1-7-2024

university of groningen
faculty of spatial sciences

Powering Progress

"Integrating renewable energy for an efficient transition in Dutch environmental and infrastructure planning"

Robin Andonov
RIJKSUNIVERSITEIT GRONINGEN
Master Environmental and Infrastructure Planning
Supervisor: Charné Theron

Abstract

The transition to renewable energy is a critical challenge for the Netherlands, aiming for a sustainable and efficient energy future. This study evaluates the current state of renewable energy sources, assesses the effectiveness of governmental policies, and identifies the challenges and opportunities in integrating renewables into existing infrastructure. By emphasizing technological innovation, adaptive policy frameworks, and stakeholder engagement, this research develops strategies that maximize cost-effectiveness, speed, and minimal disruption. The methodology includes a comprehensive analysis of policy documents and interviews with key stakeholders to understand the socio-technical dynamics of the energy transition. The findings highlight the importance of upgrading grid infrastructure, enhancing energy storage capabilities, and implementing smart grid technologies. Additionally, public acceptance and stakeholder collaboration are crucial for mitigating conflicts and ensuring the successful implementation of renewable energy projects. The study concludes with policy recommendations to strengthen frameworks, invest in technological innovations, and promote collaborative governance models. This holistic approach ensures that the Netherlands can navigate the complexities of the energy transition and serve as a model for other nations.

.

Table of contents

Chapter 1: Introduction

1.1 Research background

Following the 2015 Paris Climate Agreement, the Netherlands has committed to ambitious greenhouse gas (GHG) emission reduction targets: at least 49% by 2030 compared to 1990 levels (Rijksoverheid, 2019), and a staggering 95% reduction by 2050 (EZK, 2019). Achieving these goals necessitates a fundamental shift from the current fossil-fuel-dominated energy system to one that is sustainable and climate-neutral. The transition towards such an energy system carries significant implications, not only for the energy infrastructure itself but also for broader society (Sijm et al., 2019). However, the specific characteristics and outcomes of this transition in the coming decades remain highly uncertain (Sijm et al., 2019).

The Netherlands, known for its low-lying geography and high population density, faces challenges in transitioning towards renewable energy while ensuring environmental sustainability and robust infrastructure (IEA, 2020). Historically reliant on natural gas, the country aims to shift its energy mix towards renewable sources as outlined in its National Energy Agreement and Climate Agreement.

Approximately 90% of the Netherlands' energy consumption is derived from non-renewable sources, indicating a significant reliance on fossil fuels (IEA, 2020). However, efforts have been made to boost renewable energy, particularly in wind power. These efforts have been supported by ambitious offshore wind farm projects like Borssele and Hollandse Kust that have accelerated the country's renewable energy capacity (IEA, 2020).

Given its vulnerability to climate change-induced sea-level rise and the need to protect landscapes and biodiversity, environmental planning in the Netherlands has been pivotal in ensuring a sustainable future. Similarly, infrastructure planning plays a crucial role, with investments in upgrading energy infrastructure and integrating smart technologies to accommodate renewable energy fluctuations (Leas et al., 2014).

Policy frameworks, such as the Renewable Energy Directive and various national policies, have set targets for renewable energy production and emission reduction (IEA, 2021). However, challenges persist in balancing energy security, affordability, and environmental concerns during the transition (Leas et al., 2014). Social acceptance, spatial planning conflicts, and the optimization of existing infrastructure for renewable integration remain critical issues that require continuous research (PBL Netherlands Environmental Assessment Agency, 2024). Some scientific studies, such as those conducted by organizations like the Dutch Environmental Assessment Agency (PBL) and academic institutions such as Wageningen University & Research and Delft University of Technology, provide such insights into the socio-economic and environmental implications of the energy transition in the Netherlands (PBL Netherlands Environmental Assessment Agency, 2024). Transitions within the energy sector are a widely researched topic. Scholars have extensively analyzed various aspects of energy transitions, including technological advancements, policy frameworks, socio-economic impacts, and environmental consequences. However, despite the breadth of existing literature, there is a notable research gap regarding the optimization of these transitions for greater efficiency, partly due to the dynamic nature of the problem and constant technological advances. Academic studies have explored different dimensions of energy transitions. For example, Sovacool et al. (2016) provided a thorough review of the diverse drivers and barriers to energy transitions, highlighting the complex interplay between technological, economic, social, and political factors. Similarly, Geels (2014) examined the multi-level perspective (MLP) on sustainability transitions, emphasizing how changes at the niche, regime, and landscape levels collectively drive transitions in the energy sector.

Despite these extensive analyses, there remains a critical gap concerning the efficiency of these transitions. Efficiency, in this context, refers to achieving energy transitions in a manner that maximizes benefits such as cost-effectiveness, speed, and minimal disruption while meeting environmental and social goals.

While considerable research focuses on the development of renewable energy technologies (e.g., solar, wind, bioenergy), literature on optimizing the integration of these technologies into existing energy systems remains limited. Existing research often explores policy instruments (e.g., subsidies, carbon pricing) to promote energy transitions. However, there is less emphasis on designing policies that enhance the overall efficiency of these transitions. For instance, the work of Elzen, Geels, and Green (2004) suggests that more adaptive and flexible policy frameworks are needed to respond to the dynamic nature of energy markets and technological advancements. A study by Jacobson et al. (2015) underscores the potential of renewable energy but calls for more efficient strategies to scale these solutions and integrate them seamlessly into the grid. This highlights the need for a holistic approach that combines technological development with adaptive policy design to optimize the integration of renewable energy into existing systems. Existing research often explores policy instruments (e.g., subsidies, carbon pricing) to promote energy transitions. However, there is less emphasis on designing policies that enhance the overall efficiency of these transitions. For instance, the work of Elzen, Geels, and Green, (2004) suggests that more adaptive and flexible policy frameworks are needed to respond to the dynamic nature of energy markets and technological advancements.

The socio-economic implications of energy transitions, such as job creation, equity, and community impacts, are well-documented. However, efficient energy transitions require strategies that optimize these socio-economic benefits while minimizing negative consequences.

Sovacool and Dworkin (2015) highlight the importance of just transitions but call for more research on frameworks that ensure equitable and efficient outcomes.

Environmental sustainability is a central theme in energy transition literature. Nonetheless, research often focuses on the long-term environmental benefits rather than the efficiency of achieving these benefits. Studies by Rockström et al. (2009) and Steffen et al. (2015) emphasize the urgency of meeting climate goals, suggesting a need for more efficient pathways to reduce greenhouse gas emissions rapidly.

In summary, while the energy transition is a well-explored domain, there is a discernible gap in research focusing on optimizing these transitions for efficiency. Addressing this gap involves integrating technological, policy, socio-economic, and environmental considerations into comprehensive strategies that enhance the effectiveness and efficiency of energy transitions. Future research should prioritize these aspects to develop more robust frameworks that can facilitate smoother and more efficient transitions in the energy sector.

Efficiently incorporating renewable energy sources into environmental and infrastructure planning in the Netherlands is pivotal for facilitating a seamless energy transition. This necessitates a holistic understanding of various factors, including the current landscape of renewable energy sources, the efficacy of governmental policies, and the inherent challenges and opportunities associated with integrating renewables into existing infrastructure.

The Netherlands currently witnesses a robust expansion and diversification of renewable energy sources, marked by substantial investments in wind, solar, and biomass energy. Despite this progress, challenges such as intermittency and grid integration persist, underscoring the need for targeted solutions to fully harness the potential of renewables within the energy mix.

Governmental policies support this expansion and serves as a linchpin in expediting the transition to renewable energy. Policy measures like feed-in tariffs, renewable energy targets, and incentives for energy efficiency have catalyzed rapid growth in renewables. However, opportunities for refinement exist, including streamlining regulatory processes and bolstering financial support mechanisms to further accelerate the transition.

The integration of renewables into existing infrastructure presents a dual landscape of challenges and opportunities. Challenges encompass grid modernization, storage capacity, and land-use conflicts, posing obstacles to seamless integration. Yet, opportunities abound in fostering innovation, stimulating job creation, and enhancing energy security, pointing towards a path of sustainable growth.

1.2 Problem statement

This study aims to provide valuable insights into enhancing the efficiency of the renewable energy transition in the Netherlands by investigating and recommending adjustments to strategies that are aligned with this transition. Through a comprehensive analysis of the current landscape, policy interventions, and infrastructure considerations, it endeavours to contribute to the development of strategies that propel the nation towards a more sustainable and resilient energy future.

Central to this master thesis is the primary research question: *How can the energy transition of renewable energy sources be efficiently incorporated into environmental and infrastructure planning to facilitate an efficient and socio-economically beneficial energy transition in the Netherlands?*

To address this primary research question effectively, it is essential to explore several secondary research questions. Firstly, sub-question 1 is: what is the current state of renewable energy sources in the Netherlands? The second sub-question is: How effective are governmental policies in facilitating the transition to renewable energy? This sub-question will shed light on the role of policy frameworks in driving efficiency. The final sub-question is: What are the key challenges and opportunities involved in integrating renewables into existing infrastructure and environment? That last question can help to understand these factors to facilitate the development of strategies aimed at optimizing the transition process.

1.3 Scientific and societal relevance

The scientific significance of investigating the energy transition, environmental planning, and infrastructure development in the Netherlands is primarily centered on the efficient implementation of practical policies and engagement in theoretical sustainability and urban planning debates. This research domain provides an empirical comprehension of how a densely populated and low-lying country manages the challenges of transitioning to renewable energy sources, simultaneously addressing environmental concerns and optimizing infrastructure. It not only contributes to theoretical discussions on sustainable development but also provides practical insights into the efficient integration of renewable energy into existing urban landscapes and infrastructure. Moreover, it illuminates the socio-economic impacts of energy transition policies, actively participating in theoretical conversations on stakeholder engagement, socio-technical transitions, and the governance of complex systems. By effectively bridging the theory-practice gap, this research cultivates a more profound understanding of the inherent complexities in sustainable energy transitions within the realm of urban environments and infrastructure planning.

The second main goal of this thesis is related to the societal relevance of this research**.** The societal relevance of investigating the integration of renewable energy sources into environmental and infrastructure planning in the Netherlands is paramount in addressing contemporary global challenges. This research directly impacts citizens by shaping the future energy landscape, influencing energy affordability, reliability, and environmental sustainability. Socially, it holds the potential to enhance job creation through the development of renewable energy sectors while fostering community engagement and empowerment through participatory planning processes. Moreover, by mitigating environmental risks associated with conventional energy sources, this research directly contributes to improving public health and quality of life. The findings offer citizens a stake in decision-making processes, fostering awareness and understanding of the societal benefits of transitioning towards sustainable energy sources. Ultimately, the societal relevance of this research lies in its potential to pave the way for a more resilient, equitable, and sustainable energy future for the Netherlands and beyond.

1.5 Thesis structure

The thesis will be structured into several key sections to comprehensively address the primary and secondary research questions. Chapter 1 will consist of an introduction which will provide an overview of the research objectives and the significance of the study. Following this, Chapter 2, the literature review, will delve into existing research and theories related to energy transition, renewable energy integration, governmental policies, and infrastructure challenges. The methodology section will be covered in Chapter 3 and outline the research approach, data collection methods, and analytical techniques employed in the study. Subsequently, the findings chapter will present the results of the analysis, addressing each secondary research question in turn. Discussion and analysis sections will interpret the findings in the context of existing literature and theory, highlighting implications for policy, practice, and future research. Finally, the conclusion will summarize the key findings, discuss their significance, and suggest avenues for further inquiry.

Chapter 2: Literature Review

As previously mentioned, the Netherlands is determined to rapidly transition to a carbon-neutral economy while fostering economic growth and ensuring energy security (Saviuc et al., 2022). Historically, the country has heavily relied on domestic natural gas production, which has been pivotal for industry and heating needs as seen in Figure 1. However, recent developments have seen the Netherlands shift from a natural gas exporter to a net importer (PBL, 2020).

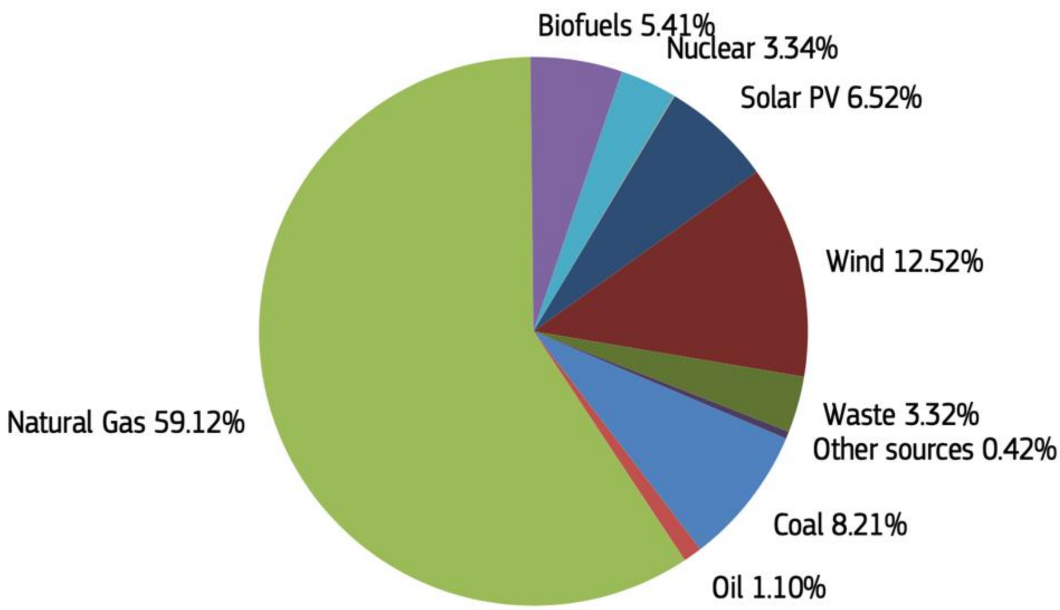


Figure 1: Energy generation mix in The Netherlands in 2020 (IEA, 2020).

In response to these shifts, the Netherlands has set ambitious renewable energy targets, aiming to increase the current share of renewables from 18% to an impressive 75% by 2030 (IEA, 2020). This commitment underscores the country's dedication to reducing carbon emissions and embracing sustainable energy sources. Central to this transition is the extensive electrification of various sectors, including transportation, heating systems, and industrial processes. With plans to electrify nearly two million vehicles, heating systems, and industrial processes, the Dutch electric system is undergoing a significant transformation towards reliance on electricity and low-carbon hydrogen (IEA, 2020). This strategic approach reflects the Netherlands' proactive stance in aligning its energy infrastructure with environmental sustainability goals while promoting innovation and resilience in the energy sector (IEA, 2020).

Research indicates that the increasing demand for flexibility in the Netherlands can primarily be satisfied through (foreign) power trade and, to a significant degree, through (domestic) demand response (Sijm et al., 2019). To achieve carbon neutrality and facilitate this objective through a diverse array of flexible sources to accommodate intermittent renewable energy sources, the Dutch government advocates for a blend of various sources (Saviuc et al., 2022). These sources, including storage, interconnection, green hydrogen flexible generation, and demand response, among others, are deemed essential for addressing the forthcoming flexibility challenges (Saviuc et al., 2022). By endorsing the establishment of a resilient, low-carbon hydrogen market, the Netherlands aims to uphold its position as an energy hub for the EU during its transition to a carbon-neutral economy. The Hydrogen Strategy delineates the systemic role of hydrogen in achieving a zero-carbon energy supply for the Netherlands and lends support to the National Hydrogen Programme, which aims to gradually introduce the production and utilization of low-carbon hydrogen by 2030 (Government of the Netherlands, 2020).

2.1 The vision of the Netherlands regarding energy transition

The Dutch government has set ambitious targets for reducing carbon dioxide emissions by 2030. Achieving this goal requires a significant energy transition in the Netherlands, which will have profound implications for both its citizens and businesses. Therefore, gaining support from these sectors within Dutch society for the necessary policies is crucial.

Research conducted by Vringer and Carabain (2020) revealed a limited correlation between general support for analyzed interventions (output legitimacy) and the endorsement of policy objectives (input legitimacy). This suggests that while there may be backing for policy goals, it does not necessarily translate into support for the associated interventions.

To address this, Vringer and Carabain (2020) advise policymakers to assess policy interventions beforehand to gauge their legitimacy, thereby enhancing the effectiveness and efficiency of policies. They also recommend further research into the operationalization of policy legitimation, including examinations of a broader array of interventions and variations thereof.

Transitioning governance toward a post-carbon society is not a one-size-fits-all endeavour. Cultures, structures, and practices vary significantly depending on the context, necessitating customized transition strategies tailored to local circumstances (Laes et al., 2014). By observing and comparing existing strategies and paths toward low-carbon solutions and adapting them to fit the local context, we can gain insight into the diverse range, effectiveness, and combination of essential ingredients needed for navigating toward a low-carbon energy system (Laes et al., 2014).

The Netherlands is working on an energy system that emits hardly any CO2. By 2050, the energy supply must be almost entirely sustainable and CO2-neutral. In December 2020, the leaders of the European Union (EU) agreed to strive for a European CO2 reduction target of 55%. Transitioning to a sustainable energy supply is crucial to combat climate change. Moreover, in the Netherlands, there are increasingly fewer fossil fuels, especially natural gas, available. Since the Netherlands does not want to be fully dependent on energy from other countries, additional challenges arise (Rijksoverheid, 2024). The additional challenges of transitioning to a sustainable energy supply in the Netherlands are multifaceted. As fossil fuel reserves, particularly natural gas, dwindle, the country faces the immediate need to develop alternative energy sources. Reliance on imported energy can expose the Netherlands to geopolitical risks, price volatility, and supply uncertainties, which could threaten energy security. Overcoming these challenges is essential not only to meet environmental goals but also to ensure a stable, self-sufficient, and resilient energy system that can support the nation's long-term economic and social well-being (van Vuuren et al., 2018). Furthermore, a study by Kalair et al. (2021) emphasizes the importance of transitioning to renewable energy to mitigate the depletion of natural resources and reduce dependence on energy imports, highlighting the need for strategic planning and investment in sustainable technologies.

Additionally, the climate agreement outlines the Netherlands' aim to achieve a 70% share of renewable electricity in total electricity production by 2030. Furthermore, the member states of the European Union (EU) have committed to ensuring that by 2030, a minimum of 32% of the energy generated in the EU (including electricity, gas, and heat) is sourced sustainably. (Rijksoverheid, 2024).

2.2 Promoting Public Investments in Sustainable Technology Infrastructure

In the Netherlands, significant public investments are poised to propel the development of clean energy infrastructure in the coming years. Two primary sources of funding stand out, each targeting distinct areas of sustainability.

Firstly, the national climate and transition fund is set to mobilize €35 billion over the next decade. This substantial financial commitment aims to facilitate the modernization of energy infrastructure while fostering sustainability in mobility and the built environment (Chen et al., 2023). This investment is critical for achieving the Netherlands' long-term climate goals and transitioning to a sustainable energy system (Ministerie van Economische Zaken en Klimaat, 2021).

Complementing this initiative, the Dutch Recovery and Resilience Plan allocates €846.9 million towards four key climate-related investment programs, as outlined below:

- **Wind at Sea**: Intending to double wind energy capacity in the North Sea to 21 gigawatts by 2030, this program focuses on integration costs rather than the construction of wind farms themselves. Funding is directed towards initiatives such as ensuring shipping safety, enhancing ecological preservation, and promoting sustainability within the fishing sector (Government of the Netherlands, 2022). This initiative aligns with the EU's broader offshore renewable energy strategy (European Commission, 2020).
- **Green Hydrogen**: Extending until 2028, this program supports demonstration projects aimed at testing the feasibility of large-scale electrolysis. Additionally, it encompasses an extensive research and development agenda geared towards advancing hydrogen technology, alongside efforts to cultivate a skilled workforce capable of supporting this burgeoning sector (International Energy Agency, 2020). This is part of a broader

European push to develop hydrogen as a key component of future energy systems (Hydrogen Europe, 2021).

- **Zero Emission Services**: This project endeavors to kickstart the market for fully electric inland shipping by providing funding for batteries, 45 fully electric inland vessels, and charging stations powered by green electricity. By investing in both the technologies and infrastructure necessary for emissions-free navigation, the initiative aims to accelerate the transition towards sustainable inland shipping practices (Dutch Ministry of Infrastructure and Water Management, 2021). This supports the EU's Sustainable and Smart Mobility Strategy (European Commission, 2020).
- **Aviation in Transition**: Geared towards achieving the decarbonization of the aviation sector by 2050, this multi-year program focuses on fostering breakthrough technologies for ultra-efficient aircraft development. Through long-term research initiatives and associated activities, the program aims to lay the groundwork for a more sustainable future in aviation (International Civil Aviation Organization, 2021). This is in line with global efforts to reduce aviation emissions as outlined by the International Air Transport Association (IATA, 2019).

In summary, these targeted public investments underscore the Netherlands' commitment to fostering innovation and driving sustainable development across various sectors. By addressing key challenges and opportunities in clean technology infrastructure, these initiatives aim to catalyze transformative change towards a more environmentally conscious and resilient future.

2.3 Stakeholders and context

In the Netherlands, the landscape of energy transmission and distribution involves several key stakeholders who play critical roles in maintaining and developing the energy infrastructure. The transmission system operator (TSO), TenneT, is a central figure in this system, overseeing the high-voltage transmission infrastructure that forms the backbone of the Dutch electricity grid. TenneT's responsibilities include ensuring the reliability and stability of the transmission network, facilitating cross-border electricity flows, and integrating renewable energy sources into the grid (Saviuc et al., 2022).

Conversely, the distribution network is managed by six distinct distribution system operators (DSOs), with the primary operators being Liander, Enexis B.V., and Stedin B.V. These DSOs are responsible for the regional and local distribution of electricity, ensuring that power reaches end-users, including households and businesses. They manage the medium and low-voltage networks, addressing issues such as grid maintenance, infrastructure upgrades, and the integration of distributed energy resources like rooftop solar panels (Saviuc et al., 2022).

As of the conclusion of 2021, the retail market in the Netherlands featured the activity of 61 suppliers, indicating a moderately competitive market environment. Despite this number, the market is notably dominated by the three largest suppliers, who collectively serve approximately 70% of consumers. This concentration suggests that while there is a diversity of suppliers, a few large players hold significant market power. Within the retail market, an even higher level of concentration is observed, with the three major companies catering to around 80% of consumer needs. This dominance impacts pricing, service quality, and the overall competitive dynamics within the market (Saviuc et al., 2022).

Regulatory oversight in this domain is facilitated by the Netherlands Authority for Consumers and Markets (Autoriteit Consument en Markt, ACM). The ACM delineates operational guidelines for various facets such as grid management, metering, and data exchange. These regulations are enforced through comprehensive frameworks like the Electricity Grid Code (NetCode Elektriciteit), which sets out technical and organizational rules to ensure the efficient operation of the electricity market. The ACM's role includes monitoring compliance, addressing anti-competitive practices, and protecting consumer interests by ensuring transparency and fairness in the market (ACM, 2022).

TenneT, as the TSO, is crucial for the large-scale integration of renewable energy sources into the national grid. The company is involved in projects that expand grid capacity and enhance interconnections with neighboring countries, facilitating the flow of renewable energy across borders. TenneT's initiatives, such as the development of offshore wind transmission systems, are pivotal for meeting the Netherlands' renewable energy targets and ensuring energy security (TenneT, 2021).

The Distribution System Operators (DSOs), including Liander, Enexis B.V., and Stedin B.V., are at the forefront of the energy transition at the local level. They manage the integration of decentralized renewable energy sources, such as residential solar power systems and electric vehicle charging infrastructure. DSOs are also responsible for implementing smart grid technologies that enhance grid flexibility and reliability, crucial for managing the variable output of renewable energy sources (Enexis, 2021).

The competitive landscape of the retail market is influenced by the largest suppliers, who drive innovation and customer service standards. These suppliers offer a range of energy products, including green energy tariffs, energy efficiency services, and smart home solutions. Their market power, however, necessitates regulatory oversight to prevent monopolistic practices and ensure fair pricing for consumers (Saviuc et al., 2022).

The Netherlands Authority for Consumers and Markets (ACM) plays a pivotal role in maintaining market integrity. By enforcing regulations like the Electricity Grid Code, the ACM ensures that grid operations are conducted transparently and efficiently. The ACM's oversight extends to issues such as tariff setting, market entry conditions, and consumer protection, which are essential for fostering a competitive and fair energy market (ACM, 2022).

The structure of the Dutch energy market presents both challenges and opportunities. The concentration of market power among a few large suppliers could potentially limit competition and innovation. However, the regulatory framework established by the ACM aims to mitigate these risks by promoting transparency and fair competition.

The integration of renewable energy sources presents a significant opportunity for TenneT and DSOs. As the Netherlands pushes towards its renewable energy targets, the need for robust and flexible grid infrastructure becomes paramount. Investments in smart grids, energy storage solutions, and grid interconnections are essential for accommodating the increasing share of renewables in the energy mix.

Moreover, the active participation of stakeholders at all levels, from national transmission to local distribution and retail supply, is crucial for the success of the energy transition. Collaborative efforts among these stakeholders can drive the innovation and infrastructure development needed to meet the Netherlands' climate goals.

In conclusion, the Dutch energy market is characterized by a well-defined structure with key stakeholders playing distinct and complementary roles. The regulatory oversight provided by the ACM ensures that the market operates efficiently and fairly, fostering a competitive environment that benefits consumers and supports the country's energy transition objectives.

2.3 The energy transition theory and policy paradigm

The transition to low-carbon energy represents a socio-technical shift, necessitating significant changes in the governing institutions of society (Andrews-Speed, 2016).
The socio-technical regime concept acknowledges the interdependence of technology and society, highlighting that they are not isolated domains but deeply intertwined. Technology influences societal behaviour, while societies actively shape and choose technologies to align with their preferences and needs. (Andrews-Speed, 2016). It can therefore be said that society and technology co-evolve (Rip & Kemp, 1998).

A fundamental element within a socio-technical regime is the 'policy paradigm,' a concept stemming from Thomas Kuhn's work on scientific research and discovery (Kuhn, 1970). In the realm of policy and politics, a paradigm refers to a collective set of beliefs, values, ideas, and principles about a specific domain or sector. This prevailing paradigm establishes the intellectual, political, and organizational context through which policy issues are recognized and tackled. Policy responses are crafted within this framework, typically aligning with the underlying paradigm (Hall, 1993). Policy paradigms have a considerable influence in governing the energy sector, given its substantial political and economic significance (Helm, 2007; Mitchell & Mitchell, 2008; Kuzemko, 2013).

Considering that the transition to a new socio-technical or energy regime often spans multiple decades, it is suggested that governments should establish a long-term vision or an envisioned future extending 25 years or more. This foresight can serve as a roadmap for crafting policy options and establishing interim objectives (Meadowcroft, 2009; Voß et al., 2009; Kemp & Loorbach, 2006; Grin, 2006).

The long-term vision ought to encompass more than just measurable targets, such as the composition of the fuel mix or overall emission levels. It should also encompass qualitative objectives concerning the future governance landscape. In this regard, the long-term vision is akin to a 'paradigm,' as discussed earlier, which articulates collective understandings regarding the nature of the challenge and how preferred solutions will be identified (Andrews-Speed, 2016).

The shift towards a low-carbon economy necessitates swift and transformative actions to take place in most industrialized and industrializing countries. Consequently, the concept of adaptive capacity, initially originating in the life sciences, is now being embraced in the social sciences, particularly within the context of socio-technical regime transitions. Adaptive capacity within a society refers to its capability to address challenges stemming from alterations in its environment, whether through proactive anticipation or reactive response to such changes (Engle, 2011). Various factors contribute to a nation's adaptive capacity, encompassing elements spanning society and the economy. These factors may comprise of tangible resources such as infrastructure, information technology, and communication systems, as well as intangible assets like human and social capital, alongside wealth and financial resources (Smith et al., 2005).

In a comparative analysis carried out by Kash (2010), three societal attributes were pinpointed, alongside those previously discussed, that influence the capacity for innovation in intricate technological domains. Kash (2010) also posited that innovation thrives in non-hierarchical societies marked by collective decision-making and a high level of interpersonal trust. In cases where personal trust is lacking, a robust legal system becomes essential (Kash, 2010). This is important for the research question because understanding the multifaceted nature of adaptive capacity is crucial for facilitating the energy transition in the Netherlands.

The integration of renewable energy sources into existing infrastructure requires not only technological advancements but also significant changes in social and economic structures.

The insights provided by Engle (2011) and Smith et al. (2005) highlight the importance of both tangible and intangible resources in enhancing a nation's adaptive capacity. Additionally, Kash's (2010) findings on the influence of societal attributes such as interpersonal trust and collective decision-making emphasize the need for a supportive social framework to foster innovation and effective policy implementation. These factors are essential for developing comprehensive strategies that address the challenges and leverage the opportunities associated with the energy transition, ultimately contributing to the success of the research objectives.

2.4 Economic opportunities

The Dutch government relies heavily on the business sector to achieve a carbon-neutral energy supply. Consequently, it actively encourages businesses to invest in sustainable energy initiatives. For instance, through the Sustainable Energy Production Incentive (SDE++), larger energy projects like geothermal energy and solar parks, along with technologies reducing CO2 emissions such as carbon capture and storage, are incentivized. For example, subsidies are provided for renewable energy, particularly for smart technologies integrating energy generation and storage or enhancing smart grid capabilities. The Energy Investment Allowance (EIA) offers fiscal benefits to businesses investing in various energy-efficient and environmentally friendly technologies. Furthermore, the Investment Subsidy for Sustainable Energy (ISDE) supports the adoption of heat pumps and solar water heaters, accessible to both businesses and individuals. These measures collectively aim to empower businesses to transition towards sustainable energy practices, aligning with the broader national goal of achieving carbon neutrality (Rijksoverheid, 2024).

Moreover, public investments are poised to further drive the development of clean energy infrastructure. As mentioned before, the national climate and transition fund is set to mobilize €35 billion over the next decade, targeting modernization of energy infrastructure and fostering sustainability in mobility and the built environment (Chen et al., 2023). Complementing this, the Dutch Recovery and Resilience Plan allocates €846.9 million towards key climate-related investment programs, such as doubling wind energy capacity in the North Sea and supporting green hydrogen projects aimed at large-scale electrolysis (Chen et al., 2023).

These substantial financial commitments are not only directed at large-scale projects but also at fostering innovation at the local level. For example, the Zero Emission Services project funds the market for fully electric inland shipping, providing batteries, electric vessels, and charging stations powered by green electricity (Chen et al., 2023). Similarly, the Aviation in Transition program focuses on decarbonizing the aviation sector by 2050 through breakthrough technologies and long-term research initiatives (Chen et al., 2023).

Research by the International Energy Agency (IEA, 2020) underscores the critical role of smart grid technologies and energy storage solutions in enhancing the efficiency and reliability of renewable energy systems. Smart grids facilitate better management of electricity demand and supply, integrating diverse renewable sources more effectively. This integration is crucial for addressing the intermittency issues associated with renewable energy, thereby stabilizing the energy supply (IEA, 2020).

In addition to government incentives and public investments, the role of adaptive policy frameworks is highlighted in academic literature. According to Sovacool et al. (2015), policies that are flexible and responsive to technological advancements and market dynamics are essential for the successful implementation of energy transitions. These policies must also promote stakeholder engagement and public acceptance to ensure broad-based support and minimize resistance to change (Sovacool et al., 2015).

Furthermore, the emphasis on renewable energy in urban planning can yield significant socio-economic benefits. As Smith and Stirling (2018) highlight, incorporating renewable energy projects within urban development plans can enhance public health by reducing pollution and promoting cleaner air. Additionally, it can lead to economic revitalization by creating jobs in the renewable energy sector and stimulating local economies. For instance, the deployment of solar panels and wind turbines can provide employment opportunities in manufacturing, installation, and maintenance, contributing to regional economic growth (Smith & Stirling, 2018).

Academic studies also emphasize the importance of participatory planning processes. Wolsink (2018) argues that engaging local communities in the planning and decision-making stages of renewable energy projects can improve social acceptance and reduce opposition. This participatory approach ensures that the concerns and preferences of residents are considered, leading to more sustainable and community-supported outcomes. Moreover, it can foster a sense of ownership and responsibility among citizens, further enhancing the success of renewable energy initiatives (Wolsink, 2010).

Overall, the strategic alignment of fiscal incentives, public investments, and adaptive policies creates a robust foundation for the Netherlands to advance its renewable energy agenda. This multifaceted approach not only accelerates the transition to sustainable energy but also enhances economic competitiveness and environmental sustainability, paving the way for a carbon-neutral future.

2.5 Sustainable energy for individuals

The transition to sustainable energy in Dutch households signifies a significant shift in energy consumption patterns, particularly the move away from gas for residential heating. This trend is accompanied by increased adoption of energy-conserving practices and sustainable energy generation technologies within homes (Rijksoverheid, 2024). One prominent initiative supporting this transition is the provision of subsidies for individuals who install heat pumps or solar water heaters, which are pivotal for sustainable energy generation. Although the national subsidy scheme for solar panel installations has been phased out, other financial incentives remain available to encourage the adoption of renewable energy technologies (Rijksoverheid, 2024).

Academic studies corroborate these developments, highlighting the critical role of policy and financial incentives in promoting household adoption of renewable energy technologies. According to Boomsma et al. (2012), financial incentives, including subsidies and tax credits, significantly influence the adoption rates of technologies like heat pumps and solar water heaters. Similarly, a study by Sopha et al. (2013) emphasizes the importance of supportive policy frameworks in facilitating the transition towards sustainable energy in residential sectors. These frameworks not only provide financial support but also aim to increase awareness and acceptance of renewable energy solutions among the public.

Furthermore, research by Hesselink and Chappin (2019) indicates that consumer behaviour is increasingly leaning towards sustainability, driven by both environmental concerns and economic incentives. The authors argue that this shift is essential for achieving national energy transition goals. The combination of government policies, financial incentives, and changing consumer attitudes forms a robust foundation for the continued growth of sustainable energy practices in Dutch households.

2.6 Analysis of governmental policy

The Dutch government has implemented a series of policies aimed at achieving a sustainable energy transition, emphasizing the reduction of greenhouse gas emissions and the promotion of renewable energy. Analyzing these policies reveals a strategic approach that has evolved over time to address both national and international climate commitments. This timeline between 2011 and 2022 is described below, along with additional information illustrated in Table 1:

2011: Local Climate Agenda The Local Climate Agenda represents a collaborative effort among municipalities, provinces, water boards, and the national government to achieve climate and sustainability goals. This decentralized approach ensures that local entities play a crucial role in implementing climate policies, fostering a broad-based commitment to sustainability at all levels of governance (Rijksoverheid, 2011).

2013: Energy Agreement for Sustainable Growth and Climate Agenda The Energy Agreement for Sustainable Growth was a landmark agreement involving the government, employers, trade unions, and environmental organizations. It set targets for 16% renewable energy by 2023 and outlined a framework for sustainable growth. The Climate Agenda, introduced the same year, provided a comprehensive approach to climate change, addressing both domestic and international dimensions (Rijksoverheid, 2013).

2015: International Climate Agreement (Paris Agreement) The Netherlands' commitment to the Paris Agreement underscored its dedication to global climate goals. This agreement aligned with the national Energy Agreement, setting ambitious targets for greenhouse gas emissions reduction, adoption of renewable energy strategies, and energy-saving measures (UNFCCC, 2015).

2016: Energy Report and Energy Agenda The Energy Report 2016 and the Energy Agenda outlined long-term energy goals, aiming for 16% sustainable energy by 2023 and significant CO2 reductions by 2030 and 2050. These documents charted a path towards a low-carbon energy supply by mid-century, highlighting the need for continuous policy adaptation and technological innovation (Rijksoverheid, 2016).

2017: Agreement on Energy-Intensive Industries This agreement focused on energy savings within energy-intensive industries, recognizing the critical role these sectors play in national emissions. It aimed to enhance energy efficiency and reduce the carbon footprint of heavy industries through targeted measures (Rijksoverheid, 2017).

2018: Legislative and Policy Milestones Several significant policies were introduced in 2018, including:

- **Ban on Electricity Generation with Coal by 2030**: This decisive action aimed to phase out coal-based electricity, a major step towards reducing carbon emissions (Rijksoverheid, 2018).
- **Introduction of Climate Act Proposal**: This proposal aimed for a 95% reduction in emissions by 2050, establishing a clear long-term vision for climate policy (Rijksoverheid, 2018).
- **Publication of Climate Agreement Outlines and Passage of Climate Act**: These initiatives set interim targets, including a 49% CO2 reduction by 2030, and facilitated discussions on implementing the Dutch Climate Agreement (Rijksoverheid, 2018).

2019: Integrated National Energy and Climate Plan In 2019, the passage of the Climate Act by both chambers of parliament formalized CO2 reduction targets and ensured a comprehensive climate plan. The completion of the Climate Agreement and the submission of the Integrated National Energy and Climate Plan to the European Commission marked critical.

2021: UN Climate Conference (COP26) At COP26, global agreements were reached that reinforced the Netherlands' commitment to international climate goals. These agreements highlighted the importance of global cooperation in addressing climate change (UNFCCC, 2021).

2022: Coalition Agreement of Rutte IV Cabinet and Climate Policy Program The Coalition Agreement of the Rutte IV Cabinet outlined ambitious climate policies, aiming for at least a 55% emission reduction by 2030. The Draft Climate Policy Program and the annual Climate Day presentations further demonstrated the government's ongoing commitment to tightening climate goals and ensuring transparency in progress (Rijksoverheid, 2022).

Year	**Policy**	Description
2011	Local Climate Agenda	Collaborative effort among local entities and the national government to achieve climate goals.
2013	Energy Agreement for Sustainable Growth and Climate Agenda	Set targets for renewable energy and provided a comprehensive approach to climate change.
2015	International Climate Agreement (Paris Agreement)	Aligned national targets with global climate goals..
2016	Energy Report and Energy Agenda	Outlined long-term energy goals and the path towards a low-carbon energy supply.
2017	Agreement on Energy-Intensive Industries	Focused on enhancing energy efficiency in heavy industries.
2018	Various Legislative Milestones	Included a coal ban, Climate Act proposal, and Climate Agreement outlines.
2019	Integrated National Energy and Climate Plan	Formalized CO2 reduction targets and aligned national policies with EU directives.
2021	COP26 Agreements	Reinforced commitment to international climate goals.
2022	Coalition Agreement of Rutte IV Cabinet and Climate Policy Program	Aimed for ambitious emission reductions and transparent progress tracking.

Table 1: Overview of the Dutch governmental policies

The policy document analysis aimed to understand the national, regional, and municipal strategies, regulatory frameworks, and strategic priorities influencing the energy transition in the Netherlands. By examining a series of pivotal documents over a timeline, the study sought to evaluate the evolution, effectiveness, and alignment of Dutch climate policies with both national and international commitments.

The evolution of Dutch government policies regarding the energy transition reflects a strategic and multi-faceted approach to addressing climate change. The policies have progressively set higher targets and broader frameworks, indicating a deepening commitment to sustainability. Several key elements illustrate the comprehensive nature of these policies and will be discussed in more detail below:

- **Collaborative Governance**

Early policies, such as the Local Climate Agenda of 2011, underscored the importance of collaborative governance. This agenda involved municipalities, provinces, water boards, and the national government working together to achieve climate and sustainability goals. Collaborative governance ensures that policies are not only top-down mandates but are also supported and implemented effectively at local levels. This approach fosters local buy-in, essential for the successful execution of climate policies (Jordan and Lenschow, 2010).

- **Long-Term Vision**

The Dutch government's policies are characterized by a clear long-term vision, crucial for guiding incremental progress toward ambitious climate goals. The Energy Agenda and the Climate Act Proposal exemplify this vision. The Energy Agenda, established in 2016, set long-term goals for 2050, including a transition to a low-carbon energy supply. The Climate Act, passed in 2019, formalized these ambitions with a target of a 95% reduction in emissions by 2050 (Rosenow et al., 2017). These documents provide a strategic framework that helps align short-term actions with long-term objectives, ensuring continuity and coherence in policy implementation.

- **Sector-Specific Strategies**

The Netherlands has implemented sector-specific strategies to address significant sources of emissions effectively. For example, the Agreement on Energy-Intensive Industries (2017) targeted energy savings within heavy industries, which are major contributors to national emissions. Similarly, the ban on electricity generation with coal by 2030, introduced in 2018, was a targeted measure to reduce reliance on high-carbon energy sources. Such sector-specific strategies are crucial for addressing the unique challenges and opportunities within different parts of the economy, enabling more precise and effective interventions.

- **International Alignment**

The Netherlands has consistently aligned its national policies with international climate agreements. The commitment to the Paris Agreement in 2015 demonstrated the country's dedication to global climate goals. Participation in international forums, such as the UN Climate Conferences (COP), further underscores this alignment. By integrating international commitments into national policy frameworks, the Netherlands reinforces its role in the global climate agenda and ensures that its policies are in harmony with broader global efforts (Meadowcroft, 2009).

- **Adaptive and Inclusive Policies**

The introduction of adaptive and inclusive policies has been a cornerstone of the Dutch approach to the energy transition. The Energy Agreement for Sustainable Growth (2013) is a prime example, involving a wide range of stakeholders, including the government, employers, trade unions, and environmental organizations. Such inclusivity ensures that diverse perspectives are considered, enhancing the legitimacy and acceptance of policies (Hoppe et al., 2016). Adaptive policies, capable of evolving in response to new information and changing circumstances, are essential for maintaining momentum and addressing the dynamic nature of energy transitions.

The Dutch government's policies demonstrate a comprehensive, inclusive, and evolving strategy to achieve a carbon-neutral energy supply. By integrating local actions with national and international commitments, and focusing on both regulatory measures and incentives, the Netherlands is positioning itself as a leader in the global energy transition. The strategic alignment of collaborative governance, long-term vision, sector-specific strategies, international alignment, and adaptive policies creates a robust foundation for sustained progress toward sustainability.

2.7. Energy-inclusive planning

The integration of renewable energy sources into environmental and infrastructure planning in the Netherlands necessitates an energy-inclusive approach to ensure an efficient and effective energy transition. Energy-inclusive planning systematically incorporates renewable energy considerations into all levels of spatial planning and policymaking, demanding a multidisciplinary framework that bridges environmental sustainability with infrastructure development. Loorbach et al. (2017) emphasize that successful energy transitions depend on collaborative governance models that involve stakeholders from various sectors, including government, industry, and local communities, to co-create and implement comprehensive energy policies. Such an inclusive approach can help mitigate potential conflicts between renewable energy projects and existing land uses, as highlighted by Wolsink (2010), who underscores the importance of spatial compatibility and social acceptance in renewable energy deployment. Additionally, robust planning frameworks must account for the dynamic nature of technological advancements in renewable energy, ensuring that infrastructure is adaptable and resilient to future changes (Sovacool, 2016).

This adaptability is crucial in addressing the uncertainties and evolving needs associated with renewable energy technologies. Moreover, integrating renewable energy into infrastructure planning involves addressing grid capacity, storage solutions, and smart grid technologies to enhance efficiency and reliability (Hvelplund, 2013). Therefore, to facilitate an efficient energy transition in the Netherlands, it is imperative to adopt an energy-inclusive planning strategy that integrates renewable energy considerations into environmental and infrastructure planning, promotes stakeholder collaboration, adapts to technological innovations, and ensures the development of resilient energy infrastructures.

The integration of renewable energy sources into environmental and infrastructure planning in the Netherlands necessitates an energy-inclusive approach to ensure an efficient and effective energy transition. Energy-inclusive planning systematically incorporates renewable energy considerations into all levels of spatial planning and policymaking, demanding a multidisciplinary framework that bridges environmental sustainability with infrastructure development. Loorbach et al. (2017) emphasize that successful energy transitions depend on collaborative governance models that involve stakeholders from various sectors, including government, industry, and local communities, to co-create and implement comprehensive energy policies. Such an inclusive approach can help mitigate potential conflicts between renewable energy projects and existing land uses, as highlighted by Wolsink (2010), who underscores the importance of spatial compatibility and social acceptance in renewable energy deployment. Additionally, robust planning frameworks must account for the dynamic nature of technological advancements in renewable energy, ensuring that infrastructure is adaptable and resilient to future changes (Sovacool, 2016). This adaptability is crucial in addressing the uncertainties and evolving needs associated with renewable energy technologies. Moreover, integrating renewable energy into infrastructure planning involves addressing grid capacity, storage solutions, and smart grid technologies to enhance efficiency and reliability (Hvelplund, 2013). Therefore, to facilitate an efficient energy transition in the Netherlands, it is imperative to adopt an energy-inclusive planning strategy that integrates renewable energy considerations into environmental and infrastructure planning, promotes stakeholder collaboration, adapts to technological innovations, and ensures the development of resilient energy infrastructures.

Building on the need for energy-inclusive planning, the Netherlands must prioritize integrating renewable energy into existing infrastructure through adaptive and resilient frameworks. This involves addressing the technical, economic, and social dimensions of the energy transition. Technical aspects include upgrading grid infrastructure to accommodate decentralized renewable energy sources, enhancing energy storage capabilities, and implementing smart grid technologies (Geels et al., 2017). Economically, it is vital to create incentives for renewable energy investments and ensure fair market conditions that favour sustainable energy solutions (Van der Waal, 2018). Socially, public acceptance and community involvement are critical, as Wolsink (2010) highlights the importance of stakeholder engagement in fostering local support and minimizing opposition to renewable energy projects. Furthermore, incorporating renewable energy into urban planning can lead to co-benefits such as improved air quality, enhanced public health, and economic revitalization (Smith and Stirling, 2018). A holistic approach to planning not only focuses on the deployment of renewable energy technologies but also considers broader socio-economic impacts and environmental benefits. Such an approach ensures that the energy transition is not only efficient but also equitable and sustainable, aligning with the broader goals of sustainable development and climate change mitigation (Loorbach et al., 2017). Thus, it is suggested that the Netherlands can achieve a successful energy transition by adopting comprehensive planning strategies that integrate renewable energy, promote technological innovation, and engage diverse stakeholders in the transition process.

2.8 Conceptual model

The conceptual model illustrated in Figure 2 depicts the framework of concepts to understand how the energy transition of renewable energy sources can be efficiently incorporated into environmental and infrastructure planning in the Netherlands. Central to this model is the primary research question, which is addressed through four interconnected domains: the vision of the Netherlands, the energy transition theory and policy paradigm, government policies, and energy-inclusive planning.

The Vision of the Netherlands This domain emphasizes the national goals of achieving a sustainable and CO2-neutral energy system by 2050, aligning with EU climate goals and addressing fossil fuel challenges. The vision sets the overarching objectives and benchmarks for the energy transition, ensuring that efforts are geared towards long-term sustainability and compliance with international commitments. By outlining a clear and ambitious vision, the Netherlands can mobilize resources, inspire public and private sector engagement, and create a unified direction for all stakeholders involved in the energy transition.

The Energy Transition Theory and Policy Paradigm This component highlights the socio-technical shift required for the energy transition, rooted in policy paradigms and long-term visions. It underscores the importance of adaptive capacity and the role of innovation and trust in facilitating this transition. The theoretical foundation provides a comprehensive understanding of the systemic changes needed, encompassing technological advancements, policy innovations, and societal shifts. By integrating socio-technical theories, this domain helps identify the levers for change and the mechanisms through which the energy transition can be accelerated, ensuring that policies are adaptive and capable of addressing emerging challenges.

Government Policies This section focuses on the strategies and frameworks employed by the Dutch government, including collaborative governance, long-term visions, sector-specific strategies, international alignment, and adaptive and inclusive policies. Government policies are the practical tools through which the vision and theoretical paradigms are implemented. This domain ensures that the energy transition is supported by robust, coherent, and flexible policy instruments that can adapt to changing circumstances and drive sector-specific advancements. The collaborative aspect highlights the need for multi-stakeholder involvement, ensuring that policies are inclusive and benefit from diverse perspectives and expertise.

Energy-Inclusive Planning This area addresses the need for a multidisciplinary framework that integrates renewable energy considerations into spatial planning and policymaking. It emphasizes stakeholder collaboration, technical and economic dimensions, and a holistic approach to planning. Energy-inclusive planning ensures that the energy transition is embedded in all aspects of environmental and infrastructure planning, fostering synergies between different sectors and minimizing conflicts. By involving various stakeholders, including local communities, businesses, and technical experts, this domain promotes a comprehensive and inclusive approach to planning that balances environmental, economic, and social considerations.

Together, these elements form a robust model that guides the efficient integration of renewable energy into the Netherlands' environmental and infrastructure planning. Each domain contributes to the overall success of the energy transition by addressing specific aspects of the process:

- **The Vision of the Netherlands** sets the long-term goals and provides a clear direction.

- **The Energy Transition Theory and Policy Paradigm** offers the theoretical basis for understanding and driving systemic change.
- **Government Policies** provide the actionable strategies and regulatory frameworks needed to implement the vision and theoretical insights.
- **Energy-Inclusive Planning** ensures that renewable energy integration is multidisciplinary, inclusive, and holistic.

By aligning these domains, the model ensures that the energy transition is not only technically and economically viable but also socially acceptable and environmentally sustainable. This integrated approach maximizes the potential for a successful and efficient energy transition, addressing the multifaceted challenges and opportunities involved in shifting towards renewable energy sources in the Netherlands.

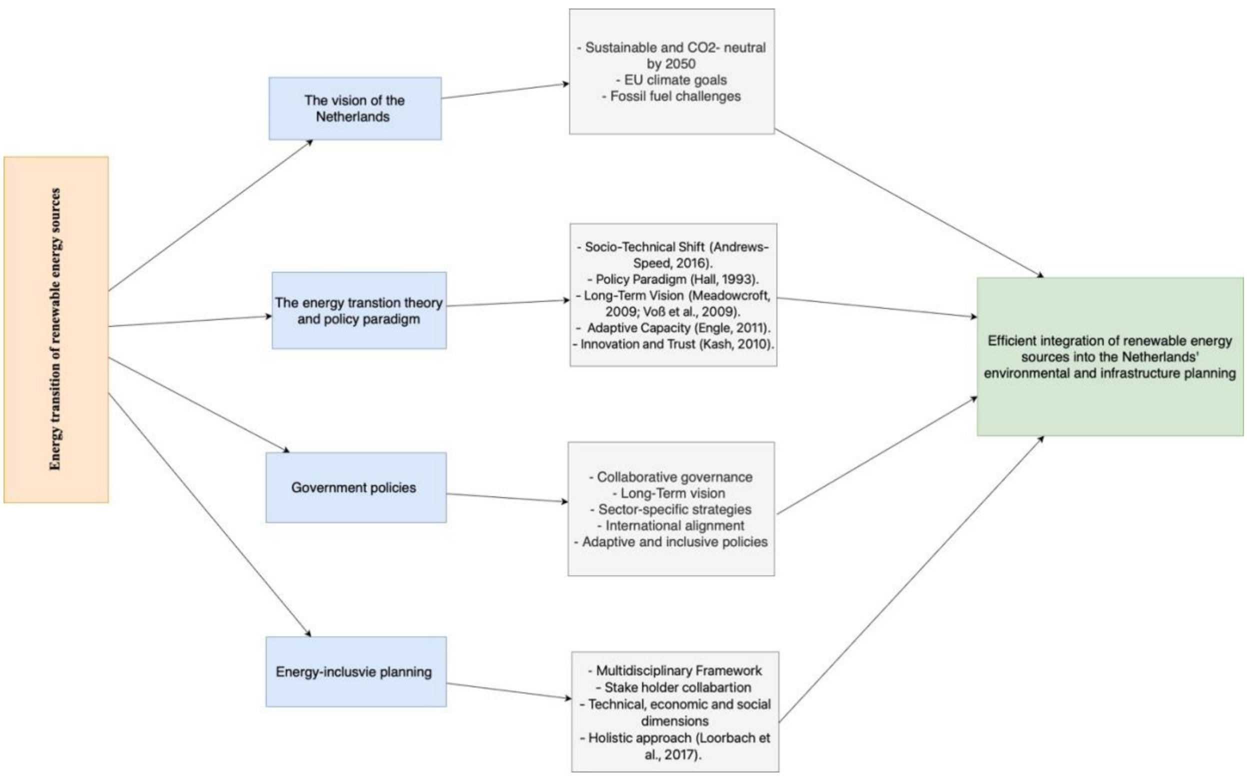


Figure 2 Conceptual model by author

2.9 Hypothesis

Based on the literature review and conceptual model outlined in Chapter 2, a key hypothesis that can be derived and tested within this research can be formulated. The results that the researcher expects to find with this study are that the efficient incorporation of renewable energy sources into environmental and infrastructure planning is crucial for facilitating a smooth energy transition in the Netherlands. It would therefore suggest that strategic integration of renewable energy technologies within existing infrastructure and environmental frameworks can enhance the efficacy of the transition process. It is further suggested that, by optimizing the alignment between renewable energy deployment and environmental considerations, the Netherlands can effectively navigate its shift towards sustainable energy sources. Key environmental considerations include biodiversity preservation, land use management, and infrastructure development. By addressing these factors, the Netherlands can minimize disruptions and maximize benefits for both the environment and society.

Chapter 3: Methodology

The methodology section of this research aims to outline the systematic approach employed to address the complex question of efficiently incorporating renewable energy sources into environmental and infrastructure planning for the Netherlands' energy transition. This section will detail the interviews utilized for data collection, analysis, and synthesis to provide comprehensive insights into the dynamics of energy transition within the Dutch context. By combining a comprehensive literature review with a qualitative research design featuring interviews with experts in the field, this study aims to provide robust strategies and recommendations to facilitate an efficient and sustainable energy transition.

This method was deemed the best for this research for several reasons. Firstly, semi-structured interviews allow for in-depth exploration of complex issues, providing rich qualitative data that captures the nuanced perspectives of experts. The flexibility of the semi-structured format enables interviewees to elaborate on their responses, leading to more comprehensive insights. Additionally, by interviewing experts directly involved in the energy sector, the study ensures that the data is contextually relevant and directly applicable to the Netherlands' specific circumstances. Lastly, the qualitative approach is well-suited to exploring new and emerging themes without the constraints of predefined categories, making it ideal for the dynamic field of renewable energy transition.

3.1 Unit of analysis

The unit of analysis was determined by defining spatial boundary, theoretical scope, and timeframe (Yin, 2003). The spatial boundary of this case study was the territory of the Netherlands while the theoretical scope was defined based on a literature study. Energy transition, Renewable energy, Environmental planning, Infrastructure planning, and Policy frameworks are the key concepts theoretically embedding this study. Especially in studying governance processes, it was relevant to define a timeframe.

The unit of analysis in this study is focused on the macro level dimensions of environmental and infrastructure planning related to the energy transition of renewable energy sources in the Netherlands. At the macro level, the unit of analysis included national policies, regulations, and frameworks governing energy transition and environmental planning. This involved examining specific legislative documents, governmental reports, and strategic plans, such as:

- **Dutch Climate Agreement (Klimaatakkoord)**: Selected for its comprehensive coverage of national targets and policy measures to reduce greenhouse gas emissions and transition to renewable energy.
- **National Energy and Climate Plan (NECP)**: Chosen for its relevance in guiding the overall energy transition framework, detailing national objectives, policies, and measures for energy and climate action.
- **Reports from the Netherlands Environmental Assessment Agency (PBL)**: Included for their critical assessments and evaluations of environmental and energy policies, providing insights into the effectiveness and impacts of current policies.
- **The Energy Agenda**: Selected to understand the strategic direction and long-term planning aspects of the Dutch energy transition.
- **Governmental Reports on Renewable Energy Targets and Policies**: These reports, including annual progress reports and evaluations of renewable energy targets, were chosen to assess the progress and effectiveness of implemented policies.

These documents were selected based on their relevance to the energy transition, their comprehensive coverage of policy measures and strategies, and their authoritative nature. They represented the key national-level frameworks and strategic plans guiding the energy transition in the Netherlands.

Furthermore, the unit of analysis extended to stakeholders involved in environmental and infrastructure planning. This included governmental bodies, regulatory agencies, energy companies, urban planners, environmental NGOs, community groups, and residents. Understanding the perspectives, interests, and roles of these stakeholders was essential for evaluating the effectiveness and inclusivity of energy transition efforts. There is a paragraph in the literature review about the stakeholders and two stakeholders were interviewed. One stakeholder that was interviewed worked for the government and gave the perspective from the Dutch government and one stakeholder that was interviewed worked for an energy transporting company and gave the perspective from an energy transport company. The interviews were designed to explore stakeholders' perspectives on the energy transition, including their experiences, challenges, and contributions. The interviews provided insights into the practical implementation of policies, the effectiveness of current strategies, and areas for improvement.

By adopting a multi-level and multi-dimensional unit of analysis, this study aims to provide a comprehensive understanding of how renewable energy sources can be efficiently incorporated into environmental and infrastructure planning to facilitate an efficient energy transition in the Netherlands. This approach enables the exploration of policy implications, governance structures, stakeholder dynamics, and practical strategies for advancing sustainable energy transition goals at various scales.

3.1.2 Policy Document Analysis

The policy document analysis discussed in chapter 2 aimed to understand the national, regional, and municipal strategies, regulatory frameworks, and strategic priorities influencing the energy transition in the Netherlands. This section details the specific documents analyzed, the rationale for their selection, and the methods used for their analysis. The policy document analysis is part of the literature review.

The following key policy documents were selected for analysis:

- **Dutch Climate Agreement (Klimaatakkoord)**: This agreement outlines the Netherlands' commitments and strategies to reduce greenhouse gas emissions and transition to renewable energy. It was selected for its comprehensive coverage of national targets and policy measures.
- **National Energy and Climate Plan (NECP)**: The NECP details the national objectives, policies, and measures for energy and climate action. It was chosen for its relevance in guiding the overall energy transition framework.
- **Reports from the Netherlands Environmental Assessment Agency (PBL)**: PBL reports provide critical assessments and evaluations of environmental and energy policies. These reports were included to gain insights into the effectiveness and impacts of current policies.
- **The Energy Agenda**: This document outlines long-term strategies for the Dutch energy transition. It was selected to understand the strategic direction and long-term planning aspects.
- **Governmental Reports on Renewable Energy Targets and Policies**: These reports include annual progress reports and evaluations of renewable energy targets. They were chosen to assess the progress and effectiveness of implemented policies.

These documents were selected based on their relevance to the energy transition, their comprehensive coverage of policy measures and strategies, and their authoritative nature. They represent the key national-level frameworks and strategic plans guiding the energy transition in the Netherlands.

The analysis of these policy documents followed a systematic approach to ensure a thorough understanding of the strategies, policies, and regulatory frameworks influencing the energy transition. The policy document analysis provided a detailed understanding of the strategic and regulatory landscape guiding the energy transition in the Netherlands. It revealed the strengths and weaknesses of current policies, identified areas for improvement, and highlighted successful strategies that could be scaled or replicated. The findings from this analysis were used to inform recommendations for enhancing the efficiency and effectiveness of the energy transition in the Netherlands.

This systematic approach to policy document analysis ensured that the research was comprehensive, replicable, and provided valuable insights into the governance structures and strategic priorities shaping the Dutch energy transition.

3.2 Data collection and participants

A comprehensive literature review was conducted to establish the theoretical framework and contextual background for the study. This involved reviewing existing research on energy transitions, renewable energy integration, and policy frameworks. Key concepts include energy transition, renewable energy, environmental planning, infrastructure planning, and policy frameworks.

The data for this qualitative study was collected by doing semi-structured interviews with experts in the field of energy transition. According to DiCicco-Bloom and Crabtree (2006) 'semi-structured in-depth interviews are the most widely used interviewing format for qualitative research. By using interviews as a research method, in-depth insights were gained about individual experiences, perceptions and motivations that are important to say something about employee attitudes and behaviour. By embracing a qualitative data collection and analysis approach, the researcher was able to delve more extensively into the current situation pertaining to energy transition in the Netherlands (Ehigie and Ehigie, 2005). The interviews provided flexibility and allowed participants to make meaningful contributions that included their own inputs relating to the issue of energy transitioning. It also enabled the researcher to ask interviewees to elaborate on their responses, thereby gaining deeper insights into their perspectives and contributing to a more comprehensive body of knowledge (Slack et al., 2015).

For the data generation, a purposive sampling method (non-probability sampling) was conducted in which interviewees were not chosen randomly but on purpose. The researcher recruited both national government employees and employees of organizations that worked in the energy sector to gain insight into their different perspectives on the energy transition. These experts worked in organizations in the Netherlands and were contacted by email. These were also, for the researcher, unknown participants who were previously examined as suitable candidates with the use of the information on the internet and by asking the potential participants if they had experienced the energy transition. The incentive for employees of the companies and government organizations to participate related to vested interest in the topic of their working field.

The participants were contacted by the author by email informing them about the topic, the duration of the interview, their privacy, and the choice between face-to-face or online interviews. Before the interview started, the participants were informed about the anonymity of the interviews and the possibility to withdraw from the voluntary study at any point in time without giving a reason. Both the interview answers as well as the personal data of the employees who participated were made anonymous and not traceable. Interviews conducted for the research lasted about 30 to 45 minutes. Two experts were interviewed. At the time of these interviews, one expert worked for a government organization and one expert worked for an energy supplier or energy transporter. This provided insight into the different views of the Dutch government and the Dutch energy companies regarding the energy transition.

The following questions will be asked to the different experts during the interviews:

1.How would you define the term "energy transition" within the context of renewable energy sources?

2. Why is it important for the Netherlands?

3. What is the current landscape of the Netherlands regarding the energy transition?

4. What are some key environmental considerations that need to be considered when incorporating renewable energy sources into infrastructure planning?

5. Can you provide examples of successful strategies used in other regions or countries to efficiently integrate renewable energy into existing infrastructure?

6.How applicable are these strategies to the Netherlands?

7. What role do you see technology playing in facilitating the energy transition towards renewable sources, particularly in terms of infrastructure development and environmental impact mitigation?

8. How do you assess the current state of infrastructure readiness in the Netherlands for accommodating increased renewable energy production?

9. What are the main challenges and opportunities in this regard?

10. What are some potential policy and regulatory changes that could accelerate the adoption of renewable energy sources while ensuring environmental sustainability and infrastructure efficiency?

11. Stakeholder engagement is often crucial for the successful implementation of energy transition initiatives. How do you recommend engaging various stakeholders, including government entities, energy companies, environmental groups, and the public, in the planning and execution process?

12. Can you discuss the economic implications of transitioning to renewable energy sources? How can cost-effectiveness be balanced with environmental considerations in infrastructure planning?

13. Are there any specific technological innovations or emerging trends that you believe will have a significant impact on the efficiency of incorporating renewable energy into infrastructure planning in the Netherlands?

14. What are the key opportunities involved in integrating renewables into existing infrastructure, and how can understanding these factors facilitate the development of strategies aimed at optimizing the transition process?

15. What are the small-scale challenges for individual residences

16 What are the large-scale challenges for local government and service providers?

17. Looking ahead, what do you envision as the key milestones or benchmarks for measuring progress towards a more efficient energy transition in the Netherlands?

Through expert interviews, the researcher gathered valuable insights on various aspects crucial to the successful incorporation of renewable energy sources into environmental and infrastructure planning in the Netherlands. Firstly, experts provided definitions and explanations of the concept of "energy transition" specific to renewable energy sources, emphasizing its significance within the Dutch context. They offered an overview of the current energy transition landscape in the Netherlands, highlighting progress made and areas requiring further development. Additionally, experts discussed key environmental considerations associated with integrating renewable energy sources into infrastructure planning, drawing from examples of successful strategies implemented in other regions or countries and assessing their applicability to the Dutch context. Moreover, experts evaluated the role of technology in facilitating the energy transition, particularly in terms of infrastructure development and environmental impact mitigation. They assessed the readiness of existing infrastructure in the

Netherlands to accommodate increased renewable energy production, identifying challenges and opportunities in this regard. Furthermore, experts proposed potential policy and regulatory changes to accelerate the adoption of renewable energy sources while ensuring environmental sustainability and infrastructure efficiency. The interviewees also provided their inputs and recommendations regarding stakeholder engagement strategies, economic implications of transitioning to renewable energy sources, and the integration of technological innovations into infrastructure planning. Finally, experts discussed key opportunities and challenges at both small and large scales, envisioning milestones for measuring progress towards a more efficient energy transition in the Netherlands and strategies for achieving these goals effectively and sustainably.

3.3 Data analysis

The data analysis process began with transcribing the interviews, using the application transkriptor. Following transcription, the researcher meticulously reviewed the transcripts while listening to the recordings to correct any errors. Notably, the interviews were conducted in Dutch, reflecting the participants' language preference, and facilitating more expressive communication. Subsequently, the Dutch transcripts were translated into English using DeepL, Nonetheless, conducting the interviews in Dutch was deemed beneficial due to the participants' familiarity with the language. The Dutch transcripts can be found in the appendix.

Atlas.ti was employed to construct a coding framework, employing an inductive approach to explore the dataset. This approach allowed for the discovery of new theories and concepts without preconceived assumptions. Initially, open coding was utilized to identify noteworthy information and assign corresponding codes. Because the researcher had two interviews, axial coding and selective coding had not been used. The researcher had enough structure to the data. The codes that the researcher have used can be found in the appendix. The researcher merged the answers of the interviewees to the interview question resulting in core categories utilized in the results and discussion sections to develop a coherent theoretical framework for the research discourse.

3.4 Ethical considerations

Ensuring ethical considerations are paramount in any academic research endeavour, particularly in the context of a master's thesis, where rigorous ethical standards are expected. Ethical principles guide researchers in upholding integrity, respecting participants' rights, and maintaining the credibility of their work.

First and foremost, informed consent stands as a cornerstone of ethical research. Participants must be fully informed about the purpose, procedures, potential risks, and benefits of the study before consenting to participate. This includes transparency regarding data collection methods, privacy measures, and any potential conflicts of interest.

Privacy and confidentiality are equally crucial. Researchers must safeguard the anonymity of participants, ensuring that sensitive information remains confidential. This involves employing secure data storage and transmission methods, using pseudonyms, or anonymizing identifiers, and limiting access to data only to authorized personnel.

Respect for participants' autonomy and dignity is non-negotiable. Researchers must refrain from coercion, undue influence, or manipulation when recruiting participants or collecting data. Moreover, researchers should be mindful of power dynamics and strive to maintain a balanced and respectful relationship with participants throughout the research process.

Another vital consideration is the minimization of harm. Researchers must anticipate and mitigate any potential risks or discomforts that participants may experience because of their involvement in the study. This includes conducting thorough risk assessments, implementing appropriate safeguards, and providing access to support services if needed.

Equity and fairness should also guide researchers' interactions with participants. It is essential to ensure diversity and inclusivity in participant selection, avoiding any form of discrimination or bias. Additionally, researchers should strive to uphold the principles of social justice and avoid reinforcing existing inequalities through their research practices.

Finally, transparency and integrity in reporting findings are fundamental. Researchers must accurately represent their data, methodologies, and interpretations, avoiding any manipulation or selective reporting that could distort the truth. This includes disclosing any limitations or biases inherent in the research process and acknowledging contributions from other scholars or sources.

In summary, ethical considerations are integral to the conduct of an academic master's thesis. By adhering to principles of informed consent, privacy, respect, minimizing harm, equity, and integrity, researchers can ensure that their work upholds the highest ethical standards and contributes meaningfully to knowledge generation and advancement.

Chapter 4: Results

The goal of this study was to explore how the energy transition of renewable energy sources can be efficiently incorporated into environmental and infrastructure planning in the Netherlands. This chapter presents the findings from two in-depth interviews conducted with experts in the field, addressing the primary and various secondary research questions. The results from the analysis of the policy documents are discussed in chapter 2.7.

Figure 3 illustrates the how the energy transition of renewable energy sources can be efficiently incorporated into environmental and infrastructure planning in the Netherlands. The model gives a schematic representation of the primary research objective through three finding from the interviews, that are interconnected domains: challenges, technological innovations, success factors, and the ultimate goal of efficient integration.The findings are organized around these research questions, providing a detailed analysis of the current landscape of renewable energy in the Netherlands, the effectiveness of existing policies, and the challenges and opportunities associated with integrating renewable energy into the Netherland's infrastructure. The information gained from the interviews, along with the author's insights obtained from the review of relevant policies, highlighted the importance of technological innovation, strategic policy frameworks, and effective stakeholder engagement in achieving a sustainable and efficient energy transition.

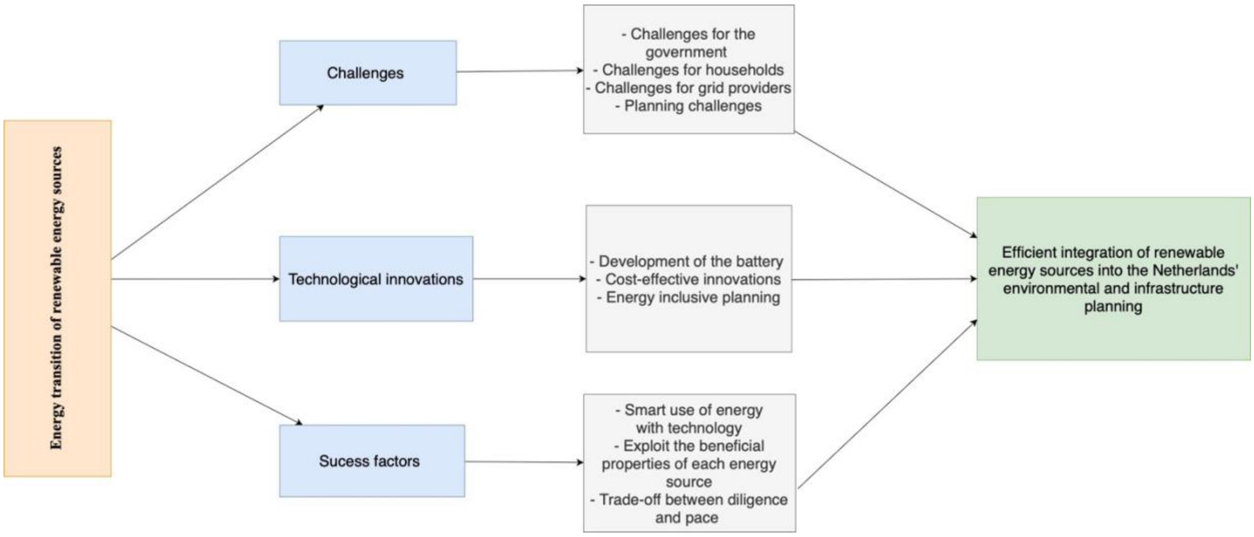


Figure 3: Figure of findings by author

The following sections present a synthesis of the interview data, structured to address each of the research questions systematically. This approach not only elucidates the current state of renewable energy in the Netherlands but also offers actionable recommendations for enhancing the efficiency and effectiveness of the energy transition process. For the results, quotes from the interviewees will be used denoted as interviewee *1 and interviewee *2.

4.1 Defining the energy transition

Firstly, the defining of the energy transition was discussed. Interviewee *1 defined the energy transition as a shift from fossil fuels to a future energy system based on sustainable sources with minimal or zero CO_2 emissions. This involves moving from fossil fuel reliance to energy primarily derived from renewable sources. This is evident from the following quote:

> "I think the most important thing is that the energy system of the future should be based on renewable sources and there should be no or very little residual CO_2 emissions. That seems to me to be a very general definition. So, we are moving from the world of fossil fuels to a world where energy is actually based on renewable sources."

The second interview defined the energy transition as moving towards a CO_2-free energy system, with a significant reliance on electricity. Approximately 80% of energy needs are expected to be met by electricity, with the remaining 20% from other renewable sources as interviewee *2 concluded in the following quote:

> "The energy transition means that we indeed want to use CO_2-free energy. And if I look a bit through the eyelashes, I think 80% electricity and 20% other things will eventually come out. So electricity is going to be a very important carrier though."

Both interviewees emphasized the shift towards a sustainable, low-CO_2 energy system, highlighting the critical role of renewable energy sources and the increasing importance of electricity in meeting future energy demands.

4.2 The importance of the energy transition for the Netherlands

Furthermore, the energy transition is important to the Netherlands for several reasons, according to the interviewees. The first interviewee concluded that the Netherlands has a large industrial sector, and that industrial sectors must become sustainable to remain competitive and maintain its position in the global market as can be concluded from the following quote:

> "Important for every country. For the Netherlands, it is particularly important because we have a very large industrial sector in the Netherlands. And if we want to keep using that industrial sector and if it wants to keep its place here, it will also have to become more sustainable. I think that is a very big task. So it is the industrial sector that makes it specifically important for us."

Furthermore, according to interviewee *2, given the high energy intensity of the Dutch economy and its dense population, the transition is critical to ensure sustainable energy use. The country's favorable geographic position, with access to wind and solar resources, underscores the need for a balanced energy mix. The move from a compact, centrally managed fossil fuel system to a decentralized renewable system presents spatial and infrastructural challenges, that can be concluded from this quote:

> "You can look at it in different ways. Look, the Netherlands is just very densely populated. We have an energy-intensive society. So yes, if you say of are we going to meet our energy needs with wind alone, that's an answer no. Probably not with solar either. Plus, all the pros and cons attached to it. If it's not windy, you have no energy. So, you also must arrange some form of storage. Yes, so it's just quite a challenge to move from basically a very compact and centrally regulated energy system to decentralised generation."

Therefore, according to interviewee 1, the Netherlands has a favorable geographic position with access to the North Sea, providing significant potential for generating renewable energy, particularly through wind power as can be concluded from the following quote:

> "And another reason why the Netherlands has a special position is because we have a certain location, a favourable location too, by the sea, so with ports. And also, because the sea, in this case the North Sea, can play an important role in generating renewable energy."

In summary, the Netherlands' large industrial sector, dense population, high energy intensity, and favorable geographic position collectively underscore the critical need for a well-planned and efficiently executed energy transition to ensure sustainability and maintain economic competitiveness.

4.3 The current state of the energy transition in the Netherlands

According to the interviewees, the Netherlands is still at the beginning of its energy transition. Interviewee *2 concluded that, the Netherlands currently derives about 25% of its energy from renewable electricity. If the climate agreement is fully implemented, 80% of this electricity will be sustainable. The country is making strides in the warm transition, utilizing less natural gas by leveraging residual heat, but there is still a long way to go, as can been seen from this quote:

> "How far along are we? This is a bit over the top. We consume about 25% of our electricity consumption from electricity. If the climate agreement is implemented, we will have 80% of it renewable. That means we are left with three quarters of fossil, which we also must do something with. The heat transition is in full swing. A lot is happening there. For example, do you need less natural gas because you use residual heat or something like that. Well, good. So yes, we are on our way. First steps are being taken, but there is still quite a long way to go."

According to interviewee *1, there has been progress in solar energy, making the country a leader in solar panel installations per capita. Offshore wind farms are also developing well. However, despite these advances, the Netherlands remains heavily dependent on fossil fuels for transportation and heating, indicating the need for further efforts to reduce fossil fuel reliance, as can be seen in the following quote:

> "There are a lot of solar panels in the Netherlands. I think we are champions in installing solar panels in recent years. And offshore wind farms, that is also starting to take shape. But for the rest, for getting rid of fossil fuels, So there we are still at the very beginning. Because, well, the cars we drive are still largely petrol cars or diesel. And heating in homes, but also in industry, that is still largely based on natural gas."

In conclusion, while the Netherlands has made notable progress in areas such as solar energy and offshore wind, and is advancing in the heat transition, both interviewees agree that the country remains at the early stages of its energy transition, with significant reliance on fossil fuels still to be addressed.

4.4 Environmental considerations in infrastructure planning

The environmental considerations in infrastructure planning are important according to the interviews. According to the interviewee *1, Infrastructure projects, including those for hydrogen, solar panels, and heat pumps, must be planned to minimize emissions. This involves complying with existing regulations on emissions and using machinery that limits pollution. Projects must adhere to regulations such as those for nitrogen emissions and the use of diesel generators to minimize environmental impact during construction. Following this quote from interviewee *1:

> "I think you just must consider that everything you do, so also things that you build in the context of the energy transition, that those in themselves also create emissions. So, you will have to regulate somehow. That building that infrastructure also takes place with limited emissions as much as possible. You then must comply with all kinds of legislation in that respect. Nitrogen legislation and the use of certain machines. That will also, if you use diesel generators, that you have emissions there too."

Renewable energy sources like wind and solar require substantial space, affecting landscapes and biodiversity. Wind turbines create noise and visual impact, while solar farms occupy large land areas, often on agricultural land. According to the interviewee *1, there must be a balance between efficiency and acceptance. Selecting the most efficient renewable sources must be balanced with public acceptance. The integration of renewables requires careful planning to minimize environmental impacts and ensure community support. Following this quote from interviewee *1:

> "Well, look, what I said, those decentralised sources, they have huge space requirements. So that means you have a huge impact. There are advantages and disadvantages to each generation. Wind turbines make noise. They have cast shadow. You can see them from far away. But they are more efficient than solar panels. In that sense, solar panels are less visible. But anyway, most solar parks are on agricultural land, but you can't do anything else underneath, so it is a mono-use of land. There are all kinds of things like that, so it does have to do with biodiversity. Well, every form of generation has its pros and cons, but they do have in common that they require a lot of space and thus have an impact on the living environment."

In conclusion, both interviewees underscore the importance of minimizing environmental impacts in infrastructure planning for the energy transition. This involves not only complying with emission regulations during construction but also balancing the efficiency of renewable energy sources with public acceptance and their environmental footprint.

4.5 Successful strategies from other countries

The researcher asked the interviewees to name an example of a successful strategy of the implementation of renewable energy sources into infrastructure and the environment from another country or region. Interviewee *1 gave the wind energy project of Denmark as an example of a successful strategy from another country. Denmark serves as a successful example, having recognized early the importance of wind energy, and developed substantial wind power infrastructure. (*1) Despite its smaller population, the country offers valuable lessons in renewable energy adoption. While Denmark's strategies are beneficial, differences such as higher population density in the Netherlands require tailored approaches. Both countries, however, benefit from their North Sea locations for offshore wind energy development. (*1)

> "I think Denmark has been very successful with wind energy. They started that in time. They realised early on that that could become very important. That's why Denmark now has a huge lead in terms of renewable generation. I think that is a good example. They may also have had it a bit easier. It is also a small country, just like the Netherlands, but fewer people live there. So perhaps it's a bit less of a struggle to get wind on land. Of course, the Netherlands and Denmark are similar in some ways. Particularly their location on the North Sea and their ability to use the North Sea and thus also offshore wind energy. In fact, I think the Netherlands and Denmark already cooperate very well there too. But indeed, I think we could have learned from Denmark's approach. But we do have differences." (*1)

Interviewee *2 gave an example of a successful strategy in the Netherlands. That example can be found in the form of The Eemshaven wind park. The Eemshaven wind park demonstrates effective integration within an industrial area, though it highlights challenges such as bird fatalities due to geographic peculiarities. (*2)

> "I think that if you look at a wind farm, for example, which is well integrated, it is, for example, the wind farm in Eemshaven. At the same time, there are also some pretty strong comments to make. Because it is simply located in a port area. It fits there just fine. It may never quite be ideal." (*2)

From the last response, it seems the Netherlands has already made great strides in implementing successful strategies. In conclusion, both interviewees highlighted the importance of learning from successful models, whether international or domestic. Denmark's early adoption of wind energy and the Netherlands' innovative integration of wind farms in industrial areas like Eemshaven illustrate that while challenges remain, strategic and context-specific approaches can significantly advance renewable energy adoption.

4.6 Role of technology in energy transition

Firstly, according to interviewee *1, building networks for electricity and gas does not require significant new technologies. However, advancements are crucial in energy storage, such as improved batteries and hydrogen storage solutions, which play a vital role in balancing energy supply and demand. (*1)

> "I think for building networks, whether it's power networks or pipelines for gas or hydrogen or whatever, that doesn't require a whole lot of new technology. I think Technology developments that you see especially in energy storage. For example, developing batteries that can store energy and electricity better, easier and more efficiently. For large-scale storage, you need hydrogen storage in salt caverns, for example, also in other places. I think technology can still play a very important role there to achieve improvements." (*1)

Therefore, technological developments in energy storage and smart grid technologies can significantly enhance the efficiency and reliability of renewable energy systems. Innovations in battery efficiency, storage capacity, and lifespan are critical. The development of technologies such as water-based energy storage also holds promise for enhancing energy reliability.

According to interviewee *2, existing infrastructure must be upgraded to handle peak loads efficiently. Technological innovations like smart homes and improved batteries are essential for optimizing energy use and storage. (*2)

> "There are a lot of technological aspects to it. Look, when you talk about infrastructure, for example. Infrastructure is explained on peak load. Well, that peak load is only a very limited part of the day. Well, through smarter use of electricity. So, well, smart homes or well, all some kind of things. Well, you could use technology for that. Can you maybe reduce the load. So using your grid more efficiently. Technical innovation is just needed anyway to increase cost and efficiency. We have seen with wind turbines that they have become much more efficient in recent years. We don't see that with solar panels, that they become cheaper and more efficient. That does something. Hydrogen is now one of those technologies that is very expensive, but may become more efficient in the future, so hydrogen will become more promising to fill a meaning." (*2)

In conclusion, both interviewees emphasized the pivotal role of technological advancements in energy storage and infrastructure optimization. While building networks may not demand new technologies, the development of efficient storage solutions and smart grid technologies is essential for enhancing the reliability and efficiency of renewable energy systems, thereby supporting the broader energy transition.

4.7 Readiness of current infrastructure

According to interviewee *1, studies indicate that the electricity grid is not yet ready for the increased load from renewable sources. Significant expansion and construction are needed, with the Tennet network potentially needing to double or triple by 2050. (*1)

"I think, it is very clear, as studies, IE3050 for example, have shown, that the power grid is far from ready. There is just a lot of building to be done. Tennet's network will have to at least double or triple by 2050. But that is just straight up hard work. And taking into account that high voltage also takes space." (*1)

The current electricity grid is insufficient to meet future demands, requiring significant expansion. The challenge lies in the physical and spatial requirements of new infrastructure. Interviewee *2) makes the comparison with road infrastructure:

> "The tricky thing with this kind of thing is, look, you know, you can say on the one hand it complies, because everyone has power now, at the same time a lot of things can't, so new developments can't be connected, so it doesn't comply. So yes, a whole lot of things need to be added. Thereby, of course, you can wonder about several things. You can compare it a bit to roads. Do you have to lay more asphalt at some point? Or should you at some point perhaps start talking about car use? I think it's a bit the same with infrastructure for energy. I just said, a quarter of our energy consumption is electric. And that other three quarters is probably going to be largely electric."

However, interviewee *1 also thinks that the gas networks, including those for future hydrogen transport, are largely in place and require minimal modifications. This presents an opportunity for efficient adaptation to renewable energy needs. (*1)

> "… I think the networks for transporting gas and, in the future, hydrogen and green gas, those are largely already in place. Not much needs to be done to them and they can last for a very long time." (*1)
> "… The gas networks can largely be reused. There will also have to be new construction, but the big difference is that for the gas networks most of what is already there can be worked with what we already have and can reuse. For electricity, a lot of new construction will be needed. (*1)

In conclusion, both interviewees highlighted the substantial infrastructure challenges and opportunities associated with the energy transition. While significant expansion of the electricity grid is essential to meet future demands, the existing gas networks offer a promising avenue for adaptation with minimal modifications, balancing the need for new construction with the reuse of current infrastructure.

4.8 Potential policy, regulatory changes, and stakeholder engagement

According to interviewee *1, streamlining and accelerating the permitting process for renewable energy projects can significantly reduce delays. Clear spatial planning and allocation of areas for specific energy uses are also crucial. It can reduce delays and facilitate the deployment of renewable projects. (*1)

> "I think it's very important that now a licence takes a lot of time. And so, I think there is room for improvement there. Speeding up permit procedures. And a good picture of what space in the Netherlands will be used for what. That is also very important." (*1)

According to interviewee *2) there must be a trade-off between diligence and pace in the government. The procedures can go faster but that means that there is less room for participation. (*2)

> "…. There is a kind of trade-off between being careful as a government and speeding up. So yes, can you go faster? Yes, then you must redesign your procedures, but that means less room for participation. Well, so then you do go faster, but then you adjust the legal protection of citizens." (*2)

Furthermore, according to interviewee *1, effective stakeholder engagement and strategic planning with clear, long-term planning is vital. This includes collaboration among national and local governments, industry, households, and environmental groups to ensure cohesive planning and execution. Clear, long-term strategic planning is needed to align infrastructure development with energy transition goals. It is a long-term process (*1)

"You have governments, so national government, but also provinces and municipalities. You have users, which can be households, which can also be industries. And you have the grid operators and the energy companies, which are all stakeholders in the whole process. And so you have to get them to work together to come up with the best solution. And that is already happening. There are all kinds of government programmes that are being worked on, such as the Provincial MIEK. For each province, you have a process that looks at how the energy system should be set up in that province and the future. And that's where all those parties you just mentioned are represented. So, I think that is already happening. This is a long-term process, and you also have to look far ahead to 2050."

According to interviewee *2, effective stakeholder management involves engaging national and local governments, industry, and the public. Existing frameworks like the omgevingswet (environmental law) emphasize participation, but practical challenges remain in involving all stakeholders effectively. (*2)

> "The Environment Act has just come into force, which requires a lot in terms of participation in processes. And this is also a continuous point of attention for governments, and we try to do this in the best possible way. What we see in practice is that it is very difficult to involve citizens, residents, when they are not directly affected. Ever since I started working in government, this has been a quest. The desire that is there does exist to involve citizens properly. But well, that is just very difficult. And companies, co-governments and other stakeholders, the professional stakeholders, they know their way around. They are simply in the network and are often involved in projects. So that is generally well managed. They will not always be satisfied with it, but that has more to do with the fact that they cannot always get their way." (*2)

In conclusion, both interviewees emphasized the importance of streamlining permitting processes, clear spatial planning, and effective stakeholder engagement to facilitate the energy transition. While accelerating procedures can lead to faster project deployment, it must be balanced with ensuring adequate public participation and long-term strategic planning.

4.9 Economic implications and balance with environmental considerations

With regards to economic implications and its balance with environmental considerations, interviewee *1 is of the opinion that transitioning to renewable energy may increase costs compared to cheap fossil fuels, necessitating strategies to maintain economic competitiveness within Europe. The energy transition has an impact on the industry. Industries dependent on cheap energy face significant adjustments. The shift to sustainable energy can affect their economic viability, requiring supportive policies to manage the transition. Therefore, coordinated policies at the European level are essential to manage costs and ensure competitive energy pricing. (*1)

> "Look, fossil energy has always been very cheap. And in the future... I think you must assume that it will only get more expensive. And that means a lot of users are not at all that enthusiastic in principle to switch. And you also must do it in such a way that you don't let the economic situation in the Netherlands deviate too much from that of neighbouring countries. So, I think you must coordinate that very well and look at it in a European context. And that is indeed what the European Union is for." (*1)

Furthermore, according to interviewee *2, the transition to renewable energy must balance cost-efficiency with environmental goals. Energy affordability and availability are crucial for maintaining economic activities and competitiveness. Interviewee *2 gives the example of the aluminum smelter company aDel that left the Dutch harbour city of Delfzijl due to the high energy costs. (*2)

> “Energy is our economy. We have an energy-intensive economy. So, the availability and affordability of energy largely determines economic activities. Renewable energy plays an increasingly important role in this. Because companies that must green up, they will at some point fall under ETS, i.e. European CO2 emissions trading, for example. But affordability and availability, in particular, determine a lot. In recent years, for instance, we have seen aDel leave Delfzijl, which was an aluminium smelter. That used a lot of energy. It had been for years that that was actually kind of hanging in there. In the end, it just couldn't pay its energy bill anymore. Otherwise, there have been more companies in recent years. So, affordability is one thing. But anyway, availability also becomes an issue at some point. Because we have grid conges and if companies can no longer have a connection, that's just not okay for your business climate.” (*2)

In conclusion, both interviewees underscore the necessity of balancing economic and environmental considerations in the energy transition. While renewable energy can increase costs, coordinated policies at the European level are crucial to maintain economic competitiveness. Ensuring energy affordability and availability is essential for sustaining economic activities and preventing the loss of industries dependent on cheap energy.

4.10 Technological innovations and trends

During the discussion around technological innovations and trends, Interviewee *1 gave multiple promising future innovations that can be successful, however a lot is still unclear as well. Ongoing innovation processes, including solid-state batteries and international electricity connections, hold promise for enhancing energy efficiency. (*1)

> “I think there are still a lot of innovation processes going on that we can expect something from. And I think there will also be some surprises. I personally think a lot is still unclear as well. You can expect something from other types of batteries, solid-state batteries for example. I think, also expect something from building more international connections, electricity connections.” (*1)

According to interviewee *2, emerging technologies such as thorium reactors and iron powder energy storage are being monitored. Market-driven adoption of new technologies highlights the importance of supportive policy frameworks and research funding. Emerging technologies like white hydrogen (naturally occurring hydrogen) could also impact future energy strategies. (*2)

> "Suppose iron powder is at once something that is totally awesome. How it usually goes is that the moment a technology emerges that is profitable, then we find that very quickly all kinds of initiators come along to see if those things are possible in the province. We have seen this with wind, and in recent years with solar. For a very long time, solar has not been profitable to do that on a large scale. At some point, due to other price developments, technological developments, you get to the point where it starts to come back around somewhere." (*2)

It should however be noted that the energy transition involves uncertainties, with potential technological breakthroughs yet to be realized. Focusing on research and development can help mitigate these uncertainties.

4.11 Opportunities in integrating renewable energy

The interviews gave multiple opportunities in integrating renewable energy. For example, the balancing op the supply and demand of energy. Integrating renewable energy sources with existing infrastructure requires balancing the variability of supply (e.g., solar and wind) with demand. This can be achieved by leveraging other energy carriers like hydrogen, which can store surplus energy and provide backup when renewable sources are insufficient. Energy storage solutions are important. Advanced storage solutions like batteries are critical for managing the variability of renewable energy sources and ensuring a stable supply. (*1)

> "I think the main opportunity is that whichever way you look at it, you will always have to deal with the fact that different energy carriers must interact. They are interrelated. If you start generating electricity on a large scale from sun and wind, the supply becomes very variable. Because the sun doesn't always shine, the wind doesn't always blow. So, you get a very variable supply. And that means supply and demand will always be in imbalance. And you must solve that somehow. And the best way to do that is to make use of the favourable properties of other energy carriers, such as hydrogen. And if you make them work well together, for example by making hydrogen at times when you don't need the electricity, or for example by using hydrogen that you have stored at times when the wind is not blowing, or the sun is not shining. I think that improves things a lot. The biggest opportunity lies there. Ensuring the best possible connections between different energy carriers." (*1)

Furthermore, according to interviewee *1, the biggest opportunity lies in creating well-connected systems where different energy carriers complement each other, enhancing overall system efficiency.

> "The biggest opportunity lies there. Ensure the best possible connections between different energy carriers." (*1)

Another example of an opportunity in integrating renewable energy is energy inclusive planning, according to interviewee *2. Integrating renewable energy into existing infrastructure requires inclusive planning. Early engagement with net operators and strategic planning can prevent future logistical challenges. (*2)

> "I would say if there were great opportunities the moment we would move to energy inclusive planning. Because what you see now is that it has been very well regulated in the Netherlands for a very long time. Infrastructure was never really a problem. It didn't take up that much space and if you had an initiative, well then, the grid manager came and installed a box, a cable and you were done. And now, the infrastructure takes up more space anyway because it just handles more power." (*2)

In conclusion, both interviewees emphasized the importance of balancing energy supply and demand through advanced storage solutions and creating well-connected systems of energy carriers. Additionally, strategic and inclusive planning involving early engagement with grid operators is essential to effectively integrate renewable energy into existing infrastructure and prevent future logistical challenges.

4.12 Challenges for households and network providers

According to interviewee *1, the biggest challenges for households in the uncertainty. Individual households face challenges in determining the best energy investments, such as whether to adopt all-electric systems or await local heat networks. Providing clear guidance and certainty is essential. Furthermore, energy poverty and uncertainty about future energy investments are significant challenges for households. Clear guidance on energy choices and financial support for sustainable investments are needed. (*1)

> "… I think for households, the biggest challenge is that, now, they don't know at all which way it will go. And, by no means everything is possible for every household. So, the big challenge is to find out of what should I invest in? What should I start doing? Should I switch to all electric? Or maybe there will be a heat grid in my neighbourhood? So, getting certainty about which energy carrier you will actually be dealing with as a household. I think that's a very important big challenge. And by no means everything is possible." (*1)

As for the network providers, the biggest challenges, are the expansion and optimization of the energy infrastructure. They need to find a balance between the need for new installations with community acceptance and environmental constraints. Providers must decide on gas network connections for households, balancing the need for continuity with the push for new energy systems. Expanding electricity networks and optimizing existing gas infrastructures for hydrogen are significant tasks. (*1)

> "They have as a major challenge, for example, that right now most households are connected to the gas grid. That won't be wrong in the future either, but for some of them it might still be. That means you must start trying to figure out where you do still connect houses to a gas grid. That could include hydrogen or green gas. And where not. And so, where you can also take away part of the network or not. I think that will be most of the work for grid operators. And the expansion of power grids of course that goes with that."

In conclusion, both interviewees highlighted the importance of providing clear guidance and support for households to navigate energy investments, while network providers face the dual challenge of expanding and optimizing infrastructure in alignment with environmental and community considerations. Ensuring coordinated efforts and clear communication between households and network providers is crucial for a successful energy transition.

4.13 Benchmarking progress and ensuring future goals

Both interviews gave a measurable goal as a benchmark for the progress. Achieving a 55% reduction in CO2 emissions by 2030 compared to 1990 levels is a clear benchmark for progress. And according to interviewee *2, the goals for 2050 are under pressure. Because of that, a benchmark could be how close we can come to the goals for 2050. (*1) (*2)

> “That is actually a very difficult or a very easy question. The easiest way and if we are at minus 55% by 2030 compared to 1990, then we are doing well. That's the easiest answer. “(*1)

> “What you're already going to see left and right, and it's probably going to be heard so much more in the coming years, 2050 we must be CO2-free. You can already see that that date is starting to come under pressure, that people are already shouting 2050, I don't know about that. You see that the heat transition is going much slower, so that homes are getting rid of natural gas much slower, so that natural gas is still being used for longer. You're already seeing these kinds of choices. So yes, I think the best benchmark is of how close we are to 2050.” (*2)

However, interviewee *1 gave an unified vision as benchmark for measuring the progress of the energy transition. Aligning all stakeholders with a unified vision for the energy transition is crucial. Government leadership and scientific contributions are key to fostering a shared commitment to achieving the 2050 goals efficiently and sustainably. Ensuring alignment among stakeholders and maintaining a unified vision are essential for meeting the 2050 goals efficiently and sustainably. (*1)

> “I think if, in 2030, you could see that everyone in the Netherlands has their nose in the same direction and is all convinced that we have moved in the right direction, that would also be a very good benchmark. Now there is still a lot of arguing about the need for certain things, of moving to sustainable and electric driving and I don't know what all. ... Yes, I think it's important, following on from my previous, what I just said, I think making sure the noses are all pointed in the same direction. Instead of arguing about what maybe shouldn't happen or that it's insecure now or that it's too expensive, I think we all just need to have, say, a vision that's kind of in the same direction. That's very difficult huh, that must happen from the government. And also, from a number of other organisations. And I also think science can contribute to it. But that seems very important to me. If you all agree that it has to go in a certain direction” (*1)

In conclusion, both interviewees highlighted the importance of measurable goals and unified vision as benchmarks for the energy transition. Achieving a 55% reduction in CO2 emissions by 2030 and aligning stakeholders towards a common vision for 2050 are essential for ensuring a successful and sustainable energy transition in the Netherlands.

Chapter 5: Discussion

The integration of renewable energy sources into the existing environmental and infrastructure planning in the Netherlands is a complex and multifaceted challenge. This discussion section synthesizes the findings from the interviews conducted with experts and the analysis of relevant literature and/or policy documentation to address the primary research question: How can the energy transition of renewable energy sources be efficiently incorporated into environmental and infrastructure planning to facilitate an efficient energy transition in the Netherlands?

5.1 Defining Energy Transition

The experts uniformly defined the energy transition as a shift from a fossil fuel-based energy system to one dominated by renewable sources, with minimal or zero CO2 emissions. This transition is seen as crucial for achieving sustainability goals and mitigating climate change impacts. The emphasis on moving towards an energy system that relies heavily on electricity and other renewable sources is consistent with the national targets set by the Dutch government.

The concept of energy transition is widely regarded as a fundamental shift from a fossil fuel-based energy system to one that relies predominantly on renewable energy sources. This transition is characterized by a substantial reduction in CO2 emissions and a movement towards sustainability. According to Sovacool (2016), energy transitions involve profound changes in energy production, consumption, and the underlying infrastructure, emphasizing the shift towards low-carbon and renewable energy technologies.

The transition is driven by the need to mitigate climate change impacts, which are exacerbated by the continued use of fossil fuels. The Intergovernmental Panel on Climate Change (IPCC) has highlighted that limiting global warming to 1.5°C above pre-industrial levels requires rapid and far-reaching transitions in energy, land, urban, and infrastructure systems (IPCC, 2018). This underscores the urgency of shifting to renewable energy to achieve sustainability goals and reduce greenhouse gas emissions.

In the context of the Netherlands, the national targets set by the government align with this global imperative. The Dutch government has committed to ambitious renewable energy targets as part of its climate policy framework. The Climate Agreement (Klimaatakkoord) aims for a significant reduction in CO2 emissions, targeting a 49% reduction by 2030 compared to 1990 levels, and a 95% reduction by 2050 (Rijksoverheid, 2019). These targets necessitate a substantial increase in the share of renewable energy in the national energy mix.

The transition to a renewable energy-dominated system also involves a shift towards electrification. As indicated by the International Energy Agency (IEA, 2020), electricity generated from renewable sources such as wind, solar, and hydropower is expected to play a pivotal role in the energy transition. This shift is evident in the Netherlands' strategy to enhance its offshore wind capacity and promote solar energy installations, positioning the country as a leader in renewable energy adoption (IEA, 2020).

Moreover, Geels (2014) highlights that energy transitions are multi-dimensional processes involving technological, economic, social, and policy changes. The integration of renewable energy into existing systems requires not only technological innovation but also supportive policies and societal acceptance. This multi-faceted approach ensures that the transition is comprehensive and addresses the various challenges associated with moving away from fossil fuels.

The emphasis on renewable energy is also reflected in the literature on sustainable energy transitions. According to Jacobson et al. (2015), transitioning to 100% renewable energy by 2050 is feasible with current technologies, provided that supportive policies and infrastructure investments are in place. This aligns with the Dutch government's focus on creating a conducive policy environment to accelerate the adoption of renewable energy.

In summary, the definition of energy transition provided by the experts in this study is consistent with the broader academic understanding of the concept. It involves a systemic shift from fossil fuels to renewable energy sources, driven by the need to mitigate climate change and achieve sustainability goals. The Netherlands' national targets and policy frameworks reflect this commitment, emphasizing the crucial role of renewable energy in the country's future energy system.

5.2 Importance of Energy Transition for the Netherlands and the role of the industrial sector in energy transition

The interviews highlighted the significant role of the industrial sector in the Netherlands, which necessitates a sustainable approach to maintain its competitiveness in the global market. Additionally, the transition is essential for meeting international climate commitments and enhancing energy security.

The industrial sector in the Netherlands plays a critical role in the country's energy transition. This sector is not only a significant consumer of energy but also a major contributor to the country's greenhouse gas emissions. Thus, achieving sustainability in the industrial sector is essential for maintaining competitiveness in the global market and meeting international climate commitments.

5.2.1 Industrial Sector's Energy Consumption and Emissions

The industrial sector in the Netherlands is characterized by its high energy intensity, particularly in industries such as chemicals, refining, and steel production. According to the International Energy Agency (IEA, 2019), the industrial sector accounts for approximately one-third of the total final energy consumption in the Netherlands. This high level of consumption is primarily due to the energy-intensive nature of the processes involved in these industries.

The sector's significant contribution to greenhouse gas emissions underscores the need for a sustainable transition. The Netherlands Environmental Assessment Agency (PBL, 2019) reports that the industrial sector is responsible for around 40% of the country's total CO2 emissions. This highlights the critical role of the industrial sector in achieving national and international climate targets.

5.2.2 Enhancing Competitiveness Through Sustainability

Sustainability in the industrial sector is not only about reducing emissions but also about maintaining and enhancing competitiveness in the global market. Studies have shown that industries that adopt sustainable practices tend to be more competitive. For example, Porter and van der Linde (1995) argue that properly designed environmental standards can trigger innovation that may lead to improved competitiveness. This perspective is supported by more recent research indicating that sustainability can drive operational efficiencies, reduce costs, and open up new market opportunities (Bocken et al., 2014).

In the context of the Netherlands, industries that invest in energy-efficient technologies and renewable energy sources can reduce their operational costs and enhance their market position. For instance, the adoption of advanced manufacturing technologies and the integration of renewable energy into industrial processes can help Dutch industries reduce their energy bills and carbon footprint, making them more competitive internationally.

5.2.3 Meeting International Climate Commitments

The transition to a sustainable industrial sector is also crucial for the Netherlands to meet its international climate commitments. The Paris Agreement, which the Netherlands is a party to, requires substantial reductions in greenhouse gas emissions. The country has set ambitious targets to reduce CO2 emissions by 49% by 2030 and 95% by 2050 compared to 1990 levels (Rijksoverheid, 2019).

Achieving these targets requires significant efforts from the industrial sector. This includes adopting low-carbon technologies, improving energy efficiency, and increasing the use of renewable energy. The industrial sector's commitment to sustainability is therefore essential for the Netherlands to honor its international climate agreements and contribute to global efforts to combat climate change.

5.2.4 Enhancing Energy Security

Energy security is another critical aspect of the energy transition in the industrial sector. As the Netherlands reduces its reliance on fossil fuels and increases the share of renewable energy, ensuring a stable and secure energy supply becomes paramount. The industrial sector, with its high and often continuous energy demands, needs to adapt to a more decentralized and variable energy supply system.

Studies have shown that diversifying energy sources and integrating renewable energy can enhance energy security (Sovacool, 2013). For the Netherlands, this means leveraging its substantial offshore wind potential and expanding solar energy use in industrial applications. By doing so, the industrial sector can reduce its vulnerability to energy supply disruptions and price volatility associated with fossil fuels.

Moreover, improving energy efficiency within the sector can also contribute to energy security. Energy-efficient technologies reduce overall energy demand, thereby lessening the strain on the energy system and improving the resilience of industrial operations.

The role of the industrial sector in the Netherlands' energy transition is multifaceted, encompassing the need to reduce emissions, enhance competitiveness, meet international climate commitments, and ensure energy security. The transition towards sustainable practices in the industrial sector is not only a national imperative but also a strategic necessity for maintaining the country's position in the global market. By investing in energy-efficient technologies, renewable energy, and innovative processes, the Dutch industrial sector can lead the way in achieving a sustainable and competitive future.

5.3 Technological Innovation in Infrastructure Readiness

Technological innovation plays a critical role in facilitating the energy transition, enabling the integration of renewable energy sources into existing infrastructure and enhancing the overall efficiency and reliability of the energy system. Upgrading grid infrastructure, enhancing energy storage capabilities, and implementing smart grid technologies are pivotal technical aspects that drive the transition towards a sustainable energy future.

5.3.1 Upgrading Grid Infrastructure

The traditional electricity grid, designed for centralized power generation from fossil fuels, requires significant upgrades to accommodate decentralized renewable energy sources such as wind and solar. The intermittency and distributed nature of these sources necessitate a more flexible and resilient grid. According to Verbong and Geels (2010), the transition to renewable energy requires a reconfiguration of the electricity grid to handle the variable output and distributed generation.

Modernizing the grid involves incorporating advanced technologies such as high-voltage direct current (HVDC) transmission lines, which are more efficient over long distances and can better integrate offshore wind farms (Gellings, 2009). Furthermore, smart grid technologies are essential for managing the bidirectional flow of electricity and optimizing the balance between supply and demand in real-time.

5.3.2 Enhancing Energy Storage Capabilities

This part relates to the implementation and integration. Energy storage is crucial for addressing the intermittency of renewable energy sources. Technologies such as batteries, pumped hydro storage, and thermal storage can store excess energy generated during periods of high renewable output and release it when demand is high, or generation is low. According to IRENA (2017), energy storage systems enhance the reliability and stability of the grid, making it possible to integrate higher shares of renewables.

Lithium-ion batteries are currently the most widely used technology for grid-scale energy storage due to their high energy density and declining costs. However, emerging technologies such as solid-state batteries and flow batteries offer the potential for even greater efficiency and capacity (Zakeri & Syri, 2015). Research into hydrogen storage, where surplus renewable energy is used to produce hydrogen through electrolysis, also presents a promising solution for long-term energy storage (Bertuccioli et al., 2014).

5.3.3 Implementing Smart Grid Technologies

Smart grids leverage digital technology to enhance the efficiency, reliability, and sustainability of the electricity grid. They enable real-time monitoring and control of the grid, facilitating the integration of decentralized renewable energy sources. Smart meters, automated demand response, and advanced forecasting techniques are key components of smart grids that help balance supply and demand (Fang et al., 2012).

Advanced metering infrastructure (AMI) allows for detailed monitoring of energy consumption patterns, enabling more accurate demand forecasts and efficient energy distribution. Automated demand response systems can adjust energy usage in response to grid conditions, helping to mitigate peak loads and integrate renewable energy more effectively (Palensky & Dietrich, 2011).

5.3.4 Challenges and Opportunities in Infrastructure Readiness

The readiness of existing infrastructure to support increased renewable energy production presents both challenges and opportunities. Upgrading and expanding the grid infrastructure requires significant investment and coordinated planning. One of the main challenges is the need for substantial capital investment in grid modernization and the deployment of energy storage systems (Bhowmik. et al., 2020).

However, these challenges also present opportunities for innovation and economic growth. Investment in grid infrastructure and energy storage can stimulate job creation and drive advancements in technology. For instance, the development of smart grids and energy storage technologies can position the Netherlands as a leader in the clean energy sector, attracting investment and expertise (IRENA, 2017).

Moreover, the transition to a modernized grid offers the opportunity to improve energy security and resilience. A more flexible and resilient grid can better withstand extreme weather events and other disruptions, ensuring a reliable supply of electricity (Panteli & Mancarella, 2015). This is particularly important as climate change increases the frequency and severity of such events.

5.4 Challenges and Opportunities in Integration

Integrating renewables into existing infrastructure involves addressing several challenges, including grid modernization, storage capacity, and land-use conflicts. However, these challenges also present opportunities for fostering innovation, stimulating job creation, and enhancing energy security. The interviews underscored the need for comprehensive and adaptive planning frameworks that can respond to the dynamic nature of energy markets and technological advancements (McKinsey & Company, 2022).

Integrating renewable energy sources into existing infrastructure is a complex process that involves overcoming several key challenges while also seizing various opportunities. This section delves into these aspects, supported by insights from academic sources and interview findings.

5.4.1 Challenges

- **Grid Modernization**: One of the primary challenges in integrating renewables is the need for significant upgrades to the electricity grid. The current grid infrastructure in many regions is not equipped to handle the variability and distributed nature of renewable energy sources like wind and solar power. Studies have shown that grid modernization is essential to accommodate increased loads and ensure stability and reliability (Lund et al., 2015).
- **Storage Capacity**: The intermittent nature of renewable energy sources necessitates robust storage solutions to balance supply and demand. Current storage technologies, such as batteries and pumped hydro storage, need further advancement to become more cost-effective and efficient. Research indicates that enhancing storage capacity is critical for a reliable renewable energy system (Denholm et al., 2010).

- **Land-Use Conflicts**: The deployment of renewable energy projects often leads to conflicts over land use. For instance, wind farms and solar installations can compete with agricultural land, conservation areas, and residential zones. Wolsink (2007) highlights the importance of spatial planning and public acceptance in mitigating these conflicts and ensuring successful project implementation.

5.4.2 Opportunities

- **Fostering Innovation**: Addressing the challenges of integrating renewables provides a significant impetus for technological innovation. Innovations in smart grid technologies, energy storage solutions, and energy management systems can significantly enhance the efficiency and reliability of renewable energy integration (Geels, 2012).
- **Stimulating Job Creation**: The transition to renewable energy has the potential to create numerous jobs across various sectors, including manufacturing, installation, maintenance, and research and development. Studies have shown that renewable energy projects often generate more employment opportunities compared to fossil fuel projects (Cameron & Zwaan, 2015).
- **Enhancing Energy Security**: By diversifying the energy mix and reducing reliance on imported fossil fuels, integrating renewable energy sources can enhance national energy security. This transition can make the energy system more resilient to geopolitical tensions and price volatility in global fossil fuel markets (Cherp et al., 2012).

5.4.3 Comprehensive and Adaptive Planning

The interviews underscored the importance of adopting comprehensive and adaptive planning frameworks to navigate the dynamic nature of energy markets and technological advancements. Such frameworks should include the following elements:

- **Stakeholder Engagement**: Effective integration requires the involvement of various stakeholders, including government agencies, industry players, local communities, and environmental organizations. Collaborative governance models can help align diverse interests and facilitate consensus-building (Loorbach et al., 2017).
- **Regulatory Flexibility**: Policies and regulations must be flexible enough to accommodate emerging technologies and evolving market conditions. Adaptive policy frameworks can support innovation and ensure that regulatory barriers do not hinder the deployment of new solutions (Meadowcroft, 2009).
- **Long-Term Vision**: A clear and long-term vision is essential for guiding the energy transition. This vision should encompass both quantitative targets, such as emission reduction goals, and qualitative objectives, such as fostering sustainable development and social equity (Kemp & Loorbach, 2006).

5.5 Stakeholder Engagement and Public Acceptance

Public acceptance and stakeholder engagement are critical for the successful implementation of renewable energy projects. The involvement of various stakeholders through collaborative governance models is essential to address potential conflicts and ensure the smooth integration of renewable energy into existing systems.

5.5.1 Importance of Public Acceptance

Public acceptance is a pivotal factor in the deployment of renewable energy projects. Without the support of local communities and the public, even well-planned projects can face significant delays or fail altogether. Wüstenhagen, Wolsink, and Bürer (2007) highlight that public acceptance of renewable energy projects is influenced by three dimensions: socio-political acceptance, community acceptance, and market acceptance. Socio-political acceptance involves broad societal support, which can be fostered through effective communication and public engagement strategies. Community acceptance pertains to the support of local stakeholders, who may be directly impacted by the projects. Market acceptance involves the willingness of investors and consumers to adopt renewable energy technologies.

5.5.2 Role of Stakeholder Engagement

Effective stakeholder engagement is fundamental to achieving public acceptance and successful project implementation. Engaging stakeholders from the early stages of project development helps build trust, address concerns, and incorporate local knowledge and preferences into the planning process. According to Aitken (2010), stakeholder engagement not only enhances the legitimacy of renewable energy projects but also contributes to more resilient and adaptable project outcomes.

Collaborative governance models, which involve stakeholders from government, industry, and local communities, are essential for co-creating and implementing comprehensive energy policies. These models ensure that diverse perspectives are considered, leading to more robust and inclusive decision-making processes. Ansell and Gash (2008) define collaborative governance as a process in which public agencies engage with non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative. This approach helps mitigate potential conflicts by fostering dialogue, transparency, and mutual understanding among stakeholders.

Renewable energy projects can often lead to conflicts over land use, environmental impacts, and community benefits. Wolsink (2012) emphasizes the importance of spatial planning and public participation in mitigating these conflicts. By involving stakeholders in the planning process, project developers can identify and address potential issues early on, reducing opposition and delays. Moreover, providing tangible benefits to local communities, such as job creation, infrastructure improvements, and revenue sharing, can enhance community acceptance and support.

Fostering social acceptance of renewable energy projects requires ongoing communication and engagement with stakeholders. Devine-Wright (2009) suggests that social acceptance can be improved by addressing perceived risks and benefits, enhancing procedural fairness, and building trust through transparent and inclusive decision-making processes. Engaging local communities in the design, implementation, and monitoring of projects helps build a sense of ownership and responsibility, further promoting acceptance and support.

5.6 Recommendations for Policy and Practice

Based on the findings, several recommendations can be made to enhance the efficiency of the energy transition in the Netherlands:

5.6.1 Strengthening Policy Frameworks

Enhancing Existing Policies: To accelerate the adoption of renewable energy sources, it is essential to strengthen the current policy frameworks. This includes providing more robust financial incentives such as subsidies, tax breaks, and feed-in tariffs that encourage investments in renewable energy projects. According to Fischer and Newell (2008), well-designed financial incentives are crucial for stimulating investment in renewable technologies.

Streamlining Regulatory Processes: Regulatory processes need to be streamlined to reduce administrative burdens and expedite the approval of renewable energy projects. Simplifying the permitting process and providing clear guidelines can significantly reduce project delays. Jaffe, Newell, and Stavins (2005) highlight that reducing regulatory barriers is essential for promoting innovation and accelerating the deployment of clean technologies.

Long-Term Policy Stability: Providing long-term policy stability is vital for investor confidence. Consistent and predictable policy frameworks enable businesses to plan and invest in renewable energy projects with greater certainty. Stability in policies can reduce risks and attract more private sector investments (Del Río & Bleda, 2012).

5.6.2 Investing in Technological Innovation

From the interviews, background reading and analysis of current literature, the following section will shortly describe different investment options pertaining to technological innovations:

Upgrading Grid Infrastructure: Significant investments are needed to upgrade the existing grid infrastructure to handle the increased load from decentralized renewable energy production. This includes enhancing grid flexibility and capacity to integrate various renewable sources effectively. Lund et al. (2015) emphasize that modernizing the grid is critical for accommodating renewable energy and ensuring reliable power supply.

Improving Energy Storage Solutions: Advancing energy storage technologies is essential to address the intermittency of renewable energy sources. Investments in research and development of storage solutions, such as advanced batteries and other innovative technologies, can enhance the reliability and efficiency of renewable energy systems. Denholm et al. (2010) suggest that improved storage solutions are key to balancing supply and demand in renewable energy systems.

Implementing Smart Grid Technologies: The implementation of smart grid technologies can optimize energy distribution and improve the overall efficiency of the energy system. Smart grids facilitate better demand response, integrate distributed energy resources, and enhance grid resilience. Geels (2012) highlights the role of smart grids in transforming energy systems and supporting the transition to renewable energy.

5.6.3 Promoting Stakeholder Collaboration

In support of stakeholder collaboration, the author suggests the development and implementation of following measures:

Fostering Collaborative Governance Models: Collaborative governance models that involve government agencies, industry players, local communities, and environmental organizations are essential for co-creating and implementing comprehensive energy policies. Ansell and Gash (2008) define collaborative governance as a process that engages multiple stakeholders in a collective decision-making process, enhancing policy legitimacy and effectiveness.

Encouraging Public Participation: Engaging the public and local communities in the planning and decision-making processes can increase social acceptance and reduce opposition to renewable energy projects. Devine-Wright (2009) suggests that public participation helps build trust and ensures that local concerns are addressed, leading to more successful project outcomes.

Building Multi-Stakeholder Partnerships: Creating partnerships between different stakeholders can facilitate knowledge sharing, resource pooling, and coordinated actions. Collaborative efforts can leverage the strengths of various actors and create synergies that enhance the overall impact of renewable energy initiatives (Loorbach et al., 2017).

Chapter 6: Conclusion

The energy transition in the Netherlands is a complex, multifaceted process that requires a comprehensive and integrated approach. This master thesis has explored how renewable energy sources can be efficiently incorporated into environmental and infrastructure planning to facilitate an effective energy transition. The following conclusions can be drawn from the findings of this study:

The Netherlands has made significant progress in expanding and diversifying its renewable energy portfolio, particularly in wind and solar energy. However, challenges such as intermittency, grid integration, and continued reliance on fossil fuels for transportation and heating persist. Addressing these issues requires targeted solutions, including advancements in energy storage technologies and smart grid systems to manage the variable output of renewable sources.

Governmental policies have played a crucial role in driving the energy transition. Initiatives such as the Energy Agreement for Sustainable Growth, the Climate Act, and various subsidy programs have catalyzed the adoption of renewable energy. Nonetheless, there is room for improvement. Streamlining regulatory processes, providing robust financial incentives, and ensuring long-term policy stability are essential to accelerate the transition further.

Integrating renewable energy into existing infrastructure presents both challenges and opportunities. Grid modernization, land-use conflicts, and the need for substantial investment in new technologies are significant hurdles. Conversely, these challenges also offer opportunities for innovation, job creation, and enhanced energy security. Comprehensive and adaptive planning frameworks that can respond to the dynamic nature of energy markets and technological advancements are critical for navigating these challenges effectively.

The success of the energy transition heavily depends on public acceptance and stakeholder engagement. Collaborative governance models that involve stakeholders from various sectors, including government, industry, and local communities, are essential. Such inclusive approaches help mitigate conflicts and foster social acceptance, ensuring that renewable energy projects are supported and implemented successfully.

Technological advancements are pivotal for the energy transition. Upgrading grid infrastructure, improving energy storage solutions, and implementing smart grid technologies are necessary to accommodate decentralized renewable energy production. Ongoing innovation in battery efficiency, storage capacity, and smart home technologies will significantly enhance the reliability and efficiency of renewable energy systems.

Based on the findings, several policy recommendations can be made to enhance the efficiency of the energy transition in the Netherlands:

- **Strengthening Policy Frameworks**: Enhance existing policies to provide more robust financial incentives and streamline regulatory processes to accelerate the adoption of renewable energy sources.

- **Investing in Technological Innovation**: Focus on upgrading grid infrastructure, improving energy storage solutions, and implementing smart grid technologies to accommodate decentralized renewable energy production.
- **Promoting Stakeholder Collaboration**: Foster collaborative governance models that involve all relevant stakeholders in the planning and implementation of renewable energy projects.
- **Addressing Socio-Economic Impacts**: Develop strategies that optimize socio-economic benefits, such as job creation and community engagement, while minimizing negative consequences.

This thesis underscores the importance of a holistic and integrated approach to the energy transition. By aligning technological innovation, strategic policy frameworks, and effective stakeholder engagement, the Netherlands can achieve a sustainable and resilient energy future. The insights from academic research and expert interviews provide a robust foundation for developing strategies that optimize the integration of renewable energy and capitalize on the opportunities presented by the energy transition.

The transition to renewable energy is not merely a technical challenge but a socio-economic and political one that requires the concerted efforts of all stakeholders. By embracing adaptive and inclusive policies, investing in technological advancements, and fostering public acceptance, the Netherlands can navigate the complexities of the energy transition and set a precedent for other nations to follow.

Reference list

Aitken, M. (2010). Why we still don’t understand the social aspects of wind power: A critique of key assumptions within the literature. *Energy Policy, 38*(4), 1834-1841.

Andrews-Speed, P. (2016). Applying institutional theory to the low-carbon energy transition. *Energy Research & Social Science*, 13, 216-225.

Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory, 18*(4), 543-571.

Autoriteit Consument en Markt (ACM). (2022). Electricity Grid Code (NetCode Elektriciteit). Retrieved from

Bertuccioli, L., Chan, A., Hart, D., Lehner, F., Madden, B., & Standen, E. (2014). "Development of Water Electrolysis in the European Union." Fuel Cells and Hydrogen Joint Undertaking.

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). "A literature and practice review to develop sustainable business model archetypes." Journal of Cleaner Production, 65, 42-56.

Bhowmik, C., Kabeyi, M. J. B., & Olanrewaju, O. (2020). Sustainable Energy Transition for Renewable and Low Carbon Grid Electricity Generation and Supply. *Frontiers in Energy Research*. Retrieved from

Boomsma, T.K., Meade, N., and Fleten, S.E. (2012). "Renewable energy investments under different support schemes: A real options approach." *European Journal of Operational Research*, 220(1), pp. 225-237.

Cameron, L., & Zwaan, B. (2015). Employment factors for wind and solar energy technologies: A literature review. *Renewable and Sustainable Energy Reviews, 45*, 160-172.

Chen, C., Kirabaeva, K., Minnett, D. N., Parry, I. W., Massetti, E., Tim, T., & von Thadden-Kostopoulos, S. (2023). *Assessing Recent Climate Policy Initiatives in the Netherlands: Selected Issues Papers 2023(022) A001*. International Monetary Fund.

Cherp, A., Jewell, J., & Goldthau, A. (2012). Governing global energy: Systems, transitions, and policy options. *Global Environmental Change, 22*(3), 586-589.

Del Río, P., & Bleda, M. (2012). Comparing the innovation effects of support schemes for renewable electricity technologies: A function of innovation approach. *Energy Policy, 50,* 272-282.

Denholm, P., Ela, E., Kirby, B., & Milligan, M. (2010). The role of energy storage with renewable electricity generation. *National Renewable Energy Laboratory (NREL)*.

Devine-Wright, P. (2009). Rethinking NIMBYism: The role of place attachment and place identity in explaining place-protective action. *Journal of Community & Applied Social Psychology*, *19*(6), 426-441.

DiCicco-Bloom, B., & Crabtree, C. (2006). The qualitative research interview. Medical education, 40(4), 285-393. DOI: 10.1111/j.1365-2929.2006.02418.x

Dutch Ministry of Infrastructure and Water Management. (2021). Zero Emission Services. Accessed on 19-6-24 Retrieved from https://www.government.nl/ministries/ministry-of-infrastructure-and-water-management.

Elzen, B., Geels, F.W., & Green, K. (eds.) (2004) *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy*. Cheltenham: Edward Elgar.

Enexis. (2021). Annual Report 2021. Retrieved from www.enexis.nl

Engle, N. L. (2011). Adaptive capacity and its assessment. *Global environmental change*, *21*(2), 647-656.

European Commission. (2020). [EU Offshore Renewable Energy Strategy]. Accesed on 20-6-24, Retrieved from https://energy.ec.europa.eu/index_en

EZK (2019). *Klimaatwet*, Ministerie van Economische Zaken en Klimaat (EZK), Den Haag.

Fischer, C., & Newell, R. G. (2008). Environmental and technology policies for climate mitigation. *Journal of Environmental Economics and Management, 55*(2), 142-162.

Fang, X., Misra, S., Xue, G., & Yang, D. (2012). "Smart grid—The new and improved power grid: A survey." IEEE Communications Surveys & Tutorials, 14(4), 944-980.

Geels, F.W., Berkhout, F. and van Vuuren, D.P. (2016) 'Bridging analytical approaches for low-carbon transitions', *Nature Climate Change*, 6.

Geels, F.W. (2014) 'Regime resistance against low-carbon transitions: Introducing politics and power into the multi-level perspective', *Theory, Culture & Society*, 31(5), pp. 21-40

Geels, F. W. (2012). A socio-technical analysis of low-carbon transitions: Introducing the multi-level perspective into transport studies. *Journal of Transport Geography, 24*, 471-482.

Gellings, C. W. (2009). "The Smart Grid: Enabling Energy Efficiency and Demand Response." The Fairmont Press.

Government of The Netherlands. (2020). Government strategy on hydrogen. Retrieved at 15-03-2024, from government.nl

Government of the Netherlands. (2022). [Dutch Recovery and Resilience Plan]. Retrieved from government.nl.

Grin, J. (2006). Reflexive modernisation as a governance issue, or: designing and shaping re-structuration. *Reflexive governance for sustainable development*, *57*.

Hall, P. A. (1993). Policy paradigms, social learning, and the state: the case of economic policymaking in Britain. *Comparative politics*, 275-296.

Helm, D. (Ed.). (2007). *The new energy paradigm*. OUP Oxford.

Hesselink, L.X.W. and Chappin, E.J.L. (2019) 'Adoption of energy efficient technologies by households – Barriers, policies and agent-based modelling studies', *Renewable and Sustainable Energy Reviews*, 99, pp. 29-41.

Hoppe, T., Coenen, F., & van den Berg, M. M. (2016). Examining the influence of local governance modes on the performance of local energy and climate policies: Results of an explorative case study in the Netherlands. *Sustainability, 8*(1), 1-24.

Hvelplund, F. (2013) 'Renewable energy and the need for local energy markets', *Energy*, 31(13)

Hydrogen Europe. (2021). European Hydrogen Backbone. Accesed on 20-6-24, Retrieved from https://hydrogeneurope.eu

International Air Transport Association. (2019). Decarbonizing Aviation. Accessed on 19-6-24 Retrieved from https://www.iata.org/en/programs/environment/climate-change/.

International Civil Aviation Organization. (2021). Aviation and Climate Change. Accessed on 15-6-24 Retrieved from https://www.icao.int/environmental-protection/Pages/climate-change.aspx.

International Energy Agency (IEA). (2020). *Netherlands 2020 Energy Policy Review*. IEA.

International Renewable Energy Agency (IRENA). (2017). "Electricity Storage and Renewables: Costs and Markets to 2030."

Invest in Holland (2024). Energy. Retrieved at 27-02-2024, from https://investinholland.com/doing-business-here/industries/energy/

Jacobson, M.Z., Delucchi, M.A., Cameron, M.A., & Frew, B.A. (2015) '100% clean and renewable wind, water, and sunlight (WWS) all-sector energy roadmaps for the 50 United States', *Energy & Environmental Science*, 8(7), pp. 2093-2117.

Jaffe, A. B., Newell, R. G., & Stavins, R. N. (2005). A tale of two market failures: Technology and environmental policy. *Ecological Economics*, *54*(2-3), 164-174.

Jordan, A., & Lenschow, A. (2010). Environmental policy integration: a state of the art review. *Environmental Policy and Governance*, *20*(3), 147-158

Kampman, B., Blommerde, J., & Afman, M. (2016). "The potential of energy citizens in the European Union." CE Delft.

Kash, D. E. (2010). Technological innovation and culture: research needed for China and other countries. *Journal of Science and Technology Policy in China*, *1*(2), 100-115.

Kalair, A., Abas, N., Saleem, M. S., & Kalair, A. R. (2021). Role of energy storage systems in the energy transition from fossil fuels to renewables. *Journal of Energy Storage*, *35*, 102245.

Kemp, R., & Loorbach, D. (2006). Transition management: a reflexive governance approach. *Reflexive governance for sustainable development*, 103-130.

Kuhn, T. (1970). The nature of scientific revolutions. *Chicago: University of Chicago*, *197*(0).

Kuzemko, C. (2013). *The energy security-climate nexus: Institutional change in the UK and beyond*. Springer.

Laes, E., Gorissen, L., & Nevens, F. (2014). A comparison of energy transition governance in Germany, the Netherlands and the United Kingdom. Sustainability, 6(3), 1129-1152.

Loorbach, D., Frantzeskaki, N. and Avelino, F. (2017) 'Sustainability transitions research: Transforming science and practice for societal change', *Annual Review of Environment and Resources*, 42(1), pp. 599-626.

Lund, H., Østergaard, P. A., Connolly, D., & Mathiesen, B. V. (2015). Smart energy and smart energy systems. *Energy*, *86*, 256-265.

McKinsey & Company. (2022). Upgrade the grid: Speed is of the essence in the energy transition. Retrieved from https://www.mckinsey.com/business-functions/sustainability/our-insights/upgrade-the-grid-speed-is-of-the-essence-in-the-energy-transition

Meadowcroft, J. (2009). What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy sciences*, *42*, 323-340.

Ministerie van Economische Zaken en Klimaat. (2021). [National Climate and Transition Fund]. Retrieved from government.nl.

Mitchell, C., & Mitchell, C. (2008). *The political economy of sustainable energy*. Basingstoke: Palgrave Macmillan.

Netherlands Environmental Assessment Agency (PBL) reports. (2024). Retrieved at 17-01-2024, from

Netherlands Environmental Assessment Agency (PBL). (2019). "Trends in the industrial sector and the impact on emissions."

Palensky, P., & Dietrich, D. (2011). "Demand side management: Demand response, intelligent energy systems, and smart loads." IEEE Transactions on Industrial Informatics, 7(3), 381-388.

Panteli, M., & Mancarella, P. (2015). "Modeling and evaluating the resilience of critical electrical power infrastructure to extreme weather events." IEEE Systems Journal, 11(3), 1733-1742.

PBL Netherlands Environmental Assessment Agency. (2020). Netherlands climate and energy outlook 2020. The Hague. PBL publication number: 4299.

PBL Netherlands Environmental Assessment Agency. (2020). "Planning for renewable energy: A comparative analysis of the Netherlands and Germany."

Porter, M. E., & van der Linde, C. (1995). "Toward a New Conception of the Environment-Competitiveness Relationship." Journal of Economic Perspectives, 9(4), 97-118.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., & Foley, J.A. (2009) 'A safe operating space for humanity', *Nature*, 461, pp. 472-475.

Rosenow, J., Kern, F., & Rogge, K. S. (2017). The need for comprehensive and well targeted policies: Insights from energy transition in Germany. *Energy Research & Social Science*, *23*, 82-93.

Rijksoverheid. (2011). Local Climate Agenda. Retrieved from www.rijksoverheid.nl

Rijksoverheid. (2013). Energy Agreement for Sustainable Growth. Retrieved from www.rijksoverheid.nl

Rijksoverheid. (2016). Energy Report and Energy Agenda. Retrieved from www.rijksoverheid.nl

Rijksoverheid. (2017). Agreement on Energy-Intensive Industries. Retrieved from www.rijksoverheid.nl

Rijksoverheid. (2018). Climate Act and Climate Agreement. Retrieved from www.rijksoverheid.nl

Rijksoverheid. (2019). Integrated National Energy and Climate Plan. Retrieved from www.rijksoverheid.nl

UNFCCC. (2015). Paris Agreement. Retrieved from https://unfccc.int/process-and-meetings/the-paris-agreement

UNFCCC. (2021). UN Climate Conference (COP26). Retrieved from https://unfccc.int/conference/glasgow-climate-change-conference-october-november-2021

Rijksoverheid. (2022). Coalition Agreement of Rutte IV Cabinet and Climate Policy Program. Retrieved from www.rijksoverheid.nl

Rijksoverheid (2019). *Klimaatakkoord*, Den Haag (28-06-2019).

Rijksoverheid. (2024). Duurzame energie Retrieved at 26-02-2024, from https://www.rijksoverheid.nl/onderwerpen/duurzame-energie/meer-duurzame-energie-in-de-toekomst

Rijksoverheid. (2024). Klimaatbeleid. Retrieved at 26-02-2024, from https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatbeleid/ontstaan-klimaatbeleid

Rip, A., & Kemp, R. (1998). Technological change. In *Human choice and climate change: Vol. II, Resources and Technology* (pp. 327-399). Battelle Press.

Saviuc, I., Lopez, C., Puskas, A., Rollert, K. and Bertoldi, P., Explicit Demand Response for small end-users and independent aggregators, EUR 31190 EN, *Publications Office of the*

European Union, Luxembourg, 2022, ISBN 978-92-76-55850-7, doi:10.2760/625919, JRC129745.

Sijm, J., Beurskens, L., Marsidi, M., Niessink, R., Scheepers, M., Smekens, K., ... & de Wilde, H. (2019). *Review of energy transition scenario studies of the Netherlands up to 2050* (No. TNO 2019 P12095). TNO.

Sijm, J., Koutstaal, P., Özdemir, Ö., & van Hout, M. (2019). Energy Transition Implications for Demand and Supply of Power System Flexibility: A Case Study of the Netherlands Within an EU Electricity Market and Trading Context. In E. Gawel, S. Strunz, P. Lehmann, & A. Purkus (Eds.), The European Dimension of Germany’s Energy Transition. Springer.

Smith, A. and Stirling, A. (2018) 'Innovation, sustainability and democracy: An analysis of grassroots contributions', *Journal of Self-Governance and Management Economics* 6(1):64

Sovacool, B. K. (2016) 'How long will it take? Conceptualizing the temporal dynamics of energy transitions', *Energy Research & Social Science*, 13, pp. 202-215.

Sovacool, B.K., & Dworkin, M.H. (2015) 'Energy justice: Conceptual insights and practical applications', *Applied Energy*, 142, pp. 435-444.

Sovacool, B. K. (2013). "Energy & Ethics: Justice and the Global Energy Challenge." Palgrave Macmillan.

Sopha, B.M., Klöckner, C.A. and Hertwich, E.G. (2013) 'Adoption and diffusion of heating systems in Norway: coupling agent-based modeling with empirical research', *Environmental Innovation and Societal Transitions*, 8, pp. 42-61.

Sovacool, B.K. (2016) 'How long will it take? Conceptualizing the temporal dynamics of energy transitions', *Energy Research & Social Science*, 13, pp. 202-215.

Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., & Sörlin, S. (2015) 'Planetary boundaries: Guiding human development on a changing planet', *Science*, 347(6223), pp. 736-746.

TenneT. (2021). Annual Report 2021. Retrieved from https://www.tennet.eu/about-tennet/investor-relations/financial-reports

Van der Waal, E.C., Das, A.M. and van der Schoor, T. (2020) 'Participatory Experimentation with Energy Law: Digging in a ‘Regulatory Sandbox’ for Local Energy Initiatives in the Netherlands', Energies, 13(2), p. 458.

Van Vuuren, D. P., Stehfest, E., Gernaat, D. E. H. J., Doelman, J. C., van den Berg, M., Harmsen, M., ... & Hof, A. F. (2018). Alternative pathways to the 1.5 °C target reduce the need for negative emission technologies. *Nature Climate Change*, *8*(5), 391-397.

Verbong, G. P., & Geels, F. W. (2010). "Exploring sustainability transitions in the electricity sector with socio-technical pathways." Technological Forecasting and Social Change, 77(8), 1214-1221.

Voß, J. P., Smith, A., & Grin, J. (2009). Designing long-term policy: rethinking transition management. *Policy sciences*, *42*, 275-302.

Vringer, K., & Carabain, C. L. (2020). Measuring the legitimacy of energy transition policy in the Netherlands. *Energy policy*, *138*, 111229.

Wolsink, M. (2012). The research agenda on social acceptance of distributed generation in smart grids: Renewable as common pool resources. *Renewable and Sustainable Energy Reviews*, *16*(1), 822-835.

Wolsink, M. (2010) 'Contested environmental policy infrastructure: socio-political acceptance of renewable energy, water, and waste facilities', *Environmental Impact Assessment Review*, 30(5), pp. 302-311.

Wolsink, M. (2007). Wind power implementation: The nature of public attitudes: Equity and fairness instead of 'backyard motives'. *Renewable and Sustainable Energy Reviews*, *11*(6), 1188-1207.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy*, *35*(5), 2683-2691.

Yin, R.K. (2003) Case study Research: Design and Methods. Sage Publications, Thousand Oaks, London

Zakeri, B., & Syri, S. (2015). "Electrical energy storage systems: A comparative life cycle cost analysis." Renewable and Sustainable Energy Reviews, 42, 569-596.

Appendices

Appendix 1Transcription of interview 1

SPK_2
Ja, nou ik ben benieuwd naar je vragen en ik zal ook even mijzelf voorstellen, Jarig Steringa. Ik werk bij GasUnie inderdaad al heel erg lang, meer dan dertig jaar al. En een groot deel van die tijd heb ik me beziggehouden met de lange termijnplanning en ontwikkeling van het aardgasnetwerk en de laatste jaren ...is daar natuurlijk meer en meer bijgekomen dat een deel van het netwerk... ...zal worden omgebouwd naar een waterstoftransportnetwerk... ...en alles wat daarbij komt kijken.

SPK_2
En ik zit nu bij de afdeling die zich bezighoudt met het energiesysteem als geheel. Dus we kijken niet alleen naar aardgas of waterstof... ...maar we kijken ook naar de verbanden met elektriciteit... ...en ook met afvang van CO2 en transport en opslag daarvan. Dus eigenlijk naar het hele energiesysteem en de onderlinge samenhang en het begrip systeemintegratie speelt daar een rol bij.

SPK_1
Ja, top. Helemaal goed. Nou, laten we maar meteen beginnen met de eerste vraag. Ik had als eerste vraag, hoe zou je de term energietransitie definiëren binnen de context van hernieuwbare energiebronnen?

SPK_2
Ja, ik denk dat het belangrijkste is dat het energiesysteem van de toekomst gebaseerd moet zijn op duurzame bronnen en dat er geen of heel weinig resterende uitstoot van CO2 moet zijn. Dat lijkt mij een hele algemene definitie. Dus we gaan van de wereld van de fossiele brandstoffen naar een wereld waarbij energie eigenlijk gebaseerd is op duurzame bronnen.

SPK_1
Ja, top. En dan als klein sub-vraag had ik dan, waarom is het belangrijk dan ook voor Nederland specifiek?

SPK_2
Voor elk land belangrijk. Voor Nederland is het in het bijzonder belangrijk, omdat wij een hele grote industriesector hebben in Nederland. En als we die industriële sector willen blijven gebruiken en als die hier zijn plaats wil blijven behouden, dan zal die ook moeten verduurzamen. Dat is denk ik een hele grote opdracht. Dus het is de industriële sector die het voor ons specifiek belangrijk maakt.

SPK_2
En een andere reden waarom Nederland een bijzondere positie heeft, is omdat wij een bepaalde ligging hebben, een gunstige ligging ook, aan zee, dus met havens. En ook omdat de zee, in dit geval het Noordzee, een belangrijke rol kan spelen in het opwekken van duurzame energie.

SPK_1
Wat denk je dat de huidige situatie is in Nederland met betrekking tot de energietransitie? Hoe ver zijn we eigenlijk?

SPK_2
Ik denk eigenlijk dat het nog helemaal aan het begin staat. Het is inderdaad zo dat er in Nederland de afgelopen jaren een soort van versnelling heeft plaatsgevonden in Bijvoorbeeld de opwekking van elektriciteit uit zon. Er zijn heel veel zonnepanelen in Nederland. We zijn kampioen zonnepanelen plaatsen geloof ik de laatste jaren. En windparken op zee, dat begint ook wel goed vorm te krijgen.

SPK_2
Maar voor de rest, voor het afkomen van fossiele brandstoffen, Dus daar staan we nog helemaal aan het begin. Want, nou ja, de auto's die we rijden zijn toch nog grotendeels benzineauto's of diesel. En verwarming in huizen, maar ook in de industrie, dat is nog grotendeels op aardgas gebaseerd.

SPK_1
Ja, klopt. De volgende. Wat zijn enkele belangrijke milieuoverwegingen die moeten worden meegenomen bij het opnemen van de nieuwe hernieuwbare energiebronnen? En vooral dan ook in de planning van de infrastructuur?

SPK_2
Even kijken. Misschien begrijp ik deze vraag toch niet helemaal goed. Dit gaat specifiek over de bouwen van de infrastructuur.

SPK_1
Bijvoorbeeld de waterstofinfrastructuur, de zonnepanelen, alle warmtepompen, dat soort dingen.

SPK_2
Ja, ik denk dat je er gewoon rekening mee moet houden dat alles wat je doet, dus ook dingen die je bouwt in het kader van de energietransitie, dat die op zich ook weer een uitstoot met zich meebrengen. Dus je zult op een of andere manier moeten regelen. Dat het bouwen van die infrastructuur dat dat ook zo veel mogelijk met beperkte uitstoot plaatsvindt. Je moet dan allerlei wetgevingen al houden wat dat betreft. Stikstofwetgeving en ook het gebruik van bepaalde machines.

SPK_2
Dat zal ook, als je dieselaggregaten gebruikt, dat je daar ook uitstoot hebt.

SPK_1
Kun je misschien voorbeelden geven van succesvolle strategieën die in andere regio's of misschien landen zijn gebruikt om eigenlijk de energietransitie wat efficiënter te laten plaatsvinden?

SPK_2

In andere landen?

SPK_1
Ja.

SPK_2
Even kijken hoe succesvol... Ik denk dat... Ik denk dat Denemarken heel succesvol is geweest met windenergie. Daar zijn ze op tijd mee begonnen. Dat hebben ze vroegtijdig ingezien dat dat heel belangrijk kon worden.

SPK_2
Daarom heeft Denemarken nu een enorme voorsprong voor wat betreft duurzame opwek. Ik denk dat dat een mooi voorbeeld is. Die hebben het misschien ook wat makkelijker gehad. Het is ook een klein land, net als Nederland, maar er wonen nog wat minder mensen. Dus misschien ook wat minder moeite om wind op land voor elkaar te krijgen.

SPK_2
Maar toch, ik denk dat dat een goed voorbeeld is.

SPK_1
En dan de sub vraag was, is dit ook dan toepasbaar voor Nederland? Of denk je inderdaad omdat het echt de karakteristieken van Denemarken en dat het niet echt hier haalbaar is?

SPK_2
Ja, Nederland en Denemarken lijken in sommige opzichten natuurlijk wel op elkaar. Met name die ligging aan de Noordzee en het kunnen gebruiken van die Noordzee en dus ook de wind op zee. Ik denk dat Nederland en Denemarken daar trouwens ook al heel goed samenwerken. Maar inderdaad denk ik dat wij hadden kunnen leren van hoe Denemarken het aanpakt. Maar we hebben wel verschillen.

SPK_2
We zijn een klein land, maar wel met veel mensen. Dus het is toch niet helemaal goed te vergelijken.

SPK_1
Nee, precies. Welke rol ziet u voor de technologie weggelegd in de energietransitie? Ja, en dan ook, ja, dat vooral. En dan vooral ook dan met het punt op de infrastructuur van de, ja, de energie-infrastructuur, zeg maar.

SPK_2
Ja. Kijk, ik denk dat voor het aanleggen van netwerken, of het ook stroomnetwerken zijn of buisleidingen voor gas of waterstof of zo, daar is niet heel erg veel nieuwe techniek voor nodig. Ik denk dat Technologieontwikkelingen die je vooral ziet bij opslag van energie. Bijvoorbeeld het ontwikkelen van batterijen die beter, gemakkelijker en efficiënter energie en elektriciteit op kunnen slaan. Voor de grootschalige opslag heb je bijvoorbeeld waterstofopslag nodig in zoutcavernes, ook op andere plekken.

SPK_2
Ik denk dat daar technologie nog een hele belangrijke rol kan spelen om daar tot verbeteringen te komen.

SPK_1
Ja, top. En hoe beoordeelt u de huidige staat van de infrastructuurgereedheid in Nederland? Om met de toename van de productie van de hernieuwbare energie, om dat op te vangen. Zijn we daar klaar voor?

SPK_2
Ik denk, het is heel duidelijk, dat is ook gebleken uit studies, IE3050 bijvoorbeeld, dat het elektriciteitsnet lang niet klaar is. Er moet gewoon heel veel gebouwd worden. Het netwerk van Tennet zal tot 2050 minstens moeten verdubbelen of verdrievoudigen. Maar dat is gewoon recht toerecht aan hard werk. En rekening houden met het feit dat hoogspanning ook ruimte kost.

SPK_2
En verder denk ik dat de netwerken voor het transporteren van gas en in de toekomst waterstof en groengas, die liggen er eigenlijk grotendeels al. Daar hoeft niet heel veel aan te gebeuren en die kunnen ook nog heel lang mee.

SPK_1
Ja, dus eigenlijk moet het energienet vergroot worden. Dat is inderdaad al gegeven. De rest is wel gereden.

SPK_2
Je hebt eigenlijk het elektriciteitsnet moeten worden uitgebreid. Het moet echt sterk worden uitgebreid. De gasnetten kunnen grotendeels worden hergebruikt. Er zal ook wel nieuwbouw gepleegd moeten worden, maar het grote verschil is dat voor de gasnetten het meeste er eigenlijk al ligt en verder gewerkt kan worden met datgene wat we al hebben en kunnen hergebruiken. Voor elektriciteit zal er heel veel nieuwbouw moeten worden gepleegd.

SPK_1
En waterstof? Dat was ook wel... Nou ja, dat.

SPK_2
Is grotendeels hergebruikt van aardgasleidingen.

SPK_1
Ah, vandaar. Top. Duidelijk.

SPK_2
Dus daar hoef je relatief weinig nieuwbouw te plegen. En dat is ook het fijne van het inzetten van het netwerk van GasUnie. Het is minder nodig voor het transporteren van aardgas. Daardoor vallen er leidingen vrij en die leidingen zijn geschikt om te kunnen inzetten voor het transporteren van waterstof.

SPK_1
Wat zijn enkele potentiële beleids- of regelgevingsveranderingen die de adoptie van hernieuwbare energiebronnen kunnen versnellen?

SPK_2
Ik denk dat het heel belangrijk is dat op dit moment kost een vergunning heel veel tijd. En ik denk dat daar dus nog wel wat aan kan verbeterd worden. Het versnellen van vergunningprocedures. En een goed beeld van welke ruimte in Nederland waarvoor gebruikt gaat worden. Dat is ook heel belangrijk.

SPK_1
Stakeholder management is natuurlijk vaak cruciaal voor succesvolle implementatie van initiatieven, ook voor de energietransitie. Hoe zou u de verschillende belanghebbenden, waaronder dus overheid, instanties, energiebedrijven, bewoners en milieugroepen aanbevelen om te betrekken bij de planning of uitvoeringsproces?

SPK_2
Ja, inderdaad, de partijen die je noemt, die zijn belangrijk. Je hebt de overheden, dus landelijke overheid, maar ook provincies en gemeentes. Je hebt gebruikers, dat kunnen huishoudens zijn, dat kunnen ook industrieën zijn. En je hebt de netbeheerders en de energiebedrijven, dat zijn allemaal belanghebbenden in het hele proces. En die moet je dus laten samenwerken om tot de beste oplossing te komen.

SPK_2
En eigenlijk gebeurt dat ook al. Er zijn allerlei overheidsprogramma's waaraan gewerkt wordt, zoals het Provinciale MIEK. Per provincie heb je een proces dat kijkt naar hoe het energiesysteem in die provincie en de toekomst moet worden ingericht. En daar zijn al die partijen die jij nu net noemt, die zijn daarin vertegenwoordigd. Dus ik denk dat dat ook al wel gebeurt.

SPK_2
Dit is een proces van een lange adem en je moet ook ver vooruitkijken tot 2050.

SPK_1
Zeker. Kunt u de economische implicaties bespreken van de overgang naar de hernieuwbare energiebronnen? En hoe zou dat kost-efficiëntie, kost-effectiviteit in balans worden gebracht met de milieuoverwegingen?

SPK_2
Even kijken. Ik denk dat dat best een heel veelomvattende vraag is.

SPK_1
Ja, dat is het ook. Zal ik de eerste nog maar even... Kunt u de economische implementaties bespreken van de overgang naar hernieuwbare energiebronnen?

SPK_2
Ja, ja. Kijk, fossiele energie is altijd heel goedkoop geweest. En in de toekomst... denk ik dat

je er van uit moet gaan dat het eigenlijk alleen maar duurder wordt. En dat betekent dat heel veel gebruikers helemaal niet zo enthousiast zijn in principe om over te gaan.

SPK_2
En je moet het bovendien op zo'n manier doen dat je de economische situatie in Nederland niet al te veel laat afwijken van die van de omringende landen. Dus ik denk dat je dat heel goed op elkaar af moet stemmen en in een Europees verband moet bekijken. En daar is de Europese Unie dus inderdaad ook voor.

SPK_1
Zijn er specifieke technologische innovaties of opkomende trends waarvan u gelooft dat ze een significante impact zullen hebben op de efficiëntie?

SPK_2
Ik denk dat er nog een heleboel innovatieprocessen lopen waar we wat van kunnen verwachten. En ik denk dat er ook nog wel een aantal verrassingen zullen optreden. Ik denk zelf dat ook heel veel nog onduidelijk is. Je kan iets verwachten van andere soorten batterijen, vaste stofbatterijen bijvoorbeeld. denk ik, ook wel iets verwachten van het aanleggen van meer internationale verbindingen, elektriciteitsverbindingen.

SPK_2
Er zijn ook allerlei dingen waar wel over gepraat wordt, waarvan we helemaal nog niet weten of het er is. Er wordt ook nog gesproken over waterstofvoorraden die in de grond zitten. Die zijn er wel, witte waterstof, die zijn er echt wel. Afhankelijk van hoe winbaar dat is, of je er wat aan gaat hebben of niet. Dus eigenlijk is er heel veel onzeker en we kunnen eigenlijk alleen maar zeg maar ons best doen om datgene wat we in eigen hand hebben, zoals het ontwikkelen van nieuwe technologieën, om dat zo goed mogelijk aan te sturen en te stimuleren.

SPK_1
Wat zijn de belangrijkste kansen bij het integreren van hernieuwbare energiebronnen in de bestaande infrastructuur? Ja, dat.

SPK_2
Wacht even, nog een keer. Het gaat om het integreren van bestaande bronnen, van nieuwe bronnen in de bestaande infrastructuur?

SPK_1
Ja, wat zijn de belangrijkste kansen bij het integreren van hernieuwbare energiebronnen in de bestaande infrastructuur?

SPK_2
Ik denk dat de belangrijkste kans is dat je, hoe je het ook went of keert, altijd te maken krijgt met het feit dat verschillende energiedragers met elkaar moeten samenwerken. Die hangen met elkaar samen. Als je elektriciteit gaat opwekken op grote schaal uit zon en wind, dan wordt het aanbod heel erg variabel. Want de zon schijnt niet altijd, de wind waait niet altijd. Dus je krijgt een heel variabel aanbod.

SPK_2
En dat betekent dat aanbod en vraag eigenlijk altijd in onbalans zullen zijn. En dat moet je op de een of andere manier oplossen. En dat krijg je het beste voor elkaar door gebruik te maken van gunstige eigenschappen van andere energiedragers, zoals bijvoorbeeld waterstof. En als je die goed met elkaar laat samenwerken, bijvoorbeeld door waterstof te maken op momenten dat je de stroom niet nodig hebt, of bijvoorbeeld door waterstof te gebruiken die je hebt opgeslagen op het moment dat het niet waait of de zon niet schijnt. Ik denk dat dat de zaak heel erg verbetert.

SPK_2
De grootste kans ligt daar. Zorgen voor zo goed mogelijk verbindingen tussen de verschillende energiedragers.

SPK_1
Wat zijn de kleinschalige uitdagingen voor de individuele huishoudens? En wat zijn de grootschalige uitdagingen voor de dienstverleners, de netbeheerders?

SPK_2
Nou, ik denk dat voor de huishoudens de grootste uitdaging is dat ze op dit moment helemaal niet weten welke kant het op gaat. En ook lang niet alles is mogelijk voor elk huishouden. Dus de grote uitdaging is om te weten te komen van waar moet ik in investeren? Wat moet ik eigenlijk gaan doen? Moet ik overgaan op all electric?

SPK_2
Of komt er misschien een warmte net in mijn buurt? Dus zekerheid krijgen over welke energiedrager jij eigenlijk mee te maken krijgt als huishouden. Ik denk dat dat een hele belangrijke grote uitdaging is. En lang niet alles is mogelijk. En voor de netbeheerders, die dus moeten zorgen voor de aansluiting, daar geldt eigenlijk voor dat ze ook op een gegeven moment een keuze moeten maken.

SPK_2
Die hebben als grote uitdaging bijvoorbeeld, dat nu op dit moment de meeste huishoudens aangesloten zijn op het gasnet. Dat zal in de toekomst niet mis ook zijn, maar voor een deel misschien nog wel. Dat betekent dat je moet gaan proberen uit te zoeken waar je huizen nog wel op een gasnet aansluit. Dat kan ook waterstof zijn of groengas. En waar niet.

SPK_2
En waar je dus ook een gedeelte van het netwerk weg kunt halen of niet. Ik denk dat dat het meeste werk voor netbeheerders zal zijn. En de uitbreiding van de stroomnetten natuurlijk die daarbij hoort.

SPK_1
Hier mijn laatste vraag. Vooruitkijkend, wat voorziet u als de belangrijkste meldpaal of benchmark voor het meten van de vooruitgang van de efficiënte energietransitie?

SPK_2

Dat is eigenlijk een hele moeilijke of een hele makkelijke vraag. De makkelijkste manier En als we in 2030 op min 55% zitten ten opzichte van 1990, dan doen we het goed. Dat is het makkelijkste antwoord. Eigenlijk, als ik er ietsje serieuzer naar kijk, dan zijn er nog wel veel meer zaken waar je rekening mee moet houden. Ik denk dat als je in

SPK_2
2030 zou zien dat iedereen in Nederland de neus dezelfde kant op heeft en allemaal ervan overtuigd is dat we het goede pad op zijn gegaan, dat dat ook een hele goede benchmark is. Nu wordt er nog heel veel geruzied over de noodzaak van bepaalde dingen, van het overgaan op duurzaam en het elektrisch rijden en weet ik allemaal wat. Als we daar in 2030 Als zeg maar 80 of 90 procent van de Nederlanders het daar allemaal over eens zou zijn, dan is dat volgens mij ook een heel goede indicator en dus een hele goede benchmark. Je kunt dit op een heleboel manieren aanvliegen, deze vraag.

SPK_1
Klopt, daarom heb ik hem ook als laatste. En dan heb ik nog één klein toevoeging aan de vraag. Hoe kunnen we misschien ervoor zorgen dat we deze doelen, de 2050 doelstelling bijvoorbeeld, efficiënt en duurzaam worden bereikt?

SPK_2
Ja, ik denk dat het belangrijk is, eigenlijk in aansluiting op mijn vorige, wat ik net zei, ik denk zorgen dat de neuzen allemaal dezelfde kant op staan. In plaats van te ruziën over wat er misschien niet moet gebeuren of dat het onzeker nu niet uitkomt of dat het te duur is, ik denk dat we gewoon allemaal zeg maar een visie moeten hebben die een beetje dezelfde kant uitgaat. Dat is heel moeilijk hè, dat moet vanuit de overheid gebeuren. En ook vanuit een aantal andere organisaties. En ik denk ook dat de wetenschap eraan bij kan dragen.

SPK_2
Maar dat lijkt me heel belangrijk. Als je het er met z'n allen over eens bent dat het een bepaalde kant uit moet.

SPK_1
Dat is een mooie afsluiting. Ja, dat was het eigenlijk. Dat waren mijn vragen.

SPK_2
En je gaat nog meer interviews houden met andere...

SPK_1
Het doel is er rond de vijf. En verder ben ik al bezig geweest met een literatuuronderzoek.

SPK_2
Ja.

SPK_1
En daarna moet ik nog dus de data verwerken van de interviews. En uiteindelijk hoop ik met wat conclusies te komen. Oké. Dus ik ben nu, ik hoop het voor de zomer af te hebben.

SPK_2
Ja.

SPK_1
Voor af te studeren, dus nog druk bezig, zeg maar.

SPK_2
En die interviews, dit interview wat je nu met mij hebt ook, dat komt op de een of andere manier in jouw verhaal te staan in jouw rapport en hoe gaat dat anoniem?

SPK_1
Ja, het wordt anoniem inderdaad.

SPK_2
Ja.

SPK_1
En ik verwerk zeg maar de data. Ik heb alles opgelogen en dan verwerk ik het, transcribeer ik het eerst en dan verwerk ik het in een datasysteem. En aan de hand daarvan probeerde ik verbanden te leggen tussen de verschillende interviews op mijn vragen. En dan hoop ik dat er wat uitkomt.

SPK_2
Dan hoop je dat er een soort van richting uitkomt.

SPK_1
Ja, of juist niet.

SPK_2
Of juist niet.

SPK_1
Dat zou ook heel interessant zijn.

SPK_2
Iedereen denkt er weer anders over.

SPK_1
Dat kan ook. Mijn doel is inderdaad om verschillende invalshoeken. Dus overheid, bedrijven, netbeheerders. Dus ik ben benieuwd inderdaad.

SPK_2
Ja, en als je dan dat rapport hebt, krijgen wij ook een exemplaar ofzo.

SPK_1
Zeker als u zo wilt, dan kan ik hem zeker doorsturen.

SPK_2
Ja, ik ben wel geïnteresseerd hoor. En mocht je ondertussen nog vragen hebben, als je denkt van aanleiding van dit gesprek van ik wil toch nog net iets meer weten of ik begrijp niet helemaal wat je nou net gezegd hebt, dan ben je van harte welkom. Of nog even weer sturen mail of bel mij even. Het kan altijd.

SPK_1
Nou, heel erg bedankt. Dan zou ik zeker in gedachten huilen.

SPK_2
Ja.

SPK_1
Nou, in ieder geval heel erg bedankt voor dit interview.

SPK_2
Ja, graag gedaan.

SPK_1
Ik hoop dat ik er wat mee kan. Ik denk het wel.

SPK_2
En succes. Veel succes.

SPK_1
Ja, dankjewel.

SPK_2
Oké.

SPK_1
Tot ziens.

SPK_2
Allee.

Appendix 2 Transcription of interview 2

SPK_1
Ik ben werkzaam bij de Provincie Groningen. Daar ben ik programma manager energie en infrastructuur. Dat houdt zich met name bezig met netcongestie. Dat nu met name op de elektriciteitsnet en het oplossen daarvan.

SPK_2
Ja, laten we maar meteen beginnen.

SPK_1
Laten we losgaan. Ik heb ook niet meer dan een uur. Ik heb hierna weer een afspraak. Dus er is geen uitloop aan de achterkant.

SPK_2
Nee, ik denk dat het ook wel goed komt hoor. Nou, de eerste vraag die ik had is hoe zou u de term energietransitie definiëren binnen de context van hernieuwbare energiebronnen?

SPK_1
Wat bedoel je daar precies mee? Ik ga hem nu een beetje interpreteren.

SPK_2
Ik probeer het eigenlijk een beetje te zeggen van welke bronnen wij misschien dan het meest, waar we naartoe willen gaan. In plaats van natuurlijk de fossiele brandstoffen. Ik denk dat welke bronnen het voor de hand liggen om die te gaan gebruiken. Ik denk dat je dat zo een beetje...

SPK_1
De energietransitie houdt in dat we inderdaad CO2-vrij energie willen gebruiken. En als ik een beetje door de oogharen heen kijk, dan denk ik dat 80% elektriciteit en 20% andere dingen uiteindelijk ook uitkomen. Dus elektriciteit gaat wel een heel belangrijke drager vormen.

SPK_2
En is dat ook nog voor Nederland, dat het zeg maar als land, dat wij meer bijvoorbeeld minder afhankelijk kunnen zijn van windenergie of zonne-energie, dat er nog een, hoe zeg je dat, meer kunnen focussen op juist op wind, omdat wij veel wind hebben of juist niet.

SPK_1
Nou ja goed, kijk, het is denk ik goed om te realiseren hoeveel energie wij gebruiken. En kijk, fossiele energie is heel... Nou ja, we gebruiken het niet voor niets, omdat het eigenlijk heel compact is en heel veel energie-inhoud heeft. En op het moment dat je dus andere vormen van energie gaat gebruiken, dan kom je al snel op een ruimtevraagstuk uit. Nou ja, kijk, uiteindelijk, het antwoord is, we gaan alles nodig hebben.

SPK_1
Ja, je kunt er op verschillende manieren naar kijken. Kijk, Nederland is gewoon heel dicht bevolkt. We hebben een energie-intensieve samenleving. Dus ja, als je zegt van gaan we met alleen wind onze energiebehoefte voorzien, dan is dat een antwoord nee. Met zon ook waarschijnlijk niet.

SPK_1
Plus nog alle voor- en nadelen die eraan zitten. Als het niet waait, dan heb je geen energie. Dus je moet dan ook nog een vorm van opslag regelen. Ja, dus het is gewoon best wel een uitdaging om van eigenlijk een heel compact en centraal geregeld energiesysteem naar een decentrale opwekking te gaan.

SPK_2
Ja, nee precies. En wat is de huidige status denk je dan, waar Nederland nu in verkeert?

SPK_1
Hoe ver zijn we? Dit is een beetje over de duim. We verbruiken ongeveer 25% van ons elektriciteitsverbruik uit elektriciteit. Als het klimaatakkoord uitgevoerd is, dan hebben we 80% daarvan verduurzaamd. Dat betekent dat we nog drie kwart fossiel overhouden, waar we ook iets mee moeten.

SPK_1
De warmtetransitie is in volle gang. Daar gebeurt heel veel. Heb je bijvoorbeeld minder aardgas nodig omdat je restwarmte gebruikt of iets dergelijks. Nou ja, goed. Dus ja, we zijn op weg. Er worden eerste stappen gezet, maar er is nog best wel een lange weg te gaan.

SPK_2
Ja, precies. Wat zijn enkele belangrijke milieu-overwegen die moeten worden meegenomen in het namen van hernieuwbare energiebronnen in de planning van de infrastructuur, dus waar we rekening moeten houden met de infrastructuur?

SPK_1
Wat milieuoverwegingen zijn, nou ja, kijk, natuurlijk landschap, natuur en landschap is altijd een ding. Maar heb je het nu puur over infrastructuur alleen, of over opwerken?
SPK_1
Ja, de opwerkingen eigenlijk ook, inderdaad. Dat is natuurlijk ook heel belangrijk.

SPK_1
Nou ja, kijk, wat ik al zei, die decentrale bronnen, die hebben enorm ruimtebeslag. Dat betekent dus dat je een enorme impact hebt. Aan elke opwek zitten weer voor- en nadelen. Windmolens maken lawaai. Die hebben slagschaduw.

SPK_1
Die zie je van heel ver. Die zijn wel efficiënter dan zonnepanelen. Zonnepanelen zijn in die zin weer minder zichtbaar. Maar goed, de meeste zonneparken zijn op landbouwgrond, maar daaronder kun je verder niks meer, dus het is wel een mono-gebruik van de grond. Zo zijn er allerlei dingen, dus dat heeft wel weer met biodiversiteit te maken.

SPK_1
Nou goed, elke vorm van opwekking heeft een voor en nadeel, maar ze hebben wel gemeen dat ze veel ruimte vragen en daarmee een impact hebben op de leefomgeving.

SPK_2
Ja, dan moet je dan inderdaad kijken wat de meest efficiënte oplossing is. Dat is natuurlijk de puzzel.

SPK_1
Nou ja, efficiënt en het heeft ook met acceptatie te maken.

SPK_2
Ja, dat ook.

SPK_1
En dat is denk ik het... Een van de belangrijkste, als je het hebt over hoe we de energietransitie kunnen versnellen, dat is gewoon draagvlak voor maatregelen. Iedereen die op straat vraagt is voor duurzame energie en energietransitie totdat het bij hem in de buurt komt.

SPK_2
Kunt u misschien een voorbeeld geven van een succesvolle strategie voor de hernieuwbare energie efficiënt integreren in de infrastructuur?

SPK_1
Hernieuwbare energie integreren in de infrastructuur?

SPK_2
Bijvoorbeeld van die zonneparken. Ja, die inderdaad op een landbouwgrond, maar dan misschien een ander soort initiatief. Zijn er misschien wat voorbeelden van?

SPK_1
Er zijn allerlei zonneparken die op zich goed ingepast zijn of worden. Ik denk dat, als je kijkt naar bijvoorbeeld een windpark wat op zich goed geïntegreerd is, is het bijvoorbeeld het windpark in de Eemshaven. Tegelijkertijd zijn er ook best wel nog wel forse kanttekeningen bij te plaatsen. Want het ligt gewoon in een havengebied. Dat past daar prima.

SPK_1
Dat is eigenlijk tussen de zware industrie heb je dan windmolens. Tegelijkertijd zijn de bedrijven vaak niet zo blij mee, omdat het extra risico's met zich meebrengt. De ligging van de Eemshaven maakt dat je daar veel vogelslachtoffers hebt. Vogels hebben de neiging om land t volgen totdat ze niet meer verder kunnen En door de ligging van de Eemshaven, die ligt eigenlijk een beetje op het einde van zo'n route. Maar daar komen dus heel veel vogels samen.

SPK_1
Dus dat is een beetje geografische eigenaardigheid. Maar daar zijn dus heel veel vogels die

tegen die wieken doodvliegen. Nou ja, goed. Dus op zich ligt dat park daar goed. Maar goed, ook daar zitten wel weer een aantal nadelen aan.

SPK_2
Ja, precies. Dus eigenlijk, nou ja.

SPK_1
Ideaal wordt het misschien wel nooit helemaal.

SPK_2
Nee, precies. Je hebt altijd kanttekenen natuurlijk. Ja. Even kijken. Ja, welke rol zit u voor de technologie weggelegd in het faciliteren van de energietransitie?

SPK_1
Technologie in de algemene zin?

SPK_2
Ja.

SPK_1
Ja, er zitten heel veel technologische aspecten aan. Kijk, als je bijvoorbeeld hebt over infrastructuur. Infrastructuur is uitgelegd op piekbelasting. Nou, die piekbelasting is maar een heel beperkt deel van de dag.

SPK_2
Ja.

SPK_1
Nou ja, door slimmer gebruiken van elektriciteit. Dus, nou ja, smart homes of goed, allemaal wat soort dingen. Nou, dat zou je technologie voor in kunnen zetten. Kun je wellicht de belasting verminderen. Dus je netwerk efficiënter gebruiken.

SPK_1
Technische innovatie is gewoon sowieso nodig om kostprijs en efficiëntie te verhogen. We hebben met windmolens gezien dat die afgelopen jaren veel efficiënter zijn geworden. We zien dat niet met zonnepanelen, dat ze goedkoper en efficiënter worden. Dat doet wat. Waterstof is nu zo'n techniek die heel duur is, maar wellicht in de toekomst ook efficiënter kan worden, zodat de waterstof kansrijker zal worden om een betekenis in te vullen.

SPK_1
Dat soort dingen. Er zit best wel een hele technologische uitdaging aan.

SPK_2
Ja, precies. En daarop terugkomen, hoe beoordeelt u de huidige staat van het infrastructuurnet eigenlijk van Nederland? Je zei al dat het efficiënter kan natuurlijk.

SPK_1

Het lastige met dit soort dingen is, kijk, weet je, je kunt aan de ene kant zeggen het voldoet, want iedereen heeft stroom op het moment, tegelijkertijd kunnen een hoop dingen niet, dus nieuwe ontwikkelingen kunnen niet aangesloten worden, dus eigenlijk voldoet het niet. Dus ja, er moet een hele hoop bij komen. Daarbij kan je natuurlijk verschillende dingen afvragen. Je kunt het een beetje met wegen vergelijken. Moet je op een gegeven moment meer asfalt gaan aanleggen?

SPK_1
Of moet je op een gegeven moment misschien over autogebruik gaan hebben? Dat is denk ik met infrastructuur voor energie een beetje hetzelfde. Ik zei net al, een kwart van ons energieverbruik is elektrisch. En die andere drie kwart gaat waarschijnlijk voor een groot deel elektrisch worden. Als je daar allemaal nieuwe infrastructuur voor moet gaan aanleggen, dan is dat een behoorlijke...

SPK_1
Dat zal je echt wel gaan zien in je omgeving. En daar zal niet iedereen blij mee zijn. Dat doet iets met het landschap. Maar ook op wijkniveau, al die transformatorhuisjes. Er moet enorm veel van dat soort dingen bijkomen.

SPK_1
Dus het is een... Ja. Er moet best wel wat gebeuren nog. En de vraag is van hoe maakbaar is dat? Je kunt het niet sneller doen dan...

SPK_1
dan de fabrieken nieuwe dingen opleveren en de mensen zijn om ze te installeren. En dat zien we nu wel als een rem op de energietransitie.

SPK_2
Ik had nog een sub-vraag over wat de belangrijkste uitdagingen en kansen zijn. De kansen zijn natuurlijk een beetje meer ook het efficiënte gebruik, voorbeeld. Maar inderdaad het uitbreiden, maar hoe je dat dan wil of iedereen het wil?

SPK_1
Het makkelijkste is besparen, dus de vraag beperken. Daar zou je iets kunnen doen. We hebben wel gezien dat er nog nooit zoveel energie bespaard is sinds het uitbreken van de Oekraïne-crisis. Waarbij de gasprijzen in één keer omhooggingen. Dan zie je dat mensen toch best wel wat kunnen besparen.

SPK_1
Dus dat. Beparen. Technologische innovatie. In Nederland hebben we verschillende uitdagingen. We hebben een planologische uitdaging.

SPK_1
Nederland is gewoon vol. En dat geldt voor fysieke ruimte, maar ook voor bijvoorbeeld milieuruimte. Dus geluidhinder en gedreun die je mag produceren. Dus alles wat erbij komt, kan gewoon heel lastig een plek vinden. Dat betekent dat je dus heel lang aan het zoeken bent.

SPK_1
Naar de procedures die je moet belopen. Dat kost gewoon heel veel tijd. Nederland is ook een land waar dingen goed geregeld zijn. Dus je kunt als burger nog bezwaar maken. Dat proces kost heel veel tijd, dus dat is een uitdaging.

SPK_1
Planologisch het plek vinden, dus gewoon de ruimte. En wat op dit moment ook een probleem is, is gewoon überhaupt... In meer of mindere mate loopt heel Europa hier wel tegenaan. Dus je ziet fabrieken die onderdelen produceren, die kunnen ook maar een bepaald tempo maken. Dus daar zie je een bottleneck.

SPK_1
En de andere is gewoon de beschikbaarheid van mensen. Dus het zijn gewoon geen handjes om het werk uit te voeren.

SPK_2
Nee, precies. Duidelijk. Wat zijn enkele potentiële beleids- of regelwetgeving veranderingen die de adoptie van, ja, die de energietransitie kunnen versnellen of verbeteren, denk jij?

SPK_1
Dit is best wel een lastige, want hier wordt in overheidsland natuurlijk heel veel over gesproken. Er zit een soort trade-off tussen zorgvuldig als overheid zijn en tempo maken. Dus ja, kun je sneller? Ja, dan moet je je procedures anders gaan inrichten, maar dat betekent dus dat er minder ruimte is voor inspraak. Nou ja, dan ga je dus wel sneller, maar dan past je wel de rechtsbescherming van burgers aan.

SPK_1
Zelf denk ik dat dat evenwicht... Nu, mijn collega die komt binnen. Heb je bezwaar als ik hier zit? Oké, goed. Dus ik denk dat er weinig regels zijn die het echt gaan versnellen.

SPK_1
Wat misschien wel zal helpen is... Je ziet, we komen natuurlijk uit een periode waarin best wel liberaal overheidsbeleid is gevoerd. Zo wordt de keuze bij de markt of marktpartijen gelegd. is dat er duidelijke keuzes gemaakt worden voor bepaalde systemen of ontwikkelingen. Om een voorbeeld te geven, je ziet nu in de warmtetransitie, de gemeente moet een warmtevisie maken.

SPK_1
En in die warmtevisie wordt dan berekend wat dan de optimale vorm van duurzame verwarming is voor bepaalde wijken. Dat gaat heel erg uit van dat het gewoon een markt is. Die marktpartijen willen binnen vijf jaar hun investeringen afschrijven. Die zitten weer aan bepaalde regels, waardoor een bepaald kostenplaatje ontstaat. Als je dan dingen tegen elkaar af gaat zetten, dan kom je al heel snel dat warmtepompen voordeliger zijn.

SPK_1
Maar goed, dat ligt heel veel bij de burger. Dus de kosten bij de burger. Terwijl, je misschien ook zou kunnen zeggen van ja, we vinden warmte wel een belangrijke nutsfunctie. We vinden

dat burgers recht hebben op betaalbare warmte. We nemen als overheid de verantwoordelijkheid om warmtenetten aan te gaan leggen.

SPK_1
Dit soort keuzes, nu gaan wel dingen veranderen, want iedereen ziet wel dat er dingen nodig zijn. Maar het gaat dan heel langzaam en dit soort grote besluiten, die eigenlijk wel nodig zijn, die laten gewoon lang op zich wachten.

SPK_2
Ja, tuurlijk. Duidelijk. Dan heb je natuurlijk stakeholderbetrokkenheid. Dat is vaak cruciaal voor de succesvolle implementatie van initiatieven, ook voor de energietransitie. Hoe zou je verschillende belanghebbenden, waaronder de overheid natuurlijk, de energiebedrijven en de burgers, aanbevelen om te betrekken bij de planning en de uitvoeringswerkzaamheden?

SPK_2
Om eigenlijk alles, iedereen bij elkaar te betrekken.

SPK_1
Ja, er wordt al heel veel geparticipeerd hoor. Dus wat dat betreft... ...Zou ik niet weten hoe dat anders of beter moet.

SPK_2
Nee, het is zeg maar nu al veel, de participatie.

SPK_1
Ja. De omgevingswet is net ingegaan, die vraagt heel veel ten aanzien van participatie bij processen. En ook dit is voor overheden ook echt wel een continu aandachtspunt en we proberen dit ook wel optimaal te doen. Wat we in de praktijk zien is dat Het heel moeilijk is om burgers, inwoners, te betrekken op het moment dat ze niet direct raakt. Al sinds ik bij de overheid werk is dit al een zoektocht. De wens die is er wel degelijk om burgers goed te betrekken.

SPK_1
Maar goed, dat is gewoon heel lastig. En bedrijven, medeoverheden en andere stakeholders, de professionele stakeholders, die kennen hun wegen wel. Die zitten gewoon in het netwerk en die worden vaak gewoon betrokken bij projecten. Dus dat is over het algemeen goed geregeld. Ze zullen er niet altijd tevreden mee zijn, maar dat heeft meer met dat ze niet altijd hun zin kunnen krijgen.

SPK_2
Dat heb je altijd natuurlijk. Verder dan, kunt u nu misschien de economische implementatie bespreken van de overgang naar hernieuwbare energiebronnen?

SPK_1
Ja goed, energie is onze economie. We hebben een energie-intensieve economie. Dus de beschikbaarheid en de betaalbaarheid van energie bepaalt voor belangrijke mate ook economische activiteiten. Duurzame energie speelt daar een steeds belangrijker rol in. Omdat

bedrijven die moeten vergroenen, die vallen op een gegeven moment bijvoorbeeld onder ETS, dus Europese CO2-emissiehandel.

SPK_1
Maar met name de betaalbaarheid en de beschikbaarheid, dat bepaalt heel veel. We hebben afgelopen jaren bijvoorbeeld aDel uit Delfzijl zien vertrekken was een aluminiumsmelter. Die gebruikte heel veel energie. Het was al jaren dat dat eigenlijk een beetje ertegenaan hing. Uiteindelijk kan die gewoon de energierekening niet meer betalen.

SPK_1
Anders zijn er al meer bedrijven geweest de afgelopen jaren. Dus de betaalbaarheid is één ding. Maar goed, beschikbaarheid wordt op een gegeven moment ook een issue. Omdat we een netcognessie hebben en als bedrijven niet meer kunnen beschikken over een aansluiting, dan is dat voor je vestigingsklimaat gewoon niet oké.

SPK_2
Ja, en dan de volgende. Zijn er specifieke technologische innovaties of opkomende trends waarvan je denkt van die kunnen een significant impact kunnen hebben op de efficiëntie van het opnemen van hernieuwbare energie. Nou vooral met de infrastructuur, dus bijvoorbeeld met betrekking tot het warmtenet of wat dan ook.

SPK_1
Ik weet het niet. Ik kan er niet zo, er schiet me zo niks te binnen.

SPK_2
Nee, ja misschien dan niet.

SPK_1
Wij worden ook wel uitgedaagd. Dit is een politiek-bestuurlijke organisatie, dus we hebben dan provinciale staten. En die komen dan regelmatig met vragen over bijvoorbeeld thorium, ijzerpoeder, dat soort dingen. Dat soort ontwikkelingen houden we wel in de gaten. Wij maken daar geen keuzes in.

SPK_1
Stel dat ijzerpoeder in één keer iets is wat helemaal geweldig is. Hoe het doorgaans gaat is dat op het moment dat er een technologie ontstaat die rendabel is, dan merken wij dat al heel snel allerlei initiatiefnemers langskomen om te kijken of die dingen mogelijk zijn in de provincie. Dat hebben we gezien met wind, de afgelopen jaren met zon. Zon is heel lang niet rendabel geweest om dat op grote schaal te doen. Op een gegeven moment, door andere prijsontwikkelingen, technologische ontwikkelingen, kom je op het punt dat het ergens weer om gaat hangen.

SPK_1
En dan zie je dat initiatiefnemers, gewoon commerciële partijen, beginnen met initiatieven te ontplooien. Die rekenen er dan op dat die trend doorzet. Die denken van, we willen de eerste zijn. Die komen dan heel snel met allerlei initiatieven. En op het moment dat het dan rendabel is, of rendabeler wordt, dan zie je dat er steeds meer initiatieven komen.

SPK_1
Dat hebben we in ieder geval met zon gezien. Dat is eigenlijk het punt dat wij ook beleid gaan maken van waar willen we dat, hoe willen we dat. We zien het nu met batterijen. Doordat er steeds meer duurzame bronnen op het elektriciteitsnet zitten, is de opslag belangrijk. Nu komen er heel veel partijen bij ons met van kunnen wij ergens een batterij initiatief doen.

SPK_1
En dat is nog wel, want als je het over technologieën hebt... Die doorontwikkeld zou moeten worden, dan wel die heel belangrijk gaan worden, dan is de batterij, of in ieder geval de opslagtechniek, echt essentieel.

SPK_2
En dan de efficiëntie van de batterij en de opslagcapaciteit?

SPK_1
De capaciteit, efficiëntie, de opladingsduur, de levensduur. De batterij is natuurlijk wel, want er zijn heel veel Volgens mij wordt daar best wel veel onderzoek naar gedaan. Omdat het niet alleen voor het elektriciteitsnet, maar ook in auto's en telefoons en... Ja. ...veel van het is.

SPK_2
Ja, klopt. Top. Wat zijn de belangrijkste kansen bij het integreren van de hernieuwbare energiebronnen in de bestaande energie infrastructuur? En hoe kan het begrijpen van deze factoren, de ontwikkeling, ja, eigenlijk ook verbeteren?

SPK_1
Ah ja, kijk ik zou zeggen van het gaat... Ik zou zeggen van er zijn grote kansen op het moment dat we naar energie inclusieve planologie zouden gaan. Want wat je nu ziet is dat Het is heel lang heel goed geregeld geweest in Nederland. Infrastructuur was eigenlijk nooit een probleem. Het nam niet zoveel plek in en je had een initiatief, nou dan kwam de netbeheerder en kastje, kabeltje, klaar. En nu, de infrastructuur neemt sowieso meer plek in omdat het gewoon meer vermogen aangaat.

SPK_1
Maar is het goed als je een ontwikkeling hebt, een nieuwe woonwijk, een bedrijventerrein, dat je al van tevoren bedenkt van hoe ga ik dat ontsluiten? Hoeveel energie moet er heen? Wat heb ik wel voor nodig? En dat voorkomt een hoop gedoe. Als je dat al in een vroegtijdig stadium A.

SPK_1
integreert in planvorming en B. de gesprekken met de netbeheerders.

SPK_2
Wat zijn kleinschalige uitdagingen voor bijvoorbeeld de individuele huishoudens? En wat zijn de meer grootschalige uitdagingen voor de lokale overheid of de provincie?

SPK_1

Ik zou zeggen de kleinschalige. In Groningen is de provincie waar de meeste energiearmoede is. Het komt er eigenlijk om neer, dat stijgende energieprijzen. Je ziet met name in Oost-Groningen, het zijn vaak wat grotere huizen of slechte huizen, lage inkomens, dat het daarmee wel kwetsbaar is voor prijsstijgingen op het gebied van energie. En dat men vaak ook niet de middelen heeft om daar iets mee te doen.

SPK_1
Er wordt al heel snel gezegd ah leg dan zonnepanelen op het dak. Maar dat vraagt wel een investering en veel mensen hebben niet een paar duizend euro in hun sok zitten. Dus dat is echt wel een uitdaging. Kijk, als Groninger zijn we een energieprovincie, dat is meer om een grotere uitdaging. En hoe laat je bewoners ook profiteren van, dit is echt een Gronings vraagstuk, meeprofiteren van een wat grootschaliger ontwikkeling.

SPK_1
We hebben natuurlijk het gasdossier gehad. Waar Groningen eigenlijk relatief weinig van geprofiteerd heeft, maar wel heel veel last van heeft gehad. De angst is dat dat weer gebeurt met grotere ontwikkelingen. We zijn de provincie na Flevoland met de meeste windmolens. Dus dat is best wel een relevante vraag.

SPK_1
Wat was het tweede deel van je vraag?

SPK_2
Even kijken. Voor de grootschalige uitdaging voor de overheid.

SPK_1
Dus dat sluit eigenlijk aan bij beide vraagstukken zijn grote uitdagingen voor ons. Dus de betaalbaarheid van energie, kwaliteit van de huizen heeft dat veel mee te maken, maar ook met de economische situatie. Dus dat, dat zijn wel de grote uitdagingen. Naast alles wat ik eerder noemde, de planologie.

SPK_2
Ja, nee duidelijk. Top. Dan de laatste vraag alweer. Vooruitkijkend, wat voorziet u als de belangrijkste mijlpalen of benchmarks van het meten van de vooruitgang naar een efficiëntere energietransitie in Nederland?

SPK_1
Ja, dat is best wel... Want je hebt het over efficiënter dus dan zou het sneller moeten gaan. Maar je hebt eigenlijk helemaal geen vergelijk. Dus dat is altijd een beetje lastig om daar dan iets over te zeggen. Nou ja, kijk, ik denk dat je...

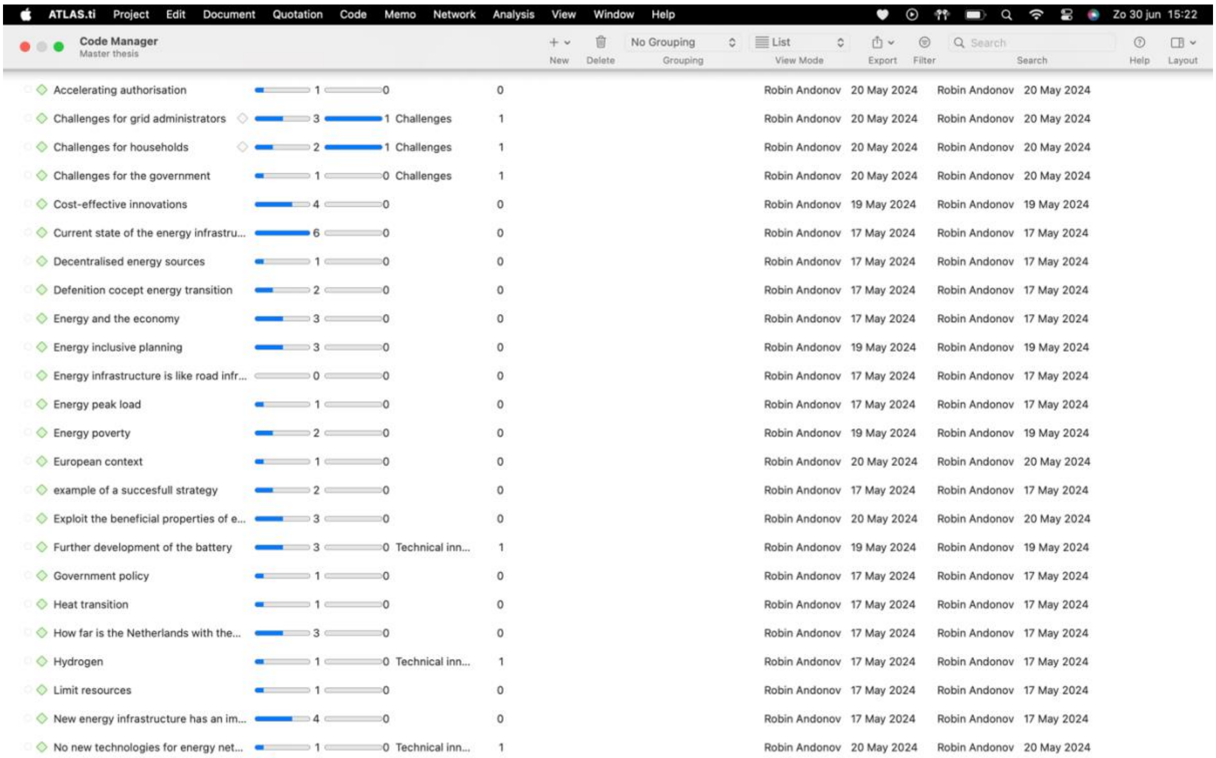
SPK_1
Ja. Ik zit even te kijken voor welke resultaten kun je nou meten. Zegt dat iets over de snelheid van energietransitie? Kijk, het oplossen van netcongestie zou je als parameter kunnen nemen. Maar goed, weet je, ook de benchmark is natuurlijk ook uiteindelijk CO_2-uitstoot.

SPK_1

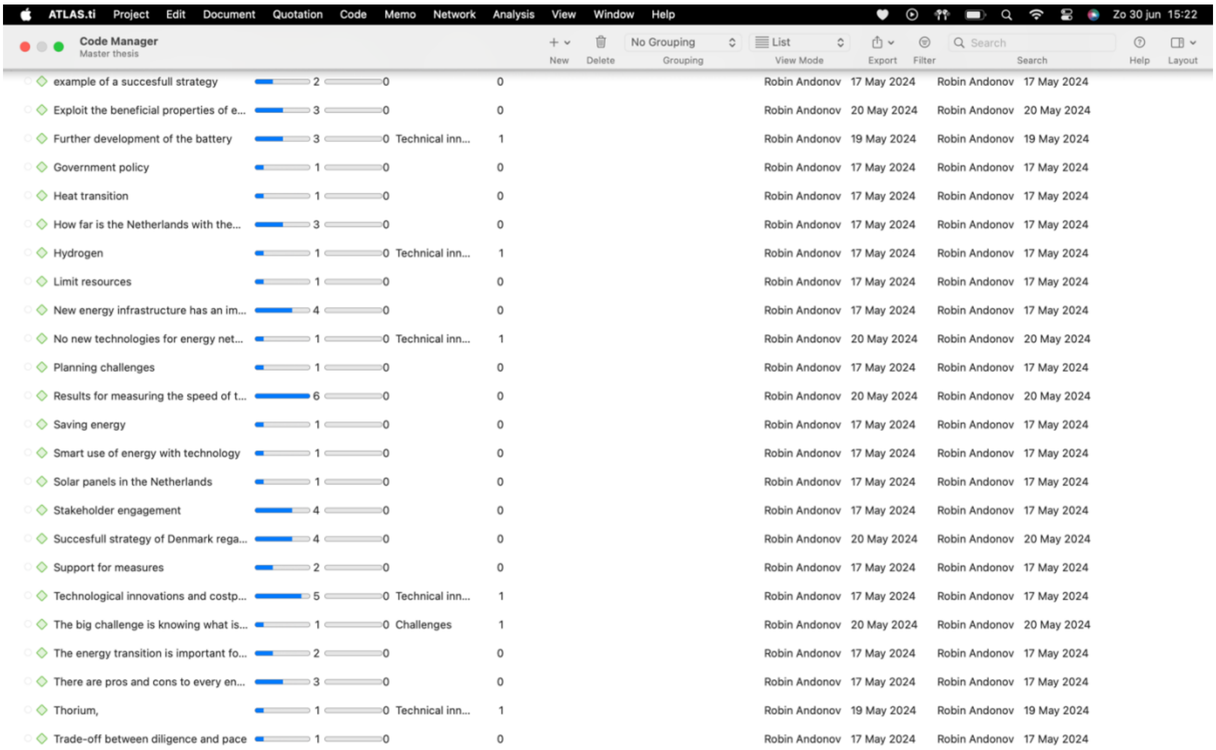
Wat je nu al links en rechts gaat zien, en het zal de komende jaren waarschijnlijk zo nog vaker gaan horen, 2050 moeten we CO2-vrij zijn. Je ziet nu al dat die datum onder druk begint te komen, dat mensen al gaan roepen van 2050, dat weet ik niet hoor. Je ziet dat de warmtetransitie veel minder snel gaat, dus dat de woningen veel minder snel van het aardgas afkomen, dus toch nog langer aardgas gebruiken. Dit soort keuzes zie je nu al. Dus ja, ik denk dat de beste benchmark is van hoe dicht we bij 2050 uitkomen.

SPK_2
Ja, oké. Ja, dat is inderdaad wel een goeie. Ja, dat was het eigenlijk van mijn kant. Dat waren mijn vragen.

Appendix 3 AtlasTI codes used



Accelerating authorisation	1	0		0	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Challenges for grid administrators	3	1	Challenges	1	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Challenges for households	2	1	Challenges	1	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Challenges for the government	1	0	Challenges	1	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Cost-effective innovations	4	0		0	Robin Andonov	19 May 2024	Robin Andonov	19 May 2024
Current state of the energy infrastru...	6	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Decentralised energy sources	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Defenition cocept energy transition	2	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Energy and the economy	3	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Energy inclusive planning	3	0		0	Robin Andonov	19 May 2024	Robin Andonov	19 May 2024
Energy infrastructure is like road infr...	0	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Energy peak load	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Energy poverty	2	0		0	Robin Andonov	19 May 2024	Robin Andonov	19 May 2024
European context	1	0		0	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
example of a succesfull strategy	2	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Exploit the beneficial properties of e...	3	0		0	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Further development of the battery	3	0	Technical inn...	1	Robin Andonov	19 May 2024	Robin Andonov	19 May 2024
Government policy	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Heat transition	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
How far is the Netherlands with the...	3	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Hydrogen	1	0	Technical inn...	1	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Limit resources	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
New energy infrastructure has an im...	4	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
No new technologies for energy net...	1	0	Technical inn...	1	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024


ATLAS.ti Project Edit Document Quotation Code Memo Network Analysis View Window Help Zo 30 jun 15:22

Code Manager
Master thesis
New Delete No Grouping Grouping List View Mode Export Filter Search Help Layout

example of a succesfull strategy	2	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Exploit the beneficial properties of e...	3	0		0	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Further development of the battery	3	0	Technical inn...	1	Robin Andonov	19 May 2024	Robin Andonov	19 May 2024
Government policy	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Heat transition	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
How far is the Netherlands with the...	3	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Hydrogen	1	0	Technical inn...	1	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Limit resources	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
New energy infrastructure has an im...	4	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
No new technologies for energy net...	1	0	Technical inn...	1	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Planning challenges	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Results for measuring the speed of t...	6	0		0	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Saving energy	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Smart use of energy with technology	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Solar panels in the Netherlands	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Stakeholder engagement	4	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Succesfull strategy of Denmark rega...	4	0		0	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
Support for measures	2	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Technological innovations and costp...	5	0	Technical inn...	1	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
The big challenge is knowing what is...	1	0	Challenges	1	Robin Andonov	20 May 2024	Robin Andonov	20 May 2024
The energy transition is important fo...	2	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
There are pros and cons to every en...	3	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024
Thorium,	1	0	Technical inn...	1	Robin Andonov	19 May 2024	Robin Andonov	19 May 2024
Trade-off between diligence and pace	1	0		0	Robin Andonov	17 May 2024	Robin Andonov	17 May 2024