

University of Twente, Enschede

B. Sc. Management, Society & Technology / Public Governance across Borders

The use of AI technology for sustainability

The envisioned meaning and role of sustainable AI in climate political discourses in
Denmark and Germany

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Abstract

The main research question of this Bachelor thesis is “*What is the envisioned meaning and role of sustainable AI in Danish and German climate political discourses?*“ To answer this question, a comparative case study applying a textual content analysis will be performed. This analysis will be based on policy documents from both countries, concerning their AI strategies and climate action policies, as well as their envisioned cooperation of both concepts. The data will be collected via online accessible governmental databases. Documents from the Danish government will be assessed in the English language, while German policy papers will be analyzed in English, as well as in their original form and language. The answer to this question and therefore the relevance of this paper is about showing, how innovative technology can be used to help tackle the climate crisis and enhance sustainable development. It is also about underlining the gap between the envisioned role and actual implementation of sustainable AI in regard to climate action. The findings of this analysis could potentially provide incentives and motivation as guidance for other climate political actors to enhance their climate action by implementing sustainable artificial intelligence into their climate policies.

1. Introduction

1.1. Background

The climate crisis is the biggest threat and the greatest wicked problem of humanity. There is no quick-fix solution, even though urgent climate action is needed to prevent further damage and mitigate its current effects. Multilevel collaborations, adaptation, and innovative solutions are some of the key elements for effectively solving this wicked problem. It is also crucial to incorporate measures to combat climate change into national policy, increase citizen commitment and promote sustainable behavior (United Nations 2022). The European Green Deal, launched in December 2019, is a comprehensive strategy with a set of legislative actions to combat the threat of environmental degradation as a consequence of climate change, make Europe the first climate-neutral continent in the world, and transform Europe into a modern and resource-responsible climate actor (European Commission n.d.). Reaching net-zero greenhouse gas emissions by 2050 is one of the main objectives of the European Green Deal. Sustainable mobility, decarbonizing building heating and cooling systems, as well as preserving and restoring biodiversity, and reducing air and water pollution (European Commission n.d.) are other aspirations set in the EGD. These ambitious objectives require a green transformation and enhanced climate action.

In times of the digital era and the ever-expanding technological opportunities, innovative technology solutions, such as artificial intelligence, can play a significant role in combatting and adapting to climate change. AI can collect and analyze complicated data, generate useful information for planning and decision-making, and enhance processes in the energy, transportation, agricultural, or economic sectors (Gailhofer et al. 2021). Mitigation, adaptation, and resilience are other important areas of climate change AI can have an impact on (Maher et al. 2023) and states need to improve. Hence, the current state of the art is that the entire potential of AI-based solutions has not yet been realized, even though they are win-win-win solutions for politics, business, and society and can contribute to achieving almost all targets included in the UN's proposed Sustainable Development Goals (Zhao & Fariñas 2023). Expectations derived from AI technology in terms of climate action are, that it can upgrade climate action processes and support society in dealing with the effects of climate change. It can therefore be an important factor in tackling the climate crisis, enhancing previous efforts, and offering advanced approaches to the wicked problem, that EU member states are obliged to tackle.

Existing literature provides valuable insights into the benefits and potential that sustainable AI offers for environmental action and protection. However, how states, such as Denmark and Germany, which are both advanced in their technological and sustainable development and

significantly contribute to fulfilling the EGD targets, envision making use of green technology in their sustainable development is not addressed by scholars yet. To investigate how these influential nations seek to innovate and effectively combat climate change or, in which ways their climate policies already include innovative AI technology and how this led the countries to be leading players in climate action would fill this knowledge gap and add to the current state of the art. The assessment of their approaches could also demonstrate to other countries, how climate action can be more effective and enhanced with the use of modern technology, such as AI applications.

1.2. Research Questions

It is known that AI technology has the potential to enhance climate action and have a significant impact on countries' sustainable development efforts. The potential of AI technology in various situations, especially for climate action, has been researched. As new approaches and innovations are needed to solve the climate crisis, it is obvious to use promising technologies such as artificial intelligence to address the problem. There are climate political actors more successful than others in both, addressing the climate crisis and making use of modern, innovative technological approaches. What has not been researched so far is, how and if climate political leaders and technologically advanced actors, such as countries, envision the use the potential of artificial intelligence for their purposes, and whether or not they have been successful in implementing it. The thesis therefore aims to demonstrate, how AI technology can effectively be enforced for climate action and enhance this political discourse. Accordingly, the main research question that will be answered with this analysis is *“What is the envisioned meaning and role of sustainable AI in Danish and German climate political discourses?”*.

Since the analysis looks at the cases of Denmark and Germany, the two countries need to be compared in regard to their envisioned roles of AI implementations in climate policies. The first subquestion is, therefore, *“What are the similarities and differences between Danish and German climate political discourses?”*. This question seeks to identify characteristics, commonalities, and variations of AI implementations in climate political discourses in Denmark and Germany. Potential findings include similarities in goals, differences in political structures, policy approaches, and priorities, as well as variations in political language and shared challenges and opportunities of implementing sustainable AI in climate policies. Those findings will give insights into what has already been achieved and what is still considered a challenge in climate action, for both countries individually. The gained insights can be compared and demonstrated to show the potential of AI applications for climate action.

The second subquestion “*What are the different meanings and roles attributed to sustainable AI in Danish and German climate political discourses?*” is connected to the first subquestion and specifically addresses the individual characteristics of the climate political discourses in Denmark and Germany, as well as their interpretation of the term sustainable artificial intelligence. It explores the potential variations of the term “sustainable AI” and how this concept is applied in different contexts, in this case, the climate political discourses of Denmark and Germany. Differences regarding cultural contexts, technological capabilities, and stakeholder perspectives can be evaluated. Potential challenges and possibilities for promoting green AI on a global scale can be identified by examining its potential disparities in meaning and function.

1.3. Research Approach & Outline

To answer these research questions, a comparative case study between the climate political discourses of Denmark and Germany will be performed. The textual analysis will focus on the meaning of words and interpret them in policy documents about climate politics and AI implementations from both countries. By interpreting the meaning of words, one can answer questions about the envisioned role of sustainable AI in climate political discourses, as asked in the main research question. To give insights into similarities and differences between the two chosen cases, data from both countries will be compared regarding selected aspects, such as instruments, challenges, and objectives of their climate politics, or the areas of use, regulations, and benefits of AI implementation in climate policies. Those aspects will also be applied as codes in a textual coding scheme.

After an introduction to the background of the addressed topic of this Bachelor thesis, the current state of the art and the knowledge gap, that this thesis aims to fill are presented. The posed research question and subquestions are explained, followed by the research approach to how these questions will be answered. In the Theory part, the key theoretical concepts of climate politics and sustainability, as well as the term “sustainable artificial intelligence” as applied in this paper will be described. Favoring arguments for sustainable AI in climate political discourses will be presented. For methodological insights, the cases to be investigated are described and justified. The data collection and analysis processes are explained. The analysis is structured according to the posed research questions. The individual analyses of both cases, and AI implementation in Danish and German climate policies are followed by the comparison of both countries and a final interpretation of the findings. To conclude, the key insights are summarized and discussed for further research. An answer to the research question is provided. Contributions and suggestions for further research are

offered based on what has now been added to the state of the art. The insights are compared to arguments from scholars. The analysis' limitations are presented and a message to policymakers to conclude, what can be learned from this Bachelor thesis.

2. Theory

2.1. Introduction

The underlying theoretical concepts of this Bachelor thesis are the climate political discourse and green technology. The theoretical background also aims to determine whether and how the two concepts can be interrelated, as the main purpose of this Bachelor thesis is to find out, how the implementation of sustainable AI is envisioned in specific climate political discourses. These arguments and insights will give a theoretical answer to the research question “*What is the envisioned meaning and role of sustainable AI in Danish and German climate political discourses?*“. Insights into the climate political discourse will show its relevance and development to climate political decision-making. An investigation will reflect its purpose, as well as the interests and priorities of climate political actors involved in that discourse. It will also show, which challenges emerge that possibly need to be tackled in the cases of Denmark and Germany. The concept of green technology will be introduced to explain its idea and delineation of contents in contrast to the concept of brown technology. The idea of sustainable technology and sustainable artificial intelligence in particular will be explained as a specific aspect of green technology. Due to its increasing importance for transitioning to a more sustainable future, an evaluation of AI’s potential can help to determine, to which extent this potential is already envisioned in practice. To bring these two concepts together, arguments for implementing green AI into climate policies will be presented to underline its role in climate political discourses. These insights can then be related to the selected cases to investigate in the analysis.

2.2. The Climate Political Discourse

A discourse focuses on the interaction of knowledge and power. On one hand, it brings out policy recommendations and messages to political actors (Arnall et al. 2014). On the other hand, the discourse offers a framework responsive to political developments and the implementation of scientific knowledge. Thus, the climate political discourse has a significant impact on how climate policies are developed, how the public supports sustainable development and climate action, and how climate political decisions are made. Additionally, it illustrates the variety of viewpoints, interests, and concerns on environmental action. The discussion drives the search for efficient and long-term answers to the problems caused by global warming. The political discussion of this crisis includes a wide range of subtopics, including those related to sustainable development and environmental preservation. Mitigation and adaptation strategies for dealing with the negative consequences of global heating are on the political agenda of national and international level actors

(Arnall et al. 2014). To solve the global warming issue, involved actors have to find a common understanding. In the case of the political discourse about solving wicked problems, this is a particular challenge because the variety of actors with different perspectives and interests have to find a collective solution. Therefore, the climate crisis and environmental problems have become subjects of discursive struggles and conflicts of interpretation and meaning (Lindseth 2006). Political decision-making is the result of a complex agenda-setting process of multiple actors involved. Before an issue becomes subject to political regulation, it must be framed as a problem that can be solved by political decision-making. In the case of climate politics, there had to be a transformation of the climate catastrophe into an object of routine political regulation (Weingart et al. 2000), to properly address measures and policies. The topics of climate action and sustainable development emerged on political agendas due to their urgency and importance.

Climate politics refers to numerous political measures, regulations, and plans that organizations, governments, and people utilize to address the problem of the climate crisis. A wide range of strategies, such as reducing greenhouse gas emissions, preparing for climate change's effects, and fostering international collaboration on climate policy is included in this concept. Having a plan to address climate change is necessary, given that the consequences are already significant (Giddens 2008). Governments are crucial for carrying out climate politics, as they establish and implement policies to address and mitigate global warming. Because global climate politics is a complex issue that requires various stakeholders and their perspectives, international institutions like the United Nations are important players. Their Framework Convention on Climate Change (UNFCCC) provides guidelines for other climate political actors who aim to implement their climate action framework. The goal of climate politics is not to alter the climate itself, but rather to alter the underlying principles and institutions involved and engaged in climate action (Beck 2010). Understanding how these issues affect international relations as well as how countries and international organizations handle environmental concerns and regulations is significant to the green theory approach. This practice emphasizes how connected global environmental issues are and how vital it is for everyone to cooperate to address them. Additionally, it highlights the potential for environmental NGOs and activist groups to shape environmental policy, promote sustainable development, and push for more equitable and environmentally responsible global governance (Dyer 2018). Humanity's reliance on goods and services, as well as the interests of national governments and businesses, are threatened by climate change. Thus, the complex goals of the political discourse on climate change include promoting qualified decision-making, the creation of policies, and collective action to address the pressing issues forced by climate change. The scope of

the problem depends on both the participants in the debate and recent technological developments that might result in the creation of cures for climate catastrophe (Lindseth 2006).

2.3. The Role of Green Technology

“Technology is bound to be of key importance in combating climate change“ (Giddens 2009, p. 9), as it exceeds human capabilities. Hence, technology is able to solve problems for which human capacity is limited and insufficient. The climate crisis is a problem, that is pushing people to the limits of their capabilities and therefore requires far-reaching solutions. Innovations that are specially developed to address environmental issues, advance sustainability, and reduce the human impact on the environment, are so-called “green technology“ (Soni 2015). Those inventions have “a green purpose“ (Soni 2015, p. 1), as they are intended to reduce greenhouse gas emissions, conserve natural resources and enhance people’s sustainable behavior. Green technologies offer a promising alternative that aims to replace traditional, “brown technologies“, by using renewable resources and lessening their impact on the environment (Shafiei & Abadi 2017). While brown technologies rely on limited natural resources, such as fossil fuel, oil, and coal, and are therefore among the main contributors to global warming (Butlin-Moran n.d.), green technologies use natural resources like solar power, water, and wind to generate energy. Through the utilization of modern technology, renewable energy can considerably contribute to fulfilling basic energy needs (Shafiei & Abadi 2017), and provide climate-neutrally produced energy. Sustainable technologies are crucial for the shift to a low-carbon economy and the development of a more durable environment for future generations and, therefore “an approach towards saving earth“ (Soni 2015, p. 1). That also describes the main role and importance of green technologies. Their main criteria are sustainability, economic viability, and social equity while utilizing environmental technologies for monitoring, evaluation, pollution prevention, and control, cleaning, and restoration. Therefore, sustainable technologies have the potential to contribute to green growth and make the shift from using polluting and harmful technologies. This would not only enhance sustainable development and climate action but also have benefits for a more durable and persistent economy, infrastructure, and energy supply in the future. Sustainable development, that “should meet the needs of society in ways that can continue indefinitely into the future without damaging or depleting natural resources“ (Shafiei & Abadi 2017, pp. 948-949) is closely linked to the purpose of green technology, which is why both concepts complement each other.

One of the most recent technological innovations is artificial intelligence (AI). AI is the kind of information and communication technology that simulates and sophisticates human intelligence

(Nordgren 2022). When used to handle the most complicated issues, it may integrate thousands of computers and resources and provide insights that would otherwise be concealed in unstructured data (Nishant et al. 2020). Therefore, it enables the automation of crucial yet time-consuming and repetitive processes. AI can be defined as a software technology that has the capacity for perception, decision-making and prediction, automatic knowledge and extraction, and pattern recognition (Vinuesa et al. 2020). Therefore, this type of technology can play a crucial role in tackling wicked problems, like climate action and sustainable development. One can refer to this technology as “sustainable AI“ while noting that it has two different interpretations. On the one hand, sustainable AI can be referred to as “AI that is compatible with sustaining environmental resources for current and future generations“ (van Wynsberghe 2021, p. 1). This terminology is about the sustainability of AI applications itself. In this thesis, sustainable AI is discussed and referred to as a technology that addresses issues of sustainable development. According to van Wynsberghe (2021), “the goal is to explore the application of AI to achieve sustainability [...] [and] the United Nations Sustainable Development Goals (SDGs)“ (p. 2). In this regard, AI is seen as a tool to accomplish climate action-related targets, by combining the enormous benefits of AI with the environmental ideals required to reduce carbon emissions and prevent our world from further impact and damage caused by climate change (Cojocea 2022). In the coming years, a wide range of industries, including energy, transportation, agriculture, and manufacturing, will heavily rely on AI-powered solutions to cut waste, pollution, and resource usage (Ariyo 2023). As a result, artificial intelligence has enormous potential to contribute to addressing fundamental societal challenges such as stopping global warming, improving environmental sustainability, and benefitting innovation on economic sustainability (Schoormann et al. 2021). Therefore, green AI can be seen as the expected answer to society’s carbon-intensive activities as it is a promising green technology that can provide contemporary solutions to climate change if implemented to its full extent and potential.

2.4. The Role of Sustainable AI in climate political discourse

AI is able to minimize the gap between science and technology, and policy-making, especially in terms of climate politics. Its true significance for climate politics is in how it supports and facilitates efficient environmental governance (Nordgren 2022). By giving better tools and insights to create more successful strategies and policies, AI can alter how political actors deal with climate change. The key aspects to look at are its usefulness, for example in terms of supporting climate politics, the freedom it leaves to human decision-making, the justice that must be respected, and the responsibility that must be taken when applying AI technology (Nordgren 2022). Green

growth has become an increasingly popular topic in discussions about global policy. It is strongly related to environmental regulations, which are nevertheless sometimes perceived as limiting rather than promoting growth (Jacobs 2012). Environmental measures may stimulate economic growth, especially if they incorporate advanced technical innovations like sustainable artificial intelligence.

Key aspects of the role of sustainable AI in climate political discourse are related to its technological abilities, which exceed human conditions, far-reaching knowledge, and immense capacity for information, data, and software. In the areas of controllability, large data processing, cyber attack prevention, smart grid, IoT, robotics, energy efficiency optimization, predictive maintenance control, and computational efficiency, AI techniques surpass traditional models. New developments in AI technology are revolutionizing several industries (Ahmad et al. 2021). In terms of data analysis, AI can identify patterns, trends, and potential impacts, for example, climate models, socio-economic indicators, or atmospheric measurements. AI-generated information, therefore, provides a scientific basis for climate political debates and policy discussions, and formulations. This information can also be useful for risk assessment and prediction. Forecasting is important to prepare for and deal with extreme climate phenomena, such as sea-level rise, the spread of diseases, or drought, not only for policy-makers but also for potentially affected society. It helps to find optimal strategies and assess the expected impact and extent of events, on the political, economic, and social levels. AI-based solutions assist policymakers in making decisions and formulating policies by assessing complex and interrelated climate-related issues and providing information and knowledge support. They can weigh trade-offs, assess the probable effects of various policy decisions, and recommend practical solutions for achieving sustainable development objectives. Society must adapt to and mitigate climate change. AI supports research and development in order to produce clean energy systems, smart grids, efficient transportation, sustainable agriculture, and other revolutionary technologies. Sustainable AI enables decision-makers, scientists, and citizens to make more informed choices. It also encourages evidence-based policy dialogues and speeds up the transition to a more resilient and sustainable future in the face of climate change issues. Because of these benefits, AI has become an essential tool in the current political dialogue around climate action.

AI is expected to transform global productivity, equality, and inclusion, as well as sustainable development in the short and long term. To ensure its contribution to environmental action, fast-developing AI technology must be backed by adequate regulatory insight and oversight (Ahmad et al. 2021). Currently, institutions lack appropriate legislation and therefore hinder the viability and benefits of new technologies, because they are unable to follow the pace of innovative

science (Ahmad et al. 2021). For technology, such as sustainable AI, which is considered to be a key tool in accomplishing green growth, it is necessary to be provided with adequate policy and legislative frameworks. Depending on the needs and areas for improvement of each country, AI policies and adaptations therein vary. The goal of the governments' AI policies is to maximize the broad benefits of artificial intelligence while drastically decreasing the dangers and harms associated with it. This is important for both society and the economy (Ahmad et al. 2021). In the political discussion surrounding climate change, green AI serves to support and improve decision-making processes by utilizing AI technologies while emphasizing environmental sustainability. The climate political discourse centers around addressing climate change, finding long-term solutions for its negative consequences, and establishing sustainable and renewable development processes, to make the environment durable and resistant for the future.

2.5. Conclusion

The necessity and significance of tackling its effects are what drive the political conversation on climate change. Addressing the issues brought on by global warming calls for intelligent decision-making, the development of policies, and collaborative action. The participation and technology advancements that could potentially provide solutions to the climate dilemma will determine the scope of the discussion. Such a solution is provided by green technology, particularly artificial intelligence. They are essential for the shift to a low-carbon economy, sustainable growth, and climate change mitigation, as they incorporate environmental technologies for monitoring, evaluation, pollution prevention, control, cleaning, and restoration while placing an emphasis on sustainability, economic viability, and social equality. Green technologies can support long-term economic, infrastructure, and energy supply sustainability by evolving away from polluting technologies. To reach environmental goals, sectors like energy, transportation, agriculture, and manufacturing are anticipated to heavily rely on AI-powered solutions. Sustainable AI seeks to maximize AI's advantages while decreasing carbon emissions and the negative impact on the environment that technological advancements take. Future green technology will rely heavily on green AI as it has the ability to offer modern solutions to climate change. It also contributes significantly to the political discourse on climate change by bridging the divide between science, technology, and decision-making. The most important things to think about are how it can help environmental politics, how it works with human decision-making, how important justice is, and how responsible employing AI technology is. By analyzing complicated nature-related concerns and suggesting workable solutions for sustainable development, green AI assists policymakers. In the

face of climate change, AI speeds up the transition to a resilient and sustainable future by enabling informed decision-making and evidence-based policy discussions. Sustainable AI facilitates the creation of long-term solutions for tackling climate change and encouraging sustainable and renewable development in the political discourse on the issue.

3. Methods

3.1. Introduction

This Bachelor thesis aims to answer interpretive as well as comparative questions about the envisioned role and meaning of sustainable AI in two specific climate political discourses, namely, in Denmark and Germany. A comparative case study will be performed as the best-suited research design for this research goal because a comparison seeks to look at two or more units of data, which within a case study design refer to the selected countries' climate political discourses to compare. Reasons for investigating these two countries will be presented, as well as the method of collecting data from these two countries. In relation to these documents, criteria for limiting the amount of data are mentioned and justified. To analyze the gathered documents and get in-depth knowledge about certain aspects, the data will be assessed via content analysis. Its outcomes will be contrasted to discover similarities and differences and to evaluate the significance of these parallels and differences (Given 2008). They will then serve as the basis for interpreting the attributed meanings and roles of sustainable AI in Danish and German climate political discourses in the gathered data. Consequently, the interpretation from the content analysis of this thesis will give insights into the meaning of words mentioned about the implementation of AI technology in climate policies and strategies.

3.2. Case Description and Selection

The objects of analysis in this are the climate political discourses of the EU member states Denmark and Germany. More specifically, their discourses are analyzed regarding the envisioned meaning and role of sustainable AI that policymakers express in selected governmental documents. These countries have been selected as two important and influential member states of the European Union, which, because of their position, also have the potential to be seen as role models for other countries. Denmark is among the most technologically advanced countries (World Population Review 2023a) and is ranked as the most sustainable and environmentally friendly country in the world (World Population Review 2023b). Its position relates to its efforts in environmental protection, which is carried out through governmental services, regulations, and policies that developed environmental protection and restoration procedures. With the most effective regulations for reducing greenhouse gas emissions, clean energy, and sustainable agriculture, Denmark is leading the way in promoting renewable energy and building sustainable transportation (World Population Review 2023b). For both people and municipalities, the Danish government actively encourages the use of technology for sustainable development. They established a long-term goal in

2006, aiming to employ a new energy strategy - for which technological applications are required to be completely independent of fossil fuel and nuclear power (Sovacool 2013).

German policy-making is, compared to Danish governance, often still ideological, rather than proactive in terms of sustainability and climate protection measurements (Richter 2013). Even though the nation is a global leader in sustainable development and technologically even higher advanced than Denmark, it still does not use its capabilities and contingencies to its full extent. The country could make even better use of its extensive technological capabilities by following the example of Denmark and thus make further advances in climate protection with the help of AI. The decarbonization of Germany's economy has advanced significantly during the past decade, and the country is widely regarded as a leader in the field of climate policy. The use of AI in Germany's climate policies might yet be improved in several areas, though. With a combination of fossil fuels, renewable energy sources, and storage technologies, Germany has a large and sophisticated energy system. By forecasting energy demand and supply, controlling energy storage, and coordinating the operation of various energy assets, AI may assist in the system's functioning. Improving energy efficiency is another area where Germany may use AI more in its climate initiatives. Even if there are some programs in this area, such as the "Energy Efficiency Campaign" of the German Federal Ministry for Economic Affairs and Climate Action (n.d.), there is still room for more AI use in this field. Germany might also do more to encourage the creation and application of AI technologies that can help it achieve its climate goals. This could entail policies to encourage the commercialization of these technologies as well as greater financing for research and development of AI technology that could help in decarbonization efforts. Due to their status, capabilities, and influence in the European Union, these two countries are well-placed to exemplify this challenging combination of innovative technology and climate protection and have been selected to make the issue of implementing sustainable AI in climate action plans researchable.

3.3. Method of Data Collection

The main sources of the data will be the online accessible government databases of Denmark and Germany. Here, policy documents regarding the envisioned role and meaning of sustainable AI in climate political discourses in Denmark and Germany will provide the basis for analysis, in the form of policy strategy papers on both climate action plans and AI implementation strategies, as well as governmental statements, laws, agreements, and programs on climate action and the use of AI. Also, governmental reports, proposals, and adjustments for future strategies based on previous policies will be investigated. The amount of available data for both cases will be

reduced in terms of their date of publishing. Only published papers since the establishment of the European Green Deal and the emergence of Artificial Intelligence on the political agenda, namely from 2018 onwards, will be examined. This is because the European Green Deal (EGD) serves as an international guideline for climate politics and is the main document of reference for European member states to base their climate policies on. The technology of Artificial Intelligence just emerged on political agendas in the past few years. Therefore, the data objects of the investigation only focus on the period when AI technology could theoretically be mentioned in climate action policies based on the targets outlined in the EGD.

To reduce the amount of available data not only in terms of date and place as explained above, but also regarding their topics, the concepts of climate politics and sustainable AI will serve as filters like in a coding scheme. Climate politics and AI politics describe the general topic of the data, which will then be assigned to the categories of instruments, objectives, and challenges of climate politics, and areas of use, regulations, and benefits of AI politics. Keywords related to these concepts and potential combinations of both will be used to search for relevant data to examine. Exemplary keywords are instruments, such as AI and ML, challenges like mitigation and adaptation, or objectives, for example, climate neutrality, sustainable development, and renewable energy for the concept of climate politics. Data discussing the concept of AI politics will be scanned with the help of keywords like areas of use, such as climate action, energy or transport, regulations in terms of strategies and legal frameworks, and, benefits of AI implementation in terms of automation and enhancement. Danish policy documents will be retrieved and evaluated in the English language, while German data will be retrieved and analyzed in their original German form and, if available, in English. Hence, two different sets of filters and keywords in two languages will be applied to gather relevant data, pictured in Figures One and Two.

3.4. Method of Data Analysis

The comparative case analysis will use textual data, as research seeks to interpret and understand the meaning of words to gain detailed knowledge and understand what is said and tried to express in written sources. Given the research questions, which aim to interpret and compare climate action and AI-related issues, a content analysis of policy documents related to climate action strategies and AI implementation policies is the preferred technique of data analysis. The content analysis aims to identify recurrent themes and patterns. Therefore, during this analysis, textual data will be classified into such conceptual categories, in this case referring to sustainable AI implementation or climate politics as presented in the coding schemes in Figures One and Two. To

help structure the data and filter relevant passages from the data, a similar technique as will be applied for the data collection will also be used for evaluating the data. As codes present a “link between data collection and their explanation of meaning“ (Charmaz as cited in Saldana 2016, p. 3), the keywords and synonyms, as used in the data collection will serve as these codes to search for the suitable passages and to attribute data content to these chosen criteria of interest for the research. As already mentioned above, the data will be retrieved in English and German. Therefore, a separate coding scheme for each language will be used. The coding scheme for English data is provided in Figure 1, while Figure 2 presents the translated coding scheme in the German language for German data.

The process of applying the codes to the selected data and identifying interesting sections in the textual documents will be done manually, due to a rather small data set and the limited amount of relevant passages to analyze. Besides, in content analyses, it is often an issue of formulation and interpretation, when it comes to identifying applicable arguments and statements, so reading and evaluating the documents manually seems to be more effective than using textual coding software. This way one can make sure that nothing gets lost in translation or formulation. Codes to apply to the concept of climate politics are objectives and goals of climate politics, implied challenges, and applied instruments. For analyzing the concept of sustainable AI implementation, the codes are regulations and strategies, the areas of use for green AI, and their benefits. The filtered data sections, that match the codes and contain information on the topics described by the codes will provide the data basis for the comparative content analyses. The governments’ arguments, strategies, and objectives found in these data sections will serve as the basis to interpret their envisioned meaning and role of sustainable AI in climate politics. Consequently, the content provided in the textual data will be evaluated and interpreted regarding the meaning of words, to answer the main research question of “*What is the envisioned meaning and role of sustainable AI in Danish and German climate political discourse?*“. To analyze the subquestion of similarities and differences between the two cases, aspects mentioned in the coding scheme will be specifically looked at and contrasted by hand. The outcomes of the analysis will also be interpreted in relation to the attributed meaning and role of sustainable AI in Danish and German policies, in particular, to answer the last subquestion.

Figure 1

Coding Scheme in English for Danish and partially German Data

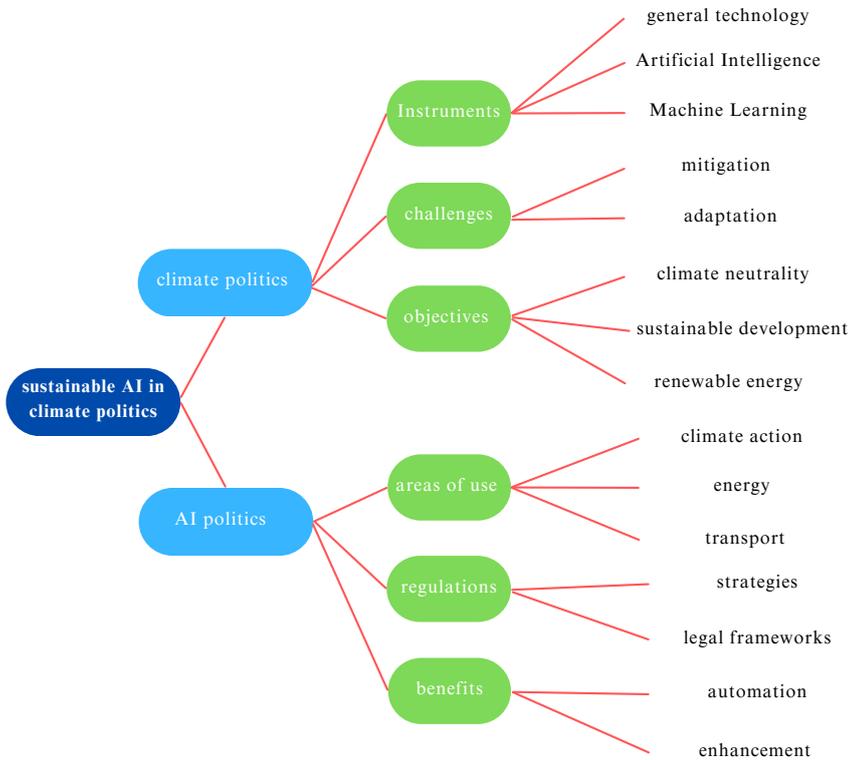
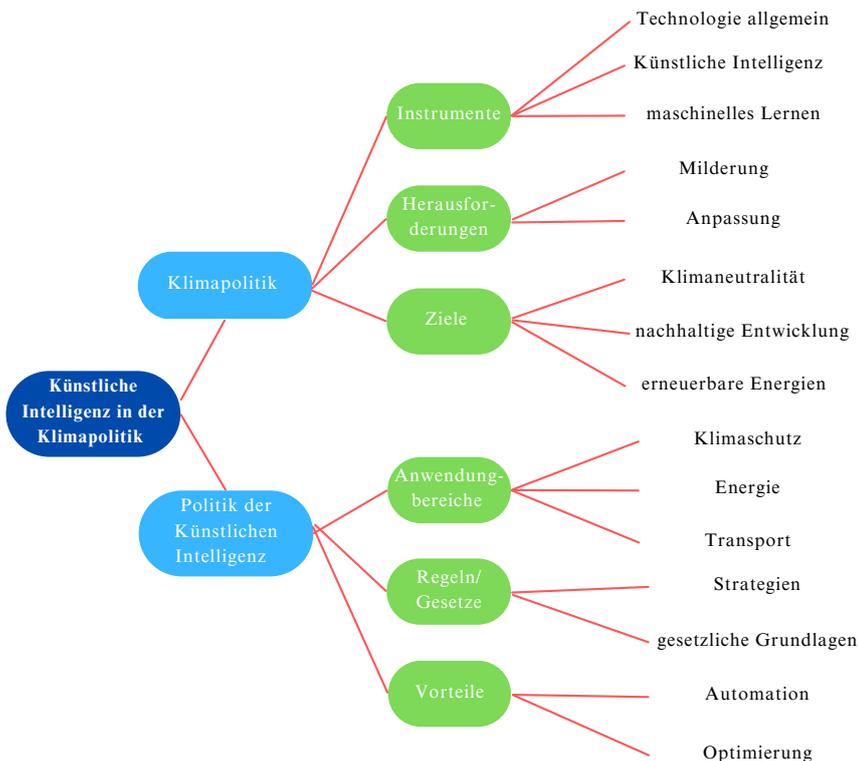


Figure 2

Coding Scheme in German for German Data



3.5. Conclusion

Germany and Denmark are well known for their initiatives of transitioning to renewable energy sources and their ambitious climate goals. To demonstrate how different countries are using this technology and what can be gained from their tactics, a comparison of German and Danish climate policies using AI can be made. The used dataset for this analysis consists of open-access policy documents from the Danish and German governments' databases, published from 2018 until today. The comparative content analysis that will be performed in this thesis seeks to interpret the formulations and intentions expressed in relevant data about the implementation of AI technology in the field of climate political discourses. The coding scheme will be applied to the data, referring to climate politics and AI politics and the most important aspects therein. Keywords will be attributed to relevant data sections. Via content analysis, the filtered data sections will be identified, analyzed, and interpreted. The gained insights will then be used for answering the research questions: to pinpoint characteristics, similarities, and differences between the German and the Danish approach to implementing sustainable AI in their climate policies. Examining the successes and failures of these two countries will help researchers and policymakers identify best practices and areas for development in integrating AI into climate policy.

4. Analysis

4.1. Introduction

The analysis seeks to point out, how sustainable AI is envisioned in both Danish and German climate political discourse, by investigating relevant policy documents and interpreting their meaning of words. Because AI can solve a wide range of societal challenges, including environmental challenges, and can have an impact on climate change and adaptation, energy efficiency, and of course sustainability (Lindberg et al. 2019), the consideration of using green AI in climate action is appropriate. Furthermore, the foundation for a quicker global transition to a greener economy and adaptability is the close connection between technical cooperation, assistance for growth, and climate diplomacy (The Danish Government 2020). Therefore, the aim is to find out what role AI is attributed to in the climate protection of the two countries and whether their climate policy challenges are addressed with the help of sustainable AI. Contrasting both countries' approaches regarding the implementation of green AI in climate policies will reveal, where the countries' put their emphasis on and what this means for their general attitude towards using technology for climate action. Since green technology is in high demand (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019) and offers innovative solutions, interpreting especially the differences between the countries' approaches will give insights into the overall meaning and role of sustainable AI in the climate political discourse.

4.2. Denmark's envisioned role of Sustainable AI in the climate political discourse

Denmark is considered a global leader in terms of sustainable development and climate change mitigation (Energi-, Forsynings- og Klimaministeriet 2018, World Population Review 2023b). Alongside its claim to be "a green [...] nation" (The Danish Government 2020, p. 8), the government highlights the country's knowledge and expertise in green technology solutions. Based on these claims, one would expect the country to make use of its advanced sustainable technology in its climate action policies.

In order to support and "form the basis for a more rapid green transition" (The Danish Government 2020, p. 20), the Danish government will enhance its partnership with technology development (The Danish Government 2020) by creating a "close link between technical cooperation, development assistance, climate diplomacy, and export promotion" (The Danish Government 2020, p. 20). Hence, Denmark focuses on the implementation of the most recent achievements in green technologies, which also include artificial intelligence applications, as they present new opportunities, solutions, and improvements for making the transition from conventional

policies and practices to sustainable and renewable ones. The technological process is considered a contributing factor to this transformation's viability and "made it realistic to envision a scenario in the near future where green solutions can be delivered on commercial terms" (Energi-, Forsynings- og Klimaministeriet 2018, p. 2). Danish climate programs outline specific climate action goals that are intended to be achieved, such as mitigation and adaptation efforts or monitoring and forecasting techniques (Danish Ministry of Climate Energy and Utilities 2020b). AI would be able to accomplish those targets (Maher et al. 2023), but a technological solution to these problems is not yet denoted in the government's general climate policies. Instead, Danish policy papers dealing with climate action and sustainable development about the usage and implementation of green technologies, such as sustainable AI highlight, that those technologies are applied in specific areas that contribute to the green transition goals. The areas that Denmark already put an emphasis on implementing AI technology as "strategically important" (Lindberg et al. 2019, p. 36) for greener solutions are its transport system, the agricultural sector, and the energy industry, (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019).

In Denmark's National AI Strategy, it is stated, that AI will play a role and be part of green transport initiatives (Danish Ministry of Climate Energy and Utilities 2020a, Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019). Denmark's digital solutions for sustainable transport include electric cars and autonomous driving approaches (The Danish Government 2018), which are beneficial for the environment in several ways. Reduced greenhouse gas emissions and consequently less air pollution, together with an increased energy efficiency of those cars, are the key advantages. In addition, solutions for autonomous and electric vehicles can improve traffic flow through better logistical planning. Traffic congestion can be lessened with the use of AI-driven algorithms that optimize routes and minimize unnecessary cruising and braking. As a result, there is better traffic flow, less fuel use, and pollutants. Consequently, sustainable mobility services require an enhanced intelligence system to be efficient and effective. AI is not only used for actual mobility but also for the facilities around sustainable transport options. AI is meant to create tools that can identify patterns in sounds, vibrations, or temperatures for better maintenance of electrical plants. Then, based on AI-generated data, one may forecast when a given item deviates from the norm and needs to be replaced or maintained (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019). As this releases resources and improves citizen behavior monitoring, the Danish government expects sustainable AI in Danish transportation solutions to support green mobility and citizen adaptation to sustainable mobility solutions.

Because the Danish agricultural sector has constantly kept being up to date with new technologies and used them for smart farming (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019), it claims to be one of the “most efficient in the world“ (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019, p. 66). The country emphasizes staying among the leading nations in terms of agriculture and believes, that “Artificial Intelligence can be used to support the development of precision agriculture in order to continue sustainable agriculture in Denmark“ (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019, p. 62). This assertion demonstrates that, on the one hand, AI is intended to significantly advance this area of sustainability, and that the agricultural sector is one of the key industries for AI deployment. On the other hand, this statement underlines the absence of a clear plan for employing green artificial intelligence. An example of a specific deployment of sustainable AI in the agriculture sector would be the “intelligent irrigation“ project, mentioned in Denmark’s national AI strategy. In this project, the technology is envisioned as a method to control field irrigation and predict irrigation needs based on weather data (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019). Farmers can fertilize and spray precisely where yields may be increased and weeds are emerging because of AI's ability to organize, analyze, and apply complex information. As a result, AI in agriculture is particularly valuable for effective water management, crop production monitoring, and precision agriculture. This improves resource use, productivity, and environmental impact while also contributing to more sustainable and resilient farming techniques, that are aimed for by the Danish government.

Another main contributor that has a significant impact on Danish climate action and sustainable development is its energy system. With an impactful production of environmentally friendly products and services in the energy industry, Denmark claims to have a strong point of departure for further improvements toward a completely green energy supply (Danish Ministry of Climate Energy and Utilities 2020b). Furthermore, the country announced climate agreements on the green transformation of the energy sector (Danish Ministry of Climate, Energy, and Utilities 2020a), for which the application of AI is essential (Ministry of Finance & Ministry of Industry, Business, and Financial Affairs 2019). Despite the emphasis put on a green energy transition and the use of smart technology for enhancement, the government does not mention a specific approach to accomplish its goal. However, the Danish Energy Agreement also states that a professional and efficient energy sector is the basis for the transition to a sustainable green society (Energi-, Forsynings- og Klimaministeriet 2018), which also entails the integration of renewable resources, as well as efficient energy consumption. Although AI is known to be able to contribute to such

objectives, Danish policy papers are aware of the potential but lack specific strategies on how to make use of sustainable AI in the energy sector. Danish climate-related policies emphasize the use of artificial intelligence especially in sectors related to sustainable development and green growth, like the transportation, agricultural and energy sectors. Their envisioned role for AI applications lies in enhancing an already developed state of the art, mainly for keeping Denmark's sustainable and technological development on a high level and expanding that for even more progressive advancement in both climate action and technological progress.

4.3. Germany's envisioned role of Sustainable AI in the climate political discourse

Germany, just like Denmark, is a leading European Union member state regarding climate action, but foremost in technological advancement and innovations. So, Germany is also expected to make use of its standing and capabilities, especially when addressing global problems in policies and political discourses. The country would be able to use existing technology effectively, for example for climate protection and sustainable development. The assessment of policy documents related to Germany's climate action plans and AI implementation plans reveals, that the country is aware of its potential in terms of the use of artificial intelligence in the field of climate protection and "wants to reconcile economic, social and environmental interests with an effective research and innovation policy guided by sustainable development" (Deutscher Bundestag 2023a, p. 28¹). A "consistent use of the opportunities of digitalization", the government claims, "forms the basis for a free, sustainable, and resilient society today and for future generations" (Deutscher Bundestag 2023a, p. 28¹). This statement highlights, that being technologically preeminent is the goal in order to maintain economic success while also increasing climate protection and people's adaptability. Hence, the focus of German climate action is on staying economically efficient, rather than technologically innovative climate action.

German policy documents on AI and climate politics emphasize the country's potential in that regard, while not offering concrete approaches for implementing sustainable technology anyway. Instead, it is pointed out, that "the technologies and concepts for climate-neutral industry, resource efficiency, [...], renewable energy [...] and sustainable mobility of the future" (Deutscher Bundestag 2023a, p. 29¹) are urgently needed to realize the government's objectives. As soon as achievable, technologies should be put into practice, according to the future strategy for research and innovation, announced by the German government (2023a). Despite its capabilities, the government does not specifically envision AI for these targets and formulate their implementation vague without concrete strategies. At the same time, the German government states that, for

example, the development and application of forward-thinking analytical and data processing techniques like machine learning and artificial intelligence in sustainability-related areas, such as biodiversity, and climate research can offer novel insights and a deeper comprehension of the components and interactions of the Earth system (Deutscher Bundestag 2023a).

However, Germany puts a stronger emphasis on research and evaluation of AI's potential for sustainable development than the actual application of such technology in the field of climate action, by funding and promoting promising, innovative, and transformative areas, such as artificial intelligence, sustainable mobility and environmental and climate technology (Deutscher Bundestag 2023b). The governmental funding initiative "KI-Leuchttürme" (AI lighthouses) (Deutscher Bundestag 2023c, p. 36) encompasses 15 projects using artificial intelligence-based techniques to compile models, data, and forecasts of environmental conditions (Deutscher Bundestag 2023c, Die Bundesregierung 2019). An example of such a funded research project is called FutureForest. In this project, AI is used in forest condition analysis, evaluation of future forest development, and decision preparation for climate-adapted forest conversion. The goal is to build "forests of the future" using AI-supported advice for where to plant specific tree species or forest kinds. Data on tree species composition and vitality, soil condition, pest development, and climatic data are collected, harmonized, and analyzed utilizing AI, to design a forest ecosystem capable of coping with the difficulties of climate change (Die Zukunft-Umwelt-Gesellschaft GmbH n.d.a). A project focusing on AI-based adaptation of cities to climate change is called I4C, short for Intelligence for Cities. Since urban areas are particularly vulnerable to the effects of climate change, it is necessary to counteract threats like extreme weather events. The I4C project's goal is to create an AI-based 3D city model that includes weather and climate prediction and identifies demographic groups, trees, and structures that are more sensitive to heat stress, floods, and storms. Machine learning approaches are utilized to adapt the weather forecast model to actual climatic patterns, as well as for prediction and causal analysis. The findings can be used to develop planning, policy, and legal strategies to improve cities' adaptability to catastrophic occurrences (Die Zukunft-Umwelt-Gesellschaft GmbH n.d.b). The government funding initiative shows, that artificial intelligence is indeed intended to contribute to and be used for climate action and sustainable development. However, according to the German government, the potential of artificial intelligence applications is first to be studied and evaluated, before being put into practice or implemented in climate action policies, to be able to utilize the potential of AI to the fullest extent possible (Deutscher Bundestag 2023a).

Despite the primary emphasis on research and optimizing sustainable AI before implementing it, German climate and AI policies already envision areas in which the application of artificial intelligence can benefit society and climate. To build a sustainable and resilient society, opportunities provided by digital technologies are envisioned to be consistently utilized and updated (Deutscher Bundestag 2023a). The ministries of areas in which digital applications are implemented are requested to routinely evaluate the impact and the advancement made with sustainable AI by the research practices indicated previously, in order to discover and prevent unfavorable developments at an early stage (The Federal Government 2018, 2020). In its AI Strategy, the government explicitly states that AI is envisioned to be used for achieving sustainable development (The Federal Government 2018). “The issues of [...] environmental and climate protection [...] take center stage in the initiatives“ (The Federal Government 2020, p. 9) to fulfill those goals, as the government wants to ensure, that technology benefits humans and its development is also aligned with the SDGs. “There are concrete opportunities in the application fields of renewable energies and energy systems, energy efficiency, resource conservation and recycling, water protection, and water management [...], nature conservation and mobility“ (The Federal Government 2020, p.15). Thus, the main areas in which green AI is envisioned to contribute to climate protection and sustainable development are related to the energy sector, agriculture, transportation, and adaptation and mitigation support.

For example, in the agriculture sector, AI systems are envisioned to produce patterns and models based on smart measuring methods, for example for optimizing watering systems. Hence, sustainable AI can be used for monitoring the ecosystem and researching improving plant and animal welfare, as well as biodiversity (The Federal Government 2020). This vision relates to the government’s funded project FutureForests, which shows, that an emphasis is put on landscape protection. In the mobility sector, AI is envisioned to improve road safety and design and support sustainable transport systems. Especially automated driving is perceived as a pillar of Germany’s competitiveness in terms of the development and implementation of sustainable AI (The Federal Government 2020). AI should help automate and liquefy traffic and enable innovative forms of mobility and contribute to automated driving, also in the logistics sector. This will help to reduce emissions and optimize logistics (Deutscher Bundestag 2021, 2022).

It is claimed that utilizing artificial intelligence will offer prospects for improving and achieving sustainability. Through research and innovation, it is intended to fully realize the potential of technological advancements to address urgent environmental issues and transformative problems (Deutscher Bundestag 2023a). Therefore, one can note that the potential of artificial intelligence in

the field of climate protection and sustainable development has been recognized. However, taken from the documents, Germany's strategy is to first research and evaluate risks, chances, and opportunities of implementation, before making use of sustainable artificial intelligence in the climate sectors.

4.4. Comparison of the countries' envisioned roles of Sustainable AI for climate change

The first commonality between Denmark and Germany, which is also one reason for investigating and comparing the two countries in this analysis, is that they are both leading in terms of their climate actions, and technological advancements (World Population Review 2023a, 2023b, Energi-, Forsynings- og Klimaministeriet 2018), and future goals of improving these two aspects (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019, Deutscher Bundestag 2023a). Both countries propose future climate action be enriched by technology, as it provides new opportunities and can enhance sustainable development. The Danish government claims, that "Artificial Intelligence can help maintain [its] leading position and strengthen the green transition" (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019, p. 65). It is communicated in Germany's AI strategy paper, that the country wants "to utilise the potential of AI for sustainable development and thus to help achieve the sustainable development goals in the Agenda 2030" (The Federal Government 2018). It follows that the two countries are also well-equipped and capable of implementing green technologies into their climate policies and sectors that are related to climate action and sustainable development. Denmark and Germany both already inhabit an advanced status quo in terms of their climate actions and technological achievements compared to other European Union member states and global climate political actors. The two countries are both also aware of their progressed position and based on that, aware of the associated opportunities regarding the implementation of green technologies for climate action and sustainable development (Danish Ministry of Climate Energy and Utilities 2020b, Deutscher Bundestag 2023c). Since green artificial intelligence, in particular, is capable of solving problems that push people to their limits, and this type of technology is already well developed in both countries, AI can be effectively planned for Denmark's and Germany's climate protection plans. The usage of digital technologies and sustainable AI is already envisioned in both climate policies, although at different conditions and to different extents. However, the main climate-related fields in which green AI is envisioned and already implemented, are similar in the two countries. For both, the most potential for making use of AI for climate action is seen in the energy, agriculture, and transportation sectors

(The Federal Government 2018, Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019).

In terms of agriculture, both Denmark and Germany emphasize that sector, due to its importance and significance for society and the climate. AI is intended to contribute to smart farming through intelligent systems to support farming, enhance watering systems, detect irrigations, and offer preventive solutions, as well as better use of limited resources for farming. For the energy sector, both countries envision sustainable AI to improve energy efficiency and establish new forms of renewable energies, as well as enhance the already existing systems and technologies. In both countries, this sector is the biggest and most significant field of action for Sustainable AI. It has the biggest impact on the climate, and therefore the biggest potential for advancements and positive influence. Denmark and Germany both launched “initiatives contributing to a green transition of the industry through energy efficiency improvements“ (Danish Ministry of Climate Energy and Utilities 2020a, p. 1, Deutscher Bundestag 2023a). The sector closest to people and hence, also closely related to issues of adaptation to climate change effects, is the transportation sector. In this area, sustainable AI is supposed to offer “digital solutions for electric cars, driverless cars“ (The Danish Government 2018, p. 10), and green mobility options (The Federal Government 2020). Apart from the transportation field, Denmark and Germany both have plans for climate change mitigation and adaptation with the help of sustainable AI. While other approaches focus on the industry and economy, these plans are meant to directly benefit society and help adapt to climate change and assistant technologies such as AI.

On the opposite side, not all aspects of Denmark’s and Germany’s envisioned role of sustainable AI in their climate action policies are alike. Denmark implemented its AI strategies earlier than Germany (Ahmad et al. 2021, p. 4), which led to an earlier application of sustainable AI in various sectors, such as climate action and sustainable development. Furthermore, Denmark focuses on implementing AI for further growth, and development and keeping the already high-status quo, as “AI helps maintain Denmark’s leading position and strengthen the green transition“ (Ministry of Finance & Ministry of Industry, Business and Financial Affairs 2019, p. 65). This shows that Denmark’s focus is, next to further improve climate action with digital technologies, also on defending its standing among other climate political actors. Denmark will likely focus on offering solutions and efforts to the rest of the world because of its high standards, which will have a greater impact on the world due to its greater impact in terms of global emissions (The Danish Government 2020). This shows, that Denmark puts its narrow focus on strengths in terms of its AI strategy. Germany on the other hand, focuses on research and testing processes, to

compromise and estimate possible risks and harm that the implementation of sustainable AI could cause. Even though in German policy documents, many fields for possible AI applications are listed, there are no concrete approaches for using these technologies mentioned. This underlines the different attention that Germany is paying to the capabilities of sustainable AI. While Denmark already applies technologies and has established a strong framework for green AI applications in climate-related fields, Germany is still in the process of building the foundation of AI implementations for climate action.

4.5. Attributed meanings and roles to Sustainable AI in climate political discourses

Based on a comparison of Denmark's and Germany's envisioned meanings and tasks, one may now assess the assigned meanings and roles of sustainable AI in their respective climate political discourses. Even though both countries are major climate political actors, they attribute different roles and meanings to green AI applications in their climate political discourses.

Denmark recognizes AI's potential in addressing climate change and contributing to sustainable development. In its climate action papers and AI strategies, Denmark prioritizes its competence in green technology solutions and claims to be striving to incorporate advanced sustainable technology into climate action programs (The Danish Government 2020). This underlines the government's aim for a stronger collaboration between the government and science and demonstrates, that the theoretical potential of AI to reduce the divide between science and political decision-making is assigned to sustainable AI implementations in Denmark. Further, taking scientific and technological knowledge and innovations into account when designing new political approaches and strategies demonstrates Denmark's informed decision-making approach. As making qualified decisions is a major goal in political discourses and especially in climate political discourses, where it is about the interaction of knowledge and power, AI gets a powerful role of serving as a crucial source of information to base political decisions and actions on. Besides, the Danish government highlights the importance of maintaining and advancing Denmark's sustainable and technological development (The Danish Government 2020). In this aim, the attributed role of sustainable AI is to support efficient environmental governance by ensuring to make efficient use of the technology for the country's further development.

For concrete implementations of sustainable AI in Danish climate action plans, the country focuses on using AI in the transportation, agriculture, and energy sectors, which shows that the potential of green AI applications has not only been recognized but also integrated into climate action plans. This displays, that artificial intelligence is not only theoretically able to alter how

political actors deal with climate change (Nordgren 2022), but that this technology has already impacted Danish climate action and that the possibilities offered by AI are taken into question when addressing climate-related problems in political strategies. Overall, most theoretical expectations derived from sustainable AI in the context of climate action and sustainable development apply to Denmark's envisioned role of sustainable AI in its climate political discourse. Green technology's ability to solve complex issues is recognized by the government and intended to be used to solve its climate problems. The country is aware of the power that AI holds and also aware of the advanced position that Denmark has regarding the development of AI technology. So, the attributed role of sustainable AI in the Danish climate political discourse is to maintain current points of departure, but also to expand and build from this to achieve innovative technology-supported climate action.

Germany has a different focus and, as a result, a different envisioned role for green AI in its climate policy discourse. Although Germany, like Denmark, recognizes the overall potential of AI and the country's ability to benefit from that potential for climate protection and sustainable development, the country's focus is mostly on study and assessment, rather than concrete implementation of green technologies. This demonstrates that technology is not given the same executive power as it is in Denmark, even though the capabilities of artificial intelligence are expected to support efficient environmental governance and potentially solve the government's climate change issues. In Germany, it seems like AI does not get to impact climate action to its full potential, due to no specific attributed targets. While there is still a gap in the actual implementation of sustainable AI in sustainable development strategies, the gap between science and technology and, political decision-making gets closed, especially with Germany's heavy focus on evaluating potentials, risks, and limitations of green technology. Since actual artificial intelligence applications are not predominant in German climate action policies, the extent to which these implementations already influence general climate political decision-making and policy agendas on sustainable development is limited. It follows that the main intention assigned to sustainable AI in the German climate political discourse seems to be the bridging of scientific research and political decision-making and therewith contribute to informed agenda-setting. As making qualified decisions is preminent in political discourses and these discourses are also about the interaction of knowledge and power, green AI gets to enhance governmental work and judgments related to climate action and sustainable development by providing founded insights about its capabilities. However, unlike in Denmark, AI does not seem to have the same ability to impact how political actors deal with climate change, due to a different focal point when it comes to green technologies and the lack of practical experience in using sustainable AI for climate actions, that could demonstrate its potential

for further implementations.

4.6. Conclusion

The main similarity between Denmark and Germany as climate political actors is that both are technological and climate action leaders. They claim to be able to integrate green technologies into their climate policy and are aware of the possibilities of technology, especially artificial intelligence, to improve sustainable development. Both nations envision the use of digital technologies and sustainable AI in their climate policies, particularly in the energy, agriculture, and transportation sectors, because they have advanced positions compared to other European Union member states and are aware of the opportunities associated with implementing green technologies. AI in agriculture is viewed as a tool for resource optimization, bettering irrigation systems, and smart farming. Sustainable AI in the energy sector aims to raise awareness of renewable energy sources and increase energy efficiency. A focus area for sustainable AI is the transportation industry, which offers solutions for driverless cars, electric vehicles, and green mobility alternatives. Denmark prioritizes retaining its leadership position and accelerating the green transition. It has adopted AI procedures earlier than Germany. On the other hand, Germany strongly emphasizes research and testing procedures to evaluate any risks or effects connected with the application of sustainable AI. Germany is still laying the groundwork for AI deployment in climate action, but Denmark has already deployed sustainable AI in domains relevant to climate change. Denmark allocates a more active and significant role to sustainable AI in its political discourse on climate change, using technology as a tool to address climate-related issues and advance technical progress. Conversely, Germany places more emphasis on weighing the advantages, disadvantages, and possibilities of green technology, with greenAI enhancing governmental work and decisions connected to climate change and sustainable development.

5. Conclusion

5.1. Answer to the main research question

To answer the main research question “*What is the envisioned meaning and role of sustainable AI in Danish and German climate political discourses?*”, a textual analysis of relevant policy documents has been performed. This content analysis revealed, that in both countries, green technologies and hence, sustainable AI is envisioned to support, improve and ease the countries’ sustainable development and climate action. Key insights from the analysis, however, are, that Denmark and Germany prioritize different aspects and see different potentials in implementing sustainable AI in climate policies. Denmark’s approach to climate-neutral artificial intelligence is proactive, stating its enhanced technological development and highlighting its contributions to the progress of becoming a climate-neutral nation. Several sectors that impact the environment and therefore, are of interest to undertake a green transition already make use of sustainable AI. These sectors are namely, transportation, agriculture, and the energy sector. There, the main roles of sustainable AI are, to solve problems that exceed human capabilities and support efficient environmental governance. In Germany, green AI and its potential are rather an object of research, than tools for climate action. The focus lies on calculating risks and opportunities. This does not contribute to climate action directly, but still minimizes the gap between science and politics, which is beneficial for the governments’ informed decision-making and enriches the climate political discourse. Proposed areas of use for sustainable AI in German climate action are comparable to Denmark also transport, agricultural, and energy sectors. Governmentally led or supported research on sustainable AI also focuses on applications and strategies in these three sectors. Additionally, mitigation and adaptation plans are on Germany’s agenda for sustainable AI, since an emphasis is also placed on society’s alteration and behavior change regarding sustainable thinking and acting in an environmentally conscious manner. Even though Denmark and Germany have different policies, strategies, and priorities when it comes to using AI for climate action, both countries see the potential of green technologies and especially green AI to be of importance in order to fulfill their climate goals. Consequently, sustainable AI is envisioned to support and influence climate political acting and assist with effective environmental governance in both countries.

5.2. Contributions and Limitations

A lack of research on how states envision sustainable AI to contribute to climate action and sustainable development was defined as the knowledge gap. This gap has been filled with this

analysis, as it provides an evaluation of both Denmark's and Germany's climate action policies and the meaning and role attributed to sustainable AI in this context. The two countries' relevant policy papers have been assessed with regard to their AI-supported climate action strategies. Similarities and differences thereof have been evaluated and compared, to determine progress, points for improvement, and challenges for implementing sustainable AI in national climate action policies. An analysis concentrating only on states as climate political actors is a contribution to the state of the art and shows, that nations are also powerful political players in matters of climate and the environment. As they are obliged to fulfill the targets of the European Green Deal, their approaches are of special interest to other climate political actors aiming to do the same.

The analysis' findings support some of the scholars' statements of discursive struggles and interpretive conflicts, as well as the evolution of climate politics. According to Lindseth (2006), there are now debates and misunderstandings around climate catastrophe and the solutions being proposed. In addition to highlighting diverse ways to adopt green technologies, the analysis of the climate political discourses of Germany and Denmark also emphasizes that various actors have various objectives when addressing the threat of climate change. The aim of climate politics, according to Beck (2010), is to change the fundamental beliefs of climate action. This proposed shift is made possible by the use of sustainable AI, which has the potential to change how political actors on the climate address their tactics in the future. Despite Jacobs (2012) claim, that environmental regulations may sometimes complicate green growth, the analysis results and interpretations highlight, that sustainable technology such as sustainable AI enriches and enhances climate action if implemented in climate policies to its full potential. It is shown, that green AI displays an innovative solution to the climate crisis and can support climate policies that aim to realize the green transition.

The fact that this analysis only concentrated on the envisioned meaning and role of sustainable AI in Danish and German climate political discourses, as well as similarities and differences therein can also be seen as a limitation to general research on sustainable AI in climate action. The content analysis was solely concerned with the meaning of words. Technical backgrounds, practical performances, and whether or not the envisioned implementations are realistic are beyond the scope of this analysis. Since AI is also a rather innovative topic on political agendas, there are no insights on recent evolvments or changes to using sustainable AI in climate action. Gained insights rely on recent and current states of the art and do not picture the reasons for and against considering green technologies for sustainable development.

5.3. Discussion of practical implications

Given the insights gained from the analysis performed in this thesis, there are different practical implications for both the Danish and the German governments as climate political actors concerning their envisioned implementations of sustainable AI. Since Denmark is already progressed in using green AI for sustainable development, German policymakers can learn from their course of action. Germany could make the shift from researching and weighing risks and opportunities to implementing and improving sustainable AI as it is in use. This would turn German climate action from being reserved and observing to being proactive and more innovative. Therewith, green technology would benefit the environment and its protection, as it is currently mainly beneficial for research purposes, even though this research brings scientific knowledge closer to political decision-making. Denmark on the contrary, could focus more on research on green technologies and especially green AI, to profit from founded scientific background knowledge when creating climate action plans. This would enhance the interaction of knowledge and power and enrich the climate political discourse in Denmark, as more research results and scientific information could be taken into account when addressing sustainability topics.

By drawing lessons from Denmark's and Germany's approaches to considering sustainable AI as a tool for climate action and sustainable development, other climate political actors can learn from their progress and fasten their green transition. The main points to learn from are the implementation of innovative technological solutions in sectors that impact the environment the most and where a green transition would therefore have the most significant outcome. Such sectors are, as Denmark's and Germany's policy papers address, the transportation, agriculture, and energy sectors. Furthermore, climate political actors can learn from investments in research and innovation and emphasize similar investments by funding research projects and encouraging collaborations that use sustainable AI for climate-related projects. This is closely connected to the argument for making data-based and informed decision-making a priority. Germany and Denmark have already realized the importance of data and analytics in guiding climate policies. Policymakers may learn from massive data sets, enhance climate modeling, and take more informed decisions by utilizing sustainable AI technologies. Real-time data collection and analysis can be improved by integrating AI systems into monitoring and reporting processes, enabling more effective climate action. Above all, climate political actors can recognize, that artificial intelligence is a powerful tool for tasks that exceed human capabilities and wicked problems, that need a solution. Hence, acknowledging this potential and using it to its full extent can alter how climate action is addressed in the future.

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Appendix

Data

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Translated Quotes German - English

„Die Regierung möchte mit einer wirkungsvollen Forschungs- und Innovationspolitik, die sich an einer nachhaltigen Entwicklung als Richtschnur orientiert, wirtschaftliche, soziale und ökologische Interessen in Einklang bringen.“ (Deutscher Bundestag 2023a, p. 28) translated in “The government wants to reconcile economic, social and environmental interests with an effective research and innovation policy guided by sustainable development.” in chapter 4.3 Germany’s envisioned role of Sustainable AI in climate political discourses on page 22.

„Eine konsequente Nutzung der Chancen der Digitalisierung bilden die Grundlage für eine freiheitliche, nachhaltige and resistente Gesellschaft von heute und für künftige Generationen.“ (Deutscher Bundestag 2023a, p. 28) translated in “Consistent use of the opportunities of digitalisation forms the basis for a free, sustainable and resilient society today and for future generations.” in chapter 4.3 Germany’s envisioned role of Sustainable AI in climate political discourses on page 22.

„Wir brauchen schnellstmöglich die Technologien und Konzepte für eine klimaneutrale Industrie, den effizienten Einsatz von Ressourcen, zirkuläres Wirtschaften, eine auf erneuerbaren Energien beruhende Energie- und Wärmeversorgung, klimaneutrale Brennstoffe und die nachhaltige Mobilität der Zukunft.“ (Deutscher Bundestag 2023a, p. 29) translated in “We urgently need the technologies and concepts for climate-neutral industry, resource efficiency, circular economy, renewable energy and heat supply, climate-neutral fuels and sustainable mobility of the future.” in chapter 4.3 Germany’s envisioned role of Sustainable AI in climate political discourses on page 22.