Are Small Modular Nuclear Reactors Necessary for Realizing Norway's Ambitions in Reaching Its Climate Goals by 2050? - A Qualitative Study

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October 1, 2023

MASTERTHESIS

SEMESTER:

Autumn 2023

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Are Small Modular Nuclear Reactors Necessary for Realizing Norway's Ambitions in Reaching Its Climate Goals by 2050? - A Qualitative Study

Keywords:

Nuclear power, energy, Small modular reactors, Rogaland and Vestfold og Telemark counties, SMR, environment, sustainability

Pages:

91 Pages

STAVANGER 01.10.23

Abstract

Today, the world is witnessing many environmental challenges related to global warming, pollution resulting from carbon emissions, etc., which force many countries to change their consumer and economic policies, especially energy production policies. To face these challenges, most first-world countries, including Norway, have made many pledges and developed many plans in order to reach the desired environmental goals. Here SMR (Small Modular Reactor) technology appears as a promising and sustainable solution derived from nuclear energy technology that is considered one of the proven and well-known solutions for producing clean energy but simultaneously capable of resolving issues related to nuclear energy such as safety and waste management. Anyway, this technology still suffers from rejection at the global level and in Norway, mainly due to the questionable stereotype associated with nuclear energy technology, and the future of SMR depends on the amount of political and societal support to overcome these obstacles. Therefore, this thesis provides an in-depth study of the future of SMR by clarifying the global trend and the stresses it applies to the Norwegian energy system and analyzes the position of the socio-technical system with regard to integrating this technology into the energy mix based on the classic qualitative research method and guided by The Multi-Level Perspective (MLP) framework.

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List of Abbreviations

CCS	Carbon Capture Storage
CO_2	Carbon Dioxide
EU	European Union
GHG	Greenhouse Gases
GDP	Gross Domestic Product
IFE	Institute for Energy Technology
MLP	Multi-level Perspective
NGOs	Non-Governmental Organizations
NSD	Norwegian Centre for Research Data
SDGs	Sustainable Development Goals
SMRs	Small modular reactors
UN	United Nations

1. Introduction and background:

Nowadays, the global energy landscape is witnessing major transformations as a result of environmental challenges that are getting worse day by day therefore the countries around the world are striving to meet their energy needs in clean and more sustainable ways in order to contribute to confronting environmental challenges. In this context, nuclear energy appears as one of the most controversial technical solutions for energy production, with conflicting opinions about it, where the first opinion praises its ability to generate large amounts of electricity and reduce greenhouse gas emissions and introduces it as a promising technology to so solve the energy challenges that can provide a reliable, low-carbon source of energy and can contribute in provide to a stable clean energy source and reduce the consequences of the climate change. On the other hand, there are those who believe that nuclear energy technology should be subject to considerable scrutiny and criticism due to concerns related to safety and environmental issues, primarily those technical problems related to the disposal of nuclear waste and potentially catastrophic accidents.(Chu & Majumdar, 2012)

Norway has long been recognized as a world leader in renewable energy as a result of its hydropower resources.(Government.no, 2016) However, the demand for energy is increasing day by day and is causing an increase in the need for stable and consistent energy supplies, which has led to increased discussions on diversifying the energy mix and considering alternative sources such as nuclear energy and re-evaluating its role in achieving sustainable and safe energy which can help in fulfilling Norway's pledges in general, and pledges Rogaland, Vestfold and Telemark counties particularly. (Lende, 2023)

However, the exploration of Rogaland and Vestfold og Telemark counties' potential possibilities of integration of nuclear power in the energy mix represents a complex interplay of multiple factors that including technical feasibility, political considerations, public opinion, and economic viability. Therefor, the exploration of attitudes towards nuclear power in the context of assessing the support or opposition for the nuclear technology integration into the Norwegian energy mix encompasses evaluating the underlying values, beliefs, and perceptions and how they can drive the

actors' attitudes toward engaging in an informed-dialogue among them as stakeholders in order to facilitating a well-rounded understanding of the implications of adopting nuclear power in Rogaland and Vestfold og Telemark counties.

1.1. Research Objectives

The research objectives of this study are to provide a comprehensive understanding of attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties in Norway by employing a qualitative research approach to deeply explore the perspectives and underlying factors that shape these attitudes.

One key objective is to examine the perceptions and beliefs of the stakeholders regarding nuclear power in Rogaland and Vestfold og Telemark counties to understand the various perspectives held by various stakeholders, where this study aims to uncover the factors that influence their attitudes towards integrating the nuclear power in the Norwegian energy mixture. These stakeholders sample includes the local political parties, national political parties, scientific communities, NGOs and civil societal groups, economic actors, and the energy sector bureaucracy by exploring the beliefs and perceptions of these stakeholders, the study aims to uncover the factors that influence their attitudes towards nuclear power.

Another key objective that needs to be analysed is the socio-political dynamics and decision-making processes related to nuclear power in Rogaland and Vestfold og Telemark counties. Therefore, this study seeks to highlight on the socio-political factors that influence the attitudes toward nuclear energy whether supportive or rejective in order to understand the interactions among stakeholders, the role of local and national political parties, and the influence of scientific communities and civil societal groups in shaping the discourse and decision-making processes surrounding nuclear power.

Furthermore, this study aims to investigate the stakeholders' economic considerations and implications associated with nuclear power in Rogaland and Vestfold og Telemark counties in order to recognise the importance of the economic factors in energy decision-making processes. Also, it seeks to understand the different perspectives of economic actors such as businesses and industry representatives

regarding the role of nuclear power in the counties' energy mix and its impact on the local economy. Moreover, this study explores the views of scientific communities and technical experts in Rogaland and Vestfold og Telemark counties regarding the potential risks and benefits associated with nuclear power.

Based on all the above, these research objectives amie give the opportunity to understand the attitudes towards nuclear energy in Rogaland and Vestfold og Telemark counties by considering the perspectives and dynamics within the political, civil societal, scientific, and economic spheres in order to provide valuable understanding for the complexity of decision-making processes that are related to the counties' energy future towards nuclear energy.

To understand local attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties, the following research questions have been designed to guide the study's investigation to achieve the research objectives and do a comprehensive assessment of the acceptance level towards nuclear power in this specific region with its unique characteristics in a way that can help the policy-makers and stakeholders to make informed decisions and develop appropriate strategies for more sustainable energy planning by understanding the factors influencing these attitudes.

What are the political perspectives and stances on nuclear power in Rogaland and Vestfold og Telemark counties?

How does the civil societal sector in Rogaland and Vestfold og Telemark counties perceive and engage with nuclear power?

What is the scientific community's stance on nuclear power in Rogaland and Vestfold og Telemark counties?

What are the economic considerations and implications of nuclear power in Rogaland and Vestfold og Telemark counties_

1.2. Significance of the Study

The significance of this study lies in its contribution to the existing body of knowledge on attitudes towards nuclear power in the context of Rogaland and

Vestfold og Telemark counties by examining the perspectives and dynamics within the political, civil societal, scientific, and economic spheres, this study provides valuable insights that can inform energy policy decisions, public discourse, and future research in the field. However, it is also likely that the findings here are representative of Norway which has had a long-term policy against nuclear power, etc…

Furthermore, understanding the attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties is important for policymakers and energy planners, where they seek to fulfil the current energy demand while transitioning towards a more sustainable and low-carbon future, thus, nuclear power can be considered as a potential energy source. Therefore, exploring the beliefs and perceptions of the stakeholders can provide a comprehensive understanding of the factors that guide the policymakers in developing effective energy policies, considering stakeholder perspectives, and fostering public acceptance.

Moreover, this study aims to achieve a broader academic understanding of the social acceptance of nuclear energy technologies by examining the socio-political dynamics and decision-making processes surrounding nuclear power in Rogaland and Vestfold og Telemark to understand the complex interaction between the different stakeholders and public opinions, where the findings can enhance our understanding of the social, cultural, and institutional factors that influence the adoption or rejection of nuclear power in a specific regional context. Therefore, broader theoretical frameworks such as the Multi-Level Perspective are needed for providing empirical evidence and insights into the application of these frameworks in the context of energy transitions.

Furthermore, this study's exploration of the economic considerations and implications of nuclear power in Rogaland and Vestfold og Telemark counties contribute to the understanding of the economic dimensions of energy decision-making where examining the perspectives of economic actors can provides insights into the economic feasibility, and the impact and the potential role of nuclear power in achieving energy security, economic growth, and sustainable development.

Lastly, the examination of the scientific and technical perspectives on nuclear power contributes to the broader understanding of the stakeholders' different points of view toward the risks and benefits associated with this energy source, where this study considers the different views of scientific communities and technical experts in Rogaland and Vestfold og Telemark counties that can inform public debates and decision-making processes.

1.3. Scope and Limitations of the Study

The scope of this study is focused on exploring attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties in Norway, within the political, civil societal, scientific, and economic spheres where this study aims to provide a comprehensive understanding of the factors that shape the acceptance or resistance towards nuclear power by examining the perspectives of key stakeholders, including local and national political parties, scientific communities, NGOs and civil societal groups, economic actors, and the energy sector bureaucracy.

In terms of geographical scope, the study concentrates on Rogaland and Vestfold og Telemark counties with acknowledging that attitudes towards nuclear power can vary across different regions due to distinct socio-cultural, economic, and political contexts. However, the study had limited to Rogaland and Vestfold og Telemark counties for the empirical context based on its specific characteristics, energy needs, and economic development goals , in addition to the counties unique position as an important energy hub that increases its aspirations for sustainable development which make it an interesting study case for understanding the dynamics surrounding nuclear power.

However, it is important to acknowledge the limitations of this study as it relies primarily on qualitative data collected through interviews that can offer in-depth insights and allow for a nuanced exploration of attitudes, but the study's findings may not be generalizable to the entire population of Rogaland county as a result for the sample size limitations where their perspectives may not fully represent the diverse range of opinions within Rogaland and Vestfold og Telemark counties. Furthermore, the study focuses on the identified niches within the political, civil

societal, scientific, and economic spheres, but there may be other influential stakeholders or factors that are not extensively examined in this study which can influence the niches identification.

Moreover, this study acknowledges that attitudes towards nuclear power are dynamic and can evolve over time, where the data collected and analyzed in this study reflect a specific point in time and may not capture potential changes in attitudes or new developments that may have occurred since then, conversely of the longitudinal studies that can provide a more comprehensive understanding of evolving views.

Lastly, the study's findings are subject to potential biases, including researcher subjectivity and participant response biases, although a lot of efforts are made to mitigate these biases through rigorous data analysis techniques, cross-referencing with multiple data sources to maintaining transparency and reflexivity throughout the research process, as discussed in the 2nd Chapter under ’Strengths and Weaknesses.’ .It still important to recognize that biases may still exist and can influence the interpretation of the findings.

Despite these limitations, this study provides valuable insights into attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties and contributes to the existing body of knowledge on energy transitions, stakeholder dynamics, and the social acceptance of energy technologies, which can contribute by its findings in providing the policymakers, energy planners, and researchers by a better understanding to the energy context, sustainable energy strategies for increase the engage stakeholders and promote informed decision-making processes in the pursuit of a clean and secure energy future for those counties and beyond.

2. Methodology

This chapter discusses the study methodology that was chosen to be used in this thesis, the extent of its alignment with the research objectives and the rationality of its use. Moreover, it explains the study method that was used, and how it was designed, implemented and executed.

2.1. The Multi-Level Perspective (MLP) Frameworks:

The Multi-Level Perspective (MLP) is a theoretical framework that has gained prominence in the field of sustainability and technological transitions ((Geels, 2005; Smith et al., 2005; Williams et al., 2005). It offers a comprehensive understanding of socio-technical systems and their dynamics by considering the interactions between different levels of analysis, including niches, regimes, and landscapes (Geels, 2005). Niches represent spaces where innovative technologies and practices emerge, regimes represent the dominant socio-technical systems and institutions, and landscapes encompass the broader socio-economic and political contexts in which transitions occur (Geels, 2005; Smith et al., 2005; Williams et al., 2005)by examining the interplay between these levels, the MLP provides insights into the processes and factors that shape technological transitions and sustainability transformations.

Moreover, applying the MLP framework in this research context holds significant value for several reasons where it offers a holistic and multi-level perspective that goes beyond a reductionist understanding of technological transitions (Geels, 2005)by considering the interactions and dynamics between niches, regimes, and landscapes which allows for a comprehensive examination of the complex socio-technical systems and the factors that drive or hinder sustainable transitions(Smith et al., 2005).

Furthermore, applying the MLP framework allows for the identification of key barriers, drivers, and mechanisms that affect the adoption and diffusion of sustainable technologies for providing policymakers and practitioners with the needed information to make informed decisions regarding sustainable technologies(Smith et al., 2005), where the MLP contributes to a more nuanced understanding of the

complexities inherent in sustainable development processes by recognizing the socio-economic and political dimensions of technological transitions.

Based on all above , the research objectives align with the MLP framework by incorporating multiple levels of analysis to understand attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties such as the political, civil societal, scientific, and economic spheres that represent the different levels within the MLP framework, allowing for a comprehensive examination of the factors influencing the adoption or rejection of nuclear power.

Moreover, applying the MLP framework to examine attitudes towards nuclear power in Rogaland and Vestfold og Telemark counties provides a comprehensive and systematic approach to understanding the complexities of this issue by considering the political, civil societal, scientific, and economic spheres in order to capture the different perspectives and interests which influence the shaping process of attitudes towards nuclear power. Furthermore, the MLP framework allows for an analysis of the interactions and dynamics between these spheres and highlights the broader socio-technical regime in which decisions related to nuclear power are made, which gives a deeper understanding of the complex dynamics surrounding nuclear power and how various stakeholders in different spheres interact and shape attitudes towards this energy source. Furthermore, applying the MLP framework in this research provides a better understanding of the barriers, drivers, and potential pathways for the adoption or rejection of nuclear power in the study's geography space.

The working mechanism of MLP framework use 3 level which are Niches, Regimes and Landscapes for understanding of technological transitions and sustainability transformations, where it examines the interactions between niches, regimes, and landscapes while considering the social, economic and political dimensions in order to highlight the dynamics that influencing the adoption and diffusion of sustainable technologies in the animus to contribute to the advancement of sustainable development goals, As explained in more detail below.

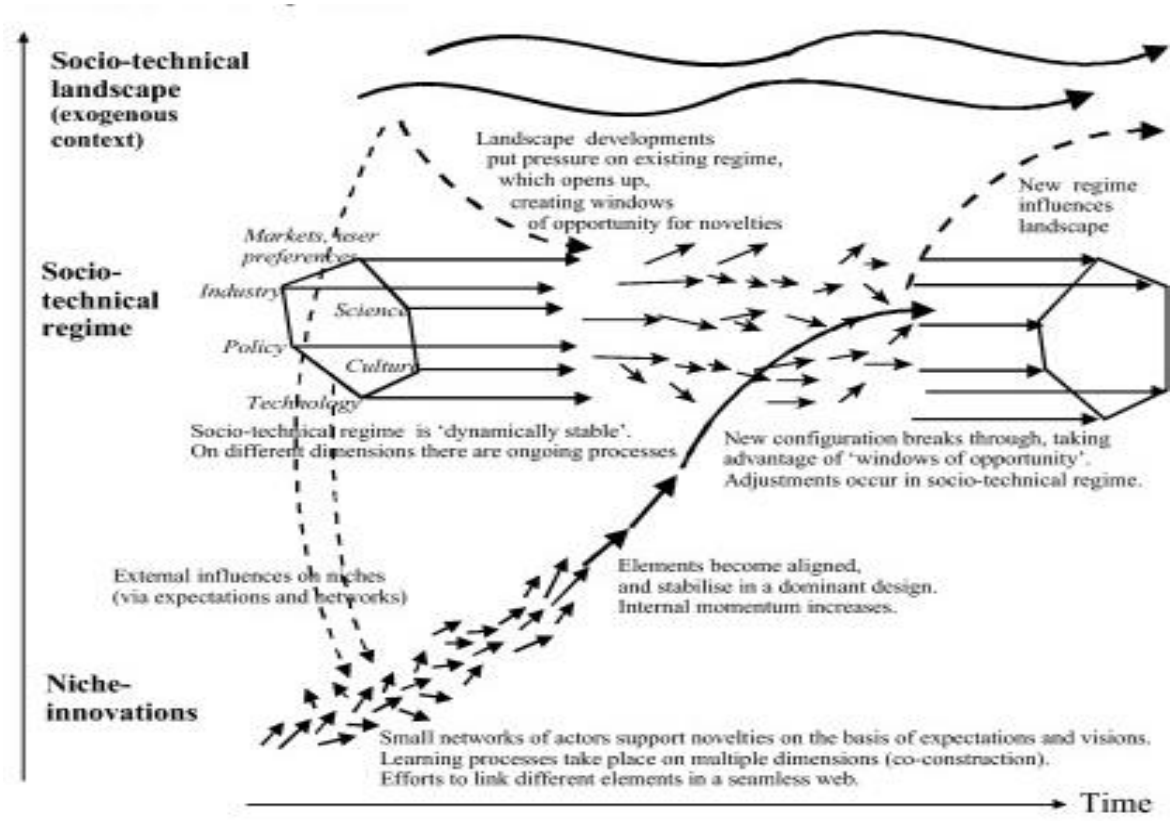

Figure 1- A Dynamic Multi-level perspective on System Innovations / Source: Adapted from Geels (2004), by (Genus & Coles, 2008, p. 1438)

2.1.1. Niches, regimes, and landscapes

The MLP framework emphasizes the importance of understanding the interplay between niches, regimes, and landscapes in shaping technological transitions ((Geels, 2010; Penner et al., 2005). Niches refer to spaces where innovative technologies, practices, or business models emerge and develop.(Geels, 2010)These niches often represent alternative and sustainable approaches that challenge the dominant regime. Regimes, on the other hand, represent the dominant socio-technical systems and institutions that govern the existing practices and technologies (Jørgensen, 2012). They are characterized by established rules, norms, and power structures. Landscapes encompass the broader socio-economic, political, and cultural contexts in which transitions occur (Penner et al., 2005) They shape the opportunities and constraints for technological innovation and diffusion.

2.1.2. Technological transitions and socio-technical systems

The MLP framework recognizes that technological transitions involve shifts in socio-technical systems, which encompass the interconnected elements of technology, infrastructure, user practices, markets, regulations, and cultural norms (Geels, 2010) where transitions occur when new technologies and practices gain momentum and challenge the existing regime, leading to system-wide changes. This perspective frames a rule that technological change doesn't occur according to the performance or characteristics change of the technology itself, but also through the social and institutional dynamics surrounding its adoption and diffusion.

2.1.3. Multi-level interactions and dynamics

The MLP framework highlights the importance of understanding the interactions and dynamics between different levels of analysis (Geels, 2010), where it recognizes that transitions are influenced by processes occurring within niches, as well as interactions between niches and the wider regime and landscape which can include a interaction that can involve tensions, conflicts, or alignment between various actors, institutions, and socio-technical configurations. Here the benefits of using multi-level dynamics showed up where it helps to understand and identify the barriers, drivers, and mechanisms that shape the emergence, diffusion, and stabilization of sustainable technologies (Penner et al., 2005).

In summary, the MLP framework provides a conceptual basis for understanding technological transitions and sustainability transformations where it examines the dynamics between niches, regimes, and landscapes, and by considering the multi-level interactions and socio-technical systems, this framework offers valuable insights into the complexities of adopting and diffusing sustainable technologies.(Jørgensen, 2012)

2.2. In-depth interview method:

The method used in the thesis relies on interviews for collecting data and critical discourse analysis as the analysis method, the interviews had covered a

diverse spectrum of stakeholders in Norway. In the following table, there is an overview of the category to which the participants belong, their amount and their geographical location.

Interviews are a qualitative research method aimed at verifying the sample's answers to questions that require recall of human experiences and expertise (Seidman, 2006) and that is what makes it suitable for this research, which wants to know the perceptions of stakeholders, society, and the scientific elite about the future of inclusion of SMR and the extent of its acceptance.

No.	Category	Number of participants	Number of participants who have influence over the same geographical location			The Percentage
			Norway	Rogaland	Telemark og Vestfold	
1	Representatives of the Prime Minister's office	1	1	0	0	3.8%
2	Parliament representatives	2		1	1	7.7%
3	Municipal representatives	2		2	0	7.7%
4	Right-wing parties	4		3	1	15.4%
5	Center parties	4		4	0	15.4%
6	Left-wing parties	3		1	2	11.5%
7	Scientific Community	2		2	0	7.7%
8	Industry representatives	4		1	3	15.4%
9	Civil and environment organizations.	4		3	1	15.4%
The total		26	1	17	8	100%
The Percentage		100%	3.8%	65.4%	34.6%	

Table 1- The distribution of the research sample

The semi-structured interviews have been chosen as it is the most effective way to collect the data where a group of questions has been designed to be used for a pre-chosen sample from pre-chosen categories, and those open-ended questions will be used to control the dialogue with interviewee while leaving the door open for any extra information or interacting with interviewees to absorb their own expertise and perspective around the research objectives.(DiCicco-Bloom & Crabtree, 2006)

The interviews were prepared according to the guidelines provided by the University of Stavanger and the advice provided by the thesis supervisor from NTNU University, in addition to using "A Guide for Designing and Conducting In-Depth Interviews for Evaluation Input'' (Boyce & Neale, 2006) as the framework for the interview process and a guideline for the steps that have been used in executing the interviews which is listed below.

2.2.1. 1st Step: Interview preparation:

Firstly, Stakeholders related to the research topic had been categorized and the geographical areas to be researched were identified, in addition to preparing a list of positions and professional descriptions of the people who wanted to be part of the sample, and one to one interview method had been chosen .

After that, a search was made for people who belong to the previously mentioned characteristics, and they had divided equally between different geographical regions and different categories. Then, a list of the potential participants was made that includes their contact information.

After that, an information letter was prepared and sent to the Norwegian Centre for Research Data (NSD) that included information about the research, its purposes and objectives, the rights of the participants, and the consequences of volunteering in the project etc, and had been sent to the participants after gotten the approval form the NSD.

Furthermore, an email was sent to the participants containing information about the research topic and objectives and what the interview

questions would be like. However, mentioning the exact context of the questions that will be asked in the interview was avoided and only an overview of the interview's major headlines was given to give the participants enough information for prepare themselves and at the same time to avoid any bias in the interviews.

So, after receiving all the responses, interviews were scheduled with those who agreed to participate in the project and started a new search for alternatives for those who refused to participate.

2.2.2. 2nd Step, In the interviews

After discussion with the participants, the method of communication in the interview was determined, whether physical meeting or via online video, according to the participants' preferences.

The interview began with an introduction to the participant, her scientific background, and her current studies. Moreover, the participants were also asked to give permission to record the conversation for research purposes.

After the participants allowed the interview to be recorded, the interview began by asking the participants to introduce themselves and their experiences. Moreover, an exchange some friendly conversation between the interviewer and participants had been done to remove any kind of discomfort on the part of the participants and make the dialogue during the interview take a smooth turn.

After that, the interview began asking questions, discussing the participants' responses, and giving them the opportunity to add and elaborate, while adhering to the interview topics as much as possible, in addition to trying to adjust the time interview duration to between 15 to 30 minutes to ensure obtaining sufficient information and at the same time avoid complicating the process of analyzing the interviews.

2.2.3. 3rd Step : After the interview (data processing):

After completing the interviews, the recording of the interviews was stored in password-protected files and sorted according to the geographic region and the category of stakeholders to which it belonged. After that, each interview was listened to several times in order to convert it into corresponding readable texts, and each text was stored next to the recorder to which it belonged in order to preparing these files for the analysis process.

2.3. Strengths and Weaknesses.

There are many advantages to using the Multi-Level Perspective framework where it provides a comprehensive understanding of socio-technical systems and their dynamics and a systematic approach to understanding the complexities of the issue that the research studies form different aspects like the political, civil societal, and scientific on the methodology different levels. ((Geels, 2005; Smith et al., 2005; Williams et al., 2005)

On the other hand, there are some reservations and criticisms about using the Multi-Level Perspective methodology where opponents argue that it is biased about the direction of change from the bottom to the top, as its results tend to consider that changes begin from the level of niches through the regimes to the landscapes. Moreover, they argue that the landscape is a level that carries with it all the remaining contexts that do not belong to the other levels, which makes it an indefinite level and a kind of concept of a garbage can, in addition to other criticisms like the lack of agency and flat ontologies versus hierarchical levels.(Geels, 2011)

Furthermore , the in-depth interview method that used in this research creates many advantage where it provides a more friendly and relaxed atmosphere with the participants, which allows for the extraction of a greater amount of information compared to other methods. Moreover, It allows the interviewer to clarify some answers more and confirm the intentions of the participants, thus eliminating any possibility of distorting the information by Misunderstanding. (Boyce & Neale, 2006)

On the other hand, this method may be accompanied by some disadvantages, as it is a symptom of the participants' bias in their answers in order to confirm the point of view that agrees with their interests or the parties to which they belong. Furthermore, this method requires more research resources compared to other methods, as it takes longer to find the required participants and the dates that suit them, in addition to the time needed to conduct the interviews, write them down, and process and analyze the data that are collected through them.(Boyce & Neale, 2006)

Finally, it is worth pointing out that there was an unintentional bias in the distribution of the test sample used in the interviews where some participants apologized for participating in the late stages, which made it difficult to find a replacement for them. These unexpected withdrawals from participation resulted a heterogeneous distribution in the sample where the percentage of the sample belonging to the Telemark og Vestfold county was about 35%, while the percentage of the sample from the Rogaland county was 65%. Furthermore, there are some stakeholder's categories that were not represented in the Telemark og Vestfold county sample as there was no representative of the municipality, the center parties and the scientific community. This variation in the sample may lead to weakening the generalizability of the results to the Telemark og Vestfold country.

3. Brief Overview of the Current Status of Nuclear Power

According to Ho et al. (2019), in 2017, there were 454 nuclear power plants in 31 countries, providing over a tenth of the world's usable electricity. Despite its haunted past, nuclear power offers a clean energy source with zero emissions, unaffected by weather or time of day, and boasts reliability unmatched by other low-carbon technologies.(Ho et al., 2019) However, the development of traditional nuclear power plants requires substantial investments in infrastructure, time, and human resources, In addition, site selection poses challenges due to public concerns about proximity and safety, while increased distances from population centers result in higher costs and grid maintenance difficulties.(Agency, 2015)

The process of nuclear power production is also misunderstood by many, which contributes to public apprehension about its safety and waste management (Alvarez et al., 2003). In reality, nuclear power plants produce less waste than many modern manufacturing plants, with proper disposal methods in place to encase toxic waste in concrete and protect against contamination (Alvarez et al., 2003). Furthermore, the economic viability of nuclear energy improves as new technologies and processes emerge, and safety features and policies continue to be implemented.(Boarin et al., 2011; Locatelli et al., 2014)

While nuclear energy alone cannot meet all human energy needs, its market share is set to grow alongside other clean energy sources as we learn and implement more.(Boarin et al., 2011; Locatelli et al., 2014)

Given the pressing need to counteract the environmental damage caused by human activities, nuclear power can play a significant role in achieving sustainable energy goals (Zhan et al., 2021). While no perfect solution exists, nuclear reactors can be part of a comprehensive plan that includes various clean energy sources like wind, solar, hydro (Zhan et al., 2021).

3.1. Small Modular Reactors: An Overview

The Small Modular Reactors (SMRs) are the latest and most advanced form of nuclear power generation and offer more advantages over traditional nuclear plants,

where it designed to provide up to several hundred MWe, but they can also generate loads as little as 20 MWe when required thus showing significant potential in relation to grid integration(Nguyen et al., 2019). SMRs are intended to be used as multiple units with many locations hosting two to four, eight to ten, or whatever number of reactors might be necessary to meet the power demands associated with a particular location and grid capacity (Nguyen et al., 2019). The concept of SMRs dates back to the 1950s, but it was not until the 21st century that the technology necessary for implementation began to gain momentum. The benefits of SMRs include improved safety performance, smaller unit size, and greater levels of customized fit in relation to existing power grid demands. SMRs are quicker and less expensive to set up than traditional nuclear plants, making them an attractive option for many countries (Nguyen et al., 2019).

In a world increasingly focused on climate change and greenhouse gas emissions, nuclear power has seen a resurgence of interest as one of the cleanest sources of energy to sustain our continued progress and growth as a species as many experts claim even while taking into consideration the shadow of nuclear disasters past like the Chornobyl and Three-Mile Island meltdowns (Uddin, 2019). Although safety concerns remain significant, modular technology allows for standardization across multiple reactors which helps to eliminate iterations of trial-and-error processes involved in building, setting up, and bringing online an enormous and complex machine. Moreover, standardization enables SMRs to achieve economies of scale, which makes them more cost-effective than traditional nuclear plants.

With the above in mind, one of the most significant advantages of SMRs is their improved safety performance, where unlike large-scale nuclear plants, SMRs use features which eliminate the risk of coolant failure and other types of system failures that can lead to reactor meltdowns. One of those features is using passive cooling mechanisms that rely on natural forces such as gravity, convection, and radiation to remove heat from the reactor, which makes it less prone to failure. Another feature is the ability to locate the SMRs underground or in reinforced structures, which provides an additional layer of protection against external threats

such as natural disasters or terrorist attacks. Moreover, SMRs have smaller-size reactors, which allows for more flexibility in siting and integration into the existing power grid and gives the possibility to place them near the end-users which reduces transmission and distribution losses and ensures a more reliable power supply. Moreover, SMRs can be used to provide power to remote and off-grid communities, which is a significant advantage in developing countries where electricity access is still a challenge (Pilat, 2019).

However, some criticisms of SMRs remain, where according to Sainati while focusing on the scale in the dissection of SMRs as investment tools, SMRs lose many of the benefits of the megaprojects according to the trading economics scale for economies of multiples. Moreover, SMRs are more subject to the pitfalls of licensing processes as the smaller and more widespread nature of their operation necessitates far more bureaucratic paperwork and red tape regardless that both SMRs and classic reactors are functioning in a similar fashion overall.(Sainati et al., 2015)

These additional risks can be somewhat defrayed by locating many SMRs with other industrial plants, allowing for a combined EPZ (Emergency Planning Zone) and a smaller geographical footprint for the reactors, a pair of crucial aspects to consider for the potential profitability of an investment in this technology (Sainati et al., 2015).

Similarly, Sovacool & Ramana argue that much of the rhetoric surrounding SMR deployment is imbued with elements of fantasy, falling into five distinct visions: one of risk-free energy, which would eliminate catastrophic accidents such as nuclear meltdowns; one of indigenous self-energization, which would see the widespread use of SMRs in geographically disparate areas, empowering remote communities specifically within developing economies; one of water security, wherein SMR desalination provides fresh, clean water all around the world; one of environmental nirvana, wherein SMRs are the leading provider of electricity in a waste-free, carbonless manner; and one of space exploration, wherein SMRs are setup off-planet to assist in colonizing the moon, Mars, and possibly beyond. They point out that much of this rhetoric is exaggerated at least slightly and designed to play up the potential benefits while glossing over the real risks from which nuclear power, in

any form, can never be fully extricated. They argue that safe nuclear power is an unattainable promise and renewable energy is the only way to proceed, meaning we need to increase the viability of our cleanest options (Sovacool & Ramana, 2015).

In general, SMRs represent a promising and innovative approach to nuclear power generation where it has several advantages over traditional nuclear plants which include improved safety performance, smaller unit size, and greater flexibility in relation to existing power grid demands. SMRs offer a clean and reliable source of energy that can help meet the growing demand for electricity in a world that is more focused on climate change and greenhouse gas emissions. Moreover, the standardization of SMR technology has enabled the elimination of trial-and-error processes involved in building, setting up, and bringing online an enormous and complex machine, which can solve some of the significant safety concerns regarding nuclear technology (Lloyd, 2020).

3.1.1. Existing Patterns of SMR Use

There are significant global developments are ongoing in relation to SMRs as a result of the promise of SMR technology that the cases below demonstrate its significant potential in a way that can be used to understand the opportunities of using SMRs in providing Norway with some of the energy that it is currently lacking.

3.1.1.1. SMRs in Canada

Canada released the Federal SMR Roadmap in 2018 and the SMR Action Plan in 2020, emphasizing that successful SMR deployment would bring with it many advantages such as lower investment costs, finer control over power grids, and ease of redundancy to ensure power flows continuously within the areas covered by multiple small reactors as opposed to a single, monolithic power source. As early as 2020, 15% of Canadian energy was created by four nuclear power stations, ranking

second only to hydroelectric in terms of total power production. As the world's leader in promoting SMR development, Canada expects to have their first small reactor online in 2028, at the site of the existing Darlington Nuclear Power Plant. There are 10 vendors proceeding through the review process to become SMR providers as the country continues to spool up production. Already the leader in the associated technology, Canada is on the path to become the world leader in the production of energy from SMRs. As Canadian energy production evolves and more of their power needs are supplied by renewable sources such as nuclear, western reliance and demand for middle eastern oil imports will experience a sharp down-turn and shift the balance of economic power.(Murakami & Anbumozhi, 2022)

3.1.1.2. SMRs in China

Beyond the technological necessities and into the real world, China has not only developed light water reactors but also implemented them into their grid and begun to export this new technology to places such as Pakistan and South Korea. China plans a massive expansion to the construction of reactors and entering the nuclear reactor market. As a cornerstone in their plan to become the leading power in the world, nuclear energy provides a way to escape dependency on foreign fossil fuels and fosters the kind of self-reliance the regime promotes within the people as well as reducing costs and increasing the amount of control that can be exercised upon the larger populace and increase the power of the Chinese Communist Party within the larger framework of global politics (Ramana et al., 2013). As an economic and military superpower, China is uniquely positioned among those countries who have already fully adopted SMR technology and are already producing energy therefrom, putting

> them in a position strongly ahead of many of the competing nations atop the global power rankings, and increasing their ability to continue to grow at an accelerating pace and giving them a strong base upon which to strive for the position of the world's leading superpower. With China forecast to increase SMR production as a share of total nuclear production by 19% over the next eight years, it is showing an ambitious growth trajectory for these reactor types.(Ho et al., 2019)

3.1.2. The Political and Technological Challenges of SMRs

Even though SMRs may have significant potential for Norway, Crawford & Akins (2011) present an overview of the challenges facing the development of SMR technology domestically, such as the necessary expansion of industrial capacity, promoting the growth of the workforce, resolving issues with licensing, and securing financing to ensure American competitiveness in the global marketplace. They also show why the US and the nuclear industry should respond to these challenges, creating thousands of jobs and ensuring a leadership position in the energy sector for decades to come, shaping the future political and environmental debates and forming recommendations that will help SMR technology grow throughout the world, increasing the viability of the SMR supply chain industry and investing heavily in both the demand for, and the infrastructure to provide, a growing percentage of nuclear options for energy production around the globe.(Crawford & Akins, 2011)

However, these bold moves are not without their counterarguments-chiefly, a national requirement that locally made components or services conducted by domestic providers have to be used in energy infrastructure, a licensing requirement of proven technology, and a requirement that reactors must be land-based. Moreover, the success of the investment in solar technology has driven energy costs for solar systems below that at which SMRs can compete. Therefore, the adoption of SMRs in the energy mixture needs the public to be won over multiple times in many different areas where the public has, heretofore, shown strong opposition to nuclear power which makes SMRs an unlikely

candidate for serious progress in the near term. Despite SMRs show significant promise for the generation of sustainable energy in the present or near future, their political and technological realism remains in doubt .(Cogswell et al., 2017)

Finally, in illustrating some of the challenges associated with SMRs, Ramana & Mian (2014) assert that many proponents of SMR technology present them as the answer to problems as varied and disparate as catastrophic accidents, radioactive waste, the proliferation of nuclear weaponry, the continuous injection of greenhouse gasses and toxic chemicals into the atmosphere. They examine the basic features of several kinds of SMRs to show that no single design actually encompasses all of these solutions, instead picking and choosing among a bevy of options to focus on one or two challenges which tends to make other challenges more acute. They also point to a series of other factors such as the evolving cultural and political landscapes which contribute to widespread enthusiasm, as well as historical and technical reasons to question these promises- specifically, four unresolved problems: costs, safety, waste, and proliferation. In this post-Fukushima world, still dealing with the lingering effects of a global pandemic and lacking a permanent and safe repository for spent fuel and radioactive waste, the rapid decline in renewable energy costs contributes to making these unresolved problems significantly more cogent than some analysts would like to admit.(Ramana & Mian, 2014)

3.2. The Future Potential of Thorium

Norway has a long history of involvement in the nuclear industry and is well-equipped to explore the potential of thorium as an energy source regardless of its current position against the use of nuclear power in the country's energy mix, where it has the necessary infrastructure and expertise to develop thorium-based reactors as it is already a major producer of thorium oxide which is used in the manufacture of high-quality ceramics and glass.

However, the report identifies several challenges that must be addressed in order for thorium to become a viable source of energy where thorium has been used in experimental reactors in the past but commercial-scale reactors have not been developed yet which means there is a need for a significant investment in research

and development the develop a thorium-based fuel cycle. Furthermore, there is a need to address public concerns about nuclear energy, where many people still have reservations about nuclear energy due to safety concerns and the potential for nuclear accidents even against thorium which is a safer alternative to traditional nuclear fuels.(Committee, 2008)

Despite these challenges, the report stated that thorium has the potential to become an important source of sustainable energy in Norway where it recommends the government to invest in research and development regarding thorium-based reactors to address the technical and public acceptance challenges associated with this technology. Furthermore, the report suggests that Norway could benefit from international collaboration on thorium research and development where thorium could play a significant role in Norway's transition to a more sustainable energy future by exploring the potential advantages of thorium that make it a promising alternative to traditional nuclear fuels, and by solving the challenges that the facing the spread of SMRs technology. This necessary investment and research could lead Norway to become a leader in the development of thorium-based reactors and contribute to the global effort to reduce greenhouse gas emissions and combat climate change.(Committee, 2008)

4. The Context of Norway's Ambitious Climate Goals

At the baseline, Norway has set ambitious climate reduction goals in alignment with the Paris Agreement, which had been translated to the country's principal strategies have been associated with emissions reduction programs, green technology, and carbon capture and storage (CCS) projects. Norway has committed to reducing its greenhouse gas (GHG) emissions by at least 50% and towards 55% by 2030, compared to 1990 levels (Norwegian Ministry of Climate and Environment, 202 to achieve the goals of becoming a low-emission society by 2050 by reducing emissions by 90-95% from 1990 levels (Environment, 2019) reflecting Norway's dedication to maintaining its position as a global leader in environmental sustainability.

To achieve its climate reduction goals, Norway has adopted various sector-based strategies that focus on transportation, industry, and energy production, by taking the area of transportation as an example, Norway has been a forerunner in promoting electric vehicle (EV) adoption, where the government offers incentives such as tax exemptions, reduced tolls, and free public charging stations (Figenbaum & Kolbenstvedt, 2016) as Norway aims for all new passenger cars and light vans to be zero-emission vehicles.(Environment, 2021) Moreover, the industrial sector can also involved in those plans where Norway aims to significantly reduce industrial GHG emissions to line up with the EU Emissions Trading System (ETS) by providing financial support for green industrial transitions and investing in research and development for sustainable solutions .(Environment, 2021)

Furthermore, Norway is a global leader in shifting to energy production where hydropower used to produce around 88% of its electricity generation, with wind power contributing another 10 % of its energy mix .(energy, 2021) In keeping with that, Norway is focused on further expanding its renewable energy capacity, with a particular emphasis on offshore wind power.(Energy, 2023) Moreover, Norway has invested in research, development, and implementation of the technology related to carbon capture and storage (CCS)), where the "Longship," is a full-scale CCS flagship project initiative aimed at capturing CO2 emissions from industrial sources to storing them in geological formations beneath the North Sea .(Environment, 2021) This project, along with other CCS

technologies, will be essential in achieving Norway's long-term emissions reduction goals .(IEA, 2023)

In terms of international cooperation, Norway's climate goals extend beyond its borders where it actively participates in international efforts to combat climate change by financing global climate initiatives, supporting developing countries in their climate actions, and collaborating with international partners to promote sustainable development .(Environment, 2021) Writ-large, Norway's climate-related ambitions are some of the most significant in the world where it is attempting to achieve these goals by using renewable energy sources. However, Norway's current policies seem to be focused on clean non-nuclear resources only as discussed below, which raises a question about whether Norway's goals are realistic and attainable without the use of nuclear power or other alternatives.

4.1. The Challenges of Norway's Climate Goals Using Current Renewables

With these ambitious goals in mind, Norway faces several challenges in achieving its climate reduction targets. The country's reliance on oil and gas exports presents a significant barrier to decarbonization .(Iacobuta et al., 2018) Additionally, climate adaptation measures are needed to address the impacts of climate change on its ecosystems and infrastructure.(Agency, 2022) The primary obstacles to Norway's implementation of these plans include the country's reliance on oil and gas exports, balancing economic growth, and the limitations of current technologies as well as the economic impacts of its plans. Writ-large then, implementation faces a myriad of challenges that are interlocking in nature, and which reflect the complexity of the basic ecosystem in the first place .(Sydnes, 2019)

One of the most significant barriers to meeting Norway's emissions reduction targets is the country's reliance on oil and gas exports. The petroleum sector is a cornerstone of the Norwegian economy, accounting for around 14% of its GDP and 40% of its exports in 2019 .(Julie L. Hass et al., 2017) Reducing emissions from this sector is challenging due to the high demand for fossil fuels in the global market, the financial incentives for Norway to continue extracting and exporting oil and gas, and the power of the country's lobby. As a result, the Norwegian government has faced

criticism for its continued support of oil and gas exploration and production, which may undermine its climate commitments.(Colman, 2019) The challenge for Norway lies in reconciling its economic dependence on fossil fuels with its climate goals, necessitating a transition towards a more sustainable economic model .(Bang & Lahn, 2020)

Another challenge in meeting Norway's emissions reduction targets is balancing economic growth with climate action. While the country has made significant strides in promoting green technologies and renewable energy, the transition to a low-emission economy requires substantial investments and policy changes. For example, the transition to electric vehicles (EVs) has been successful in Norway, with the country having the highest number of EVs per capita worldwide .(Bjerkan et al., 2016) However, the broader economic implications of this transition, such as the impact on the automotive industry and job market, must be considered. Ensuring that the shift towards a low-emission economy does not negatively affect economic growth and social equity presents a complex challenge for Norway (Sydnes, 2019). (Sydnes, 2019)

Emblemsvåg (2023) illustrates the complex problems Norway faces in regard to energy generation, noting the difficulties inherent in trying to build up renewable energy production while at the same time closing down the emission-producing coal-firing plants. Looking at the problem from an economic perspective, it a shown that the current double-conversion plan is severely flawed in terms of potentially being unable not only to meet demand but also to provide enough jobs to the economy or tax revenue to the state, unless energy-dense sources such as nuclear are added as well .(Emblemsvåg, 2023)

While Norway has invested in research and development of green technologies, the limitations of current technologies pose challenges for meeting its emissions reduction goals. For instance, carbon capture and storage (CCS) is a critical component of Norway's climate strategy, but the technology is still in its early stages of development and has not yet been widely adopted .(IEA, 2023) Moreover, the expansion of renewable energy sources, such as offshore wind power, requires significant investments and advancements in energy storage and grid integration.

Overcoming these technological barriers will be crucial for Norway to achieve its emissions reduction targets .(Sydnes, 2019)

Blaker (2023) draws attention to a report released by Statnett, revealing that the expected energy requirements of Norway throughout the next 28 years had increased by over 30 TWh as compared to the same report two years ago. This is more than 10 to 15 times the output of Norway's largest wind farm, meaning that even the best-case scenario of current infrastructure will be woefully inadequate and leading to a requirement of floating offshore wind power generation- a technology which, as of today, is little more than an idea, and which would be so much more expensive that energy prices would have to nearly double historical averages in order for it to become profitable. SMR technology provides an option that is 45% less expensive to run than offshore wind farms, requires no reconfiguration of existing grids and offers predictable, and partially adjustable, power supply independent of wind or sun. Regardless, Statnett remains firm that nuclear power is not an option in the near future.(Blaker, 2023)

Ultimately then, there is a very clear indication that, without the use of nuclear power or another more effective renewable energy source, Norway will not be able to achieve its ambitious carbon emission reduction goals where Norway's focus on hydropower and wind power is insufficient for meeting the ambitious climate goals discussed above which brings a situation in which it must make use of alternative non-carbon-based energy sources if it is to meet these goals that includes nuclear power representing the only tested structure by which such energy can be produced and distributed in a reliable manner, it very much appears that a significant consideration of nuclear energy will be necessary unless the production and storage capabilities associated with hydropower and wind power grow significantly in the short to medium term .(Sydnes, 2019)

4.2. The Ongoing Norwegian Debate Regarding Nuclear Power

With the above in mind, the Norwegian political sphere has been subjected to ongoing debate regarding the adoption of nuclear power and the discussion has gained prominence in the country due to the diverse perspectives across the political spectrum,

local officials, and civil society and lobbying groups.(Digges, 2019) The complexity of the issue makes it multifaceted where there are various opinions on the potential role of nuclear power in Norway's energy mix especially while taking into consideration the facts that Norway does not have any commercial nuclear power production, and the country's national policy does not support any using for the nuclear energy for the electricity production. (Lydersen, 2023)

Despite the country's official stance, the fact that the issue of nuclear power remains unsettled in Norway regardless of the high sensitivity of the topic. This fact is supported by there are ongoing debates on whether to include nuclear power in Norway's energy mix (Valderhaug, 2022), where regardless of the government's position of the previous government, which was run by the Conservative Party, that considered involving nuclear power in the energy mix means that Norway was giving up on its clean energy goals, the government ordered an investigation into what Norway would require to generate nuclear power by 2050.(Lydersen, 2023)

This contradiction appears clearly in the differences of opinion of the parties, where the opponents of nuclear power, like Energy Minister Terje Aasland, argue that there are too many risks associated with nuclear power, including nuclear accidents, and radioactive waste disposal. (Ertesvåg, 2022) On the other hand, SV leaders in Rogaland and Gjesdal are now openly supporting wholesale transitions to nuclear energy for their jurisdictions,(Søndeland, 2023) where in spite of historical opposition to nuclear power from many Norwegian municipalities and counties, a large number of Norwegian towns, notably Aure, Vennesla and Høyanger, have seen their leaders voice public support for nuclear energy in the context of continuing industrialization and growth .(Hovland, 2023) This contradiction appears also in the recent survey that shows while 37% of Norwegians disagree with enhancing the country's use of nuclear power, 51% of the population supports increasing nuclear power usage .(NTB, 2023)

The political parties in Norway have historically held diverse opinions on nuclear power with most opposing it due to the country's high levels of oil production and focus on renewable energy. However, Høyre has shifted towards supporting the analysis of nuclear power and investigating lifting the ban on its use, where they argue

that nuclear power could significantly contribute to Norway's low-carbon economy transition and reduce greenhouse gas emissions .(Lydersen, 2023) Moreover, FRP has also voiced an openness to exploring the potential of nuclear power and supports the creation of a separate nuclear power authority .(Meisfjord, 2023) In addition to that, the currently ruling Arbeiderpartiet (Ap) has committed to investing 200 million NOK to create a new research center regarding potential Norwegian uses of nuclear power in partnership with other research laboratories in France, Japan and South Africa in the context of the country's ambitious emissions reductions goals.(Lynnebakken, 2023)

In addition to that, the various civil society and lobbying groups in Norway have differing views on nuclear energy where some of the environmental groups, like Bellona and Zero, support nuclear power as a low-carbon energy source that could help reduce greenhouse gas emissions.(Andersson, 2022; Digges, 2019) On the converse, other groups like Naturvernforbundet and ICAN oppose nuclear power where they are arguing that it is neither sustainable nor safe.(ICAN, 2023)

Furthermore, the nuclear industry and associated lobbying groups also participate in the debate where several groups advocate for nuclear power usage in Norway, asserting that it is a safe and reliable energy source and support exploring and developing uranium mines in Norway as fuel for nuclear power plants.(Egeland, 2019)

The debate surrounding nuclear energy in Norway reflects the diverse opinions and perspectives of local officials, civil society, and lobbying groups where despite some support for nuclear power, there is also significant opposition due to concerns about safety, waste disposal, and proliferation. Therefore, the role of nuclear power in the country's future energy mix will likely remain a subject of ongoing debate and discussion in Norway's pathway to fulfil its pledges to transition to a low-carbon economy.(Lydersen, 2023)

In a question posed to the Minister of Oil by Aasland (2023) about there is a strong case for investment into nuclear power for Norway, based on its adoption by the country's neighbours the increased necessity of energy production in the years and decades to come as a result to its low expense compared with the other energy sources. The Minister responds by laying down a hard no based on Norway's geography and

recent investment increase in the wind sector, as well as pointing to the original nuclear debate in the 1970's where it was decided that Norway would not pursue nuclear power half a century ago.(Aasland, 2023) On the other hand, Solheim (2023) reports that a growing number of individuals, including nuclear physicist Sunniva Rose and Norsk Kjernkraft AS founder Trond Mohn are moving to build SMRs without government assistance, as long as they can avoid government intervention. They plan to build a reactor the size of the Ullevaal stadium, and they are not without allies in the government such as Ola Svenneby, leader of the Unge Høyre. Ola believes that his parent party Høyre is effectively putting "sticks in the wheels" of progress and exhorts it to reconsider their harsh stance against nuclear power. Despite harsh warnings from party leader Erna Solberg, the party agreed to give SMR technology another chance and is reconsidering, but there are still significant obstacles to overcome. Norway, being non-nuclear, has no processes or infrastructure in place for dealing with nuclear waste and no significant comparative advantages in the nuclear trade .(Solheim, 2023)

One aspect of this debate about nuclear energy can be seen in the Norwegian media, which has begun to discuss nuclear energy in more detail recently. Olsstrom (2022) recalls the disaster of Fukushima Daiichi in March of 2011 and shows how Japan has turned back to nuclear, in spite of the fear created but the exposure to the danger that is present in nuclear technology, amidst a rising energy crisis, where every nuclear reactor was shut down for tests, but they are running again now, new ones are being built and the life of the existing ones will be extended. Here it is worth noting that before the earthquake, almost a third of Japan's power was supplied by nuclear reactors which decreased now to below 10% but the Japanese government wants to rebuild nuclear infrastructure to account for at least 20% by 2030 as part of a larger plan to be carbon-free by 2050. This example can be related to Norway's energy needs and how to fulfil them and is indicative of the importance of the growing discussion of nuclear power use in Norway .(Olsson, 2023)

During a four-hour conference in (2023) regarding Snøheia, the mountain area between Høyanger and Viksdalen in Sunnfjord, the 300 participants instead unanimously passed two initiatives requesting the Høyanger municipal council to solicit

applications for a nuclear power plant from several suppliers by 2025, and not to open license processing for a new wind power plant unless there is a simultaneous nuclear power plant being considered at the same time. What was surprising at this conference was that the only thing on attendees' minds was nuclear power as they left a wind energy conference where the only single dissenting vote, Olav Osvall, had been invited to present wind options before the conversation changed course. As a presenter and not an attendee, he was informed he did not have the right to vote and told NRK he did not take the vote seriously. Subsequent action has been taken within the government, but there are still voices in the crowd that caution against too much optimism, as even the fastest of SMR setups would still be inactive for the remainder of this decade and the intervening years are going to require additional power as well .(Nyhus, 2023)

Another potential benefit of nuclear power is its potential to help Norway meet its greenhouse gas emissions reduction targets which need to decarbonize the economy by finding ways to reduce emissions from sectors such as transportation, industry, and heating where nuclear power could contribute to it as a low-carbon energy source. However, the risks associated with nuclear power, such as accidents and waste disposal, must be carefully considered.

Moreover, there is another factor that may influence the debate on nuclear power in Norway is the country's strong commitment to renewable energy sources as it is already considered a leader in hydropower production, and there are significant opportunities for further development of wind and solar power. On the other hand, there are those who argue that Norway is focused on developing its renewable energy sources without investigating the nuclear power possibilities.

Furthermore, Thorium has been proposed as one potential solution to address some of the concerns regarding nuclear power in Norway where it is a radioactive chemical element that has the potential to fuel nuclear reactors but with fewer safety and waste disposal risks than traditional uranium-based reactors. Moreover, Thorium reactors produce less radioactive waste, and the waste produced has a much shorter half-life, making it easier to handle and store which could be a safer and more sustainable alternative to traditional nuclear power as the advocates of thorium-based

reactors suggest. However, others argue that thorium is not yet commercially viable and that more research is needed before it can be a realistic solution .(Halper, 2013)

Finally, the debate on whether Norway should adopt nuclear power remains complex and multifaceted which is likely to remain during Norway continues its transition to a low-carbon economy, where the supporters argue that nuclear power could contribute to a more sustainable energy system and reduce greenhouse gas emissions, while opponents raise concerns about safety, waste disposal, and proliferation.

5. Analysis and Findings

In this section, the responses of the sample representing stakeholders during the interviews to 11 questions which had been designed for the research's interviews will be analysed. In addition, this analysis will be evaluated according to the research objectives in order to absorb the findings of the research.

5.1. The analysis of stakeholders' opinions regarding the use of SMRs units in the Norwegian energy mix

To understand the different points of view of the different stakeholders' represented that have contributed as a sample in this research, it is necessary to analyse their answers to each question as explained below:

5.1.1. The 1st question: Personal Perspectives on Norway's Nuclear Power Position

The content analysis of mentions related to Question 1, which focused on the perspective on Norway's current use of nuclear power, revealed several recurring themes among the interviewees. One prominent theme was the absence of a perceived need for nuclear power in Norway's energy mix. Many respondents emphasized that Norway had shut down previous research reactors and cited the lack of demand and desire for nuclear energy among the population. This notion of unnecessary reliance on nuclear power was a prevalent sentiment among the interviewees. This said, the State secretary at the Office of the Prime Minister Andreas Bjelland had stated that " we don't have nuclear power generation at part of our power mix today as a result of the success of hydropower historically", but he left the door ajar regarding the possibility of using the nuclear Power technology, adding to his words that: " we know that we will need a lot of new renewable electricity generation so it might be relevant in the future to consider nuclear power

production also". On the other hand, he stipulated that technological breakthroughs in SMR technology occurrences are necessary for the happening of that where he stated that: "Whether or not this will happen depends on some important factors and I think the key one is the development of SMR technology and whether the technology can be commercialized and piloted by the mid-2030s as some important players in the field argue or not."

Moreover, one senior Rogaland official from the Center Party stated that “I used to be very against it, but in the past 20 years the technology has improved immensely. So now I’m more in the opinion Norway needs to look into it closer on this power source.” Similarly, a senior local Høyre official in Rogaland stated that “[Norway’s use of nuclear power] is rather lacking. We should dare to do more. We are supportive of it both in Stavanger, Høyre and I also believe it in our Municipal Party Program.” In turn, another Rogaland Høyre official simply stated “I support it 100%.”

The cost factor emerged as another significant theme where the interviewees frequently mentioned the excessive cost associated with nuclear power, highlighting the current electricity prices and the potential increase in costs if nuclear power were to be integrated. The financial implications and the need for electricity prices to be significantly lower were deemed as crucial factors in evaluating the feasibility of nuclear energy in Norway.

The interviewees' perspectives also reflected concerns regarding the safety and potential risks associated with nuclear power. While not a dominant theme, several respondents expressed scepticism and mentioned accidents like Chernobyl and Fukushima as cautionary examples. The perceived risk and uncertainty surrounding nuclear energy contributed to the hesitation and resistance towards its adoption.

The analysis also revealed a connection between the perceived need for nuclear power and the energy shortage in the country. Respondents highlighted the importance of addressing energy shortages and the potential for alternative energy sources, such as wind and hydropower, to fulfil the energy requirements. The focus on finding solutions within existing energy sources rather than integrating nuclear power indicated a preference for more established and environmentally friendly options.

Overall, the content analysis illustrated a general consensus among the interviewees that there is no current need for nuclear power in Norway's energy mix. The recurring themes of unnecessary reliance, high costs, safety concerns, and alternative energy sources characterized the perspectives on Question 1. These insights provided a valuable understanding of the interviewees' viewpoints and shed light on the current stance on nuclear power in Norway.

5.1.2. The 2nd question: Personal Views on Nuclear Energy

The analysis of responses to Question 2, which explored personal views on nuclear energy, revealed several key themes that were consistently mentioned by the interviewees. One prevalent theme was the divided perspective on nuclear energy, indicating that individuals had contrasting opinions on its merits and drawbacks. While some interviewees expressed enthusiasm for the potential benefits of nuclear energy, others expressed reservations and concerns.

Safety concerns emerged as a significant theme in the analysis. Many interviewees mentioned major nuclear accidents like Chernobyl and Fukushima, which had a lasting impact on public perception. These incidents highlighted the potential risks associated with nuclear power and contributed to a sense of caution among respondents. The fear of potential disasters and their devastating consequences shaped the overall sentiment towards nuclear energy. Where the State secretary Andreas

Bjelland state that "From the current perspective, the waste challenge which needs to be tackled may have the security risk which is small for most countries but as we can see in Ukraine right now with the separator plant it could be significant if it falls into the wrong hands.". Moreover, one senior local from the Green Party, Miljøpartiet De Grønne official stated that “At present, I believe the risk is too high, the probability of a disaster happening is small, but if something happens, it can be so serious and large, that since the risk probability may be the potential for damage, I believe the potential for injury is so great that this risk is not included.” Another opponent, a senior Greenpeace official states “I see it as a castle in the sky, my understanding is that it is possible for companies to submit an application to NVE to the state to build nuclear power, this no one has done as of yet.”

The high cost associated with nuclear power was another frequently mentioned theme. Interviewees emphasized the substantial financial investment required for the construction and maintenance of nuclear power plants, as well as the expenses related to managing nuclear waste. The financial burden of nuclear energy was seen as a significant drawback and a factor that needed careful consideration when evaluating its feasibility, where as an example, the State secretary Andreas Bjelland state that: "The cost and timeline for developing projects had been and will still challenging as we have seen in some of the finished projects that just completed.". This said, one senior official from Gjesdal muncipality stated that “I’ve always wondered why we haven’t adopted nuclear power. I found about it when I was about 15 years old. Now I think there is a bit of urgency and we need to start using nuclear power by 2040. We can’t keep going the way we’ve been doing.”

Despite these concerns, interviewees acknowledged the technological advancements in the field of nuclear energy and recognized its potential. The excitement surrounding nuclear power as a clean and

efficient energy source was a notable theme. Some interviewees viewed nuclear energy as a promising solution to the increasing global energy demand and climate change concerns. They emphasized the need to explore and harness the potential benefits of nuclear energy while addressing the associated challenges. One senior member of the business community stated that “I’m a tech optimist in general. As a technological concept, I have always been positive about nuclear power. If you have full history from the establishment of Euratom onwards, nuclear power can be up in ups and downs. The political debate about nuclear power has always been about the fact that the technology is only 15 years away from being absolutely fantastic.”

The analysis also highlighted a level of skepticism among respondents. While acknowledging the potential benefits, interviewees expressed reservations about the risks and uncertainties associated with nuclear power. The need for strict regulations, robust safety measures, and transparent oversight emerged as important considerations for those who were cautious about embracing nuclear energy.

Overall, the analysis revealed a complex and nuanced range of opinions on nuclear energy. It illustrated the delicate balance between optimism and caution that characterizes personal views on this contentious issue. The themes of safety concerns, high costs, technological advancements, excitement, and skepticism shaped the overall sentiment towards nuclear energy and provided valuable insights into the perspectives of the interviewees.

5.1.3. The 3rd question: Familiarity with SMRs

The content analysis of mentions related to Question 3, which focused on familiarity with small modular reactors (SMRs) and the technology involved, revealed a range of perspectives among the interviewees. While not extensively discussed, the theme of awareness and knowledge about SMRs emerged

consistently, indicating the presence of some level of understanding within the group.

Many interviewees acknowledged being familiar with SMRs to some extent. They mentioned having read about the technology and mentioned specific individuals or organizations involved in promoting or investing in SMRs, such as Thrond Mohn and Norsk Kjernekraft. This indicated a certain level of awareness and understanding of SMRs among the interviewees, as they were able to identify key players in the field. One senior industry official stated that "conceptually, SMR appear to be one of the better ways of achieving nuclear power. However, there are only currently three functional SMR reactors in the world, and they are located in Russia and China… So I get the same feeling of the SMR hype as of all the previous corepower plants."

However, the depth of knowledge varied among the respondents. Some interviewees had a more comprehensive understanding of SMRs and their potential benefits. They discussed the technological aspects, highlighting the modular nature of SMRs, their scalability, and the potential for enhanced safety features compared to traditional nuclear reactors. These individuals demonstrated a deeper grasp of the subject matter and showcased a more informed perspective. The State secretary Andreas Bjelland had referred to its use in the military where he stated that "It existed for many years, but they have been utilised for some particular use cases like military vessels that have a need for being able to stay out at sea for example for an extended period of time without refuelling.". Moreover, one senior Høyre official from Rogaland stated that "I think that path [SMRs] is shorter. If we are to implement such facilities, I believe that is the path Norway will take, and where we can benefit the most from it." In turn, another senior Høyre official from the reason stated that "my thoughts on this are that nuclear power is the solution for the future for several reasons. First, SMRs are relatively inexpensive. Second, they can be placed almost anywhere and is space-efficient. We don't need to use large areas to build nuclear power plants. It is also an important solution to the nature crisis, like biodiversity. This is as much a

threat to life on Earth as the threat of climate change, and nuclear power, especially SMR technology, can help us with this."

On the other hand, there were interviewees who had a more limited awareness of SMRs. Their mentions indicated a more superficial understanding or a lack of detailed knowledge about the technology. They might have briefly heard about SMRs or encountered the term in their readings, but their remarks did not delve into the intricacies of the technology or its implications for the energy sector. One local Green Party official stated that "I don't see them as a technology, just a concept… In that sense, quite so utopian to think it is [a solution]" Another opponent of nuclear power, a mayoral candidate for Høyre in Rogaland, stated that "Yes I'm familiar with it [SMR] technology, and what it does and its dangers, how we build them etc. I remember Chernobyl happening and the accident in the US." Literacy about SMRs amongst the political class thus appears mixed.

The discussion surrounding SMRs often revolved around the notion of private initiatives and research funding, indicating that the topic of SMRs is closely linked to research and investment activities in the field of nuclear energy. The mention of specific individuals and organizations involved in SMR research and investment demonstrates that SMRs have garnered attention and interest in the context of nuclear energy discussions in Norway. This suggests that SMRs are not only a theoretical concept but also a subject of practical consideration and potential development in the country.

Overall, the content analysis suggests that while there is some familiarity with SMRs among the interviewees, the depth of knowledge and understanding varies. The range of perspectives indicates a diverse level of engagement with SMR technology. Some interviewees showcased a well-informed understanding of the benefits and implications of SMRs, while others displayed a more limited or surface-level grasp of the topic. The analysis provides insights into the level of awareness and engagement with SMR technology among the interviewees, highlighting the need for further exploration and education on the subject to

facilitate informed discussions and decision-making regarding the integration of SMRs into Norway's energy mix.

5.1.4. The 4th question: Should Nuclear Be Integrated in the Norwegian Energy Mix?

The content analysis of mentions related to Question 4, which focused on whether nuclear power and/or small modular reactor (SMR) technology should be integrated into Norway's energy mix, revealed a range of perspectives among the interviewees. The responses varied in terms of support, concerns, and considerations regarding the inclusion of nuclear power or SMRs in the country's energy portfolio.

Some interviewees expressed a clear stance against the integration of nuclear power or SMRs into Norway's energy mix. They argued that there is currently no need for nuclear power and emphasized the shutdown of previous research reactors. They also highlighted the lack of public desire for nuclear power and raised concerns about the high costs associated with its implementation and waste management. These individuals believed that other alternative energy sources could sufficiently meet Norway's energy demands without the need for nuclear power. One senior Green Party official stated that “No I do not. In Norway, we have good opportunities for growth for renewable energy, such as offshore wind power, rooftop solar cells, and some onshore wind power. We have great opportunities for energy conservation, so investing so much money in a technology that has not been a success so far, I don’t think that should be part of Norwegian energy policy.” In turn, a large energy company in Rogaland refused to comment on the question, noting solely that it anticipated a large demand in increase for energy demand over the coming years.

On the other hand, there were interviewees who were open to the idea of integrating nuclear power or SMRs into Norway's energy mix, but

with certain conditions or considerations. They mentioned the need for further research and exploration of the technology before making any decisions. They emphasized the importance of identifying regions in the country that may experience energy shortages and assessing the feasibility of nuclear power or SMRs in addressing those specific needs. These individuals acknowledged that private initiatives and research funding were playing a role in exploring the potential of nuclear power and SMRs. State Secretary Andreas Bjelland stated that " From the government's point of view, the most important thing for us is to facilitate any kind of new technologies, but from a technology-neutral perspective, the more efficient technologies will be developed and connected to the energy system in the future, which is why I think both cost and waste issues will be critical. Therefore, if a cost-effective SMR technology with a relatively low amount of waste is developed, it will certainly be well suited to enriching the energy system.". Also, one cautious yet optimistic industry official stated that “this means that we must have thorough studies of what this will mean for the Norwegian power system’s stability. And if we put in some units that are producing so much… last week, they had an outage in the grid in Sweden that created frequency disruptions throughout the Nordic power grid. Because the production of a single unit is so huge compared to all other production units… [we thus] require thorough research and investigation to know how to get it.”

The content analysis also revealed that the topic of integrating nuclear power or SMRs into Norway's energy mix was subject to debates within political parties and institutions. While some interviewees mentioned that their party or institution had taken steps to research the matter, indicating a level of openness, others acknowledged that the issue was divisive and that opinions within their party or institution were varied. This suggests that the topic of nuclear power and SMRs remains a subject of ongoing discussion and deliberation among policymakers and stakeholders. One national Senterpartiet (Center Party) representative

stated that, despite the coming energy deficit, “it will be far too early for Norway anyway to bring it [SMR technology] into the energy mix, so we have to solve that energy deficit. I think this is a sidetrack to the energy debate.”-

Overall, the content analysis highlights the diverse range of perspectives regarding the integration of nuclear power or SMRs into Norway's energy mix. While some interviewees expressed opposition or skepticism, others emphasized the need for further research and consideration. The analysis underscores the complexity and ongoing debates surrounding this topic, indicating the importance of thorough assessment, research, and a nuanced understanding of the potential benefits and drawbacks associated with nuclear power and SMRs in the context of Norway's energy landscape.

5.1.5. The 5th question: Congruence between Personal and Institutional Views

The content analysis of mentions related to Question 5, which explored whether the interviewees' stance on nuclear power and SMR technology was shared by their institution or political party, revealed a diverse range of perspectives and opinions among the participants. The responses demonstrated that there is no singular or unanimous stance on this issue within the institutions or political parties represented by the interviewees.

Some interviewees expressed that their stance on nuclear power and SMRs aligns with the average viewpoint within their institution or political party. They emphasized the existence of differing opinions and divisions within their organization, suggesting that a consensus has not yet been reached. This highlights the complexity of the topic and the ongoing debate surrounding the integration of nuclear power and SMRs into Norway's energy mix.

Other participants acknowledged that their institution or political party has taken steps to explore the potential of nuclear power and SMRs. They mentioned research initiatives or discussions within their organization, indicating a degree of openness and willingness to consider these technologies. These individuals emphasized the importance of gathering more information, conducting studies, and engaging in informed debates to reach a collective position. State Secretary Andreas Bjelland stated that " The government has stated several times that we are following the International Development with respect to SMR and that we're following up that closely and at least the initiatives are successful then we will sort of evaluate the potential that can have for the power system in Norway so yeah I think I'm very well aligned with the government stated several times with respect to us.". Also, one senior Senterpartiet (Sp) official from Rogaland stated that “locally, yes, in Rogaland we are a bit split, but in Sola county, they were very positive about more knowledge about nuclear power and SMR.” Conversely, a Høyre party mayoral candidate in Sandnes muncipality, opposed to nuclear energy’s integration into the national grid, stated that “no. my opinion on these things differs from the majority of the Party/”

Moreover, the content analysis revealed the possibility of regional differences within political parties or institutions regarding the integration of nuclear power or SMRs. Some interviewees noted that during national congresses or debates, the topic was discussed, and decisions were made to research or consider nuclear power and SMRs. This suggests that regional factors, priorities, and contexts may influence the stance of different branches or factions within these organizations. In this respect, and despite Arbeiderspartiets (Ap) national opposition to nuclear, a senior Rogaland Arbeiderparti leader stated that it depends how far up in politics you go. Both Sandnes and Rogaland Arbeiderparti have made statements about nuclear power. And then there’s the

national convention on nuclear power which is going on right as we're talking so what the conclusion will there, I don't know yet."

Overall, the content analysis highlights the complex and evolving nature of the discussions surrounding nuclear power and SMRs within institutions and political parties in Norway. It underscores the absence of a singular viewpoint and the importance of acknowledging and understanding the diversity of opinions. The analysis emphasizes the need for ongoing dialogue, research, and informed decision-making processes to reach a comprehensive and consensus-driven approach to the integration of nuclear power and SMRs in Norway's energy landscape.

5.1.6. The 6th question: The Realism of Norway's Emissions Reduction Targets

The content analysis of mentions related to Question 6, which explored participants' perspectives on whether Norway can achieve its emission reduction targets using today's alternative energy sources, revealed several key themes and viewpoints. The responses provided a comprehensive understanding of the complexities and considerations involved in meeting emission reduction goals.

One prominent theme that emerged was the recognition that achieving emission reduction targets is not solely dependent on the energy sources themselves but also on the behavioral changes and choices made by individuals. Participants emphasized that the willingness of people to reduce their energy consumption and adopt more sustainable practices plays a crucial role in reaching the targets. They highlighted the need for effective communication and education campaigns to raise awareness about the environmental impact of energy consumption and to encourage responsible energy use.

Another recurring theme was the importance of industrial transformation in achieving emission reduction goals. Participants acknowledged the significance of electrifying major industries such as

manufacturing and emphasized the potential role of renewable energy sources like wind and solar power in meeting the energy demands of these sectors. However, some expressed reservations about public acceptance of large-scale wind farms and highlighted the need for comprehensive planning to ensure a balanced power supply and demand. One municipal leader from Rogaland County state that “reaching those targets… will mean that we will need to cut our oil production, we need to stop extracting gas and selling gas… electrify a lot of areas in which there are no viable technologies as of yet… So the goals we have set are in reality really really hard, if not impossible to reach. I don’t believe we can reach them.” In turn, a senior industry official stated that “when we fail to meet our climate goals by 2030, it is not because we do not have sufficient green electricity. This is unlike, say, Germany and the UK… We supply 85% power with hydropower, 10% wind and 5% import nuclear power from Sweden.”

Hydropower emerged as a key focus within the content analysis. Participants emphasized its effectiveness as a balancing force due to its capacity for flexible power generation. They pointed out the potential for further harnessing hydropower resources in Norway and underscored the importance of exploring this option as part of the overall energy mix. State Secretary Andreas Bjelland stated that " unlike very many other power systems we have a lot of regulated renewable electricity generation in the mix already today and we can through further developing the capacity of the current hydropower based system and be able to increase that regularity of the system even further than what we can today."

Furthermore, the analysis revealed the role of public attitudes and knowledge in achieving emission reduction targets. Participants stressed the need for comprehensive public education initiatives to dispel misconceptions and increase understanding of different energy sources.

They highlighted the importance of addressing concerns surrounding nuclear power and emphasized the need to communicate the advancements in safety and efficiency achieved by newer generations of reactors. This said, one senior local Miljøparti De Grønne official, opposed to nuclear energy usage in Norway stated that "what is needed is that we simply use less energy to achieve these goals" without providing any substantive direction as to how such a lessening of use could come about. A senior Greenpeace official stated that "what we need to reach new climate goals, these are new policies. We have the technology we need. The problem is that government does not want to follow the scientific climate targets, but rather tinkers with numbers." One senior Høyre official from Rogaland went as far as suggesting that "Norway might be able to do this but the world won't. Norway has exported energy for a long time, in the form of oil and gas, and I think that we can be an important supplier of energy in the future of well, and nuclear energy should be a part of thois."

In summary, the content analysis highlighted the multifaceted nature of achieving emission reduction targets, encompassing behavioral changes, industrial transformation, renewable energy deployment, and public engagement. It underscored the necessity of a holistic approach that integrates technological advancements, policy frameworks, and public participation. The findings emphasized the need for continued research, innovation, and collaboration to ensure a sustainable and successful transition to alternative energy sources in Norway.

5.1.7. The 7th question: The Steps Norway Must Take to Meet its Emission Goals

The content analysis of mentions related to Question 7, which focused on what Norway needs to change to reach its climate goals, provided valuable insights into the key considerations and perspectives on achieving these objectives. Participants shared a range of views and identified several crucial

factors that need to be addressed in order to effectively tackle climate change and reduce greenhouse gas emissions.

One notable theme that emerged from the analysis was the significance of public awareness and education. Participants emphasized the need for widespread understanding of the urgency and magnitude of the climate crisis. They suggested that increasing public awareness through education campaigns, media outreach, and community engagement can foster a sense of responsibility and encourage individuals to take action. Several participants also stressed the importance of incorporating climate education into school curricula to equip future generations with the knowledge and skills necessary to address environmental challenges. In this respect, a pro nuclear Arbeiderparti senior official from Rogaland states that "I think we're going to have make more energy because we're not willing to use less, or we're certainly not willing to use enough less." A senior energy official stated that "I wouldn't say that it [meeting emissions goals] is utopian but 2030, I think that's difficult, and so in terms of 2030 versus 2050, let's look at Denmark. Norway has very modest energy goals in comparison… here we are talking about a fourfold increase [in energy power]. We're far behind because we don't have access to affordable renewable power in Norway."

The role of technology and innovation was another prominent theme in the analysis. Participants recognized the potential of technological advancements in driving sustainable solutions. They highlighted the importance of investing in research and development to advance renewable energy technologies, improve energy efficiency, and explore innovative approaches to reduce emissions across various sectors. Participants also expressed optimism about the potential of emerging technologies such as green hydrogen, advanced energy storage systems, and carbon capture utilization and storage (CCUS) in accelerating the transition to a low-carbon economy. One pro-nuclear Senterparti senior official from Rogaland stated that "to reach these climate goals, we must start thinking nuclear. We have to build out more wind farms, both at land and sea. We have a

huge coast with a lot of potential there. Basically, build out both at land and at sea. It's wind-wind situation [sic: joke].”

The analysis further revealed the significance of international collaboration and policy coordination. Participants emphasized the need for Norway to actively engage in global climate negotiations, cooperate with other nations, and contribute to international efforts to combat climate change. State Secretary Andreas Bjelland stated that " The European quota system DTS that we are a part of is a very important part of ensuring that we reach our climate targets it facilitates efficient cutting of emissions in Europe from a lot of sources so the fact that we already have the ETS in place is probably the most important single factor for being able to achieve our goals going forward and that the plan for the ETS on cutting quotas.".

They called for the adoption of ambitious and coordinated policies to address global warming, including setting stringent emissions reduction targets, establishing carbon pricing mechanisms, and promoting sustainable practices in international trade and cooperation. State Secretary Andreas Bjelland stated" There are quite a lot of emissions that are not covered by the ETS like parts of transportation agriculture, etc. by the CO2 tax and therefore we follow the proposed increase in the CO2 text and that we combine that with sufficient and efficient support mechanisms which I think that is the crucial part for being able to decarbonize the rest of the economy fast enough.". In addition to this statement, one Høyre mayoral candidate in Rogaland County, opposed to nuclear energy, stated that “to reach the goals, it’s all about energy efficiency. We need to modernize our hydropower facilities, we can get a lot done just by doing this. Also, we need more locally produced electricity, things such as solar power.”

Participants also highlighted the importance of transitioning key sectors, such as transportation and industry, to cleaner and more sustainable alternatives. They discussed the need for investment in electric vehicles, expansion of public transportation infrastructure, and incentivizing the adoption of low-carbon technologies in industrial processes. Additionally, participants emphasized the

role of sustainable land use practices, including reforestation and responsible agricultural practices, in mitigating climate change and preserving natural ecosystems. This said, when asked for a response regarding its own plans for nuclear energy, a major provider of energy in the Rogaland region refused comment.

Overall, the content analysis underscored the multi-faceted nature of addressing climate goals in Norway. It highlighted the importance of comprehensive strategies that encompass public awareness, technological advancements, international cooperation, and sectoral transitions. The findings emphasized the need for coordinated efforts from government, businesses, communities, and individuals to effectively mitigate climate change and secure a sustainable future for Norway and the planet as a whole.

5.1.8. The 8th question: Norwegian Knowledge about Nuclear Power

The content analysis of mentions related to Question 8 provided valuable insights into the knowledge and understanding of the Norwegian population regarding the realities of nuclear power. The analysis revealed several recurring themes and patterns that shed light on the level of education and awareness among the general public.

One prominent theme that emerged from the analysis was the lingering association of nuclear power with past accidents and disasters. Participants often mentioned incidents such as Chernobyl, Fukushima, and Three Mile Island, indicating that these events have had a lasting impact on public perception. The historical context and media coverage of these accidents have shaped public opinion and contributed to a cautious and skeptical stance towards nuclear power.

Another recurring theme was the acknowledgment of outdated knowledge and the need for updated information. Many participants admitted that their understanding of nuclear power may be based on older information and expressed a desire for more current knowledge. This highlights the importance of providing the public with accurate and up-to-date information about nuclear

power, including advancements in technology, safety measures, and waste management practices. It also suggests the need for ongoing educational initiatives to bridge the gap between outdated perceptions and current realities. One municipal leader from Rogaland County stated that “I don’t think people care enough about what kind of power ‘comes out of their walls if there is light in the lightbulb.’ I do however think that we should educate people more about what kind of energy we use, and what potential there are for the future.”

Furthermore, the analysis revealed variations in knowledge levels among different individuals. Some participants demonstrated a deeper understanding of nuclear power, discussing topics such as reactor designs, waste disposal methods, and safety protocols. On the other hand, some participants displayed a limited understanding and relied on general perceptions and stereotypes. These variations may be influenced by factors such as educational background, personal interest, and exposure to information sources. It underscores the importance of targeted educational programs that cater to different knowledge levels and promote a comprehensive understanding of nuclear power. One pro-nuclear senior Arbeiderparti official from Rogaland stated “no I think there are a lot of people who are not familiar with how it works and what consequences it has, and that it is yes. People probably perceive it as much more unsafe than it is.”. Moreover, State Secretary Andreas Bjelland also stated" I think we are an energy nation both in terms of being proud of our power system and as a major oil and gas producer, then the debates about nuclear power in Norway pops up every now and then, so I think that a lot of people would know something about nuclear as a technology, but for the technological aspects, it's difficult to know all the details as it's complex, varies and there are many different nuclear technologies to talk about.".

Additionally, the content analysis highlighted the influence of public perception and preconceived notions on the understanding of nuclear power. Participants' references to accidents and safety concerns indicated that public perception plays a significant role in shaping opinions about nuclear power. Addressing these

perceptions and providing accurate information can help dispel misconceptions and create a more informed and nuanced public discourse. While one Høyre candidate for municipal office in Rogaland County was opposed to nuclear power, he nevertheless stated “No, I don’t think the people are well educated. I think a lot of the skepticism is not justified. I think we know more than a lot of other countries, but I don’t think people will care until it becomes a reality for us.”

In conclusion, the content analysis of mentions related to Question 9 revealed the influence of historical accidents, the need for updated knowledge, variations in knowledge levels, and the impact of public perception on the Norwegian population's understanding of nuclear power. The findings underscore the importance of educational initiatives, accurate information dissemination, and addressing public misconceptions to foster a well-informed public discourse. By enhancing public knowledge and understanding, Norway can facilitate a more balanced and informed approach to the integration of nuclear power into its energy mix.

5.1.9. The 9th question : Political Parties and Nuclear Energy

The content analysis of mentions related to Question 9 provided valuable insights into the attitudes and openness of Norwegian political parties towards integrating nuclear power into the country's energy mix. The analysis revealed several recurring themes and patterns that shed light on the political landscape and the potential barriers or facilitators to the adoption of nuclear power.

One prominent theme that emerged from the analysis was the recognition of changing attitudes and evolving political positions. Participants acknowledged that there has been a shift in recent years, with some political parties becoming more open to the idea of integrating nuclear power. This indicates a potential willingness to reassess and reevaluate the role of nuclear power in achieving energy and climate goals. The changing attitudes suggest that political parties are responsive to evolving scientific, technological, and environmental contexts.

Another recurring theme was the influence of interest groups and advocacy organizations on the assessment of nuclear power. Participants noted that certain interest groups may have an impact on the realistic assessment of nuclear power in Norway's energy mix. These groups can influence public opinion, shape the political discourse, and even contribute to the framing of the nuclear power debate. However, it was also mentioned that advocacy groups themselves can sometimes hinder progress by using polarizing tactics that undermine their cause. This suggests that while interest groups can play a role in shaping opinions and influencing political decisions, a balanced and constructive approach is necessary to facilitate a realistic assessment of nuclear power. In this respect, a senior Greenpeace official, opposed to nuclear power, suggested if someone came with a real proposal [for using nuclear power], the [current] interest would then decrease."

Furthermore, the analysis revealed variations in the openness of different political parties towards nuclear power. Some parties were mentioned as being more receptive to the idea, while others were perceived to be more resistant. These variations may be influenced by party ideologies, historical positions, public sentiment, and electoral considerations. Political parties operate within a complex landscape of competing interests, and their positions on nuclear power can be influenced by a variety of factors, including party platforms, coalition dynamics, and the desire to align with their voter base. It suggests that the integration of nuclear power into Norway's energy mix may require navigating different party stances and building consensus among various political actors. In relation to SMR's potential usage, a senior industry official stated "if they [the government] manage to build these SMR facilities on time and on cost, and manage to operate the cost level they have said, then it starts to become obvious that Norwegian politics is going to say yes to this." This is consistent with State Secretary Andreas Bjelland's opinion where he stated" From the Norwegian perspective, we always try to facilitate the efficient development of energy systems and we have been good at that for many decades already I think we are open to all technologies. However, I don't think we're going to see sort of

traditional nuclear power plants in the Norwegian context, so if SMR is going to play a role in the power system in Norway or not really depends on the development in SMR technology.".

Additionally, the content analysis highlighted the role of public opinion and societal values in shaping the positions of political parties. Participants mentioned that political parties may respond to public sentiment and prioritize issues that resonate with the electorate. The level of public support for nuclear power, the perception of its safety, and the consideration of long-term environmental impacts can all influence the political discourse around its integration. This suggests that public support and awareness of nuclear power's potential benefits and risks can influence the positions of political parties. It underscores the importance of engaging the public in informed and inclusive discussions to foster a more nuanced understanding of nuclear power and its role in achieving climate goals.

Moreover, the analysis indicated that the integration of nuclear power into Norway's energy mix is a complex and multifaceted issue that requires careful consideration of various factors. It involves not only assessing the technological and economic aspects but also understanding the social, environmental, and ethical implications. Decision-makers need to weigh the potential benefits of nuclear power, such as its low carbon emissions and energy security, against the concerns related to safety, waste management, and public acceptance. This comprehensive evaluation should take into account Norway's unique context, energy needs, and long-term sustainability goals. A national Senterpartiet representative stated that “what we agreed on, both from the right and left as well as the middle, is that we have to keep up with technology because our neighbors have it. It [nuclear energy] is part of the Norwegian energy mix already in that we are part of the Nordic European power market.”

In conclusion, the content analysis of mentions related to Question 9 revealed the changing attitudes, the influence of interest groups, variations among political parties, and the impact of public opinion on the integration of nuclear power into

Norway's energy mix. The findings emphasize the need for constructive dialogue, evidence-based assessments, and public engagement to navigate the complexities of nuclear power and foster informed decision-making. By considering a range of perspectives and addressing potential barriers, Norway can facilitate a more comprehensive and inclusive approach to evaluating and integrating nuclear power. This approach can help ensure that decisions regarding the energy mix align with the country's climate goals and the broader aspirations of its citizens. It is essential for policymakers to foster a transparent and participatory decision-making process, engaging stakeholders from various sectors, including scientists, environmentalists, industry experts, and the general public.

5.1.10. The 10th question: The Necessity of Nuclear Power for Reaching Norwegian Energy Goals.

The content analysis of mentions related to Question 10 revealed a diverse range of perspectives on the necessity of nuclear power for Norway to reach its climate goals. Participants expressed varied opinions on whether nuclear power is essential in achieving the country's climate targets, and their responses shed light on different aspects of the discussion.

Several participants emphasized the potential of renewable energy sources and energy efficiency measures in meeting Norway's climate goals, suggesting that nuclear power may not be necessary. They highlighted the abundance of renewable resources in the country, such as hydropower and wind energy, and the significant advancements in renewable technologies. These participants argued that by harnessing and maximizing the potential of these renewable sources, Norway can achieve substantial emissions reductions and a sustainable energy future without relying on nuclear power. One senior local Green Party official, opposed to the use of nuclear energy, stated that “no, I think this knowledge base is not mature. The existing technology, as it is, should not be further invested in on a large scale… The deposits of [fissile material] having

on a global basis will last about 25 years. Then I think, then, it would be quite unrealistic to bet on this here as an annual [sic] solution."

While some others stipulated that some factors be met before they could be adopted into the energy production mix as State Secretary Andreas Bjelland where he stated "no, as I mentioned earlier, I don't think that SMR is necessary yet, I just think it can play a role if it can be cheap and efficient but I don't think one single technology is crucial to making returns.".

However, other participants acknowledged the unique attributes of nuclear power that could contribute to Norway's climate goals. They pointed out that nuclear power offers a reliable and continuous source of low-carbon energy, capable of meeting high electricity demand and providing stability to the grid. They emphasized the potential for advanced nuclear technologies, such as small modular reactors (SMRs), to address concerns related to safety, waste disposal, and cost. These participants believed that nuclear power, if implemented responsibly and with public acceptance, could complement renewables and serve as a valuable part of Norway's energy mix. One municipal leader from a Rogaland County thus stated that "if we are to reach our climate goals we will have to use all available energy that we have. The big argument against this is that this is something so far in the future, but I say so functional effective wind farms on the ocean."

The content analysis also revealed considerations related to energy security and energy import/export dynamics. Some participants highlighted the importance of reducing dependency on energy imports and ensuring a diversified energy portfolio. They argued that nuclear power, as a domestic energy source, could enhance energy self-sufficiency and reduce reliance on external suppliers.

Furthermore, participants emphasized the need for comprehensive analysis and public engagement when evaluating the integration of nuclear power into Norway's energy mix. They stressed the significance of conducting thorough assessments of safety, environmental impacts, waste management, and long-term sustainability. The participants recognized that public acceptance and

trust are crucial factors that must be addressed through open dialogue and transparent decision-making processes.

In conclusion, the content analysis of mentions related to Question 10 underscored the existence of divergent opinions on the necessity of nuclear power for Norway's climate goals. While some participants advocated for prioritizing renewable energy sources and energy efficiency measures, others acknowledged the potential benefits of nuclear power in terms of reliability, energy security, and emissions reduction. The complex nature of the topic calls for comprehensive studies and inclusive discussions to ensure a well-informed and balanced approach to shaping Norway's energy future.

5.1.11. The 11th question: The Effects of Political and Interest Groups on the Nuclear Question in Norway

The content analysis of mentions related to Question 11 delved into the presence of political parties or interest groups that are perceived as blocking a realistic assessment of nuclear power in Norway's energy mix. The participants' responses provided valuable insights into the dynamics surrounding this issue and shed light on additional factors influencing the opposition to nuclear power integration.

Participants highlighted specific political parties that have been resistant to considering nuclear power as a viable option. They pointed out that these parties often prioritize renewable energy sources and advocate for a complete transition away from fossil fuels. Their opposition to nuclear power is rooted in the belief that investing in renewables is a more sustainable and environmentally friendly approach. These parties argue that nuclear power carries inherent risks, including potential accidents and the long-term disposal of nuclear waste, which they consider unacceptable.

Additionally, participants identified interest groups that play a role in opposing nuclear power. These interest groups often have environmental or public health focuses and emphasize the potential risks and negative consequences associated with nuclear energy. They advocate for alternative

energy sources that they perceive to be safer and more environmentally friendly. These groups raise concerns about the potential impact of nuclear accidents on human health, wildlife, and ecosystems, and argue that renewable energy technologies offer a more sustainable and less hazardous path forward.

It is important to note that some participants expressed skepticism about the motivations of certain interest groups opposing nuclear power. They suggested that some groups may be influenced by financial considerations or have vested interests in maintaining the status quo. For example, participants mentioned that fossil fuel industries may resist nuclear power as it poses a potential threat to their market share and profitability. This opposition is not solely based on safety or environmental concerns but may be driven by political factors as well, where for example State Secretary Andreas Bjelland stated " I think for example the Progressive Party that they have been the strongest an advocate for nuclear power in Norway but they get the Green Party which has been the strongest vocal against nuclear power production and then we see that has changed from time to time and especially when electricity prices are high".

Furthermore, participants noted that the opposition to nuclear power is not exclusive to specific political parties or interest groups but is also shaped by public perception and sentiment. The legacy of past nuclear accidents, such as Chernobyl and Fukushima, has instilled fear and apprehension among the general public. These incidents have had a lasting impact on public opinion, leading to widespread skepticism about the safety and risks associated with nuclear power. As a result, political parties and interest groups align themselves with public sentiment to maintain support and credibility. In this respect, one pro-nuclear Arbeiderparti leader from Rogaland stated, in reference to the effects of the Russian invasion of Ukraine, that “compared to other countries that use nuclear power, we also need energy here in Norway. We need to start thinking about the future now, and take this into account. One of the reasons we have ended up in the power crisis is because we thought we had enough power, but then it

suddenly turned out that it takes a long time to build something new once you have a deficit."

In conclusion, the content analysis of mentions related to Question 11 revealed that the opposition to nuclear power integration in Norway involves specific political parties, interest groups, and broader societal factors. Political parties advocating for renewable energy, interest groups focusing on environmental and public health concerns, and public sentiment influenced by historical nuclear accidents all contribute to the blockage of a realistic assessment of nuclear power. Addressing concerns related to safety, waste management, and environmental risks, along with fostering transparent communication and thorough research, can help facilitate a more comprehensive and balanced evaluation of nuclear power in Norway's energy mix.

5.2. The findings of the study

After analysis of the different answers of the different stakeholders, it becomes possible to come up with some different conclusions that represent the different perspectives of the stakeholders regarding the aspects related future of the SMRs in Norway as listed below.

5.2.1. The 1st aspect: Attitudes evolve over time.

Based on the data from the content analysis above, an analysis of trends in support for nuclear energy over time reveals several notable patterns and shifts in public opinion. In the earlier interviews, there appears to be a general skepticism or lack of support for nuclear energy. Many participants highlight concerns regarding the cost of nuclear power, the potential for accidents or disasters, and the challenges associated with nuclear waste management. They perceive nuclear energy as an expensive and risky option, with the potential for catastrophic events like Chernobyl and Fukushima shaping their views. Moreover, there is a prevailing sentiment that alternative energy sources can meet the country's energy needs without resorting to nuclear power.

However, as the interviews progress, there is evidence of a changing landscape and a more nuanced perspective on nuclear energy. Some participants

acknowledge the potential of nuclear energy to address energy demands, particularly in the context of industrial needs or as a balancing power source. They recognize that nuclear power can provide a stable and reliable energy supply, highlighting its advantages over intermittent renewable sources. Additionally, the mention of small modular reactors (SMRs) indicates a growing awareness of new nuclear technologies and their potential benefits in terms of scalability, safety, and waste management.

Interestingly, the views on nuclear energy appear to vary among different political parties or institutions. While some participants express a divided stance within their respective parties or organizations, others note a shift in attitudes and an increasing openness to exploring nuclear power as a viable option. This suggests that political positions on nuclear energy are not static and can evolve over time, reflecting changing circumstances and a broader understanding of the energy landscape.

The content analysis also reveals the influence of public opinion and societal attitudes on the integration of nuclear power into the energy mix. Several participants highlight the need for a supportive public and emphasize the importance of educating people about the realities of nuclear energy. They note that public perceptions are often shaped by historical events and high-profile accidents, such as Chernobyl and Fukushima, and stress the need for accurate information and transparency in discussions about nuclear power.

Furthermore, the analysis highlights the role of energy goals and climate targets in shaping attitudes towards nuclear energy. Participants discuss whether nuclear power is necessary to achieve emissions reduction goals, with varying opinions on its significance in the overall energy transition. Some argue that alternative energy sources, coupled with efforts to reduce energy consumption, can sufficiently contribute to meeting climate targets, while others see nuclear power as a potential solution for energy-intensive industries and as a reliable and low-carbon energy option.

Overall, the content analysis suggests a dynamic landscape of support for nuclear energy in Norway. While initial interviews indicate a general skepticism and

opposition, later interviews show signs of evolving opinions, growing awareness of new technologies, and a more nuanced view of the role nuclear power could play in the energy mix. Public opinion, political positions, ongoing debates around safety, cost, waste management, and alternative energy sources, as well as the influence of climate targets, are likely to continue shaping the trajectory of support for nuclear energy in Norway in the coming years.

5.2.2. The 2nd aspect: There are variant perceptions of the risk analysis.

The content analysis reveals a diverse range of perspectives regarding the perception of risk associated with nuclear energy in Norway. Initially, participants express significant apprehension and raise concerns about the potential risks and safety issues involved in nuclear power. They emphasize the catastrophic nature of nuclear accidents and their long-lasting consequences for human health and the environment. The memories of past nuclear disasters, particularly Chernobyl and Fukushima, play a prominent role in shaping the perception of risk, with participants referencing these incidents as reminders of the potential dangers of nuclear energy.

However, as the discussions progress, there are indications of evolving perceptions and a growing openness to reevaluate the risks associated with nuclear power. Some participants acknowledge that advancements in nuclear technology, such as small modular reactors (SMRs), have the potential to mitigate risks and address the concerns associated with traditional nuclear power plants. They highlight the improved safety features, enhanced waste management strategies, and the scalability of SMRs as factors that could influence their perception of risk.

Moreover, participants also discuss the need to consider the broader context of energy production and its associated risks. They recognize that alternative energy sources, such as wind and solar power, also carry certain risks, albeit different in nature. The intermittency of renewable energy, challenges in storage and transmission, and the potential environmental impacts of large-scale wind farms are raised as important considerations. This broader perspective prompts some participants to reevaluate the risk-benefit trade-offs and consider nuclear energy as a potentially viable option in the energy mix.

The changing perceptions of risk are not uniform among participants, reflecting the complexity of the issue. Some individuals remain staunchly opposed to nuclear power and emphasize the potential catastrophic consequences in the event of an accident. They advocate for a precautionary approach and prioritize the development of renewable energy sources. On the other hand, there are participants who express a more open-minded attitude, recognizing the need for a diversified energy portfolio to meet future demands while addressing climate change.

Overall, the content analysis suggests a dynamic landscape of changing perceptions of risk associated with nuclear energy in Norway. The discussions reflect a nuanced understanding of the risks and benefits of various energy sources, with participants grappling with the trade-offs and complexities involved. The evolving perceptions highlight the importance of ongoing dialogue, scientific advancements, and transparent communication to address public concerns and foster informed decision-making regarding the role of nuclear energy in Norway's energy future.

5.2.3. The 3rd aspect: The are variant perceptions regarding achieving Norway's Emissions Reduction Goals.

The content analysis reveals varying perspectives on Norway's climate goals and the changing perceptions surrounding them. Initially, participants express skepticism about the feasibility of achieving the set targets solely through the use of today's alternative energy sources. They highlight the need for significant behavioral changes and reductions in energy consumption by individuals to effectively meet the goals. Some participants emphasize that without a collective willingness to reduce energy use, Norway may struggle to achieve its emissions reduction targets.

However, as the discussions progress, there are indications of shifting perceptions and a recognition of the potential challenges and opportunities involved. Participants acknowledge the importance of exploring different energy options and technologies to diversify Norway's energy mix. While some express concerns about

the potential environmental impacts of certain alternatives, such as windmills on mountaintops, others highlight the potential of wind and solar power to contribute to achieving emissions reduction goals.

Additionally, participants discuss the role of industry in climate goals of Norway. They raise concerns about potential energy shortages in the future and the need for electrifying large industries like manufacturing. The content analysis reveals differing opinions on the most effective strategies to achieve emissions reductions in the industrial sector, with suggestions ranging from increased reliance on renewable energy sources to exploring the potential of nuclear power.

Overall, the content analysis highlights a nuanced understanding of the challenges and opportunities associated with Norway's climate goals goals. Participants recognize the need for a multifaceted approach that includes behavioral changes, the exploration of alternative energy sources, and the careful consideration of the industrial sector's energy demands. The changing perceptions reflect an ongoing dialogue and the recognition that achieving emissions reduction targets requires a combination of individual and collective efforts, technological advancements, and strategic decision-making.

The content analysis also underscores the importance of public awareness and education regarding the realities of climate goals. Participants discuss the need to inform the Norwegian population about the implications and trade-offs involved in achieving emissions reduction goals. This highlights the role of communication and transparency in ensuring that the public is well-informed and engaged in the decision-making processes surrounding Norway's climate goals.

In conclusion, the content analysis suggests that perceptions of Norway's climate goals are evolving, with participants recognizing the complexity of the task at hand. The discussions demonstrate a willingness to explore various energy options, consider the role of different sectors, and prioritize public awareness and education. These changing perceptions indicate a dynamic landscape that is responsive to new information, technological advancements, and the evolving understanding of the challenges and opportunities in achieving emissions reduction goals in Norway.

5.2.4. The 4th aspect: The are variant perceptions regarding the capability and the limitations of the wind power.

Despite the changing perceptions and growing acceptance of wind power in Norway's energy mix, the content analysis also reveals discussions around the weaknesses and challenges associated with this renewable energy source. These concerns highlight the need for a balanced assessment of wind power's limitations alongside its benefits. Two key weaknesses emerged from the analysis: intermittency and environmental impact.

Intermittency is a significant drawback often raised by participants in the content analysis. Wind power generation relies on the availability of wind, which can be unpredictable and variable. Critics argue that this intermittency poses challenges to the stability and reliability of the electricity grid. They raise concerns about the need for backup power sources to compensate for fluctuations in wind power output, which can increase costs and potentially rely on fossil fuel-based alternatives.

The environmental impact of wind power is another theme that emerged from the analysis. While wind energy is considered a clean source of power, participants highlight certain negative consequences associated with wind turbine installations. Concerns include the potential harm to bird populations, especially migratory birds, and the disturbance of natural habitats. Participants express the need for careful site selection and impact assessments to minimize these ecological effects.

Additionally, aesthetic considerations are raised in the content analysis. Some participants express concerns about the visual impact of wind turbines on the natural landscape, particularly in scenic areas. They argue that wind farms might compromise the aesthetic appeal and tourism potential of Norway's picturesque regions. Balancing the environmental benefits of wind power with the preservation of the country's natural beauty becomes a key point of discussion.

The content analysis also identifies challenges related to public acceptance and community engagement. Participants highlight the importance of effectively addressing the concerns and objections of local communities when planning wind power projects. The lack of community involvement and consultation in decision-

making processes can lead to resistance and opposition, hindering the development of wind power infrastructure.

Moreover, participants acknowledge the limitations of wind power in meeting the country's energy demands alone. The content analysis reveals the need for a diversified energy mix that includes other renewable sources and technologies to ensure a reliable and resilient energy supply.

In conclusion, the content analysis sheds light on the weaknesses and challenges associated with wind power in Norway's energy mix. Intermittency, environmental impact, aesthetic concerns, public acceptance, and the need for a diversified energy portfolio are key themes that emerge from the analysis. Acknowledging and addressing these weaknesses is crucial to developing a balanced and sustainable energy strategy that maximizes the benefits of wind power while mitigating its limitations.

5.2.5. The 5th aspect: There is an increase in support for considering nuclear energy in Norway's energy mix.

The analysis of the content from interviews conducted in this study provides valuable insights into the changing attitudes towards the consideration of nuclear power in Norway's energy mix. Through a comprehensive content analysis of the responses to questions one through thirteen, several key themes and trends have emerged, shedding light on the increasing support for nuclear power in the country.

One prominent theme that has emerged from the analysis is the recognition of the need for a diverse and reliable energy mix. Many participants highlighted the growing energy demands in Norway and the challenges associated with relying solely on renewable energy sources. They expressed the view that nuclear power can play a crucial role in providing a stable and continuous energy supply, especially as a baseload power source. The analysis indicates that stakeholders from various spheres, including policymakers, scientists, and civil societal groups, are acknowledging the potential of nuclear power to address the intermittency issues often associated with renewables.

Another significant factor influencing the increasing support for nuclear power is the pressing issue of climate change. Participants expressed concerns about the urgent need to reduce greenhouse gas emissions and mitigate the effects of climate change. They recognized that nuclear power can contribute to achieving significant emissions reductions and serve as a low-carbon energy source. The analysis reveals that this understanding is gaining traction among different stakeholders, who are increasingly viewing nuclear power as a viable option to combat climate change and transition to a sustainable energy system.

Economic considerations also play a crucial role in shaping attitudes towards nuclear power. Participants highlighted the potential economic benefits associated with nuclear energy, such as job creation, investment opportunities, and technological advancements. The analysis indicates that stakeholders, particularly economic actors and policymakers, are recognizing the potential for long-term energy affordability and regional economic development through the integration of nuclear power into Norway's energy mix.

Furthermore, the analysis of the interviews reveals a notable shift in public opinion regarding nuclear power. Many participants noted that public perception is gradually evolving, with a growing number of individuals expressing openness to considering nuclear energy as a viable option. This changing public sentiment reflects an increasing recognition of the potential benefits of nuclear power and a willingness to explore alternative energy sources to meet the country's energy needs. It suggests that public discourse on nuclear power is becoming more nuanced, encompassing a broader range of perspectives and a willingness to engage in informed discussions.

Overall, the analysis of the content from the interviews demonstrates a clear trend towards increasing support for the consideration of nuclear power in Norway's energy mix. The identified themes and trends highlight the evolving perspectives of stakeholders across different spheres, including political parties, scientific communities, civil societal groups, economic actors, and the energy sector bureaucracy. These findings have important implications for policy discussions and decision-making processes concerning the future of Norway's energy mix. They

provide valuable insights into the factors influencing attitudes towards nuclear power and the potential role it can play in achieving a sustainable and resilient energy system that meets Norway's growing energy demands while addressing climate change concerns.

6. Discussion

In the way of addressing the research inquiries underlying this master's thesis, Geels' Multi-Level Perspective (MLP) Framework has been employed as a guiding construct throughout the research process. This framework played a pivotal role in facilitating the investigation process in this thesis until it had achieved the findings and results that provided comprehensive insights showing the diverse stakeholders' perspectives related to nuclear energy technology in Norway who represented the different levels of the MLP and p into the subject.

First, let us summarize the landscape factors that contract and can drive the transaction pathway of the Norwegian context regarding the adoption the nuclear power technology where there are several factors like the increasing anxiety about global warming and climate change that are applying a several stresses on all the world countries' regimes of energy including Norway. Moreover, the pledges made by Norway in order to adhere to the European Union's 2030 climate goals plan and the Norway Climate Action Plan 2021-2030, also contribute to increasing the stress on the Norwegian energy and the socio-technical regime to be open to all available clean energy options in order to fulfil these pledges and plans where aims Norway to reducing the carbon missing by 90 to 90% comparing with it in 1990.(Act, 2017) Although Norway has taken bold and successful measures to reduce carbon emissions, achieving these goals is still difficult to achieve, especially taking into account that the Norwegian economy depends heavily on the production and export of oil, in addition to the technical limitations that restrict the technological solutions adopted by the Norwegian government, where carbon capture technology is still in the early stages of development and wind technology faces issues in energy supply stability and storage methods. This argument is confirmed by the answers we obtained for the sixth question from the research sample which belonged to stakeholders representing various approaches in the socio-technical regime that pointed directly to those challenges where all answers point to the inadequacy of current procedures in achieving environmental pledges, although they differ in what procedures must be adopted by the regime to achieve those pledges.(Damman et al., 2021)

The second point for elaborate is the socio-technical level of the MLP which represented as the Norwegian energy regime and the politics that shaping its borders, this regime is now quite stable despite the stress resulting from landscape level which can be observe from the answers of the7th and the 10th questions. The stakeholders selected as a sample in this research had referred in most of their answers to reducing the power demand as a solution to absorbs the stresses exerted by the landscape which points at most of the stakeholders looks at the certain energy regime as a solid system. On the other hand, some other answers show that the current system isn't sacred or unchangeable, as some stakeholders indicated the necessity of continuing to develop current technological solutions, searching for new innovations that can be adopt in the certain energy regime. Moreover, some of the stakeholders' answers had referred to the acceptance for modifying the energy regime to be able to integrate with the technology-breakouts in order to increase the ability to handle and absorb the loads placed on it by the landscape level's stresses.

The last level in the MLP to discuss is the Niches level, which is represented by the SMR as the focal technology breakthrough point in the nuclear power technology that this research focuses on, which is a new type of nuclear reactor technology that has been proposed as a way to achieve a sustainable and low-carbon energy system that are designed to be smaller, more flexible, and cheaper than conventional large-scale nuclear reactors, at the same time it has the potential to overcome some of the limitations of conventional nuclear reactors, including safety, cost, and flexibility. Despite the SMR technology concept can be traced back to the 1950s, the real technological breakthrough in the SMR didn't appear until the 21st century. The SMR technology has the potential to be an effective source of the Norwegian energy mix that can contribute to fulfilling Norway's environmental commitments if it is adopted by the Norwegian socio-technical system similar to the actual use of this technology by China and Russia, or similar to those future plans for using the SMR in 2028 in Canada's energy mix etc, as stated and explained in 6th chapter of this thesis.(Sovacool & Ramana, 2015; Steigerwald et al., 2023)

Despite the fact that there are stresses placed on the regime by the landscape level as the result of the nowadays issues such as the global warming issue and the international trend towards economies with low carbon emissions , the results of this research indicate that those stresses are not sufficient to create enough momentum to made the need change the regime to adopt the SMR technology, where the Norwegian energy regime is based on a long experience in producing energy from clean and sustainable energy sources using a combination of hydroelectrical energy and wind energy, which makes increasing investment in it a more acceptable and comfortable solution by the Norwegian energy regime, despite the recognition that the current trend is not sufficient to reach the declared environmental goals. This result is confirmed by the preference of the sample of stakeholders questioned in this research for both wind energy and hydroelectrical energy over the inclusion of nuclear energy in the energy mix in answering both questions four and eleven, where in spite of the questions were asking about the possibilities of integrating the SMR in the nowadays energy mix and adopting it by the energy regime, most of the answers has mentioned the wind energy and hydropower energy as a more realistic, reliable and safe option to invest and look for achieving the Norwegian environmental goals before starting to study the possibilities using the SMR as a solution option.

This trend of preferring the hydroelectrical energy and wind energy is stimulated by a decline in the level of acceptance of nuclear energy, both at the societal and political levels, as the nuclear disasters that occurred in the past still dominate the formation of the opinions of Norwegian society, its effective stakeholders, and thus the societal-technical regime, which can be observed the frequent mention of some famous nuclear disasters such as Chernobyl, Fukushima, and Three Mile Island at the answers of the 1st, 2end ,3rd, 8th and the 11th questions, where the answers had reflected concerns regarding the safety and potential risks of using the nuclear power which increase the uncertainty surrounding SMR integration opportunities to the current energy regime, and leads to more hesitation and resistance towards adoption it in the energy mix.

All of the above leads to creating financial obstacles in addition to political and social ones, as the current state of the socio-technical system does not tend to invest in

nuclear technology, instead it tends to invest in other technologies that are well known by the Norwegian energy regime in order to absorb the stresses placed on it by the landscape especially since these stresses are not high enough to lead to radical changes or destabilize the current regime .Thus The chances are almost non-existent for the niche level represented by SMR to be adopted through a transmission path that is resulted from the stresses placed on the regime. That's mean at the possible transmission path that can led to adopting the SMR technology in the Norwegian energy mix can happen through the investment of some actors in the development of SMR technology until technological breakthroughs are achieved that can be exploited to solve the issues of the socio-technical system and contributes in disposal of the pressure imposed on it by the landscape in a more effective, efficient, beneficial , profitable and safe way, which gives the Norwegian energy regimes the need momentum to adopt the technology and prefer it over competing technologies. This argument is supported by the answers provided by the selected sample of stakeholders in this research for both the 10th and 11th questions, as most of the contributors in the research indicated the possibility of considering adopting the SMR technology in the energy mix in case the development in this technology achieves some breakouts that converting it to a more attractive, efficient and safer option than other technologies. Moreover, this indicates a change in the view of the socio-technical regime from a complete rejection of nuclear technology to openness to accepting it if it is developed sufficiently to remove all doubts related to the safety of its use and if it is proven to be more efficient than other technologies, which means the happening a breakthrough in the issue of acceptance of the socio-technical regime for the Nuclear energy represented by SMR as an option for generating clean energy that contributes to reducing carbon emissions and achieving the environmental goals and pledges made by the Norwegian energy regime.

Finally, it is worth noting the challenges that we had faced during working on this thesis and the factors that could affect the accuracy of the research results that seem acceptable in our opinion when taking into account that this research is one of the first to discuss opportunities for integrating SMR technology into the Norwegian energy mix, in addation to highlighted some outlines that we believe at it will be useful to guiding the further works in solve and avoid those issues in the future. We faced some constraints

and obstacles in reaching the sample size of stakeholders that is large enough to clarify the different opinions and aspects of the research case. In addition, we faced the issue of the concentration of most of the sample elements in certain geographical areas as most of those belonging to the sample accumulated in each of the Rogaland and Vestfold og Telemark Governorates, which led to the inability to view the other opinions and aspects of the stakeholders in other Governorates, therefore we encourage any future research whether by us or by our fellow researchers to include the opinions of decision-makers and stakeholders in other Norwegian governorates that we couldn't reach . Moreover, we want to refer to the fact that the government side was limited to the Prime Minister's Office, where we faced difficulties in reaching representatives of the various wings and other government institutions, in addition to the lack of sufficient interest in the research issue. Also, we faced the same thing from the community institutions and environmental institutions and organizations, which are considered essential players and major stakeholders in the research case. Furthermore, the research results may be tainted with some bias in selecting the sample due to the fact that the research is qualitative and not quantitative, despite our serious attempts to reach the different point of view and distribute the sample fairly among the representatives of the different stakeholders, but the interaction with our research by these representatives is a voluntary which depends on their contribute. So, the consent of the targeted representatives to participate in the research or not may led to some deformities in the formation of the general shape of the sample, which may lead to some bias in the results. Therefore, we encourage conducting quantitative studies also in the future to gain more accurately determine the levels of acceptance and rejection of the inclusion of SMR technology within the Norwegian energy mix and its reasons. Finally, we hope that we have helped in clarifying some of the ambiguity related to the future of nuclear energy and the SMR technology in the Norwegian social and technical regime, and that we have created a solid a building block that can be used to continue exploring the depths of this ambiguity through subsequent research in the future.

7. Conclusion

By the name, Are Small Modular Nuclear Reactors (SMR) Necessary for Realizing Norway's Ambitions in Reaching Its Set Carbon-Free Goals by 2030-2050?, this master thesis had tried to explore the role that the SMR technology can play in the Norwegian ambitions plane to achieve the Carbon-Free Goals by 2030-2050 , and which are the opportunities to accept the adopting of the SMR technology in Norwegian energy mixture. In this thesis the traditions qualitative research method had been chosen to control the research process alone all the way by interviewing the representors of the different stakeholders and analysing existing documents to analyze the current position of the SMR technology regarding to the Norwegian energy system future by using the Multi-Level Perspective (MLP) framework as the main guide for the research.

The most important findings of this thesis explain the obstacles facing SMR technology in trying to adopt it in the Norwegian socio-technical regime as a result of societal and political rejection of it due to the association of nuclear energy as a whole with nuclear disasters such as Chernobyl, Fukushima and Three Mile Island. This thesis also gives various examples of energy systems in other countries that have adopted SMR technology and compares them to the Norwegian energy system. It also discusses how SMR technology can contribute to meeting emerging challenges and improving environmental commitments and zero carbon emission policy. In addition, this thesis analyzes the different opinions of different stakeholders regarding the adoption of SMR technology and analyzes its dimensions. It also showed that adopting SMR technology in the energy mix requires more research and refinement until some technical breakthroughs are achieved that are enough to give momentum to force the Norwegian socio-technical regime to adopt the technology.

Although this thesis clarified many points related to the subject, more research is required to cover the aspects that it was not able to cover. Therefore this thesis provided some guidance that can be useful in future research.

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Appendix:

Existing Patterns of SMR Use – Extra examples:

SMRs in Japan

Japan finds that SMR technology could be of massive benefit to the small island nation, as they are ideal for providing power to small, limited, and/or distributed power grids as well as those areas that are deficient in transmission and distribution infrastructure. There is an uphill battle for full adoption ahead of them, as many residents keenly remember the Fukushima Daiichi disaster of 2011, in which the most powerful earthquake ever recorded in Japan caused a tsunami to overwhelm numerous safety designs and features, shutting down the plant's emergency generators and leading to a loss of power and a release of irradiated water into the ocean.(Vujić et al., 2012) The small, distributed nature of SMRs can help to answer these questions, however, as they can be better placed further from coastline and major population centers without quickly accruing massively prohibitive construction and operation costs. Additionally, the lower levels of productive of radioactive waste associated with such reactors are seen as being beneficial for a small nation like Japan. The lower costs associated with the smaller reactors is another positive aspect of the switch to modular units, which are also quicker and easier to get online and producing clean energy for the populace.(Hussein, 2020)

SMRs in Poland

Bartela note that, in Poland, a crisis of energy identity is occurring on a national scale as the future of their coal-fired fleet comes into question, and SMR technology is providing a number of interesting answers to the difficulties they face. Retrofitting coal-firing boilers with small nuclear power plants can be 35% less expensive than building new ones, and the benefits of decarbonization will extend into the future. Poland has committed to the closing of 100% of coal mining operations by 2049, which has led other countries to reconsider their place within the energy cycle amidst

rising prices in greenhouse gas emission allowances. These retrofits will not only reduce greenhouse gas emissions and thereby help with Poland's notoriously poor air quality, they will also help to bolster the economy through a growth of GDP and a reduction in overall energy imports as well as a reduction in the national expenditure for these allowances. (Bartela et al., 2021)

Poland is currently almost 75% coal, and have been increasing their capacity for clean energy production steadily, but their energy security still lies in coal-fired units, almost half of which is more than 20 years old and many are twice that. With a slew of power plants due to be decommissioned in the coming year as the cost to run them skyrockets while the efficiency simultaneously plummets, new supercritical units have been built to replace many and work is being done to minimize their carbonization effects, but SMR retrofits look to be a more economically and ecologically sound option in many cases.(Qvist et al., 2020)

SMRs in Romania

The Romanian contribution to SMRs, the CANDU Nuclear Power Plant, utilizes 'heavy' water with added neutrons to limit the absorption of those shed in the nuclear reaction, which results in a better neutron economy within the reaction chamber, and allows for the use on natural, a.k.a. unenriched uranium. This skips the expensive and dangerous process of uranium enrichment entirely, streamlining the process and also eliminating a potential bottleneck. Designed to run in a set of 12 independent, self-contained modules, called NPMs, the CANDU system can easily scale in magnitude and employs a once-through, vertical helical coil steam generator design. This design is relatively, cooled entirely by natural circulation, relies on well-established light water technology, and utilizes a movable modular containment which can be built off-site and shipped.(LUCAN et al., 2022)

SMRs in Russia

Russian SMRs stand alone amidst the rest of the world, being usable for heat production in direct uses other than the production of electricity such as desalination and district heating. This is due to their Lead-bismuth eutectic cooling system, which uses heavy metals instead of water, was developed for their submarine program and

provides a number of advantages over water-cooled options. Lead-bismuth has a high boiling point of 1670°C, enabling a effective heat removal even at high pressures, and freezing point of 125°C which provides an additional layer of protection against leaks as the metal will solidify immediately in air. The most significant drawback to lead-bismuth eutectic cooling is corrosion of the fuel element claddings and other materials in the coolant flow, which is significantly lessened by working at lower temperatures. Combined with chemical control of the coolant, Russian technology allows for the continuous operation at a temperature of only ~500°C, extending the life of the reaction to 7-8 years before refilling is necessary.(Kessides & Kuznetsov, 2012)

(With Russia planning an ambitious deployment of SMRs in the Arctic region, this brings about a situation in which it appears to be seeking to maintain secrecy and distance in relation to its SMR program – thus making it more difficult to fully grasp its dynamics.(Kolomeytseva et al., 2022)

SMRs in the UK

UK Energy Minister Richard Harrington stated as aims for *the development of the Advanced Manufacturing and Construction programme* include a provision of support to UK manufacturers of SMR and other reactor components by 2030 to facilitate UK industry becoming global distributors of SMRs by 2050, but it appears the full weight of Parliament was not behind that statement. Interest has fluctuated since 2014, when high costs associated with the UK's large reactor programme, notably at Hickley Point C, inspired investigation of alternatives, and in 2015 Parliament pledged £250 million to be invested in SMR technology by 2020 to find the best SMR option for the Kingdom. In the meanwhile, as large reactors have begun to become more difficult and expensive to run, three of the five new projects scheduled to be online in 2030 have been scrapped, the budget was slashed to £100 million with no specificity as to the timeline, and most of it has been spent on more speculative non-LWR technology. (Thomas et al., 2019; Thomas & Ramana, 2022)

SMRs in the USA

Finally, America has a number of opportunities on the road to becoming a world leader in SMR technologies, including alternative baseload power generation and the

retirement of older, less efficient coal-burning plants; the potential for deployment in regions of the US with lower potential for other forms of carbon-fee electricity such as solar or wind; technical and/or market sentiments that often work against larger, GW-scale nuclear reactors. In addition, the manufacturing base can be provided domestically, creating jobs and adding to the GDP.(Rosner & Goldberg, 2011) Challenges hindering such massive adoption include the oil lobby, limited cost data, and no small amount of uncertainty in the estimates provided, and the cost of tooling up a factory dedicated to SMR manufacturing, which is still in early planning phase and will require significant investment to make a plant to produce the modules. These costs are mitigated in comparison with retooling extant plants, considering how much more readily customizable the modular systems are so they can easily fit within the needs of the grid, without overbuilding, and add capacity as needed.(Ingersoll & Carelli, 2020)

Guiding questions for interviews:

Consent: -

-Is it okay for you that the interview is to be recorded?

-Introducing myself

-Participate introduces him/herself

Questions:-

1. What is your perspective on Norway's current use of nuclear power?

2. On a personal level, what is your view on nuclear power?

3. Are you familiar with SMR technology?

4. Do you believe that nuclear power and/or SMR technology should be integrated into Norway's energy mix?

5. Does your institution or party share your attitude towards nuclear power/SMR?

6. Do you believe that Norway can achieve its emission reduction goals by using current alternative energy sources?

7. What does Norway need to change in order to reach its climate goals?

8. Do you believe that the Norwegian people are well educated when it comes to the realities of nuclear power?

9. Do you think that Norwegian political parties can become more open to integrating nuclear power into the energy mix in the future?

10. Do you believe that nuclear power must be used for Norway to achieve its climate goals?

11. Do you think that certain political parties or interest groups are blocking a realistic assessment of nuclear power in Norway's energy mix? If yes, which ones and why?