factor that could impact investments, operations, and maintenance in the value chain (e.g., geopolitical issues, oil and gas prices, green policies, etc.). Therefore, specialised suppliers could also face the greatest challenges in the energy transition.[37]

Nordsøfonden is the Danish state-owned company conducting oil and gas exploration and production activities. The firm, established after the partial privatisation of DONG (now Ørsted), owns 20% of the Danish licences awarded since 2005. Nordsøfonden (20%), TotalEnergies (43.2%) and Noreco (36.8%) are the current partners in the Danish Underground Consortium (DUC), which is responsible for about 85% and 97% of the Danish oil and natural gas production, respectively [38].

Which stakeholders are abandoning or entering the scene?

To understand the transition process and how it might evolve in the years to come, it is necessary to know the key players. In recent years there have been significant changes in the ownership of oil and gas assets in Denmark. Most remarkably, DONG (renamed as Ørsted) and Maersk sold their exploration and production businesses. The first sold its share to international chemical giant INEOS in 2017[39] and the second to French oil-producer Total in 2018.[40], Shell sold its Danish upstream interests to Norwegian energy company Noreco in 219[41] and agreed this year the sale of the Fredericia oil refinery to private investment firm Postlane Partners.[42] Moreover, the natural gas distribution network, which used to be owned by a group of companies including DONG Gas Distribution, NGF Nature Energy, HMN Gasnet and Aalborg Naturgas Net, is now owned by Evida.[43]

[37] Karsten Rieder, 'Interview with Head of Business at Business Esbjerg, Karsten Rieder, 24 June 2021 (MS Teams)'.
[38] TotalEnergies, 'TotalEnergies in Denmark'.
[39] Ørsted, 'DONG Energy Enters an Agreement to Divest Its Upstream Oil and Gas Business to INEOS' (2017).
[40] Maersk, 'Sale of Mærsk Olie Og Gas A/S Completed' (2018).
[41] Shell, 'Shell Completes Sale of Upstream Interests in Denmark to Noreco for $1.9 Billion' (2019).
[42] Shell, 'Shell Indgår Salgsaftale for A/S Dansk Shell' (2021).
[43] Evida, 'Historien Bag Evida'.

2.2.3 Policy Map: forces and dynamics driving the Danish oil and gas transition

The state and major political parties have played a decisive role in the Danish transition. According to a national political tradition, major decisions with long-term implications are usually made with broad support from all government and non-government parties. Therefore, key political targets such as the phasing out of fossil fuels are typically agreed and implemented by different governments. The following sections cover visions and decisions concerning oil and gas supply and demand since around 2005.

2.2.3.1 The emergence of the North Sea Agreement and the end of Danish oil production

This section focuses on the political process behind the North Sea Agreement as the key political intervention in the phasing out of oil and gas production in Denmark, followed by related policy elements in the current transition package.

Since the first oil crisis, in 1973/1974, the Danish energy policy has pursued security of supply based on domestically sourced fuels and energy efficiency. From the 1980s through the 2000s the country tried to achieve these goals by following a two-pronged strategy of renewable energy expansion and efficient generation based on Combined Heat and Power (CHP) and district heating on one hand and exploitation of national oil and gas resources on the other.

After the turn of the century, the overall guiding vision for the Danish energy system has been – and still is - the total phase out of fossil fuels by 2050. The target was announced by Prime Minister Anders Fogh Rasmussen as early as 2006[44] but was elaborated into what can be considered the first 100% renewable energy strategy for any country in 2011[45].

Since then, different Danish governments have embraced the 100% renewables target granting this policy a broad parliamentary backing from all the major parties, but also from leading actors in society. In the short and medium term, the country's climate and energy policy is guided by the goal, established in 2019, to reduce CO_2 emissions by 70% by 2030 compared to 1990 levels.[46]

It is understood in the country that being an oil and gas producer made it difficult for leading political forces to be truly green without being accused of being economically irresponsible. Denmark has never had a green party, but the established parties have attempted (and pretended, according to some) to integrate a 'green' dimension into their political action. This has not least had the objective to prevent a green party from becoming popular, as it has happened in several other European countries.

The closest Denmark has come to a truly green party is The Alternative (Alternativet in Danish). The party was established in 2013 and to the surprise of many it succeeded in entering parliament already in 2015 with an impressive 4.8% of votes. Early in 2019, The Alternative was the first political group to launch the idea of a 70% cut in CO_2 emissions by 2030.[47] For several reasons the 2019 general election became a so-called 'climate-election' and almost all Danish parties accepted the 70% target, which was included in a climate law approved at the end of the year. According to an NGO network called the Danish Group of 92 (referring to the UN Conference on Environment on Environment and Development in Rio in 1992), a major reason for this rapid procedure was that NGOs prior to the election forwarded a citizen proposal demanding that the parliament should implement a *climate law*[48]. A citizen proposal is a policy tool first suggested by The Alternative which compels the parliament to at least discuss a proposal when 50,000 or more adult citizens have signed it digitally.

Only a couple of months before the 2019 election, the 70% CO_2 emissions reduction target was

[44] (Rasmussen 2006, 2007; Sperling and Rüdiger 2020).

[45] Danish Government, 'Energy Strategy 2050 – from Coal, Oil and Gas to Green Energy' (2011).

[46] Klima- Energi og Forsyningsministeriet, Lov om klima 2020.

[47] Jørgen Steen Nielsen, 'Klimaloven: Når Det Samarbejdende Folkestyre Viser Sig Fra Sin Bedste Side' (Information, 2019).

[48] Troels Dam Christensen, 'Interview with Secretariat Director at 92-Gruppen,Troels Dam Christensen, 18 August 2021 (MS Teams)'.

considered completely unrealistic. An important part of this process was also played by the positive attitude of the industry, as the Danish Industry Confederation immediately after the election presented a report suggesting a pathway to reach the 70% goal.[49]

The next vital step in the transition process was to try and put an end to the production of oil and gas in the Danish part of the North Sea. A first important symbolic goal was to delay the announcement of the 8th round of tenders concerning the further exploitation of the North Sea fields.[50] This time it was also NGOs that acted. The Danish Group of 92 together with other interest groups and unions launched yet another citizen proposal in the spring of 2020.[51] "Stop looking for more oil NOW" was the name of the initiative, but the proposal was formulated in a rather technical way and received some attention in the media but not enough signatures. It is, however, a shared belief among the NGOs interviewed for this report that it was important to form a common front and that the proposal might to some extent have helped intensify the process towards the cancellation of the 8th tender.[52]

Nevertheless, non-government parties perceived the process as a protracted effort, lasting about one year, and the Ministry of Climate, Energy and Utilities as being very hesitant. According to a civil servant from the Ministry, immediately after the Social-democratic government took office, one month after the elections, in June 2019, the minister asked for an analysis of the potential CO_2 effects and economic consequences of ending oil and gas production.[53] After the summer break, an inter-ministerial task force was set up to estimate the economic effects of a national oil and gas production stop as well as its potential impact on the Danish 70% reduction target, the global climate impact was difficult to assess due to contradictory available information on the topic[54]. Therefore, in March 2020, the Minister wrote a letter to the Danish Climate Council (an independent advisory board established by the previous government) posing the question of what the global climate impact of a possible cancellation of the 8th tendering round would be.

According to the civil servant, the Climate Council focused on the broader perspectives of cancelling the 8th tendering round, and not only on the climate aspects.[55] In the media, the interpretation was that the Council had recommended a stop of tendering – at that moment and in the future.[56] Following from the analysis made by the inter-ministerial task force,continuing North Sea exploration would yield relatively low economic gains to the state after 2050.[57] In the autumn of 2020, the parties started talks and, according to the civil servant, from the Climate Ministry the negotiations were very constructive and went relatively fast as *"there was a relatively large consensus"*.[58] The result was the political decision not only to cancel the 8th tendering round, but also to end oil and gas exploration in the Danish North Sea by 2050.[59]

An important underlying explanation for the converging political views was that at the start of what was intended to become the 8th tendering round, 9 oil companies had shown some interest, but the number was later narrowed down to 4 and in the end only one firm was left. So, to a certain extent, the market called off the

[49] Næsby (n 16).

[50] Helene Hagel, 'Interview with the Head of Climate and Environmental Policy at Greenpeace Denmark, Helen Hagel, 7 September 2021 (MS Teams)'.

[51] Bjarke Rambøll, Gunnar Boye Olesen and Hans Pedersen, 'Interview with Vedvarende Energi: Secretariat Director Bjarke Rambøll, Political Coordinator Gunar Boye Olesen, Editor Hans Pedersen, 13 August 2021 (MS Teams)'; Christensen (n 48); Hagel (n 50).

[52] Rambøll, Olesen and Pedersen (n 51); Hagel (n 50).

[53] Danish Ministry of Climate Energy and Utilities, 'Interview with Public Servant at the Danish Ministry of Climate Energy and Utilities, 2 September 2021, Copenhagen'.

[54] Danish Ministry of Climate Energy and Utilities (n 53).

[55] Danish Ministry of Climate Energy and Utilities (n 53).

[56] Klimarådet, 'Danmarks Indvinding Af Olie Og Gas i Nordsøen. Vurdering Af Klimaperspektiverne i at Gennemføre Eller Aflyse 8. Udbudsrunde' (2020); Danish Ministry of Climate Energy and Utilities (n 53).

[57] Danish Ministry of Climate Energy and Utilities, 'NORDSØENS FREMTID' (2020); Martin Bahn and Andrea Dragsdahl, 'Nye Tal Fra Skatteministeriet: Kun Lille Gevinst Ved Nye Olietilladelser i Nordsøen' (Information, 2019).

[58] Danish Ministry of Climate Energy and Utilities (n 53).

[59] Danish Government, 'Aftale Mellem Regeringen (Socialdemokratiet), Venstre, Dansk Folkeparti, Radikale Venstre, Socialistisk Folkeparti Og Det Kon- Servative Folkeparti Om Fremtiden for Olie- Og Gasindvinding i Nordsøen Af 3. December 2020' (2020).

tendering procedure, once the government did put the tender on pause in 2019 to investigate the abovementioned consequences.[60] The oil firms judged the future oil and gas production in Denmark too uncertain and the political signals too negative. Some of the companies began developing a more long-term perspective, turning their attention to renewable energy and CCS/CCU.

Already during the negotiations about the North Sea Agreement, some NGOs contemplated the question of whether the deal could have been more ambitious and set an earlier deadline (2040).[61] However, this would have involved several difficulties related to the duration of existing licenses. Bilateral agreements with oil and gas producers and/or the compulsory purchase of, and compensation for, remaining licences by the state would have then become necessary. The understanding was that a possible compensation for the licence revocation would have been prohibitively costly.[62]

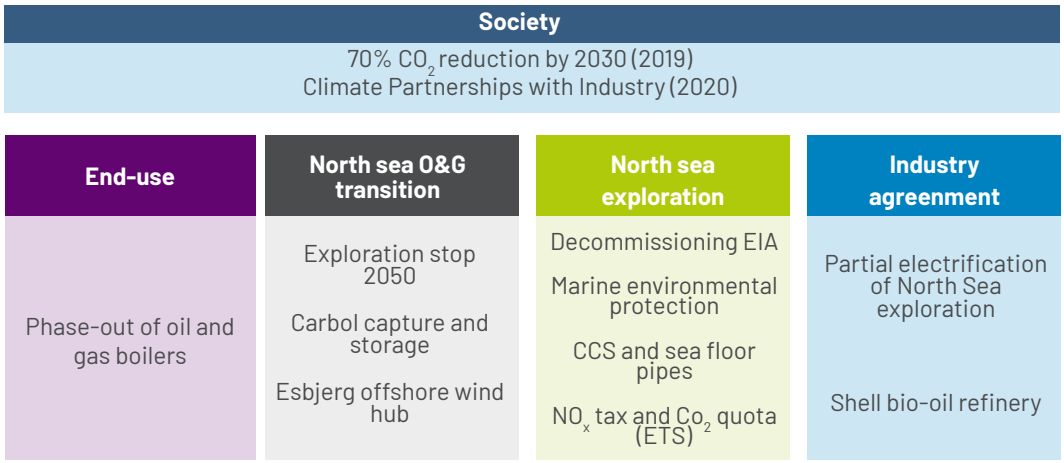
2.2.3.2 Key policies and strategies relating to the oil and gas transition

Apart from the key political intervention that the 2050 deadline represents, several other policies and strategies form the current Danish 'transition package'. One group aligns with the North Sea Agreement and the phase out of oil and gas production, while another supports a reduction of demand for oil and gas in the energy system.

Figure 6 provides an overview of the current main policies and strategies concerning the transition of the oil and gas sector in Denmark. The 2020 Climate Act[63] serves as an overall umbrella for energy and climate policy until 2030. Before that 13 Climate Partnerships with different industries did provide sector-specific CO_2 reduction commitments and recommendations on how to reach the 2030 target. These, as well as other activities,[64] have also inspired some of the actual transition initiatives in the oil and gas sector.

As can be seen from the figure (green box), a set of rules regulate ongoing offshore exploration activities ensuring compliance with environmental legislation. Platform operators are only granted a licence based on specific decommissioning plans. Installations over 20 MW are subject to the EU Emissions Trading System (ETS) and thermal activities (e.g., flaring) to a NO_x tax. Altogether, the legislative package ensuring safe and environmentally sound operation of platforms, pipes and CCS installations consists of the *Danish Subsoil Act, the Act on the Continental Shelf, the Environmental Protection Act, and the Marine Environment Act, which are supported by the Marine Spatial Planning Act*. In addition, there are Executive Orders concerning Environmental Impact Assessment, *CO_2* quotas and *NO_x taxation.*

Figure 6: Overview of areas and topics for transition policies and strategies that are of relevance for the oil and gas sector. Purple indicates legislation and programmes aiming directly at the reduction of oil and gas consumption. Grey summarizes recent support measures. Green signals the regulation of the area, while blue covers the main industry agreements.



[60] Hagel (n 50).

[61] Hagel (n 50).

[62] (e.g., Danish Ministry of Climate Energy and Utilities 2021; Hagel 2021)

[63] Klima- Energi og Forsyningsministeriet Lov om klima (n 46).

[64] (e.g. reports from Danish Council on Climate Change n.d.)

The grey box in Figure 6 summarises the support programmes put in place following the announced termination of exploration activities in 2050. On the one hand, roughly DKK 200 million went into the Danish Energy Agency's *Energy Technology Development and Demonstration Programme (EUDP)*, which supports research and development of CCS/CCU in abandoned oil and gas fields in the North Sea in 2021 and 2022. On the other hand, the North Sea Agreement allocates DKK 90 million in 2025 for the transformation of the Esbjerg Harbour into an Offshore Wind Power Hub, based on recommendations by the newly established Growth Team South Jutland (Vækstteam Sydjylland) and presumably in anticipation of the Energy Island project in the North Sea (see section 4.3.3).[65]

CCS/CCU initiatives are also mentioned in the industry's own recommendations and commitments in the abovementioned *Climate Partnerships*[66] (blue box). In addition, the partnership recommends the partial electrification of offshore operations, which has the potential to contribute 10% of the total emission saving commitment of 10 million tonne from energy intensive industries[67]. For the oil and gas industry it was a major step to join the climate partnerships, taking part in the commitments towards the 70% target. Finally, the purple box indicates legislation and programmes aiming directly at the reduction of oil and gas consumption.[68] So far, this mainly includes a series of political agreements and subsidy schemes directed at phasing out oil and gas boilers in buildings by 2030, starting from 2012.

[65] Danish Government (n 59).

[66] Partnerskab For Energitung Industri, 'Regeringens Klimapartnerskaber. Partnerskab for Energitung Industri. Afrapportering 16. Marts 2020' (2020).

[67] Partnerskab For Energitung Industri (n 66).

[68] The comprehensive amount of indirect legislation and support directed at the expansion of renewable energy, electrification of energy consumption and increased energy efficiency is not included here.

3. The role of the oil and gas sector in the economy and society

To understand how far the transition has come and the remaining obstacles to a complete phase out of oil and gas, it is important to have a picture of the role the sector plays in the Danish economy and society.

3.1 At the National Level

The Danish state receives revenues from oil and gas activities through three channels: company taxes (25% tax rate), tax on hydrocarbons (52% tax rate) and as a shareholder of oil and gas company Nordsøfonden, of which it owns 20%.[69] In the period between 1972 and 2019, the total state revenues from oil and gas have been DKK 541 billion (measured in 2019 prices). In 2019 alone, earnings amounted to DKK 5.9 billion,[70] less than 1% of total tax revenues. It is worth noting that while oil production peaked in 2004, revenues were only DKK 17 billion that year, while they reached DKK 36 billion in 2008 as the crude oil price almost tripled in that period.[71]

In terms of employment, Oil & Gas Denmark, the branch organisation for the Danish upstream gas and oil sector, has estimated there are currently 26,000 direct and indirect jobs in the industry, of which 10,000 are full time. This represents less than 1% of the total national employment, which accounts for around 3 million jobs. Some NGOs, more sceptical about the current economic significance of oil and gas production, believe these figures are far lower.[72]

Around half of all jobs related to oil and gas are located in Esbjerg and a little more than 40% in the Capital Region, with Copenhagen.[73] Regarding the distribution of the 10,000 full-time employees, 36% work directly in oil and gas companies and specialised offshore services, 24% work for hardware suppliers, and 41% in other services.[74] It has been estimated that the industry generates 7,700 indirect jobs in businesses outside the sector but delivering goods and services to oil and gas companies. On this basis, another 8,000-9,000 induced jobs are likely created due to multiplier effects from e.g., salaries. This leads to a total employment of around 26,000 in the country.[75]

Looking at the size of companies and the education level of employees, the sector is diverse. Out of 219 firms, around 65% have 49 or fewer employees, whereas Maersk is among the largest Danish companies.[76] 37% of all the sector employees are skilled and 24% are unskilled, 25% have a background from business academies and colleges and 14% from universities[77]. The high number of small enterprises is a typical Danish feature, making the economy flexible but also vulnerable because smaller firms tend to employ more unskilled workers than larger ones, in relative terms.

The total turnover of the oil and gas sector (oil and gas companies and their suppliers) varies depending on exploration and production activities and oil price levels, but it has generally been declining. It was DKK 108 billion in 2012 and had fallen to DKK 60 billion by 2017. Also, while in the past the oil and gas companies accounted for around half of the turnover of the sector,

[69] Danish Energy Agency, 'Resume Af Økonomiske Vilkår'.
[70] Danish Energy Agency, 'Økonomi for Olie Og Gas' (n 18).
[71] Danish Energy Agency, 'Resume Af Økonomiske Vilkår' (n 69).
[72] Hagel (n 50).
[73] DAMVAD Analytics, 'Olie- Og Gassektoren i Danmark. Branchestatistik' (2018).
[74] DAMVAD Analytics (n 73).
[75] DAMVAD Analytics (n 73).
[76] DAMVAD Analytics (n 73).
[77] DAMVAD Analytics (n 73).

they currently only account for a little more than one third, about the same level of hardware suppliers.[78] Similarly, oil exports have fallen since 2012. In 2017 they were at roughly DKK 30 billion or 2.5% of all Danish exports. In terms of GDP, the sector contributed DKK 30 billion DKK, around 1.5% of the total Danish GDP (DKK 1,900 billion DKK),[79] and even less in 2019 (see Table 1). This may be partially due to the ongoing renovation of the Tyra field.

In essence, the economic significance of the oil and gas sector in Denmark has been following the same downward trend as the production volume. The sale of the oil and gas activities of two major Danish companies' (DONG Energy/Ørsted and Maersk) in 2017 only amplified this tendency. Both companies had recorded significant losses in said activities in 2015[80] DONG Energy's historically large deficit of DKK 12 billion due to impairment losses in their oil and gas assets is especially noteworthy, also on a European scale.[81] But while the national significance of the oil and gas sector in terms of tax revenues, exports and employment is on the decline, the consequences may affect some local areas more than others due to a high regional concentration of its activities.

3.2 At the Local Level: The Case of Esbjerg

This section focuses on the possibilities and challenges of a just transition at the local level. Large segments of the Danish oil and gas industry are highly concentrated in a few locations, in the Region of Southern Denmark, mainly in and around the city of Esbjerg. Therefore, the way the transition progresses in this area reflects to a large extent whether it is fair for the entire oil and gas sector in the country.

With its 72,000 inhabitants, Esbjerg is the fifth largest city of Denmark.[82] Around 5,000 direct jobs and an estimated 11,000 indirect jobs related to the industry are in the region.[83] The Port of Esbjerg is the largest along the Danish west coast. It has been pivotal to the economic activities in the area since its construction, between 1868 and 1874.[84] Originally, it was largely a fishing and agricultural export centre, but since the 1970s Esbjerg has been the primary Danish port for servicing oil and gas operations in the North Sea.[85]

Since around 2000, it has developed a leading position in servicing offshore wind operations in the entire North Sea,[86] not without some luck,

Esbjerg's Transformation: From an Important Fishing Town to an Offshore Hub

To understand Esbjerg, we need to know more about its history. "The city spread, and several of the small, outlying villages were absorbed, where housing areas, suburbs and industrial estates were also appearing. But Esbjerg remained a maritime and fishing port. **The city only really began to change when oil exploration took off**, with the opening of the huge oil fields in the 1980s, and massive expansion in the 1990s, followed by yet another wave when green offshore and offshore wind turbines started to appear in the 2000s. **The growing needs of the offshore industry for highly educated personnel made it necessary to build a concert hall and other arts institutions.** Over a period of about 20 years, Esbjerg was transformed from a fishing port to a fully-fledged city with all the amenities we have come to expect".[89]

[78] DAMVAD Analytics (n 73).
[79] DAMVAD Analytics (n 73).
[80] DONG Energy, '2015 Annual Report' (2016); A.P. Møller - Mærsk A/S, 'Annual Report 2015' (2016).
[81] (DONG Energy 2016; Nielsen 2016).
[82] Statistics Denmark, 'Homepage'.
[83] DAMVAD Analytics (n 73).
[84] Business Esbjerg, 'From Fishing Village to Global Internet Hub'.
[85] The Port of Esbjerg, 'Homepage'.
[86] (Rasmussen 2021; Rieder 2021).

since some of the first large Danish offshore wind farms were unintentionally sited off the Esbjerg coast.[87] Today, the port is still of importance when it comes to Denmark's import and export of goods.[88]

Even though Esbjerg is the centre of oil and gas activities in Denmark, this is not necessarily reflected in the sector's local economic significance. This is first of all because most of the oil and gas employees are distributed across other municipalities and commute to Esbjerg for work only. Second, around two thirds of the economic activities in Esbjerg are carried out by businesses not related to oil and gas.

Due to the volatility of the oil price, company tax collected by the municipality can vary significantly between years.[90] The high rate of commuting from outside is a reason why the municipality is less vulnerable to recessions in the oil and gas industry. The other reason is the high versatility of the local energy-related businesses: *"Around 200-250 companies in the energy sector and more than 50% of them, almost 60%... have a leg in oil and gas and another in the offshore wind industry... [Esbjerg has become] if not the world's, then Europe's biggest exporter of offshore wind"*[91].

According to Business Esbjerg, the region presents opportunities in three main sectors: (1) offshore energy; (2) fibre and data business; and (3) bioenergy, biotech, and pharma.[92] In addition, while being a member of the World Energy Cities Partnership (WECP), a global association originally representing oil cities, Esbjerg has been branding itself as the Danish Energy Metropolis for several years. More specifically, Esbjerg is aiming to become Denmark's Sustainable Energy Metropolis as part of the local 2025 vision, and a CO_2 neutral municipality by 2030. This means that the local focus is shifting even further away from oil and gas.[93]

As the Mayor of Esbjerg said,[94] *"...the town has become a showcase... where everybody is coming to watch what it is that we are doing... and when they leave, they have probably realised that it is not all that easy to do the same. It is not sufficient to create flexible areas. You would also need to have the entire supply chain in the vicinity"*. Similarly, Business Esbjerg said that every year there are *"almost 200 visitors from outside to see the port and... to hear about our transition from being the biggest fishing harbour in the 1960s in Europe"*.[95]

Given this context, local actors have welcomed the North Sea Agreement, not only because it is in line with the transition of the port and local businesses to renewable energy, especially offshore wind, but also because it has secured stable operating conditions for the oil and gas sector until 2050.[96] In fact, local oil and gas companies are expected to see an increase in activity in the short term due to intensifying North Sea investments as consequence of the Agreement.[97] This may benefit local service suppliers in particular, as it is expected that larger suppliers will pull out of the Danish market[98] because they have a more long-term perspective and are more sensitive to a public debate increasingly focused on green policies. However, this may also imply that even though the crucial end date for Danish oil and gas activities has been set, operations may intensify in the short term, and thus, somewhat counteract some of the intentions behind a just transition. On the other hand, some participants in the research have argued that without stable conditions for the next 30 years, it may have been difficult to reach consensus around the North Sea Agreement.[99]

On this basis, which opportunities and challenge arise for the local oil and gas transition? Below we describe four opportunities and five challenges.

[87] A Benfeldt, 'Interview with Senior Vice President at Semco Maritime, Anders Benfeldt, 24 June 2021 (MS Teams)'.
[88] The Port of Esbjerg (n 85).
[89] Business Esbjerg (n 84).
[90] Rieder (n 37).
[91] Rieder (n 37).
[92] Business Esbjerg, 'Business Opportunities in Esbjerg'.
[93] (Nordenbæk n.d.; Rasmussen 2021; Rieder 2021)
[94] (Rasmussen 2021)
[95] Rieder (n 37).
[96] (Rieder 2021; Rasmussen 2021)
[97] Rasmussen, 'Interview with the Mayor of Esbjerg, Jesper Frost Rasmussen, 19 August 2021 (MS Teams)' (n 86); Benfeldt (n 87).
[98] Benfeldt (n 87).
[99] (Rasmussen 2021; Danish Ministry of Climate Energy and Utilities 2021)

Opportunity 1: Easy transferability of most of the workforce

Given their versatile business profile, local companies are expected to be able to reorient their strategic focus towards offshore wind and power-to-X.[100] Marine engineers (trained in Denmark) typically possess the necessary competences and security training for installing and servicing offshore wind infrastructure.[101] There are surprisingly many similarities between offshore oil and offshore wind technology, although the latter is seen as less complex and therefore easy to move into for the local oil and gas industry suppliers.[102]

Opportunity 2: Good local facilities for offshore wind and power-to-X

Both the port and the municipality are considered to provide good facilities for the local transition. The port is going to expand its area, amongst other things, to make room for wind turbine manufacturers and the growing green shipping fuel production (e.g., ammonia via power-to-X).[103] Furthermore, Business Esbjerg has a lot of experience in attracting and facilitating the establishment of businesses, including international ones.[104]

Opportunity 3: A local transition faster than expected

Local stakeholders are optimistic as there is strong support for the green transition amongst businesses. This is due to some extent to the experience of previous local industry transitions.[105] The optimism is strengthened by the fact that most (larger) energy-related businesses in the area already operate in both the oil and gas and the renewable energy sector. [106]

These conditions may lead to a situation where no significant oil and gas activities remain in Esbjerg earlier than 2050. In that case, a revision of the North Sea Agreement to raise its level of ambition might be a realistic possibility.

Opportunity 4: Education as a focal point in the municipal 'Vision 2025'.

One of the goals of the local strategy for growth and liveability is to strengthen Esbjerg's position as an 'education city' by continuously improving the quality of learning, increasing the education offer and providing better housing opportunities for students, amongst others.

Challenge 1: Age profile of oil and gas workers

Local stakeholders anticipate an age problem in oil and gas, and to some extent also in offshore wind.[107] Many workers are getting closer to their retirement age or to an age that does no longer allow them to work on the platforms.[108] The main consequence is that many workers may need early retirement or jobs in positions that are physically less demanding, possibly with prior re-skilling. Apart from a welfare commitment from the state, this will also require a moral commitment from companies to try and retain, re-skill and transfer their offshore workforce internally. In the example of Semco Maritime, rather than laying off, the company has begun to transfer some of their older offshore personnel to administrative positions or less demanding physical work, depending on their qualifications.[109] In addition, the increasing digitalisation of offshore operations may expose employees to a lower physical strain and make operations cheaper in the future.[110] However, the extent to which digitalisation may accelerate downsizing in the oil and gas sector could become an important question.

[100] Power-to-X or PtX denotes a range of technologies and fuels for which electricity is used as a starting point. Most commonly discussed are pathways, which incorporate hydrogen production (based on electrolysis of water using electricity) and where hydrogen can be further processed into various gaseous or liquid fuels, such as methane, methanol or ammonia (see for example Ridjan, Mathiesen, and Connolly 2016).

[101] Lars Hansen, 'Interview with the Chairman of the Labour Union for Mechanical and Marine Engineers (Maskinmestrenes Forening), Lars Hansen, 1 July 2021 (MS Teams)'; Rieder (n 37).

[102] Benfeldt (n 87).

[103] Rieder (n 37).

[104] Rieder (n 37).

[105] Rieder (n 37).

[106] (Rasmussen 2021)

[107] Rieder (n 37).

[108] Benfeldt (n 87).

[109] Benfeldt (n 87).

[110] Rieder (n 37).

Challenge 2: Lack of skilled personnel

While Esbjerg has been struggling to get highly educated labour to settle locally,[111] the issue may become critical if the offshore wind, CCS, and power-to-X industries expand as rapidly as local stakeholders expect.[112] This problem is also influenced by the fact that Esbjerg and the surrounding municipalities have fewer highly educated people and lower incomes than the average of Denmark or other municipalities in the Southern Denmark region. Even though this issue has been acknowledged in relation to the North Sea Agreement, and authorities have sought to address it building a Growth Team South Jutland (a public-private partnership established by the state), the initiative is seen as too short-lived because of its 'one-off recommendations'.[113] A real reorientation of local business, education infrastructure, labour unions and authorities based on the Growth Team's recommendations would require a longer-term and coordinated effort led by the municipality.[114]

Challenge 3: Pressure on smaller local businesses

Some local stakeholders anticipate that smaller local businesses (fewer than 20 employees) *"are facing some kind of a difficult time"*[115] when oil and gas companies begin to leave the area. These companies can be highly specialised and/or use unskilled labour, which could make it difficult for both firms and the workforce to reorient without coordinated support.[116] These issues, however, are currently not considered directly in national and local transition strategies and may generate additional problems because smaller companies *"are the cradle also… for younger people."*[117].

Challenge 4: Port facilities in need of expansion

To be able to service the future offshore energy industry, local stakeholders expect a channel to be dug to allow large vessels to enter the port.[118] It was crucial to get this concern addressed in the North Sea Agreement, which sets aside DKK 90 million for the development of the port in 2025,[119] leaving only half of the bill to be paid by the municipality.[120]

Challenge 5: New risks and lock-ins from focus on offshore energy

Much of the expected local developments seems to depend on the success of the Danish offshore wind strategy, including energy islands, CCUS, and power-to-X. While such a focus on green business development has been an important factor in the Danish energy transition since the 1970s, the much larger scale at which it is currently happening when compared to past experiences, makes it a risky endeavour. Esbjerg may find itself in a situation where part of the future of the local economy might depend on one or a few large investment decisions (e.g., energy islands, offshore farms, large power-to-X). Thus, having a more versatile 'Plan B' may be a necessary step to consider for the municipality and the state.

[111] Højbjerre Brauer Schultz, 'Samfundsøkonomiske Konsekvenser Af Uddannelsesniveauet i Sydvestjylland' (2020); Rieder (n 37).
[112] (Rieder 2021; Rasmussen 2021)
[113] (Rasmussen 2021)
[114] (Rasmussen 2021; Benfeldt 2021)
[115] Benfeldt (n 87).
[116] Benfeldt (n 87).
[117] Benfeldt (n 87).
[118] (Rasmussen 2021; Rieder 2021)
[119] (Rasmussen 2021; Danish Government 2020)
[120] (Rasmussen 2021)

4. Stakeholders' visions, framings and expectations of the just transition from oil and gas

Table 2 lists the organizations that were interviewed for this project. Due to Covid-19 restrictions and to secure access, all but one interview took place on MS Teams. The idea underlying these interviews was to get the most up-to-date information on the transition process as it is unfolding. Furthermore, it has been important to uncover whether there are different interpretations of the positive and negative aspects of the phasing out of oil and gas activities in Denmark.

Table 2: Overview of organisations interviewed in Denmark.

Organization / Type	Participant	Date
Olie Gas Danmark / Branch organization	Martin Næsby (Managing Director)	28 May 2021
Business Esbjerg / Business association	Karsten Rieder (Head of Business)	24 June 2021
Semco Maritime / Offshore Industry	Anders Benfeldt (Senior Vice President)	24 June 2021
Maskinmestrenes Forening / Labour union for maritime and mechanical engineers	Lars Hansen (Chairman)	1 July 2021
Vedvarende Energi / Renewable Energy Association, NGO	Bjarke Rambøll (Secretariat Director) Gunnar Boye Olesen (Political Coordinator) Hans Pedersen (Editor)	13 August 2021
92-gruppen / Network of NGOs	Troels Dam (Christensen Secretariat Director)	18 August 2021
Esbjerg Municipality / Local government	Jesper Frost Rasmussen (Mayor)	19 August 2021
Ministry of Climate, Energy and Utilities / National government	Civil servant at management level	2 September 2021
Greenpeace Denmark, NGO	Helene Hagel (Head of Climate and Environmental Policy)	7 September 2021

4.1 Drivers and Opportunities

The Danish oil and gas industry is in a state of transition, both in terms of decreasing exploration activities and new partially foreign companies entering the sector, and in terms of exploring new business opportunities beyond traditional exploration. The sector is therefore pursuing several options and development paths, including: 1) the efficient, clean exploration of oil and gas to meet global demands inside and outside the energy sector (petrochemicals); 2) the application of CCS/CCU using already existing offshore infrastructure; 3) the deployment of green fuels and power-to-X, potentially using CO_2[121]; and 4) the further development of onshore and offshore activities related to wind power.

Only a couple of months before the 2019 election, the 70% reduction goal was considered to be unrealistic by most people. An important part of this process was also the positive attitude of Danish industry immediately after the election: *"Danish Industry Confederation presented a report with a pathway to the 70 percent CO^2 emission target" (Næsby 2021).*[122]

Whereas the driving force behind increased energy efficiency, environmental protection, and security in the past has mainly been Health, Safety and Environment concerns with a focus on the employees, and energy saving agreements with the government, the so-called national "climate election" in 2019 and the following Climate Partnerships in 2020 have left a lasting impression, opening up new avenues for collaboration across industry sectors and at the political level[123](Næsby 2021): [This process has made] *"a huge impression on me because you saw these various industries committing to the climate target, including the transportation industry, energy industry, finance, banking and other industries"*[124] (Næsby 2021) all taking part in November 2019 at the 'kick off' meeting in Marienborg, the mansion of the prime minister.

Several companies have already begun diversifying their portfolio of activities and the sector has rebranded itself as "energy producing" rather than "oil and gas producing."[125] Opportunities for aligning with new national initiatives within power-to-X and Energy Islands in the North Sea have arisen while the oil and gas sector has focused on how the already established platform and pipeline infrastructure can be used in that context. An example is the idea to shift to offshore onboarding of oil to ships and using existing pipelines for transporting CO_2 and H_2 to and from energy islands.

Using wind power from energy islands to electrify exploration activities on offshore platforms replacing natural gas engines is also being discussed as an opportunity and potential solution to excess wind power production.[126] Consequently, firms originally being an integrated part of the oil and gas industry now also regard themselves "as part of the green transition".[127]

In terms of employment, at present the concern in the industry association is not outspoken[128], since in the past, when oil and gas companies laid off people, they were relatively easily re-employed in the maritime sector or the manufacturing industry. *"[T]he skills of people and the competences used in the oil and gas sector… they're now being used also in renewable energy. It's also being used on future energy like power-to-X and carbon capture and storage,"*[129] interviews recognised. Especially, the employees trained as (maritime) engineers have the skills to get jobs in many other engineering fields.[130]

[121] Næsby (n 16).
[122] Næsby (n 16).
[123] Næsby (n 16).
[124] Næsby (n 16).
[125] Næsby (n 16).
[126] Næsby (n 16).
[127] Benfeldt (n 87).
[128] Hansen (n 101).
[129] Hansen (n 101).
[130] Næsby (n 16); Hansen (n 101).

Locally, the hope is also that e.g., the DKK 90 million allocated to the port in the North Sea Agreement will help develop Esbjerg into a hub for the entire offshore industry, and that technologies like offshore wind, CCS and energy islands will attract highly educated labour, leading to an increase in population.[131]

4.2 Barriers and Threats

Oil & Gas Denmark points out the need for a clear national framework and a strategy for CCS as a major requirement for the industry to get started with moving into that technology. Paradoxically, the organisation has also raised the question whether at some point there a shortage of industrial scale CO_2 may be, considering the oil and gas industry's ambition to store large amounts of the greenhouse gas in abandoned oil fields, while applications like power-to-X may also demand large amounts of CO_2.[132]

As discussed, the municipality of Esbjerg has a challenge with attracting the necessary labour force to transform into an offshore energy hub. The two business associations, Business Esbjerg and Business Region Esbjerg, have started to map future expectations in terms of education and workforce and the Aalborg University branch in Esbjerg is also revising its current study programmes to better match future qualifications requirements.[133]

Taking a more societal perspective, however, the question in a Danish context is not so much whether the transition away from oil and gas will happen, but rather if it could not take place faster now that a fixed end point has been set in the North Sea Agreement.[134] Incumbent businesses on the one hand will seek to establish themselves within renewable energy, but other parts of the industry will carry out 'business as usual' following a discourse of a continued need to supply oil globally.[135] Therefore, some work may remain still for Danish decision-makers to find the right balance between providing stable conditions for a phase out and unnecessarily triggering new oil and gas activities.

Also, in terms of including as much of the existing workforce as possible in the transition, oil and gas workers which are unskilled or with skills only applicable in the oil and gas industry may be particularly vulnerable. This issue is gaining attention at the local level in Esbjerg, where the respective labour unions (3F Dansk Metal) participate in task forces[136] that are trying to address the problem.

4.3 The industry focusses on large-scale transition projects, technologies and business models

The following examples illustrate how some of the major Danish oil and gas companies and suppliers are and have been approaching the green transition, sometimes in close collaboration with central government. A focal point for the industry seems to be how it can convert to non-oil and gas related activities, while maintaining its fundamental business profile, building on large-scale projects and existing and new large infrastructures.

4.3.1 Ørsted: a green energy utility

DONG is an example of an oil and gas energy company that has implemented deep and rather sudden changes in its business model. With the Danish state as its major shareholder, the company has gone from producing 17% of renewable energy in 2006 to 90% in 2020.[137] When DONG Energy sold the oil and gas exploration and production activities in 2017, this included those in Danish, Norwegian and British waters of the North Sea.[138] In addition, the company changed its name to Ørsted,[139] closed three coal-fired power plants in Denmark and refurbished others to use biomass. The only remaining coal-fired power plant in their portfolio is going to be shut down by 2023. Over the past years, DONG has been

[131] Danske Kommuner, 'Esbjerg-Borgmester: Stop for Olieudvinding Er Vemodigt Men et Godt Skridt Mod Grøn Omstilling' (2020); Rieder (n 37).

[132] Næsby (n 16).

[133] Danske Kommuner (n 131); Nordenbæk (n 93); Aalborg University, 'AAU Sætter Turbo På Den Grønne Omstilling i Esbjerg' (2020) <https://www.nyheder.aau.dk/2020/nyhed/aau-saetter-turbo-paa-den-groenne-omstilling-i-esbjerg.cid491642> accessed 15 June 2021.

Hagel (n 50).

[134] Benfeldt (n 87); Næsby (n 16).

[135] (Rasmussen 2021)

[136] Ørsted, 'By the Numbers: How We Build a World That Runs on Renewable Energy'.

branding itself as a world leader in offshore wind power and announced emissions cut of 86% since 2006.[140]

The firm's new strategy focuses on large-scale wind, solar, bioenergy and energy storage projects, as well as energy solutions for customers.[141] In this way, DONG Energy re-directed its core competences and value proposition into the design, planning, implementation and operation of large energy projects (both offshore and onshore) into the renewable energy business.

4.3.2 'Green Fuels for Denmark: new partnerships for new projects

'Green Fuels for Denmark' is an example of new projects under development at the time of writing. Large logistics companies (including A.P. Moeller, Maersk, Copenhagen Airports, DFDS, DSV Panalpina, SAS and Ørsted) have joined forces to provide green fuels for road, maritime and air transport. Located in Copenhagen, the project aims to build a 1.3 GW electrolyser in a three-step plan, gradually increasing its capacity and adding new fuel products (starting with green hydrogen in 2023 and with methanol produced with CO2 captured from source-points in Copenhagen in 2027). The project is expected to reach its full scale by 2030, when it should produce more than 250,000 tonnes of green fuels.[142] The initiative will demand large amounts of renewable electricity. To ensure this, HOFOR, the municipality-owned utility in the Greater Copenhagen area, has recently joined a project to supply electricity from the 250 MW offshore wind farm the utility plans to build at Aflandshage by 2027.[143]

4.3.3 Energy Islands: new technical solutions to expand opportunities

Denmark is planning to build two energy islands to function as hubs, routing the electricity produced by large offshore wind farms (3-10 GW in the North Sea and 2 GW in the Baltic Sea) into the grid for transmission to Denmark and other neighbouring countries. One of the energy islands will be implemented in Bornholm, the other will be built artificially in the North Sea, about 80 km off the coast of Thorsminde. Discussions on the possibility of storing electricity on the islands and building power-to-X technology are also on the table.[144]

The energy island could potentially also supply green electricity to the oil and gas fields in the North Sea for electrification of operations,[145] which is a focal point for the industry.[146]

Other examples of new technologies, projects and business models linked to the transformation are:

- Shell's plans for green hydrogen and advanced biofuels at the refinery in Fredericia[147]
- Semco Maritime's new business model aiming to switch from 100% oil and gas to 20% offshore wind and 80% oil and gas[148]
- "Greensand", a CCS project by Maersk in the Danish North Sea[149, 150]

[137] Ørsted, 'DONG Energy Enters an Agreement to Divest Its Upstream Oil and Gas Business to INEOS' (n 39).
[138] Ørsted, 'About Our Name'.
[139] Ørsted, 'By the Numbers: How We Build a World That Runs on Renewable Energy' (n 137).
[140] Ørsted, 'By the Numbers: How We Build a World That Runs on Renewable Energy' (n 137).
[141] Ørsted, 'By the Numbers: How We Build a World That Runs on Renewable Energy' (n 137).
[142] Ørsted, 'Leading Danish Companies Join Forces on an Ambitious Sustainable Fuel Project' (2020).
[143] Ørsted, 'Ørsted and HOFOR Enter into Agreement on Green Power for Groundbreaking Hydrogen Project' (2021).
[144] The Danish Energy Agency, 'Denmark's Energy Islands'.
[145] Næsby (n 16).
[146] Partnerskab For Energitung Industri (n 66).
[147] Shell, 'Shell Indgår Salgsaftale for A/S Dansk Shell' (n 42).
[148] (Semco Maritime, n.d. (Benfeldt 2021))
[149] Maersk Drilling, 'Project Greensand: North Sea Reservoir and Infrastructure Certified for CO2 Storage' (2020).
[150] Maersk Drilling (n 149).

5. Future perspectives

All stakeholders seem to have accepted the 2050 deadline and reoriented their activities to meet it. Perceptions and realities changed dramatically after the so-called climate election in Denmark in June 2019. One important symbolic change is that private oil and gas firms now consider themselves as energy firms, i.e., the French oil-producing firm Total has changed its name to TotalEnergies and as mentioned, the former oil town Esbjerg considers itself as an 'energy metropolis'.

Nonetheless, some of the interviewees have also aired that an earlier deadline to end oil and gas production would be likely and desirable. Yet, a significant production is still expected as late as 2040[151].[152] An earlier phase out than 2050 would require the state to take the lead also because it is likely to involve a significant compensation to oil and gas producers. None of the interviewees seem to be concerned about an earlier deadline for other reasons. As remarked by the Greenpeace representative: *"Of course it [oil production] will stop before 2050... I am more than sure that there will be no oil production in the North Sea in 2050"* [153].[154] Across the board, all informants regard it as a clear advantage for Denmark to be a first mover, both in terms of building up new competencies, industrially and in the workforce, and as a showcase to the rest of the world.

Even though some NGOs do not consider the North Sea Agreement particularly ambitious from a sustainability perspective, they also believe that having such an agreement promoting Denmark as an example for the international community is more important to international decarbonisation than pressing for a faster closure of the national oil and gas fields of the North Sea[155].[156] According to the Danish NGOs, depicting Denmark as a showcase is a conscious strategy. Together with international NGOs, they chose to celebrate the 2050 deadline in an advertisement in the Financial Times (23 January 2021). As the representative from Greenpeace Hagel (2021) also puts it: *"We [Greenpeace and other NGOs] have done everything to exploit this decision globally... Even though it is a total no-brainer [to end the Danish production of oil] ... it is still the first time an oil-producing country of a certain size says 'no'. It is world history... But if we could use it [the decision] to convince Norway, the UK and other big countries to do the same it would be brilliant".*

It appears that the North Sea Agreement exhibits two different levels of ambition: on the one hand, as a ground-breaking and inspiring signal to the global community, and on the other, as an obvious morally and economically correct choice for Denmark.

One important lesson to be learned from the Danish case is that a spill-over of Denmark's decision to other countries would require economic rather than moral arguments. One of the NGOs said that the non-profit groups also had this discussion when they formulated the citizen proposal to end all oil production. Their debate ended up "being very much about the economy. There was not much business in the future oil production as it had often been stated" 157.158 Or, as formulated by another NGO-representative, "you need to know the figures, otherwise you'll die" [in the debate][159.160.]

[151] Energistyrelsen (n 9).
[152] Energistyrelsen (n 9).
[153] Hagel (n 50).
[154] Hagel (n 50).
[155] Hagel (n 50); Christensen (n 48); Rambøll, Olesen and Pedersen (n 51).
[156] Hagel (n 50); Christensen (n 48); Rambøll, Olesen and Pedersen (n 51).
[157] Rambøll, Olesen and Pedersen (n 51).
[158] Rambøll, Olesen and Pedersen (n 51).
[159] Hagel (n 50).
[160] Hagel (n 50).

The idea of creating and supporting a spill-over effect is not confined to NGOs, as also implied by the formulations in the North Sea Agreement. The recent Beyond Oil and Gas (BOGA) agreement, an international collaboration launched by the governments of Denmark and Costa Rica, attempts to restrict *"domestic oil and gas production in line with what is required to live up to the Paris Agreement goals"* (excerpt from the draft,[161].[162]. This step is also supported by the NGOs[163] [164] but it is still too early to say how much momentum it will create in other oil and gas producing nations.

What Denmark could do further in the future to fully substitute gas and oil is another side of the story which is going to be decisive to the country's development. Here, it is important to pay attention to the concrete actions Denmark can take to fulfil the 70% reduction target by 2030. A recent analysis of how actions in the energy system can achieve this is done by [165.166.]

One important determinant will be the channelization of private investments. Three of the interviewees pointed to the significance of pension funds going green. The representatives from Oil and Gas Denmark and the Ministry of Climate Energy and Utilities argued that these funds were well on the way, while one NGO underlined the need to push them to drop their 'black' investments[167].[168]

[161] Hashtrudi n.d.)
[162] Hashtrudi (n 161).
[163] Hagel (n 50).
[164] Hagel (n 50).
[165] Lund et al. (2020)
[166] Lund and others (n 165).
[167] Næsby (n 16); Danish Ministry of Climate Energy and Utilities (n 53); Hagel (n 50).
[168] Næsby (n 16); Danish Ministry of Climate Energy and Utilities (n 53); Hagel (n 50).

6. Conclusions and recommendations

Since the oil crises of the 1970s, the national oil and gas sector has been an important pillar of the Danish economy and energy supply. It has helped safeguard security of supply and minimise dependence on imported fossil fuels. Domestic natural gas has been instrumental for the successful rollout of district heating and combined heat and power in the 1980s and 1990s. During the same period, the country embarked on a successful transition of its energy system, becoming a frontrunner in onshore and offshore wind power. For around 30 years, until 2018, Denmark has been a net exporter of oil, but production has decreased substantially since it peaked in 2004. Major Danish companies such as Maersk and Ørsted have sold off or reduced their oil and gas activities, leaving mainly foreign companies to operate in North Sea fields.

In this context it seems natural for Denmark to be the first major oil producer in the world to set 2050 as the end date for oil and gas production. While this date is linked to the duration of current licenses, it has also been informed by the need to ensure a just transition, offering stable operating and economic conditions to companies and making room for a gradual phase out of oil and gas production and a development of cleaner on- and offshore activities.

Both economic and moral motivations are underlined in the pioneering North Sea Agreement to end Danish oil and gas activities, with the government hoping to inspire other countries to follow its lead. However, at the national level, arguing that oil and gas will run out soon and that it will become ever more expensive to both extract and to decommission offshore installations has been much more persuasive than moral arguments.

A key finding of this analysis is the lack of a strong national, or even regional, 'oil and gas identity' when comparing Denmark to the UK and Norway. This is best reflected in the versatility of the workforce and local businesses, for instance, in and around the offshore hub Esbjerg. Marine and mechanical engineers working in oil and gas are having the competences to easily switch to offshore wind or CCS, while engineering and service companies have proved to be highly flexible and are already supplying both sectors. This new business opportunity has its roots, amongst others, in the long-term national strategic focus on offshore wind power development. As a result, widespread optimism seems to prevail amongst businesses, unions, local government, but also the NGOs consulted during this research project.

Furthermore, the state has tried to promote this optimism, e.g., in Esbjerg, by allocating DKK 90 million to support the development of the harbour so that the sailing channel becomes deep enough to transport wind turbines.

To outsiders, and even many Danish actors, the case of Denmark might seem to be too good and too harmonious to be true. There are, however, several critical points. First, for a long time, politicians from most of the political spectrum have been against setting an end date for what many perceived to be the 'adventure of the North Sea'. Second, some smaller, specialised firms, as well as older employees might have to respectively close or withdraw from the labour market, especially in the municipality of Esbjerg and its vicinity. Third, Denmark has not ended all its fossil fuel activities, as it is still involved in foreign investments in oil and gas activities or in transnational fossil fuel infrastructure on Danish territory (Nord Stream 2 Danmark). Fourth, setting an end date is likely to accelerate and increase investments in oil and gas production in the short term, causing more greenhouse gas emissions, and with the risk of overinvestments if the extraction of oil and gas stops earlier than expected. Finally, given the urgency of the climate crisis, the 2050 deadline might prove to be far too late.

When making recommendations for Denmark, Norway, and the UK, which are part of this project, but also beyond, the context and history

of the country should first be acknowledged. Some general lessons can be drawn from the Danish experience:

A) It is important to put the future business case of oil and gas production under closer scrutiny. This might undermine common economic arguments in favour of continuing production and could make it more difficult to argue that drilling is needed to finance a green transition because it generates tax revenues and reduces imports.

B) Determining who the bearer of change could and should be is vital. The NGOs consulted for this report might have been early movers, but in the process leading to the oil and gas phase out by 2050 it has been very difficult to engage the public or the media, and sometimes even some NGOs and politicians. Unsurprisingly, progress was made when the media, politicians and NGOs simultaneously started to act. However, as noted by the NGOs, 'positive action' (such as pushing for the Climate Act) can be more effective in mobilising the public than 'negative action', such as phasing out oil and gas production, that the public have difficulties relating to their daily lives. A recommendation from the research is therefore to tie political and societal discussions regarding the phase out of oil and gas production to wider debates regarding future climate action.

C) As there are complementary competences between Denmark's oil and gas sector and offshore wind power, for instance, similar complementarities may exist in other North Sea countries. Due to the more comprehensive nature of the transition in other oil and gas producing nations, several such complementarities will have to be found and developed.

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