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Understanding the Connection Between Carbon Lock-in and Electrification of Norwegian Oil and Gas Platforms

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Abstract

Fossil fuels are by far the largest contributor to climate change. The oil and gas (O&G) industry is deeply embedded in the Norwegian economy, as the production provides a large share of Norway's revenue and jobs. At the same time, the sector accounts for a quarter of the country's total emissions. Hence, Norway finds itself in carbon lock-in, a concept that describes a state of path-dependence related to fossil fuels. Therefore, suggestions to phase out O&G production are often seen as controversial. However, the country has committed to ambitious emission reduction targets, and emission reduction within the O&G industry is essential to achieve them. The industry itself has proposed electrification of O&G platforms as the primary solution to reduce emissions. However, wide disagreement exists on the effects of electrification, and the literature lacks studies on how electrification will impact carbon lock-in. Avoiding systems that intensify or contribute to carbon lock-in is essential, as carbon lock-in is incompatible with a sustainable, low-carbon future.

Hence, this thesis seeks to fill this knowledge gap and examine how electrification of O&G platforms in Norway may contribute to carbon lock-in. Nine qualitative semi-structured interviews were conducted with informants holding different central positions in the debate on electrification. The data were analysed by identifying processes and traits of three different categories of carbon lock-in from Seto et al. (2016)'s framework: Technological and infrastructural, institutional and behavioural carbon lock-in.

The findings suggest that electrification will contribute to all three carbon-lock-in types. However, the extent of technological and infrastructural lock-in is seen to differ with electricity from land and electricity from offshore wind. Electrification with offshore wind is found to be less likely to contribute to technological carbon lock-in, as it allows for more flexibility and less asset specificity. Suggestions for future studies are to look into the carbon lock-in effects of other alternatives to electrification, such as carbon capture and storage and energy efficiency, and compare it to the findings of this study. That will provide a better knowledge base for policy-making on the future of the O&G industry.

List of Acronyms

CCS	Carbon Capture and Storage
NOK	Norwegian Kroner
O&G	Oil and Gas
EU ETS	European Union Emission Trading System
IPCC	International Panel on Climate Change

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1.Introduction

Climate change is one of the biggest and most complex challenges facing humanity today. The climate is changing, global temperatures are rising, and the newly released report from IPCC leaves no doubt that fossil fuels are the main contributor to it (IPCC, 2022). Fossil fuel exploration, extraction, transportation, and combustion have dramatically increased greenhouse gas emissions, the main driver behind climate change (IPCC, 2022). The report states that there is no room for new fossil fuel extraction projects, as existing and currently planned projects already exceed what the climate can handle. Thus, strategies to limit the production and use of fossil fuels are essential to limit global warming.

However, as fossil fuels are embedded into economies, institutions, infrastructures, and cultures worldwide, breaking out of carbon-intensive systems is challenging. It is particularly challenging for countries with economies that heavily depend upon fossil fuel extraction, a condition called carbon lock-in (Leichenko and O'Brien, 2019; Seto et al., 2016). Carbon lock-in describes a state of path-dependence related to a specific type of fossil fuel (Leichenko and O'Brien, 2019). The technologies, institutions and norms related to it are inconsistent and incompatible with a low-carbon, sustainable future (Seto et al., 2016). Therefore, avoiding lock-in to carbon-intensive systems is essential to battle climate change. Moreover, identifying strategies for unlocking carbon dependencies in locked-in countries is crucial. As efforts to combat dangerous climate change are exacerbated, discussions on how to break free from carbon lock-in are central and emerging.

Norway finds itself in a paradox where the country aims to be at the forefront of international efforts to address climate change while simultaneously continuing to be a significant petroleum producer with a carbon locked-in economy. The country has committed to similarly ambitious emission reduction targets as other European countries, has allocated billions of NOK to avoid deforestation and develop renewable energy systems in several developing countries, and has world-leading electric car policies (Lahn, 2019; Regjeringen, 2022; Norad, 2020). At the same time, the country's economy is highly dependent on oil and gas production (O&G). Almost all of the O&G is exported, accounting for more than half of the total value of Norwegian exports and 25% of the government's revenue (Norsk Petroleum, 2023a).

As the science and knowledge about the detrimental effects of climate change improves, oil exploration and production is becoming more controversial in Norway (Bang and Lahn, 2020). At the same time, it is a common concern that the country needs to continue the pace of the production to ensure economic stability and growth (Funnemark & Beaumont, 2022). Hence, the current Labor and Centre Government finds itself in a position where it needs to reduce emissions in the O&G sector but still wants to contain high production because of the revenue. A proposed solution to this dilemma is to run the production on electricity, either from land or offshore wind, instead of gas as most platforms currently do today. Electrification facilitates production with low emissions and makes it possible for the petroleum industry to reduce its emissions for production in line with the targets set (Regjeringen, 2021).

Some actors, such as the Norwegian Green Party, propose a managed decline of O&G production altogether and argue that electrification should not be used as an argument to open new fields (MDG, 2023). Others, such as the environmental party Friends of the Earth Norway, question the real climate effect of electrification, as over 90% of emissions stem from the use of O&G, not the production phase (Sneve, 2022; Naturvernforbundet, 2022). This is the core of the debate around electrification of the O&G fields. A debate with a 25-year-old history of political conflict. The conflict has evolved around climate targets, power scarcity, financial costs and the future of the O&G industry. Both electrification and phasing out the industry are controversial policy alternatives.

As identified in chapter 3, the academic literature lacks studies on how electrification of O&G platforms impacts already existing carbon lock-in. As it is essential to avoid carbon lock-in to avoid the worst climate consequences, it is of high importance to investigate how electrification may impact carbon lock-in. Hence, this study aims to answer the following research question:

How may electrification of Norwegian oil and gas production contribute to carbon lock-in?

This study focuses on the competing positions and interests within the Norwegian debate about electrification, and seeks to identify examples of how electrification may or may not

contribute to further carbon lock-in. The objective of the thesis is to gain a better understanding of the potential consequences of electrification by identifying traits and processes of carbon lock-in. Knowledge on potential carbon lock-in effects of electrification is important so policy makers can make decisions with a better understanding of the long-term effects of their policies. This thesis is therefore an important contribution to the literature. The discussion on whether to phase out or further develop the O&G industry, as well as how to escape carbon lock-in, goes beyond the scope of this thesis, and has been left for future studies. Whenever the term electrification is mentioned, it refers to electrification of O&G platforms.

To answer the research questions, nine expert interviews have been conducted. The sample of informants represent a wide range of perspectives on the topic, consisting of five Members of Parliament sitting in the Energy and Environment committee, a climate researcher, a representative from an environmental organisation, a representative from the O&G business organisation Offshore Norge, and one advisor from The Norwegian Confederation of Trade Unions.

The thesis starts with a background section in chapter 2 focusing on the history of carbon lock-in in Norway and the debate on electrification. In Chapter 3, I employ the academic literature's various understandings on theories of carbon lock-in to develop an analytical framework that explains my choice of theory and how I am going to apply it. The main theoretical concepts employed draw on three types of carbon lock-in: technological and infrastructural, institutional and behavioural, identified in Seto et al. (2016)'s carbon lock-in theory. Chapter 4 explains the thesis' research design and the methods used for sampling and data analysis. Chapter 5 presents the main findings from the interviews, and chapter 6 discusses these findings in relation to the theoretical framework. Both chapter 5 and 6 are structured based on the three types of carbon lock-in from the main theory used. Finally, chapter 7 includes a conclusion and recommendations for future research.

2. Background

The background section is divided into two parts. The first part identifies the history of carbon lock-in in Norway and the Norwegian oil dilemma. The second part explains what electrification of the O&G platforms in Norway involves, what it may look like and different positions and interests involved. The chapter ends with an overview of the various political parties' positions on the O&G industry and electrification, to set the context for the study.

2.1 Norway's Carbon Lock-in History

Ever since the discovery of the large oil field Ekofisk in 1969, O&G has played a significant role in Norway's history, culture and development of the welfare system (Olje og Energidepartementet, 2021). In 2019, the industry provided 28% of the government revenue and employed 6% of Norway's workforce (Norsk petroleum, 2022b; Jordhus-Lier et al., 2022). It is the single industry contributing the most to the country's economy (Olje og Energidepartementet, 2021). At the same time, the industry is the country's second largest polluter, making up 28% of the total greenhouse gas emissions (Szulecki et al., 2018). Norwegian production covers about 2% of the oil and 3% of the global gas demand (Norsk Petroleum, 2023a). In 2021, Norway supplied 20-25% of the gas consumed in the EU, and this number has increased after the EU stopped importing gas from Russia due to the invasion of Ukraine in February 2022.

The state-owned company Equinor is the main operator of 70% of production facilities on the Norwegian continental shelf (Equinor, 2023). Many other Norwegian and foreign companies are also involved in O&G activities, such as in production, distribution, delivery and service (Szulecki et al., 2021). Due to the profitability of the O&G industry, Norway has instituted generous but firm rules and regulations to attract companies seeking to explore the continental shelf. Moreover, government subsidies for the O&G industry are stable and generous (Lund et al., 2022). Due to the O&G industry being hit hard during the pandemic, the Government provided a favourable tax package to the industry to make sure that production would continue at the same pace (Lund et al., 2022). For example, the Parliament agreed that O&G companies could write off all investments immediately, instead of the standard six years (Szulecki et al., 2021). The oil tax package ended up being more lucrative than projected, which the former Prime Minister Solberg also later admitted (Rydje and Holter, 2022).

Norway has committed to ambitious emission reduction targets on an international and European level, as well as setting its own targets both nationally and for the O&G sector explicitly (Fæhn et al., 2018). In 2015, Norway signed the Paris agreement, which provides benchmarks for mitigation policies and the idea of a "carbon budget". The carbon budget describes the allowable global emissions and how much oil, gas and coal that should be left in the ground to meet the temperature targets (Lahn, 2019). In 2020, Norway updated its Nationally Determined Contributions (NDC) to the Paris agreement, committing to reduce emissions by 50-55% by 2030 compared to 1990 levels (UNFCCC, 2020).

In addition, as a member of the European Economic Area, Norway participates in the EU Emissions Trading System (European Commission, 2022). This quota system, in addition to the national carbon tax, are the two main policy instruments to reduce emissions in the petroleum sector (Finansdepartementet, 2020). In the EU ETS, one climate quota equals one tonne of CO2 or CO2-equivalents. The price of one quota has increased from about 25 euros in 2008 to a record high of 100 euros in February 2023 (European Commission, 2022). The petroleum sector is committed within the ETS to buy quotas for every tonne of emissions released. In addition, Norway has its own carbon tax (Finansdepartementet, 2020). The carbon tax was introduced in 1991, and aims to contribute to cost-effective reductions of greenhouse gas emissions. The total carbon price, consisting of both the quota price and carbon tax, is expected to reach about 2000 NOK per tonne CO2 in 2030 (Szulecki et al., 2021).

However, the aim of these taxes is not to decommission the O&G industry, as the Norwegian Government aims to develop the industry, not phase it out (Regjeringen, 2020). The taxes are rather aimed to incentivize cleaner activities and more energy efficiency (Klima og Miljødepartementet, 2021). The rationale is to make cleaner activities, such as offshore wind and CCS, more cost-effective for the decarbonisation of the sector (Szulecki et al., 2021). According to the Production Gap Report from 2021, these policies do not align with the climate ambitions Norway committed to under the Paris agreement (IISD, 2021). The report argues that fossil fuel production must decline immediately to limit global warming to 1.5 degrees, and that governments worldwide have the primary role in phasing out production.

Hence, Norway finds itself in a paradox where on one hand the aim is to develop the O&G industry, and on the other hand the country has committed to an international climate agreement that targets massive reductions in fossil fuels. However, this does not mean that Norway does not recognize the carbon budget. In fact, most actors in favour of developing Norwegian O&G production recognize the global carbon budget and that global production needs to decline drastically. Rather, the concept of a carbon budget has been used by interests in the Norwegian O&G industry to argue that the world still needs O&G in a world that achieves the 1.5 degree target, and that Norway is best suited to produce it (Lahn, 2019). This line of argumentation is justified by claiming that the emissions in Norwegian petroleum production are low compared to other producers (Lahn, 2019).

Another common argument among those in favour of continuing with O&G production in Norway is that a change needs to happen on the demand side before focusing on the supply side, otherwise production cuts in Norway would just be replaced by other producers. Offshore Norway, a business organisation for the O&G industry, are among those who have pushed this narrative (Andreassen, 2019). This is a common perspective worldwide, as mitigation policies that aim to constrain fossil fuel production and exploration receive little attention (Erickson & Lazarus, 2018). Among the ten largest producers of fossil fuels worldwide, only Germany has taken national action to end production primarily because of climate concerns (Le Billon & Kristoffersen, 2019).

On the other hand, negative reactions towards Norway's continued production and development of the O&G industry have not been lacking. The country has been criticised heavily by both national and international actors, and the debate is ongoing regarding how much responsibility Norway should take for the indirect emissions from their production, i.e. the burning of exported O&G in destination countries (Fæhn et al., 2018). In 2016, Greenpeace and Nature and Youth sued the Norwegian government for granting licences in the Barents Sea, arguing it violates the constitutional right to a safe and good environment (Jakobsen, 2022). The case went all the way up to the Supreme Court, and even though the Norwegian government ended up winning the case, it brought lots of attention to the issue and gained massive support from climate activists around the world.

The current situation with Russia's invasion of Ukraine brings in a new aspect to the debate. What was previously a sole energy discussion is now turning into a debate that to a large

extent also involves security politics (Olje og Energidepartementet, 2023). Over the past year, the EU has stopped importing gas from Russia, which has led to both increase in gas prices and energy scarcity in Europe (Olje og Energidepartementet, 2023). In light of the energy crisis, the EU and Norway agreed on a joint statement in June 2022, in which they agreed on stepping up the existing energy cooperation to ensure both short- and long-term gas supplies from Norway out to the rest of the continent (European Commission, 2022). However, it is uncertain how long the EU will demand Norwegian O&G, especially if EU member countries succeed with their climate policies aiming for a 55 % reduction in greenhouse gas emissions by 2030 and climate neutrality by 2050 (European Council, 2023).

The Norwegian carbon lock-in was demonstrated by a research study that brought together a group of stakeholders to discuss two alternative pathways for the future of Norway's O&G industry: net zero emissions in the sector and a complete phase-out (Jordhus-Lier et al., 2022). The net-zero industry was presented as a balance between released emissions and removal of emissions by 2050, and would include both direct and indirect emissions (Jordhus-Lier et al., 2022). The stakeholder groups included policy makers, representatives of businesses and civil society organisations, and the study found that the stakeholders visioned a net-zero industry more feasible than a complete phase-out of the industry (Jordhus-Lier et al., 2022). Hence, the study demonstrates how embedded O&G production is in Norwegian society, and how difficult it would be to get public acceptance for a complete transition away from fossil fuels. However, the same study emphasises the good position Norway is in financially and socio-politically to start the transition away from petroleum production.

The same point has been stated by politicians, activists and scholars, and have been used to argue that Norway should take a leading role in phasing out O&G. For example, in their party program, the Norwegian Christian Democratic Party emphasised how Norway has good conditions to succeed in the green transition, based on the strong economy, technology developments and knowledge from the O&G industry (Kristelig Folkeparti, 2021). Szulecki et al. (2021) raises the question: if Norway is not ready to face the challenge and transform their economy away from carbon-intensive systems, which country would?

2.2 Electrification of Oil and Gas Platforms

In addition to national emission reduction targets, the O&G industry has their own targets. The same tax package that gave favourable conditions also obliged the petroleum industry to cut 50% of their emissions by 2030 compared to the 1990- levels (Bjørnæs et al., 2022). More than 90% of emissions from fossil fuels are released during combustion (Ekaterina et al., 2015). As most of the O&G produced in Norway is exported and burned overseas, those emissions do not take part in Norway's climate accounting. However, the emissions released during extraction and production still accounts for about one fourth of Norway's overall emissions (Norsk Petroleum, 2023a), and reductions within this sector therefore need to be made to reach the climate targets set (Regjeringen, 2021).

The most obvious strategy to reach this target would be to reduce production. However, as seen in the previous subchapter on Norway's carbon lock-in history, the resistance towards reducing production and exploration is high. Instead, the proposed solution from the O&G industry and several political parties is to run the production on electricity either from land or electricity produced offshore, as it allows to continue production and still reduce emissions (Bjørnæs et al., 2022; Equinor, 2021). This is also what the current Government agreed on in their political platform – the Hurdal Platform (Regjeringen, 2022). Equinor plans to spend 50 billion NOK on electrification and energy efficiency on their offshore production platforms, and argues that it is one of the most important measures to reach their climate emissions reduction target (Szulecki et al., 2021). Today, most O&G platforms run on gas turbines that produce electricity offshore. Equinor argues that by replacing those turbines with electricity, the gas can be used in other places with a higher efficiency and thereby reduce emissions (Equinor, 2021). However, the plan is not to run the whole industry on electricity, but rather look at each individual project and see where it is most cost-efficient to do so (Equinor, 2021; Offshore Norge, 2022).

There are two main ways to run O&G platforms on electricity, either with electricity from land or offshore wind (Equinor, 2021). Electrification with electricity from land involves constructing cables that go from land out to the platforms, which will allow the O&G extraction and production to run on electricity produced onshore. As most of the electricity used in Norway comes from renewable sources, mainly hydropower, the emissions related to production would be reduced drastically with this solution compared to running the

production with electricity from gas turbines (NVE, 2020). It is estimated that electrification with electricity from land will require between 10 and 12 TWh energy, which is about 7% of the total national electricity production (Szulecki et al., 2021). Hence, it is a common concern that the operations will lead to power scarcity, increased pressure on the power grid and hikes in electricity prices onshore, which might have negative consequences for industries onshore as well as for Norwegian household budgets (Molnes, 2022).

The second option is to run the platforms on electricity produced by offshore wind turbines in connection to the platforms. With offshore wind, Norway can reach its climate targets and avoid power scarcity onshore at the same time (Schjølset & Evang, 2022). In addition, offshore wind in connection to platforms can distribute surplus power to land, such as in Equinor's proposed Trollvind project (Equinor, 2022). It can also contribute with development of an offshore wind technology that currently is immature, but has global potential (Bjartnes, 2021). However, offshore wind is an intermittent energy source as it depends on the amount of wind at any time. Therefore, offshore wind turbines require either a gas turbine or electricity from land in addition, so the production can run when the wind is not blowing (Elgendy et al., 2021; Blaker, 2022; Bjøræs et al., 2021). Concerns have been expressed about offshore wind being too expensive compared to electricity from land, as well as the technology being immature (Bjartnes, 2021).

The debate on electrification circulates around whether it is a good solution or not. Common counter-arguments are that electrification is expensive, ineffective and does not have enough effect on the climate compared to the investments that need to be made (Tollaksen, 2020; Øvrebekk, 2021). Even so, the fact that electrification of offshore production leads to emission cuts in Norway is usually agreed upon even by critics of electrification (Molnes, 2022, Bjartnes, 2021). Several O&G fields have already been electrified, such as Johan Sverdrup and Utsirahøyden. Johan Sverdrup demonstrates the effect of electrification, as the field releases 0,67 kg of CO2 per barrel of oil produced compared to the national average of 9 kg (Offshore Norge, 2021).

However, there is wide disagreement among both politicians, scholars and activists on whether electrification of O&G platforms leads to global emission cuts (Bjartnes, 2021). As Norway is a part of EU ETS, electrification will allow the O&G companies to buy less quotas (European Commission, 2022). In principle, this means that other countries can buy them

instead, and the end result is the same levels of emissions. However, new EU reforms make sure that surplus quotas are removed from the market and that the total amount of quotas is reduced annually (European Commission, 2022). Hence, it is more likely going forward that cuts in Norwegian production would lead to reductions in emissions globally (Bjartnes, 2021).

A report from Thema Consulting ordered by Offshore Norway was published in 2023, and it concluded that running the O&G platforms on electricity is the country's most important measure to reduce greenhouse gas emissions (Tennbakk et al., 2023). One of their main arguments was that electrification projects will lead to more quotas being removed from the system, which would lower the total amount of emissions in Europe (Tennbakk et al., 2023). Others have argued that the positive climate effects of electrification are either uncertain or non-existent, and that the costs are high compared to the potential GHG emissions reduced (Bjørnes et al., 2022). In addition, a report from Vista Analyse ordered by a group of environmental organisations, found that increased Norwegian oil production, even with electrification, will lead to increased global emissions (Vista, 2023).

The case of Melkøya is an example of the ongoing debate on electrification. Melkøya is an island outside Hammerfest in Northern Norway, which has a liquid natural gas production that Equinor operates. Equinor states that more power is necessary to continue production past 2030, and proposes electrification with electricity from land as a solution (Bokn, 2023). Before deciding on electrification with electricity from land, CCS and offshore wind were discussed as alternatives. Equinor argues that electrification with electricity from land is the best alternative as it is cost-efficient, reduces emissions and provides enough electricity to continue production (Bokn, 2023). However, the reactions and concerns have not been lacking. The locals in Hammerfest are concerned that the electrification of Melkøya will lead to power scarcity and high electricity prices onshore. Others, both political parties and environmental organisations, propose CCS as a better solution for the island as it will require less electricity from land (Hykkerud, 2023). In addition, the environmental organisation Bellona, among others, doubts Equinor's equations of the costs of CCS and argues that Equinor has stated CCS to be more expensive than it needs to be to present electrification as a better alternative (Bellona, 2023).

The composition of stakeholder interests and positions in the electrification debate is interesting as it differs from the stakeholders that populate coalitions in other climate policy debates in Norway. Environmental organisations are divided on the environmental effects of electrification, and political parties who usually oppose each other on environmental policies now share some of the same concerns. With a couple of exceptions, it is an overall broad agreement among the political parties that electrification of the petroleum industry is a good policy instrument for reaching Norwegian climate goals (See table 1 below). The Red Party and the Progress Party are the only two parties that have taken a clear stand against electrification. The Progress Party argues that electrification is symbolic politics and a waste of electricity and argues that using electricity from land will lead to further electricity scarcity on land and increased electricity prices for Norwegian households (Andersen, 2022; Vikingstad, 2022).

Table 1: Overview of the Norwegian political parties' standpoint on the O&G industry per Feb 2023

Political Parties	**In favour of electrification of the O&G industry**	**In favour of an end date for the O&G industry**	**In favour of continuous exploration of O&G**	**Reference**
The Labor Party	Yes, preferably with electricity produced offshore	No	Yes	(Arbeiderpartiet, 2020)
The Conservative Party	Yes	No	Yes	(Høyre, 2022)
The Liberal Party	Yes	No	No	(Venstre, 2021)
The Progress Party	No	No	Yes	(Fremskrittspartiet, 2021)
The Green Party	No to electricity from land. Yes to other solutions for electrification	Yes, phase out by 2035	No	(Miljøpartiet De Grønne, 2021)
The Socialist Left Party	Yes, with offshore wind	No	No	(Sosialistisk Venstreparti, 2023)
The Christian Democratic Party	Yes	Yes	Yes and no. Want to protect some especially vulnerable areas	(Kristelig folkeparti, 2021)
The Centre Party	Yes, preferably with electricity produced offshore	No	Yes and no. Want to protect some areas.	(Senterpartiet, 2023)
The Red Party	No	Not mentioned	No	(Rødt, 2021)

3. Theoretical Framework

In this thesis, the carbon lock-in theory provided by Seto et al. (2016) is used to analyse and answer the research question. This chapter starts by looking into how different literature defines and applies theories of carbon lock-in. At the end of the Chapter, an explanation of how the theory from Seto et al. will be applied in my analysis is provided.

3.1 The Carbon Lock-in Literature

There exists a general consensus on the definition and characteristics of carbon lock-in in the literature. Carbon lock-in is a concept that describes a state of path-dependence on a type of fossil fuels (Leichenko and O'Brien, 2019). It occurs when large-scale investments in fossil fuel energy, structures and infrastructure systems lead to continued reliance on fossil fuels and an increased resistance towards a transition to other energy sources (Leichenko and O'Brien, 2019). The physical, economic and social constraints are mutually reinforcing, and all contribute to a closed loop of reliance on fossil fuels (Seto et al., 2016). In a time where we need a transition to a low-carbon society, avoiding further carbon lock-in is essential to reach the 1.5-degree target from the Paris Agreement (Sato et al., 2021).

Several scholars emphasise how path-dependence is one of the main characteristics of lock-in (Janipour et al., 2020; Trencher et al., 2020; Seto et al., 2016; Wesseling & Van der Vooren, 2017). As investments are made in a certain industry and actors have gained vested interests, the costs of reversing the path-dependence are considered very high (Janipour et al. 2020). For example, Janipour et al. (2020) found that a system with fossil fuel dependence incentivises further investments in carbon-intensive systems which not only contribute to the closed loop of fossil fuels, but also has the potential to inhibit innovation and investments in cleaner, low-carbon alternatives. However, this is not always the case. Buschmann & Oels (2019) looked into the German energy transition and found that continued growth of renewables continued at the same time as the carbon lock-in in the coal industry remained.

There is less consensus in the literature on a shared way of assessing and evaluating the policy implications of carbon lock-in (Seto et al., 2016). Hence, different approaches to categorise the various causes of carbon lock-in have been provided by different literature, though with a lot of overlap. Two different ways of defining concepts that often are referred to in literature are the approaches from Seto et al. (2016) and Unruh (2002). Seto et al. (2016)

identifies three types of carbon lock-in. Technological and infrastructural lock-in, institutional lock-in and behavioural lock-in (Seto et al., 2016). Unruh (2002) identifies five similar categories of lock-in sources: technological, organisational, industrial, societal and institutional. The two different ways of categorising lock-in types covers most of the same processes, however, Seto et al.'s definitions are more clear on what each type covers.

Hence, this thesis will use the concepts of carbon lock-in as defined by Seto et al. (2016), as the approach makes a clear distinction between the different processes within each type of lock-in, but still recognizes that they are tightly intertwined. The framework and the three defined types of lock-ins contribute to outline the conditions, opportunities and strategies needed to foster transitions away from carbon-intensive trajectories (Seto et al., 2016). The theory is used to look at to what extent electrification of O&G platforms increases carbon lock-in, identify the consequences of carbon lock-in as well as how to transition away from it.

3.2 Technological and Infrastructural, Institutional and Behavioral lock-in

The first concept, technological and infrastructural lock-in, shapes the energy supply and directly or indirectly emits greenhouse gases (Seto et al., 2016). It is often referred to as built infrastructure that determines energy demand for decades after their construction, such as street layouts, land use patterns and buildings (Seto et al., 2016). Less direct types of infrastructural lock-in include fossil fuel-supporting infrastructures such as pipelines and refineries. A study from 2019 found that committed greenhouse gas emissions from already existing infrastructure will use up what is remaining of the world's "carbon budget" (Tong et al., 2019). This highlights the importance of avoiding further technological and infrastructural lock-in in order to limit temperature rise to safe levels.

An important concept within technological and infrastructural lock-in is asset specificity (Seto et al., 2016). This concept describes assets that are designed for a specific task and that cannot be used for other purposes (Seto et al., 2016). Examples of this are gas turbines on the O&G platforms whose only function is to generate power by using gas. Owners of such assets have strong incentives to favour policies that maintain the lock-in, as it provides stability and predictability. In their report from 2016 on avoiding carbon lock-in, the

European Environment Agency emphasised how carbon lock-ins often involve an overcapacity in production and might therefore expose owners of assets to the financial risk of closure (EEA, 2016).

Institutional lock-in is associated with governance and decision-making. It could for example be the government investing in certain industries (Seto et al., 2016). Politicians, policymakers and policy-making institutions at the local, national and international levels have strong incentives to maintain the status quo and to support pressures from powerful economic interests. A common feature within the institutional lock-in is the institutional feedback loop, in which the actors who benefit the most from existing energy infrastructures push for institutional rules that further their interests. This will provide them with greater resources and reinforce their political and economic dominance, which again gives them the wider opportunity to continue shaping institutions to their benefit (Seto et al., 2016).

Behavioural lock-in refers to the habits and behaviour of people associated with the demand for energy-related goods and services (Seto et al., 2016). This type of carbon lock-in is often overlooked in climate change literature, as more concrete processes such as the two previous types are easier to identify (Seto et al., 2016). However, behavioural patterns and routines are important to study as carbon-intensive behaviours, lifestyles, social norms or routines contribute to reinforce existing systems. Seto et al. (2016) divides behavioural lock-in into two main categories, lock-in caused by individual decision making or lock-in caused by social structures. The concept of individual decision-making assumes that decision-making starts with conscious behaviour before it becomes more automatic with repetition. Examples could be daily transportation choices or product preferences. The concept of social structural behaviour assumes that individual behaviour is constrained by cognitive processes and structure, and hence more overlapping with technological and infrastructural lock-in. Where the former assume that individuals have agency over their own behaviour and habits, the latter emphasise the opposite in which context have agency over individuals (Seto et al., 2016).

Overlaps between the three types of lock-in are common, and it is rarely possible to single out one cause (Seto et al., 2016). Unruh (2000) introduced the techno-institutional complex, which captures the combined technological and institutional lock-in which occurs through combined interactions between technological systems and governing institutions. As the

contexts in which carbon lock-in exists are so complex, it is often a combination of institutional and technological factors that may be difficult to distinguish from each other (Unruh, 2000). Since technological and institutional lock-in are separated in two different categories in Seto et al.'s theory, it is possible to use the definition to compare themes and find where the different concepts overlap.

The urgency to limit global warming highlights the value and importance of limiting even small risks of carbon lock-in, as carbon lock-in contributes to increased resistance to change in society (Leichenko and O'Brien, 2019). Carbon lock-in makes it both expensive and difficult to change to other energy systems, and is likely to constrain the technological, economic, political and social efforts to reduce greenhouse gas emissions (Leichenko and O'Brien, 2019). This highlights the necessity of hindering further carbon lock-in to avoid the worst climate consequences.

Efforts and pathways to combat carbon lock-in are outside the scope of this thesis. However, it is of value to understand how break-out mechanisms work, to get a better understanding of the concept for the analysis. Wessling & Van der Vooren (2017) states that "overcoming systemic lock-in requires policy interventions that go beyond independently solving individual systemic problems". Unruh (2000) adds on to that by saying that "escaping carbon lock-in will require undertaking significant initiatives and investments in the near term while retaining the flexibility to adapt, refine and replace those initiatives and investments in the long term". As lock-ins favour status quo, it is undesirable in a time where we need a transition to a low-carbon society. Carbon lock-in poses significant challenges to making such changes on the necessary timetable, especially when the changes required undoing quite entrenched and reinforced patterns and institutions in multiple technological, economic, political and social systems.

This thesis will use the three concepts, technological and infrastructural, institutional and behavioural lock-in, from Seto et al. (2016)'s theory to analyse the findings. The theory is used to answer the research question by identifying traits of the three concepts of carbon lock-in. This is used to categorise and structure the findings. The key characteristics of each concept presented by the author have been helpful in identifying specific processes of carbon lock-in in the informants' arguments. Those key characteristics have been called "themes" in this thesis, and examples can be found in Table 2 with illustrative quotes (see Chapter 5).

Hence, the theory has provided structure and theoretical depth to the analysis and discussion. Both the results and discussion chapters are structured after the three concepts.

4. Methodology

In this chapter, I will discuss the methods used for my research. In broad terms, the chapter includes explanations of the choice of method, sampling and a discussion around the limitations and challenges of my study.

4.1 Research Strategy and Design

The main objective of this study was to identify whether electrification of Norwegian petroleum production platforms contributes to carbon lock-in. To get a wider understanding, I wanted to identify the main competing views on electrification among some of the main actors in the debate. I found that the most feasible way to study these objectives would be to use a qualitative method with a case-study and semi-structured expert interviews to enable an assessment of competing views about electrification (Bryman, 2016). The decision was made considering the limited time frame and resources available, but also because in-depth interviews could give the study a broad understanding of not only what some of the main stakeholders' opinions are, but what their opinions are based on. The interviews had to be semi-structured, as I needed some structure and standard questions in order to be able to compare, but also unstructured enough so that I could let the conversation flow and ask questions to follow up on what they were saying. The informants come from different industries and have different perspectives, and the interviews needed to be adjusted individually thereafter to get the most out of them.

For practical reasons, four of the interviews were in person, and five of them were digital. Even though in-person interviews allow for more personal interaction, the digital interviews were no less in-depth or of less quality. Even though I had a similar amount of questions for each informant, the interviews varied in length from 25-45 minutes. An appendix is attached with information about each interview (See appendix 2), as well as the full interview guide (See appendix 1).

I chose to base the interviews on empirical-related questions instead of theoretical ones because the theory could be a distraction from what is empirically interesting for this study. Therefore, the questions were more related to overall views on electrification and the O&G industry, and I identified traits of carbon lock-in within the arguments. In addition, it is

especially interesting to look at empirical interactions across lock-in factors as they are limited within the existing lock-in literature (Trencher et al., 2020). However, it could mean that I would have got more data specifically related to carbon lock-in if I asked about it directly. In addition, some informants mentioned more examples of traits of carbon lock-in than others. Hence, there is an uneven representation of the number of quotes and examples from each informant in the results and discussion chapters. As the objective of the thesis is to identify potential traits and processes of carbon lock-in with electrification of O&G platforms, this has been prioritised over even representation of informants.

4.2 Sampling

I used a purposive sampling approach to collect the sample of my participants. Purposive sampling is a non-probability sampling approach, meaning that the participants are not sampled randomly but with the research goal in mind (Bryman, 2016, p. 408). Even though a purposive sampling is convenient in that it does not need to be representative, it also means that the study does not give a basis to generalise a population (Bryman, 2016). I was aiming for a sample size of 8-12 informants as it gives a good insight into the main perspectives and positions in the debate. I ended up with 9.

When making selections for informants, I made sure that I got a wide spectrum of different opinions. Half of the informants are leaning more towards being in favour of electrification, while the other half is more negative towards it. The selection criteria was to find candidates that were engaged and central in the debate and had wide knowledge on the topic. I contacted at least one representative from each political party, preferably their spokesperson on O&G, climate or energy. I received answers from seven political parties, in which five were positive to join. The five political parties represent the biggest political parties in Norway as well as some smaller ones. Even though it would have been interesting to get one from each political party, the five represented are among the largest political parties in Norway and represent a wide spectrum of the arguments in the debate. It is therefore unlikely that the research and conclusions would have looked different if all political parties were represented, as the main positions within the debate are covered.

In addition to the politicians, I contacted four other organisations that have been central in the debate to get some other perspectives represented. This was to a large extent a biased

decision based on who I think would bring valuable insight into the research. It ended up being one climate scientist, one advisor on O&G from the Norwegian Confederation of Trade Unions, a representative from a business organisation for the O&G industry as well as a representative from one environmental organisation.

4.3 Data Analysis

I recorded all interviews and transcribed them with the transcription tool in Microsoft Office. I listened through all the interviews and edited any faults from the Microsoft transcription manually for it to be correct.

Data were coded manually using a thematic analysis. I started by reading through all transcriptions to look for patterns and interesting findings. Next, I organised different categories based on the three types of carbon lock-in from Seto et al.'s framework: Technological and infrastructural, institutional and behavioural lock-in. The three concepts were my main categories. I read it several times over and looked for patterns and processes from the three categories, which is what ended up being the underlying themes under each category. I wrote down what I found in each category and the themes in an Excel spreadsheet, with the framework approach from Bryman (2016) as the starting point. Each category had its own spreadsheet, where I wrote down what the informants said on specific themes. The interviews were printed out in their original language (Norwegian). Quotes with examples of the categories and themes of carbon lock-in were written into a table, and translated manually to English. The table with English translations can be found in chapter 5 and the original Norwegian codes can be found in the appendix.

4.4 Ethical Considerations

There are often some ethical concerns to consider when doing research, to protect respondents from harm and in order to maintain the integrity of the study (Bryman, 2016). This study does not obtain sensitive or private information about the informants. All of the informants are public figures who already are open about their viewpoints on the topic either in the media or on their own platforms.

I have followed NMBU's guidelines for data collection and processing and storage of data. The study has been approved by Sikt, and all informants have signed the consent sheet. The informants were given information about the study and gave consent for the interviews to be recorded prior to participation. All recordings and transcriptions will be deleted after the completion of the thesis, as per Sikt's guidelines.

4.5 Trustworthiness

Two primary criteria are often used to assess the quality of a qualitative study; trustworthiness and authenticity (Bryman, 2016, p. 384). The first one, trustworthiness, is again assessed based on four criteria; credibility, transferability, dependability and confirmability. These criteria are developed especially for qualitative research, as they argue that there can be more than one truth about the social world (Bryman, 2016, p. 384).

The emphasis on more than one truth in qualitative studies is tested with the criterion of credibility. Credibility looks at the truth value of the data and the conclusions. If a study has good credibility, it proves that the study has been carried out with principles of good practice (Bryman, 2016, p. 384). I established credibility in this study by using triangulation, as recommended by Guba and Lincoln (1985). Triangulation increases the credibility of a study by using more than one method or source of data (Webb et al., 1966). I exercised triangulation by having interviews and comparing them to secondary data such as political party programs and public statements.

Transferability refers to what extent the study can be used as a database for making judgements for other studies in the future and how easy a study can be replicated by someone else and tested (Bryman, 2016, p. 384). As my study is based on nine informants and therefore is not representative, I found it valuable to include thick descriptions. Thick description provides the reader with a better overview of the situation in which the study has taken place (Bryman, 2016, p. 398). I chose to have a broad background section with an introduction to the history of the field, literature on the topic and the most common arguments from the public debate in order to let the reader know what background the research is based upon. In addition, if future researchers want to replicate the study or

compare it, it will increase the chances of it being done in the right way if thick description is provided.

Lincoln and Guba (1985) propose the idea of dependability in qualitative research, and suggest that to establish the merit of research in terms of its criterion of trustworthiness, it is necessary to keep an audit trail. An audit trail means that the researcher keeps complete records of the full research process, including but not limited to problem formulation, interview transcriptions and data analysis decisions (Bryman, 2016). Considering the short time frame and limited research resources, it has not been possible to do a full audit trail. I did not have enough available time nor resources to do so. However, through monthly meetings with four of my peers I have got feedback throughout the process, which can increase the dependability. I have also kept the records and transcriptions of the interviews, to make sure that I quote them as correctly as possible.

Lastly, confirmability refers to the study's neutrality and unbiasedness, often referred to as objectivity in quantitative research (Bryman, 2016, p. 384). Even though it is important to establish neutrality and unbiasedness, it is equally important to recognize that complete neutrality and unbiasedness are impossible to obtain (Bryman, 2016, p. 386). I have tried to stay neutral in the interviews and not bring my personal opinions to the table, however, it is impossible to keep all human reactions away in a conversation.

4.6 Potential Limitations

This study contains some potential limitations and challenges. All my interviews were conducted in Norwegian and most of the literature for the background section has also been in Norwegian. Translation of the data into English might allow for more personal interpretation than if it was all in the same language (Abfaler et al., 2021). As interpretation of the meaning of the data is the core of qualitative research (Abfalter et al., 2021), I have tried to do the translation as correctly as possible. However, the decision of conducting the interviews in Norwegian was taken because it is the informants' native language and I wanted to make the interviews as comfortable as possible. This is important as language influences how meanings are constructed (van Nes et al., 2010), and letting the informants speak in their native language allows them to express themselves better.

5. Results from the Interviews

First, I will present some findings from the interviews on the main competing views and positions within the debate to set the context for the analysis and create an understanding of the perspectives of the informants. Second, I will present my findings on the competing views and positions on whether and how electrification may contribute to carbon lock-in. This section is structured after the three main categories that have been used to analyse the data material: Technological and infrastructural, institutional and behavioural carbon lock-in. The main findings within each category are presented in a table with quotes (see Table 3 below).

Each informant is assigned a code that is used to refer to their quotes and arguments. A complete overview of the informants and information about the interviews can be found in Appendix 2. An overview of the informants' position on three main questions within the debate is presented in Table 1. Pol1, Pol2, Pol3, Pol4 and Pol5 are politicians from varying political parties, all Members of Parliament sitting in the Energy and Environment Committee. CR is a climate researcher, EO is an engineer working in an environmental organisation, IO1 works in a labour union and IO2 works in the business association for the O&G industry. In general, Pol2, Pol3, Pol4, IO1 and IO2 are in favour of electrification, however, it varies to what extent they favour electricity from land or offshore wind, or other alternatives such as carbon capture and storage. Pol1, Pol5 and CR are against electrification with both electricity from land and offshore wind. EO is positioned somewhere in between and thinks that both electrification with electricity from land, offshore wind and carbon capture and storage can be solutions.

Six out of nine respondents stated that electrification will extend the lifetime of Norwegian O&G production (IO1, IO2, Pol1, Pol3, Pol4, CR). One disagreed that it would extend the lifetime of production (Pol2), and two were unsure of the effects (EO, Pol5). The informant doubting that it would extend the lifetime based his argument on a report from DNV (Pol2). The report argues that the 1.5 degrees target is within reach, as long as Europe and the US set a target of climate neutrality by 2043, China by 2050 and India by 2060 (DNV, 2021). If they do so, policies need to match the target and there will not be space within the carbon budget for increased petroleum production or exploration activities (Pol2). The informant argued that with such policies and targets, reductions in petroleum production activities are not just good

for the climate, but there is also no economic rationale behind increased production because the demand for O&G will disappear.

Table 2: Main viewpoints among the informants

Question	Pol1	Pol2	Pol3	Pol4	Pol5	CR	EO	IO1	IO2
In favor of electrification with offshore wind or electricity from land		x	x	x			(x)*	x	x
Electrification will extend the oil production in Norway	x		x	x	(x)	x	(x)**	x	x
The O&G industry should be developed, not phased out			x	x	x	(x) ***		x	x

*Partly, both yes and no depending on the platform and situation

**Partly, think that it mostly depends on the demand but that Norwegian O&G will be more competitive with less emissions in production

***Thinks that the government should regulate less and rather follow international climate politics with the EU. Wants to increase the carbon tax instead of electrification.

5.1 Technological and infrastructural lock-in

The main hypothesis of Seto et al. (2016) is to look for physical infrastructure such as street layouts, land use patterns and buildings when evaluating technological and infrastructural lock-in. However, as electrification of O&G platforms has impacts offshore, it is more relevant for this study to look at indirect types of technological and infrastructural lock-in. These types are evident with fossil fuel-supporting infrastructures such as pipelines that transport power from land out to the platforms. Examples of technological and infrastructural lock-in were mentioned by both informants who were in favour and against electrification.

The examples of technological and infrastructural lock-in varied among the informants that were against electrification. Pol1 argued that Norway makes itself dependent on O&G by building the infrastructure needed to get electricity from land, because investments are made there instead of in other industries. This argument was supported by another informant who said that because electrification demands a high share of investments, the industry would

want to produce O&G longer to get a good economic return (CR). Another aspect of the investments in infrastructure is the potential power scarcity and increased electricity prices that are likely to occur on the mainland if O&G platforms get electricity from land. Pol5 argued that electrification will reduce the economic viability of green industries such as hydrogen and battery factories because the O&G platforms will demand large amounts of power, hence pushing electricity prices on land upwards.

Two informants in favour of electrification argued that investments in electrification of the O&G industry would not come at the expense of other industries (IO1, Pol4). IO1 emphasised that the aim is to increase the power production where it is possible, and not to set the O&G industry up against other industries. When it comes to the development of battery factories in Norway, IO1 argued that the US Inflation Reduction Act is a bigger threat than electrification in terms of diverting investments in renewable energy technology in Norway. Pol4 was clear that electrification would not impact investments in other industries, and Pol3 and IO2 were more vague on the question and simply said that they wanted to focus on how to develop and build enough renewable energy. Pol2 was positive towards how electrification with offshore wind can contribute with technology development in an industry that currently is immature.

Asset specificity is another important element of technological and infrastructural lock-in, in which inputs cannot be readily used by other systems because the investments are unique to a particular task (Seto et al., 2016). Several of the informants came with examples of owners of assets that do not directly burn fossil fuels but still have strong incentives to favour policies that maintain lock-in (IO1, CR). One mentioned that around 500 distribution companies work with Melkøya (IO1). Another mentioned how industries that are on provision and deliver cables will argue that electrification is a good idea because it is good business for them (CR).

EO came with suggestions for how to avoid enforcing technological and infrastructural lock-in and still electrify the platforms. The informant stated that the current system is lacking comprehensive thinking and lacks coherent standards and agile technical solutions, which are examples of systems that reinforce infrastructural lock-ins (EO). This can be avoided by making a plan on how to prioritise the O&G fields that are most optimal for offshore wind (EO). Then, you can build power production in connection with O&G installations that at a later point can switch from drawing power from the mainland to

producing for the mainland (EO). The informant thought that already now, most power cables that go out to the platforms can be turned and produce power to land, with small adjustments (EO).

There was wide disagreement among the informants in favour of electrification, on whether the O&G industry should be further developed. This impacts the technological and infrastructural lock-in, as there is a difference in terms of whether electrification is used as an argument to open new O&G fields, or whether it is used on platforms that would have produced O&G anyway. Pol2 is in favour of electrification, but is clear that it is a measure to cut emissions in existing O&G production, and should not be used as an argument to increase production or continue production for longer. Pol3 and Pol4 both want to further develop the O&G industry, and think electrification is a premise to do so. Pol1 and Pol5 are against electrification and are sceptical of the promised climate effects of it, but where Pol1 is against exploration activities, Pol5 wants to continue exploring and developing the industry.

CR mentioned another aspect that is interesting in regard to technological and infrastructural carbon lock-in: what type of energy that we are able to produce more of. The concern was that the ability to produce fossil-free energy in Europe is not good enough, especially due to the intermittency of solar and wind energy. In that case, CR proposed that coal might be on the menu, as that is an energy source that is easy to produce more of. This argument is supported by Pol5, who are concerned that by using electricity to run the O&G platforms, you are taking energy from an already energy-scarce market which renewable energy sources are unable to replace.

5.2 Institutional lock-in

Institutional lock-in is intensified when politicians, policy-makers and policy-making institutions at the local, national and international levels have strong incentives to maintain the status quo and succumb to pressures from powerful economic interests (Seto et al., 2016). As the informants include both politicians and organisations representing the O&G industry, the interviews revealed how they seek to influence the system as well as their mentioning of other powerful actors doing the same.

With one exception (Pol5), the informants that support development of the industry are supportive of electrification. Their main arguments are related to jobs, financial stability and the industry's profitability (Pol4, IO1 and IO2). Pol4 said that since electrification will allow for continued oil production, it will facilitate economic stability for workers within the industry and their families. IO1 mentioned the importance of investments in electrification or CCS that we take now will extend the lifetime and secure jobs at Melkøya past 2022, which is an argument that also relates to technological and infrastructural lock-in.

The profitability argument is also mentioned by informants who are against, or more sceptical towards, electrification. EO mentioned how the profitability of the industry makes it impossible for operators and governments to stop the production. CR mentioned how the oil industry and its stakeholders view electrification as a kinder egg because you can produce O&G for longer, it is profitable for longer and you get less political pressure related to GHG emission cuts.

The informants mention several examples of or institutional feedback loop, in which the actors who benefit the most from existing energy infrastructures push for institutional rules that further their interests, provide them with greater resources, reinforce their political and economic dominance and allow them to deploy yet greater resources to shape institutions to their benefit (Seto et al., 2016). For example, IO1 mentioned how they as a labour union negotiated the favourable oil tax package when the oil industry got hit hard during the pandemic.

An interesting finding is that the informants against electrification are split on which direction the O&G production in Norway should go in and whether it should be phased out or developed. That makes their argumentation around institutional lock-in different. Two of the informants argue that electrification is a political attempt to merge two things that do not fit well together: climate policy and petroleum production (Pol1 and CR). EO mentioned how electrification might make it easier for the O&G industry to get new installations approved, as it won't negatively impact Norway's climate gas emissions and ambitions.

5.3 Behavioural lock-in

Behavioural lock-in is the type of carbon lock-in that was mentioned the least by the informants, but it is still evident. What stood out was the view of Norway as a greener and better producer of O&G compared to other producers, both among some informants in favour and against electrification. Moreover, arguments emphasised that Norway's contributions to total climate emissions are quite small given the size of the country's economy. Examples are Pol4 saying: "I don't think that Norway, little Norway, even with millions of tonnes of emissions, has big consequences.".

CR said that there is no point in Norway phasing out the O&G industry unless other big producers of O&G do the same, as it only accounts for 2% of oil production and 3-4% of the gas production globally. Some informants mentioned that Norway is a better producer for other reasons than climate, for example, because other producers such as Saudi Arabia and Qatar are less democratic and violate human rights (CR, Pol4, Pol5). This is also related to labour rights. Pol2 nuanced this argument by separating between existing and future production, and argued that increased production leads to increased greenhouse gas emissions. Electrification can therefore not be used as an argument to open new O&G platforms (Pol2).

Another aspect was how electrification can increase public acceptance of the O&G industry and thereby intensify the behavioural lock-in. Pol5 opposed electrification because of it being a bad climate measure. However, the same informant still argued that electrification might make it easier to continue developing the industry as it will make it easier to get acceptance among the environmental parties and people who care about climate. EO mentioned a similar argument, in which it is easier to get acceptance to build an installation if it does not negatively impact Norway's climate emissions and ambitions.

Table 3: Illustrative quotes

Category	Theme	Quote	Respondent
Technological and infrastructural lock-in	Asset specificity	"You make yourself dependent on O&G by building an infrastructure like you do when you electrify with power from land"	Pol1
		"[on electrification] that is the biggest bottleneck: the ability to produce fossil free power, when there is little wind and sun. That means that the way it is today, it is in many cases coal that is on the menu. That is what you can produce more of".	CR
	Owners of assets	"A total of 500 distribution companies work with Melkøya. Lots of people who are there for a period of time'	IO1
	The impact of electrification on the lifetime of O&G	"By 2050 we should not have emissions, so then you have to use carbon capture and storage if you still want activity on the Norwegian Continental Shelf on the gas-side."	Pol4
		"I think that electrification will extend the lifetime of Norwegian O&G. For example, Wisting could not run without electricity from land because it is almost a pure oil field. It is not enough gas for it to run on gas. Then you're not just using electrification to cut emissions, but to extend the oil age."	Pol1
		"Electrification or CCS is about cutting emissions in the production we have and should not be an argument to increase the production or continue production".	Pol2
		"So yes, it is an assumption (prerequisite?), it is even decided by the Parliament that we should have the clear ambition that we should cut half of the emissions within 2030, and that is not possible without electricity from land"	IO1
		"If we open new O&G fields, electrification is a condition. We can use Melkøya as an example. When the platform there is electrified, all climatecouldotas that relates to Melkøya will disappear from EU's climate quota system. So when a new field is opened up, it will not get new quotas. That's why new fields have to be electrified, otherwise you need to pay a high price to exploit the O&G there".	Pol3
		"The O&G industry will probably be extended because of electrification. Because the alternative would have been to phase it out".	Pol3
	Investments	"There is an incentive in that if you invest a lot of money you want to get a good return. That is why I think that electrification will make you want to produce O&G longer than you would have done without it".	CR
		"The importance of investments [in electrification or CCS] that we take now will extend the lifetime and secure jobs at Melkøya past 2022"	IO1
	Alternatives	"We as an industry have set ambitious climate targets, and if we want to be competitive in the future, we need to deliver on those targets. Whether that is with electrification, energy efficiency,	IO2

		carbon capture and storage or electrification with offshore wind. The most important is that we do what we can to reduce emissions".	
		"I am not in favour of setting an end date for Norwegian O&G. I have said that we should stop the exploration activities. There are still a lot of benefits with production. We need to try to get the emissions reduced by energy efficiency(?), replace gas turbines with more efficient turbines and ban flaring. Carbon capture and storage can be a part of this picture."	Pol1
	Flexibility: Solutions to avoid infrastructural carbon lock-in	"There is no system. There is no comprehensive thinking on how to connect together grids in the Northern Sea. It seems to me like we are thinking about each project separately and that is a bit dumb because with different standards and technical solutions it also becomes less agile. Then it becomes difficult to turn it around in 50 years and get power production to land. As far as I know, almost all of the power cables that go out to the platforms can be turned and produce power to land. With small adjustments".	EO
		"When you electrify a field, a plan needs to exist on how to prioritise the O&G fields that are most optimal for offshore wind. So that you can build power production in connection with O&G installations that at one point can switch from drawing power from the mainland to producing power for the mainland."	EO
Institutional lock-in	Powerful actors seek to reinforce status quo	"O&G is extremely profitable, yes, you can spend 100 billion on building a new field and you will still profit from it within 2 years. It is impossible for operators and governments to stop it now. It is impossible because it is so profitable, and it is classic for petroholics that it is impossible to quit because it is so profitable."	EO
		"The oil industry and Offshore Norway view this [electrification] as a kinder egg because you can produce O&G for longer, it is profitable for longer and you get less political pressure for climate reasons. The third is that the society takes a large part of the investments and risks".	CR
	The legitimacy of powerful actors	"The prices that Equnior operates with [on carbon capture and storage at Melkøya] are wrong. I think they are trying to calculate their way out of the possibilities. I don't trust their calculations at all. But it is more expensive for them [than electrification with electricity from land], however, it is profitable for the society. And as a Member of Parliament, that is the effect we need to consider."	Pol2
	Example of institutional feedback loop: Konkraft pushed for the oil tax package to save the oil industry during covid	"Then we went into the pandemic and the oil industry got hit hard and we risked that Aker would reduce their employees from 11 to 3 thousand people. It looked bad and the oil price collapsed globally. We negotiated the oil tax package or the delayed tax package."	IO1
		"If the businesses shall survive, they need to make money. If you are going to do that in a way that makes you profitable, you depend on income. The oil tax package provides that".	IO1
	Institutional priorities	"It [electrification with electricity from land] is a priority because when you send power to the continental shelf you prioritise Norwegian O&G instead of mainland industries. You twist the investments away from other industries that could have been taken care of and built up".	Pol1

		"A good example is Melkøya and electrification of Norwegian O&G there. Because of the affiliation obligation, 3 TWh is reserved to Melkøya which vacuums the whole county for power. Several other businesses that I think are more sustainable than Norwegian O&G have been declined."	Pol1
		"Everything has changed with the current energy and price situation [referring to the invasion of Ukraine]. No one wants to discuss a phase out now".	Pol3
		"We are not setting an end date for O&G, but the idea before the current energy crisis was that the demand for renewables would increase so much that the O&G industry would be forced to downscale. However, now it's hotter than ever to start up with oil and gas".	Pol3
	Combining climate targets with O&G production	"Norway and the political environment has struggled the whole time with combining the climate world with O&G, and looks at it as a way to do it with less resistance. It becomes a political glue: Try to make two things that do not fit well on the outside to fit better. It has to do with national interests. Political interests are here, such as Offshore Norway, the O&G industry, and certain industries. Industries that are on provision and deliver cables will of course think that electrification is a good idea because it is good business".	CR
		"We work towards more exploration activities (O&G) and to set more into production. At the same time, the industry has set ambitious climate targets. One thing is that the emissions should be halved by 2030, but they should also be close to zero by 2050. (...) This (electrification) are the types of solutions that you by high chance needs to look at in the future, but it is not just electrification. It is possible to look at solutions for carbon capture and storage in new constructions.	IO2
		"Petroleum production has a negative climate effect. That is not a very controversial statement".	Pol1
	Cost shifting (?)	"Electrification is bad climate politics. Some of the problem is that because of the tax system the oil sector will only take part of the costs. Norwegian society will pay for most of this. When it comes to the grid development, it will be covered by Norwegian customers. So as a social economist you can easily get an overinvestment because a lot of the costs are covered by society and not as Equinor."	CR
Behavioural lock-in	Jobs	"People (ref. workers in the oil industry) are very proud of their jobs and what they do, because they know very well what it means for the welfare society and for their local environment".	Pol4
		"Today about 200 000 people work in O&G. That is people who have a job today. It is a sector that we hope to transit to other types of work slowly and steadily.	IO1
	Perceptions of Norway as an O&G producer	"I don't think that Norway, little Norway, even with millions of tonnes of emissions, has big consequences."	Pol4
		"It must be better to use oil that has travelled a relatively short distance compared to oil that has travelled half the globe. That is part of the explanation why we continue with oil. And again, the	IO1

		premise for the Norwegian debate and for us to be able to continue with O&G are a) we are making money and b), we are good at HMS and emissions. And we are probably among the best in the world on those two things".	
		(On phasing out Norwegian production): "I also think it is silly to practically transfer resources to dictatorships or states without a democratic government".	CR
		"The Rystad report does that [use electrification as an argument to increase production]. I think that is a wrong conclusion. Because you use less emissions in the production as an argument for why Norwegian production is better than others. You can use this argument for existing production, but to say that it is climate friendly to increase Norwegian production of O&G is pointless".	Pol2
	Demand	"The rest of Europe still depends on O&G for heating etc., so when their renewable sources are more up and running, it will lead to a decreased demand for gas".	Pol2
		"If the demand of oil in plastic products is considerably reduced, the demand after oil will decrease as well".	Pol2
		"Norway needs to discuss not just how to reduce the use, but also the production of O&G".	Pol2
		"I follow the IEA-report that says that we already have exploited the resources we can or even 50% more. And then we have a side discussion, the need for more hydrogen, or blue hydrogen. But then the policies need to be twisted towards blue hydrogen"	Pol2
	Public acceptance	"If we use common sense, we should extend this [Norwegian O&G production]. The need for O&G will exist for a long time coming. Even in the 1.5 degree target, and it is possible that it will be easier to get acceptance among the environmental parties to continue O&G production if we use electrification."	Pol5
		"Not to mention you can sell the O&G greener by saying that it is greener".	Pol5
		"So it is an element that it is easier to get acceptance to build an installation if it does not negatively impact Norway's climate emissions and ambitions. So it is obvious that it looks better that way".	EO
		"The will to electrify ferries a couple of years ago, would probably not have been the same today with the current situation. The risk is that we will lay behind because the debate is so polarized".	Pol3

6. Discussion

6.1 Technological and infrastructural lock-in

Electrification, both with offshore wind and electricity from land, demands large investments in infrastructure. This study finds that the intensity of technological and infrastructural carbon lock-in is determined by where the electricity comes from and how flexibility is planned for.

Electrification with electricity from land demands investments in infrastructure such as electricity cables from land out to the platforms and an upgrade of the power grid (Molnes, 2022). The electricity cables hold a high degree of asset specificity as they are not constructed to be used for other purposes than sending electricity from land to the platforms. The value of these fossil fuel supporting infrastructures is dependent on the extraction and transport of fossil fuels and there is little value in building out infrastructure that is going to be used for a limited amount of time. Therefore, it is reasonable to assume that electrification with electricity from land will intensify technological and infrastructural lock-in.

In addition, there is a risk that the electricity from land comes from other sources than renewables, which might intensify carbon lock-in even further. The reasoning behind looking at electrification as a climate measure is built on the premise that the electricity transferred to the platforms are from green renewable sources (Molnes, 2022). Then, the overall emissions from production will decline. As mentioned in the results, one of the informants was sceptical of the ability to produce enough fossil-free power when there is little wind and sun. There is a risk that the electricity sent out to the platforms might come from coal, which emits more CO2 per TWH than gas.

On the other hand, electrification with offshore wind has the potential to weaken carbon lock-in. Offshore wind makes it possible to plan for a long-term solution that is adjustable and flexible, and where the constructions and infrastructure are less tied to fossil fuels and more rigid to other types of energy. Equinor's proposed project, Trollvind, is an example of how it could have been done. They want to build a 1GW offshore wind park 65 km west of Kollsnes in Western Norway that will provide electricity to the Troll- and Osberg O&G fields and the Bergen region onshore (Equinor, 2022). These fields have a long remaining lifetime

and would likely have kept producing O&G without electrification as well. In that case, offshore wind contributes with renewable energy where gas would have been used otherwise.

As EO pointed out, as long as it is planned for, offshore wind turbines can continue providing power to land after the O&G production connected to it is phased out. “Undoing or escaping carbon lock-in requires undertaking significant initiatives and investments in the near term while retaining flexibility to adapt, refine and replace those initiatives and investments in the long term” (Seto et al., 2016), and this is what electrification with offshore wind allows for. This means that the infrastructure is less locked into carbon-intensive production, and it is possible to get an economic return also after the O&G production is phased out.

However, the premise for arguing that offshore wind does not intensify carbon lock-in is that it is not being used as an argument to open new O&G fields that would not have been opened otherwise. As seen in the results section, 6 informants argued that electrification would extend the lifetime of O&G, and 2 said that they were unsure. That was regardless of whether it happened with offshore wind or electricity from land. 2 informants from the largest political parties also argued that electrification is a condition to open new O&G fields. In that case, it is clear that electrification, also with offshore wind, might intensify carbon lock-in.

For the O&G industry and owners of direct and indirect assets, carbon lock-in is not a bad thing. It provides certainty and stability. A newly opened field with offshore wind would function as a guarantee for that field to be running for at least 50 years. Anders Opedal, CEO of Equinor, made a statement related to the Trollvind project saying that it provides the distribution and supplier industry predictability (Equinor, 2022).

Even though electrification with offshore wind might not intensify carbon lock-in or even reduce it, the O&G industry and the other owners of assets have strong incentives to resist change in terms of phasing out the industry. This brings in the commons dilemma with lock-ins: *What benefits individuals may not benefit the whole society (*Seto et al., 2016). This aspect will be discussed further in Chapter 6.2: Institutional lock-ins.

To evaluate how electrification would impact carbon lock-in, we need to look at what the alternatives to electrification would be. As IO1 pointed out, they represent the industry and the industry wants to be competitive in the future. It does not matter if that is with

electrification, energy efficiency, CCS or electrification with offshore wind, as long as the targets are met and the emissions in production are reduced (IO1). This may indicate that electrification does not necessarily intensify carbon lock-in more than other alternatives would.

6.2 Institutional lock-in

As seen in the analysis chapter, most of the examples of institutional lock-in focused on the O&G industry's contribution to the Norwegian economy, and the strong incentives to facilitate continuous prosperity. The O&G industry is the largest industry in the country based on governmental revenues, investments and exports (Norsk Petroleum, 2022a). It is therefore difficult for the government to not support it and facilitate continued profitability.

This was illustrated by the favourable tax package that was provided for the industry during the pandemic, which made sure that it remained a lucrative industry (Norsk Petroleum, 2023b). Erna Solberg, the Prime Minister in 2020 at the time when the tax package was negotiated, admitted in 2022 that the package ended up being too favourable and stimulated the industry unnecessarily (NTB, 2022). She stated that it was the strong lobbying from actors within the industry which put pressure on them to agree on the advantageous package (NTB, 2022). The same thing was confirmed by one of the informants who were a part of the negotiations (Pol2). The strong lobbying from powerful actors within the industry is an example of the institutional feedback loop and an indicator of institutional lock-in (Seto et al., 2016), and proves that carbon lock-in is very evident within the O&G industry also without the electrification debate.

Even though the previous example looks at the O&G industry independent from electrification debate, the same institutional feedback loop and economic arguments are seen with the O&G industry favouring electrification. Reduced emissions in production means reduced carbon tax and quota obligations (Oljedirektoratet, 2020). The stakeholders and the industry itself therefore have strong interest in electrifying the industry to reduce their own emissions and keep the industry economically sustainable (Equinor, 2020). As the interviews revealed, electrification is not only favourable because it will lower the expenses, but it also has the potential to make Norwegian production more competitive in a global market. We

can therefore assume that electrification is likely to contribute to institutional carbon lock-in by continuing the institutional feedback loop. The industry and their lobby organisations are likely to continue to push for initiatives that allow them to continue exploration activities and set more into production, just as IO2 stated. Electrification allows them to do just that.

The institutional feedback loop together with the technological lock-in effects of electrification, gives an example of the techno-institutional complex and how the two types of carbon lock-in often overlap. The lobbying from powerful actors within the industry involves pushing for solutions that allow for long-term stability and predictability. As seen in Chapter 6.1, electrification with electricity from land incentives long-term production as investments in such infrastructure only can be used to produce O&G. Hence, the technological lock-in and institutional lock-in creates a more robust carbon lock-in together, which is desirable for the O&G industry which will continue to lobby for it.

EO mentioned how the O&G industry has changed its position in the debate on electrification over the past decade. In early 2014, Statoil (who is now called Equinor), were against electrification of Utsira Høyden because it was too expensive. Today, with the expensive carbon tax and quotas, the O&G industry states that electrification is their main climate measure and a necessity to continue with O&G production. This example reveals how the industry is adapting to the current political environment to be able to continue with O&G for as long as possible. This can also be seen as an example of what one informant said: that electrification is an attempt to merge two things together that do not really fit well: climate policies and petroleum production. The industry is so extremely profitable, and the interviews revealed that it seems impossible for the government to go against these powerful actors as they contribute with such a large part of the state budget.

As several of the informants mentioned, electrification allows for a merge of two things that do not fit well together: climate policy and O&G production. An important aspect to look at when evaluating institutional carbon lock-in is whether or not the production would have been continued for longer without electrification. As all informants mentioned, Norway has set ambiguous climate goals and needs to cut emissions. The O&G industry wants to make money and the lobby unions want to make sure people keep their jobs.

According to Seto et al, breaking out of institutional lock-ins is difficult, and it needs to occur on both international, national and local levels to have a real effect (Seto et al, 2016). CR mentioned this as an argument for why Norway should not phase out the O&G industry unless the country has an agreement with other countries that they also stop production. An attempt to create a global agreement to stop the expansion of O&G exploration and manage a just transition to clean energy has been made and was presented by Tuvalu at Cop27 (Fossil Fuel Treaty, 2023). It has been endorsed by the World Health Organisation, The European Parliament, Vanuatu and Tuvalu (Carrington, 2022). However, as CR mentioned, it will not have a real effect unless the major emitters commit to it (Carrington, 2022).

It is difficult to get the one big emitter to sign the treaty unless all other emitters do the same. This is an example of "the commons dilemma" which is a feature within carbon lock-in (Seto et al., 2016). Individuals, in this case countries and O&G producers, make decisions that benefit themselves but harm the whole group, in this case the global climate (Edney & Harper, 1978). As seen in this study, Norwegian O&G producers justify their production by arguing that if they phase out production, it will be taken over by other producers who have more emissions in production. This argument is strengthened when the production uses electrification, and indicates that electrification strengthens the institutional carbon lock-in.

6.3 Behavioural lock-in

The attitude among some of the informants towards Norway as either a small producer in a global context or a better producer than other countries is not an unknown strategy to justify continued exploration. Lahn (2019) found that several actors who justify continued Norwegian O&G production seek to compare the industry's climate impact to the global context. A common argument from the industry is that even in a scenario in line with a 1.5 or 2-degree target, we will still have a relatively high global oil consumption for decades to come (Lahn, 2019). The argument continues by saying that the O&G that will be produced in those scenarios need to come from the production with the lowest emissions, and that Norway is well-suited (Lahn, 2019). This is the same type of arguments that were repetitive among the informants in favour of both electrification and continued O&G exploration (IO1, IO2, Pol3, Pol4).

The same arguments pre-purposes that Norwegian production would have been replaced by other producers in the case of a phase-out. A 2013 study SSB found that if Norway stops its O&G production, it will reduce global production and emissions, as only an estimated 65% of the production will be replaced by other producers (SSB, 2013). Other later studies have estimated that somewhere between 40 and 70 % will be replaced by (Erikckson and Lazarus, 2018). However, in 2021, Rystad Energy presented a report on behalf of Offshore Norway, which estimated the number of replacements to be as high as 91% (Rystad Energy, 2021). Since Norwegian O&G releases less energy in the production, and especially if all platforms will be running on electricity, the report concluded that a phase out of the Norwegian O&G industry is likely to lead to an increase in global emissions (Rystad Energy, 2021). Professor in economics, Knut Einar Rosendahl, has commented on this and said that the answer you get to the question of global effects of electrification depends on who you ask (Rosendahl, 2023). Even though it does not mean that the answers from the reports are wrong, whoever orders the report has something to say for the outcome (Rosendahl, 2023).

As seen with the examples on institutional lock-in, jobs are a big reason for why the Norwegian Government wants to continue O&G production. As electrification is likely to lead to an extension of the O&G industry, it will provide stability and less need to change lifestyle for the 200,000 people who directly or indirectly work in the industry (Norsk Petroleum, 2022a). Both IO1 and Pol4 mentioned how the workers are proud of their job and their contribution to the welfare system. This was especially evident in 2019 when it was a trend that workers in the industry changed their profile picture on Facebook saying “stolt oljearbeider” - literally proud oil worker (Freiberg, 2019). Other workers have gone public in different newspapers saying that the development of the O&G industry is important for them, as a phase-out would risk their jobs (Pettersen, 2021). Based on this it is reasonable to assume that oil workers contribute to behavioural lock-in by lobbying for electrification as a reassurance for continued production.

A study on Norwegians’ perception of climate and the O&G industry found that more people than just those working in the O&G industry want to continue with production. They found that only 44 % of the population wants to reduce Norwegian oil production (Aasen et al., 2022). That was even though less than 5 % of the Norwegian population disagree that climate change is happening, and 70% of the population believe that human activities are causing climate change (Aasen et al., 2022). As we know that rapid change in people’s behaviour and

attitude is difficult (Seto et al., 2016), a large number of people work in the O&G industry and so many believe in human activities causing climate change, it can be expected that electrification increases behavioural lock-in. This is because as the O&G industry gets "greener" with electrification it may be easier to justify continued production and support, especially at a time when we know that we need to reduce emissions.

7. Conclusion

In this thesis, I have answered the research question by identifying traits and processes of carbon lock-in based on three categorisations from Seto et al. (2016)'s framework; technological and infrastructural, institutional and behavioural lock-in.

This study found that technological and infrastructural lock-in of electrification is expected to vary depending on the degree of flexibility and asset specificity. The intensity of this type of carbon lock-in differs between the two electrification alternatives. With electricity from land, the technological and infrastructural lock-in is continued and intensified. As the cables distributing electricity from land can not be used for other purposes, the degree of asset specificity is high, and the degree of flexibility is low. Hence, high investments in new infrastructure that can only be used specifically for O&G production are expected to intensify technological and infrastructural lock-in.

Even though electrification with offshore wind also requires massive investments in infrastructure and technologies, the asset specificity is lower and the degree of flexibility higher. If planned for, offshore wind connected to O&G platforms can produce electricity and send it directly to land. Hence, it has a function even if O&G production is phased out. Electrification with offshore wind makes Norway better suited to adapt to a low-carbon future faster and is less likely to contribute to further carbon lock-in. However, this depends on the premise that using offshore wind is not used as an argument to open new O&G fields.

Further, the study found that electrification contributes to institutional lock-in, both with electricity from land and offshore wind. Statements from the interviews linked to institutional lock-in revealed that due to strict climate targets and expensive carbon taxes and quotas, it is cost-efficient for the O&G industry to electrify. The industry constantly adapts to the political environment to continue with O&G production for as long as possible. Several examples of the institutional feedback loop were found, in which the industry and its stakeholders lobby for better conditions to continue production. As the Norwegian economy currently depends on the industry because of the number of jobs and revenue it provides, the Government tends to give the O&G industry favourable conditions and subsidies. This tendency is likely to continue with electrification.

Lastly, even though examples of behavioural lock-in were mentioned the least, it is still sufficient evidence suggesting that both alternatives of electrification will intensify this type of lock-in. The most evident trait of behavioural lock-in found in this study is that reduction in emissions from the production can increase public support and acceptance of the O&G industry and thereby allow for extended production. Both electrification with electricity from land and offshore wind allow for a competitive advantage and a possibility to use greener production as an argument to produce more or continue production for longer. In addition, the argument that Norway is a better producer than others based on the democratic system and cleaner production is already evident. Therefore, reducing production emissions is likely to be another point added to the arguments for why Norway should continue producing O&G.

Overall, this study found that even though the technological and infrastructural carbon lock-in were less intense with offshore wind, both alternatives are expected to intensify carbon lock-in and extend the lifetime of O&G production in Norway. It is clear that even though electrification reduces emissions in the production phase, it contributes to carbon lock-in as it facilitates further production.

Suggestions for Future Studies

Other alternatives to electrification may also contribute to carbon lock-in. Several informants mentioned electrification as the most cost-efficient alternative to reduce emissions on the continental shelf, however several of them mentioned other alternatives such as CCS and energy efficiency as well. Hence, future studies should identify the lock-in effects of other alternatives and compare them to electrification. That would give a better perspective of the whole situation and allow for better policy decisions in a long-term perspective. While finalising this thesis, Equinor made a public statement saying that their proposed Trollvind project will be postponed as the current electricity prices make the project too expensive. As Equinor is likely to consider other alternatives now, studies comparing the lock-in effects of different alternatives are even more relevant.

8. Attachments

Appendix 1: Interview Guide

Part 1: General information

1.1 Can you give a brief explanation of your background or experience on the topic?

Part 2: About electrification

2.1 Do you support electrification of the existing O&G platforms in Norway, why or why not?

- 2.1.2 With electricity from land
- 2.1.3 With electricity from offshore wind stations

2.2 Would you support opening up new O&G fields if they..

- 2.2.1 Run on gas turbines
- 2.2.2 Run on electricity either from land or offshore wind

2.3 How will electrification of the O&G industry impact

- 2.3.1 The environment, climate and global warming
- 2.3.2 Norwegian climate goals
- 2.3.3 Investments in and developments of green, renewable industries in Norway (e.g. offshore wind, battery factories, solar companies)

Part 3: About phase-out/ carbon-lock in

3.1 Is it realistic to phase out the Norwegian O&G industry?

3.2 When should the O&G industry be phased out in Norway? Specify answer

- 3.2.1 With electrification
- 3.2.2 Without electrification

Appendix 2: Informant Interview Overview

Date	Number	Informant Code	Main Relevant Experience	Duration	In Person/ Digital
06.03.2023	1	CR	Climate Researcher	40 min	In person
08.03.2023	2	IO1	The Norwegian Confederation of Trade Unions	35 min	Digital
10.03.2023	3	Pol1	Member of Parliament, Energy and Environment Committee	23 min	Digital
10.03.2023	4	Pol2	Member of Parliament, Energy and Environment Committee	27 min	In person
13.03.2023	5	Pol3	Member of Parliament, Energy and Environment Committee	29 min	Digital
15.03.2023	6	EO	Environmental Organisation	27 min	In person
21.03.2023	7	IO2	The O&G Industry's Business Organization	33 min	Digital
22.03.2023	8	Pol4	Member of Parliament, Energy and Environment Committee	35 min	In person
23.03.2023	9	Pol5	Member of Parliament, Energy and Environment Committee	23 min	Digital

Appendix 3: Original Quotes with English Translation

Quote number	Original Quote	English Translation	Respondent
1	“Man gjør seg avhengig av olje og gass ved å bygge ut en infrastruktur slik man gjør når man elektrifiserer med kraft fra land”	“You make yourself dependent on O&G by building an infrastructure like you do when you electrify with power from land”	Pol1
2	“[om elektrifisering] Og det er det som er den største flaskehalsen: evnen til å produsere fossilfri kraft. Når det er lite vind og sol. Og det betyr at sånn som det er i dag er det i mange tilfeller kullkraft som er på menyen i Europa.””	“[on electrification] that is the biggest bottleneck: the ability to produce fossil free power, when there is little wind and sun. That means that the way it is today, it is in many cases coal that is on the menu. That is what you can produce more of”.	CR
3	“Det jobber totalt 500 leverandørbedrifter med Melkøya. Veldig mange som er inne der i en periode”	“A total of 500 distribution companies work with Melkøya. Lots of people who are there for a period of time’	IO1
4	“Til 2050 skal vi ikke ha utslipp, så da må du drive med karbonfangst og lagring hvis vi fortsatt skal ha aktivitet på norsk sokkel på gass-siden.”	“By 2050 we should not have emissions, so then you have to use carbon capture and storage if you still want activity on the Norwegian Continental Shelf on the gas-side.”	Pol4
5	“Jeg tror elektrifisering forlenger oljealderen. For eksempel, Wistingfeltet kan ikke drives uten kraft fra land fordi det er et nesten rent oljefelt, så det er ikke nok gass til at det kan gå av seg selv. Da bruker man elektrifisering ikke bare til å kutte utslipp, men til å forlenge oljealderen.”	“I think that electrification will extend the lifetime of Norwegian O&G. For example, Wisting could not run without electricity from land because it is almost a pure oil field. It is not enough gas for it to run on gas. Then you’re not just using electrification to cut emissions, but to extend the oil age.”	Pol1
6	“Elektrifisering eller karbon-fangst og lagring handler om å kutte utslipp i den produksjonen vi har og skal ikke være et argument for å øke produksjonen eller fortsette.”	“Electrification or CCS is about cutting emissions in the production we have and should not be an argument to increase the production or continue production”.	Pol2
7	“Så ja, det er en forutsetning, det er til og med vedtatt av stortinget at vi skal ha den tydelige ambisjonen at vi skal halvere utslipp innen 2030 og det får vi ikke til uten kraft fra land”	“So yes, it is an assumption (prerequisite?), it is even decided by the Parliament that we should have the clear ambition that we should cut half of the emissions within 2030, and that is not possible without electricity from land”	IO1
8	“Hvis det skal åpnes nye felt må de elektrifiseres. Hvis vi skal bruke Melkeøya som er et av de mest omdiskuterte. Når det blir elektrifisert	“If we open new O&G fields, electrification is a condition. We can use Melkøya as an example. When the platform there is electrified, all	Pol3

	blir alle de klimakvotene som tilhører det punktutslippet borte fra EU sitt klimakvote regnskap. Så hvis vi da starter opp med nye olje og gassfelt som ikke blir elektrifisert så får en ikke nye klimakvoter. Så de feltene er nødt til å elektrifiseres, hvis ikke må man betale ganske høy pris for å få de opp."	climate quotas that relates to Melkøya will disappear from EU's climate quota system. So when a new field is opened up, it will not get new quotas. That's why new fields have to be electrified, otherwise you need to pay a high price to exploit the O&G there".	
9	"Olje- og gassnæringen blir nok forlenget pga. elektrifisering. Fordi alternativet hadde vært å stenge ned."	"The O&G industry will probably be extended because of electrification. Because the alternative would have been to phase it out".	Pol3
10	"Det ligger et insentiv i det at hvis du investerer mye penger vil du få mest mulig igjen for den investeringen du har gjort. Derfor tror jeg at ved elektrifisering vil man ønske å produsere olje og gass lenger enn man ville gjort ellers".	"There is an incentive in that if you invest a lot of money you want to get a good return. That is why I think that electrification will make you want to produce O&G longer than you would have done without it".	CR
11	"Betydningen av investeringer [i elektrifisering eller CCS] vi tar nå vil forlenge levetiden og sikre arbeidsplasser på Melkøya utover 2050"	"The importance of investments [in electrification or CCS] that we take now will extend the lifetime and secure jobs at Melkøya past 2022"	IO1
12	"Vi som industri har satt ambisiøse klimamål, og hvis vi skal være konkurransedyktige i fremtiden, så er vi nødt til å levere på de målene. Om det er med elektrifisering, eller gjennom energieffektivisering, karbonfangst og lagring, eller elektrifisering med havvind. Det viktigste er at vi gjør det vi kan for å redusere utslipp."	"We as an industry have set ambitious climate targets, and if we want to be competitive in the future, we need to deliver on those targets. Whether that is with electrification, energy efficiency, carbon capture and storage or electrification with offshore wind. The most important is that we do what we can to reduce emissions".	IO2
13	"Jeg er ikke for å sette en sluttdato for norsk olje og gass. Jeg har sagt at vi skal slutte å lete. Det er mye å hente på å produsere. Vi må prøve å kutte utslipp med å effektivisere, bytte ut gassturbiner med mer effektive turbiner og forby fakling. Karbonfangst og lagring kan være en del av det bildet."	"I am not in favor of setting an end date for Norwegian O&G. I have said that we should stop the exploration activities. There is still a lot of benefits with production. We need to try to get the emissions reduced by energy efficiency(?), replace gas turbines with more efficient turbines and ban flaring. Carbon capture and storage can be a part of this picture."	Pol1
14	"Det er ikke noe system. Det er ikke noen helhetlig tankegang om hvordan man kan koble sammen et nett i Nordsjøen. Det virker for meg som om man tenker hvert enkelt prosjekt for seg og det er litt dumt fordi med forskjellige standarder og tekniske løsninger så blir det lite smidig. Det	"There is no system. There is no comprehensive thinking on how to connect together grids in the Northern Sea. It seems to me like we are thinking about each project separately and that is a bit dumb because with different standards and technical solutions it also becomes	EO

	blir vanskelig å snu det om 50 år og da få det til å være kraftproduksjon til land. Så vidt jeg vet, kan nesten alle kraftkablene som går til sokkelen snus og produsere kraft til land. Med små modifikasjoner".	less agile. Then it becomes difficult to turn it around in 50 years and get power production to land. As far as I know, almost all of the power cables that go out to the platforms can be turned and produce power to land. With small adjustments".	
15	"Når man elektrifiserer et felt, så må det ligge en plan om at kanskje man prioriterer de olje- og gassfeltene som har gode muligheter for havvind da. At man da kan bygge kraftproduksjon i tilknytning til olje og gass installasjonene også på et eller annet tidspunkt switche fra og trekke kraft fra land til å produsere kraft til land".	"When you electrify a field, it needs to exist a plan on how to prioritize the O&G fields that are most optimal for offshore wind. So that you can build power production in connection with O&G installations that at one point can switch from drawing power from the mainland to producing power for the mainland."	EO
16	"Olje og gass er så sinnssykt lønnsomt, ja, du kan bruke 100 milliarder på å bygge et felt, og du kommer fortsatt til å tjene det tilbake innen 2 år. Det er helt umulig for operatør og myndigheter og bare stoppe det altså. Det er ikke mulig fordi det er så lønnsomt, og da blir det jo sånn klassisk ting for en petroholiker at det er umulig å slutte fordi det er så lønnsomt"	"O&G is so extremely profitable, yes, you can spend 100 billion on building a new field and you will still profit from it within 2 years. It is impossible for operators and governments to stop it now. It is impossible because it is so profitable, and it is classic for petroholics that it is impossible to quit because it is so profitable.	EO
17	"Oljeindustrien (også Offshore Norge) ser dette som et kinderegg fordi du kan produsere olje og gass lenger, det er lønnsomt lenger, mindre politisk press av klimagrunner. Det tredje er at samfunnet tar store deler av investeringen og risikoen".	"The oil industry and Offshore Norway view this [electrification] as a kinder egg because you can produce O&G for longer, it is profitable for longer and you get less political pressure for climate reasons. The third is that the society takes a large part of the investments and risks".	CR
18	"Men de prisene som Equinor opererer med, mener jeg er å forsøke å regne seg bort fra mulighetene. De stoler jeg ikke på i det hele tatt. Men at det er dyrere for selskapene, det er det. Men for samfunnet er det lønnsomt å bruke karbonfangst og lagring, og som folkevalgte er det den samfunnsbetydningen og effekten vi må ta hensyn til."	"The prices that Equnior operates with [on carbon capture and storage at Melkøya] are wrong. I think they are trying to calculate their way out of the possibilities. I don't trust their calculations at all. But it is more expensive for them [than electrification with electricity from land], however, it is profitable for the society. And as a Member of Parliament, that is the effect we need to consider."	Pol2

19	“Så gikk vi inn i pandemien og det raste i oljesektoren og vi risikerte en Aker som ble redusert fra 11 til 3 tusen personer. Det så dystert ut og oljeprisen raste globalt. Vi fikk frem oljeskattepakken, eller den utsatte skattepakken”.	“Then we went into the pandemic and the oil industry got hit hard and we risked that Aker would reduce their employees from 11 to 3 thousand people. It looked bad and the oil price collapsed globally. We negotiated the oil tax package or the delayed tax package.”	IO1
20	“Skal bedriftene overleve, må de tjene penger. Hvis du skal gjøre det på en måte som gjør at du etter hvert får lønnsomhet på det nye beinet, så er du avhengig av inntekter underveis. Oljeskattepakken gir dem det”.	“If the businesses shall survive, they need to make money. If you are going to do that in a way that makes you profitable, you depend on income. The oil tax package provides that”.	IO1
21	“Det [electrification with electricity from land] er en prioritering fordi når man sender ut kraft på sokkelen så prioriterer man norsk olje og gass i stedet for fastlandsindustrien. Du vrir investeringene bort fra annen industri som man kunne både tatt vare på og bygget opp”.	“It [electrification with electricity from land] is a priority because when you send power to the continental shelf you prioritize Norwegian O&G instead of mainland industries. You twist the investments away from other industries that could have been taken care of and built up”.	Pol1
22	“Et godt eksempel er Melkøya. Elektrifisering av norsk olje og gass der. Der ser vi at pga. tilknytningsplikten har vi reservert over 3 TWh til Melkøya som støvsuger hele landsdelen for kraft. En rekke andre næringsdrivende som jeg mener er mer bærekraftig enn norsk olje og gass har fått nei.”	“A good example is Melkøya and electrification of Norwegian O&G there. Because of the affiliation obligation, 3 TWh is reserved to Melkøya which vacuums the whole county for power. Other industries that I think are more sustainable has been rejected”.	Pol1
23	“Alt har jo endret seg radikalt i forhold til prisbildet og energibildet vi står overfor nå. Det er ingen som ønsker å diskutere en sluttdato med den situasjonen vi står i nå.”	“Everything has changed with the current energy and price situation [referring to the invasion of Ukraine]. No one wants to discuss a phase out now”.	Pol3
24	“Vi setter ingen sluttdato, men det som var grunntanken før energipris krisen var at etterspørselen etter fornybar kraft ville bli så stor at olje og gassnæringen ble litt tvunget til å nedskalere seg selv. Men nå er det heitere enn noen gang å starte opp med olje og gass.”	“We are not setting an end date for O&G, but the idea before the current energy crisis was that the demand for renewables would increase so much that the O&G industry would be forced to downscale. However, now it’s hotter than ever to start up with O&G”.	Pol3
25	“Norge og det politiske miljøet har hele tiden strevet med å kombinere klimaverden med olje og gass, og ser derfor på dette som en måte å gjøre det på med mindre motstand. Det blir som et politisk lim: Prøv å få to ting som ikke fungerer så godt i lag til å	“Norway and the political environment has struggled the whole time with combining the climate world with O&G, and looks at it as a way to do it with less resistance. It becomes a political glue: Try to make two things that do not fit well on the	CR

	på utsiden fungere bedre. Har med nasjonale interesser å gjøre. Politiske interesser er her, sånn som Offshore Norge, oljeindustrien, og visse bransjer er interessert. Bransjer som går på provisjon og leveranse av kabler vil selvsagt tenke at dette er en god ide fordi det er god business."	outside to fit better. It has to do with national interests. Political interests are here, such as Offshore Norway, the O&G industry, and certain industries. Industries that are on provision and deliver cables will of course think that electrification is a good idea because it is good business".	
26	"Vi jobber for at det skal letes mer (etter olje og gass) og at man finner mer som kan settes i produksjon. Så har bransjen satt seg ambisiøse klimamål. En ting er at utslippene skal halveres i 2030, men de skal reduseres til nær null i 2050. (...) Det er jo sånne løsninger (elektrifisering) man etter all sannsynlighet må se på fremover, men det er ikke bare elektrifisering. Det går an å også se på løsninger for om det er mulig å legge til rette for karbonfangst og lagring i nye utbygginger.	"We work towards more exploration activities (O&G) and to set more into production. At the same time, the industry has set ambitious climate targets. One thing is that the emissions should be halved by 2030, but they should also be close to zero by 2050. (...) This (electrification) are the types of solutions that you by high chance need to look at in the future, but it is not just electrification. It is possible to look at solutions for carbon capture and storage in new constructions.	IO2
27	"Petroleum produksjon har negativ klimaeffekt. Det er ikke en veldig kontroversiell ting å si."	"Petroleum production has a negative climate effect. That is not a very controversial statement".	Pol1
28	"Elektrifisering er dårlig klimapolitikk. Noe av problemet er at pga. skattesystemet vil oljesektoren bare ta en liten del av kostnaden. Det norske samfunnet vil betale mesteparten av dette. Når det gjelder nettutbygging vil dette også bli dekket av kunder i Norge. Slik at som samfunnsøkonom vil man lett kunne få en overinvestering fordi mye av kostnaden blir dekket av samfunnet og ikke Equinor."	"Electrification is bad climate politics. Some of the problem is that because of the tax system the oil sector will only take part of the costs. The Norwegian society will pay for most of this. When it comes to the grid development, it will be covered by Norwegian customers. So as a social economist you can easily get an overinvestment because a lot of the costs are covered by society and not as Equinor."	CR
29	"Folk (ref. arbeidere i oljebransjen) er veldig stolt over den jobben de gjør, det de driver med. Fordi man vet forferdelig godt hva dette betyr for velferdssamfunnet og for den lokale arbeidsplassen".	"People (ref. workers in the oil industry) are very proud of their jobs and what they do, because they know very well what it means for the welfare society and for their local environment".	Pol4
30	"Per i dag er det sysselsatt rundt 200 000 i olje og gass. Det er folk som har en jobb i dag. Det er en sektor vi håper å sakte men sikkert ønsker å omstille til annen type arbeid."	"Today about 200 000 people work in O&G. That is people who have a job today. It is a sector that we hope to transit to other type of work slowly and steady.	IO1
31	"Jeg tror ikke at Norge, lille Norge, selv med mange millioner tonn	"I don't think that Norway, little Norway, even with millions of tonnes	Pol4

	utslipp, har den store konsekvensen".	of emissions, has big consequences."	
32	"Det må være bedre å bruke olje som har reist relativt kort framfor olje som har reist halve kloden rundt. Det er en del av forklaringen på hvorfor vi driver med olje. Og igjen premisset for den norske debatten, for at vi skal holde på med olje og gass er a) vi skal tjene penger b) vi er dyktige på HMS og utslipp. Og det er vi nok blant de beste i verden på."	"It must be better to use oil that has traveled a relatively short distance compared to oil that has traveled half the globe. That is part of the explanation why we continue with oil. An again, the premise for the Norwegian debate and for us to be able to continue with O&G are a) we are making money and b), we are good at HMS and emissions. And we are probably among the best in the world on those two things".	IO1demand
33	(Om utfasing av norsk olje og gass produksjon) "Jeg mener også at det er tull at du i praksis overfører ressurser til diktaturer eller stater uten noe demokratisk styresett".	(On phasing out Norwegian production): "I also think it is silly to practically transfer resources to dictatorships or states without a democratic government".	CR
34	"Det er den Rystad-rapporten som kom nå, den gjør det. Jeg mener det er en helt feil konklusjon. Fordi de bruker mindre utslipp under produksjon som et argument for at norsk produksjon er bedre enn annen. Det kan du bruke for det som er eksisterende produksjon, men de bruker også argumentet med at det er klimavennlig å øke norsk produksjon av olje og gass som er en helt meningsløs påstand."	"The Rystad report does that [use electrification as an argument to increase production]. I think that is a wrong conclusion. Because you use less emissions in the production as an argument for why Norwegian production is better than others. You can use this argument for existing production, but to say that it is climate friendly to increase Norwegian production of O&G is pointless".	Pol2
35	"Resten av Europa er fortsatt avhengig av gass som oppvarming osv., slik at når deres fornybare kilder kommer mer opp å gå, vil det gi lavere etterspørsel etter gass."	"The rest of Europe still depends on O&G for heating etc., so when their renewable sources are more up and running, it will lead to a decreased demand for gas".	Pol2
36	"Hvis etterspørsel etter olje inn i plastprodukter blir betydelig lavere vil også etterspørselen etter olje bli lavere."	"If the demand of oil in plastic products is considerably reduced, the demand after oil will decrease as well".	Pol2
37	"Norge må diskutere ikke bare hvordan vi reduserer forbruket, men også produksjonen av olje og gass."	"Norway needs to discuss not just how to reduce the use, but also the production of O&G".	Pol2
38	"Vi følger IEA og gap-rapporten om at vi allerede har de ressursene vi kan hente opp (eller 50% mer). Også har du en sidediskusjon, ikke side, men behovet for mer hydrogen, eller blått hydrogen. Men da må politikken styres mot blått hydrogen."	"I follow the IEA-report that says that we already have exploited the resources we can or even 50% more. And then we have a side discussion, the need for more hydrogen, or blue hydrogen. But then the policies need to be twisted towards blue hydrogen"	Pol2
39	"Hvis fornuften rår, bør vi forlenge dette her [norsk olje og	"If we use common sense, we should extend this [Norwegian O&G	Pol5

	gassproduksjon]. Det vil være behov for olje og gass i lang tid. Selv i 1.5 gradersmålet som sagt, og det er meget mulig at det vil være lettere å få aksept også blant miljøpartiene for å videreføre olje og gass hvis det elektrifiseres."	production]. The need for O&G will exist for a long time coming. Even in the 1.5 degree target, and it is possible that it will be easier to get acceptance among the environmental parties to continue O&G production if we use electrification."	
40	"Ikke minst kan man selge oljen og gassen dyrere ved å si at den er grønn"	"Not to mention you can sell the O&G greener by saying that it is greener".	Pol5
41	"Så er det et element av at det er lettere å få gjennomslag for å bygge en installasjon dersom den ikke negativt påvirker Norges klimagassutslipp og ambisjoner. Så det er jo klart det ser jo bedre ut sånn sett" EO	"So it is an element that it is easier to get acceptance to build an installation if it does not negatively impact Norway's climate emissions and ambitions. So it is obvious that it looks better that way".	EO
42	"Viljen til å elektrifisere ferjene hadde nok ikke vært like sterk i dag som den var da. Faren er at vi havner bakpå fordi debatten blir så polarisert."	"The will to electrify ferries a couple of years ago, would probably not have been the same today with the current situation. The risk is that we will lay behind because the debate is so polarized".	Pol3

Appendix 4: Letter of Consent

Vil du delta i forskningsprosjektet:

'Potential consequences from the electrification of the petroleum industry in Norway'?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å **identifisere påvirkningskoalisjoner og deres syn på potensielle konsekvenser av elektrifisering av oljeindustrien i Norge.** I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg. Forskningsprosjektet er en del av en mastergrad.

Formål
Formålet med prosjektet er å identifisere konsekvenser av elektrifisering av oljesokkelen i Norge. Det vil bli gjort en litteraturanalyse samt intervjuer, der formålet er:
1. Å identifisere påvirkningskoalisjoner som vil påvirke i hvilken grad elektrifisering av norsk olje og gas-plattformer skal bli gjennomført
2. Effekten elektrifisering har på begrepet «carbon-lock in»
Intervjuene vil bli gjennomført for å identifisere koalisjoner samt konsekvenser sett fra ulike perspektiver.

Hvem er ansvarlig for forskningsprosjektet?
Norges miljø og biovitenskapelige universitet, NMBU, er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Du har fått spørsmål om å delta fordi du har en interesse innenfor elektrifiseringsdebatten. Vi ønsker å få frem flere ulike perspektiver og dermed få et bredt utvalg av interesser.

Hva innebærer det for deg å delta?
Du vil bli invitert til et personlig intervju, på ca. 30 minutter. Det vil være et semi-strukturert intervju, som kan gjennomføres digitalt eller på et avtalt møtested. Jeg tar lydopptak og notater fra intervjuet. Jeg vil be om noen opplysninger om deg, slik som arbeidsplass og stilling.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Stilling og arbeidsgiver vil bli publisert i oppgaven, og navnet ditt kan bli publisert i oppgaven etter avtale.

Hva skjer med personopplysningene dine når forskningsprosjektet avsluttes?

Prosjektet vil etter planen avsluttes 15.mai. Etter prosjektslutt vil datamaterialet med dine personopplysninger anonymiseres og lydopptak vil bli slettet.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra NMBU har Sikt – Kunnskapssektorens tjenesteleverandør vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Dine rettigheter

Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke opplysninger vi behandler om deg, og å få utlevert en kopi av opplysningene
- å få rettet opplysninger om deg som er feil eller misvisende
- å få slettet personopplysninger om deg
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger

Hvis du har spørsmål til studien, eller ønsker å vite mer om eller benytte deg av dine rettigheter, ta kontakt med:

- Masterstudent Synnøve Skjelle 9888 5755/ synnoeve.skjelle@nmbu.no
- Veileder ved NMBU Guri Bang: 67232660/ guri.bang@nmbu.no
- NMBU personvernombud Hanne Pernille Gulbrandsen: 402 81 555/ personvernombud@nmbu.no

Hvis du har spørsmål knyttet til vurderingen som er gjort av personverntjenestene fra Sikt, kan du ta kontakt via:

- Epost: personverntjenester@sikt.no eller telefon: 73 98 40 40.

Med vennlig hilsen

Guri Bang	*Synnøve Skjelle*
Prosjektansvarlig (Forsker/veileder)	Student

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *[sett inn tittel]*, og har fått anledning til å stille spørsmål. Jeg samtykker til:

- ¨ å delta i personlig intervju
- ¨ at opplysninger om meg publiseres slik at jeg kan gjenkjennes, slik som stilling og arbeidsgiver

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

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(Signert av prosjektdeltaker, dato)

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